Guidelines for

Good Industry Practices
LPG Cylinder Filling

WLPGA

The World LPG Association

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

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

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

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Guide to Good Industry Practices

LPG Cylinder Filling

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Chapter One

Background

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

The two WLPGA Guidelines – Good Business Practices
(http://www.wlpga.org/wp-content/uploads/2015/09/wlpga-businesspractices-2011-2.pdf)
and Good Safety Practices
(http://www.wlpga.org/wp-content/uploads/2015/09/wlpga-safetypractices-2011-2.pdf)
have been used extensively during the last ten years all over the world to provide guidance across all areas of the LPG industry.

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

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

The first of these Guides covered the important subject of *LPG Cylinder Management* (http://www.wlpga.org/wp-content/uploads/2015/09/guide-to-good-industry-practices-for-lp-gas-cylinder-management-2.pdf). This Guide addresses the life cycle of a LPG cylinder from acquisition through to disposal.

This latest Guide, *LPG Cylinder Filling*, focuses on some of the important issues that need addressing when considering the decision to invest in assets to fill LPG cylinders. There are many choices available. From simple manually operated filling plants to fully automated ones.

There are filling plants that are designed to fill just a few cylinders an hour to ones that can handle several thousand. Some plants are designed to be permanent fixtures and require significant investment but there are other more flexible options, that are designed in containers, that can be located and moved on as the demand for LPG cylinders grows.

This *Guide to Cylinder Filling* addresses some of the key issues to consider in the decision-making process to select a filling plant that meets the current, and future, needs of the market.
These include size and location of market demand, size of cylinders to be filled, valve type, available land and whether cylinder filling is to be considered for other third parties.

There are several Appendices that are included in the *Guide to Cylinder Management* that are relevant for this Guide and so they have been repeated here for convenience.
The information in this document has been gathered from globally recognised sources, LPG Standards and Codes of Practice, as well as using best practices from major LPG companies. It is recommended that these guidelines be applied, in conjunction with any local laws, standards or regulations, to enhance the overall safety performance of the LPG business.

Chapter Two

Introduction

LPG cylinder filling plants vary considerably in size, complexity and layout. The type and size depends on such factors as maximum potential throughput requirements, size and type of cylinder filled and the number/grades of products handled. The land available and budget are of course two other important factors when deciding on the investment.

The detailed design of filling plants, and the associated cylinder filling equipment, should be undertaken by an appropriate supplier based on the required performance specification. Some suppliers may have ISO 9001 accreditation, or be working towards it, which will provide assurance on quality and business systems operations.

The plant specification should comprehensively cover the throughput, safety and quality requirements over various phases of development.

The specification would likely include:

- The basic operations undertaken in the filling plant and maintenance areas e.g. cylinder inspection, cylinder filling, leak testing, checks to ensure no overfilling, cylinder evacuation and vapour recovery, re-valving, cylinder requalification, maintenance and repair of cylinders, grit blasting, painting, etc.

- The products to be handled, including contaminated products encountered in the marketplace that needs to be stored

- A listing of all the relevant standards and legislation the plant is to comply with including Health, Safety and Environmental (HSE) requirements affecting personnel engaged in the operation of the plant and the protection of people and property in offsite areas

- Licensing and other requirements for operating an LPG plant. This should include a full risk analysis to identify any potential hazards. LPG cylinder filling plants should be in industrial zones well away from centres of population

- The number of cylinder types/sizes and cylinder valve types involved

- The projected throughput per product, per cylinder size/type, per cylinder valve type, over the planning period and peak daily/weekly/monthly demand

- The number of productive operating hours available over the planning period and peaks

- Details of all operations and limits/tolerances related to each operation, e.g. filling accuracy, size of detectable leak, check weighing accuracy’s

- Manning levels and the degree of automation

- Method of transporting and handling cylinders

- Capacity of requalification, repair, maintenance and painting facilities

- Bulk LPG storage requirements

- Storage areas for full and empty cylinders

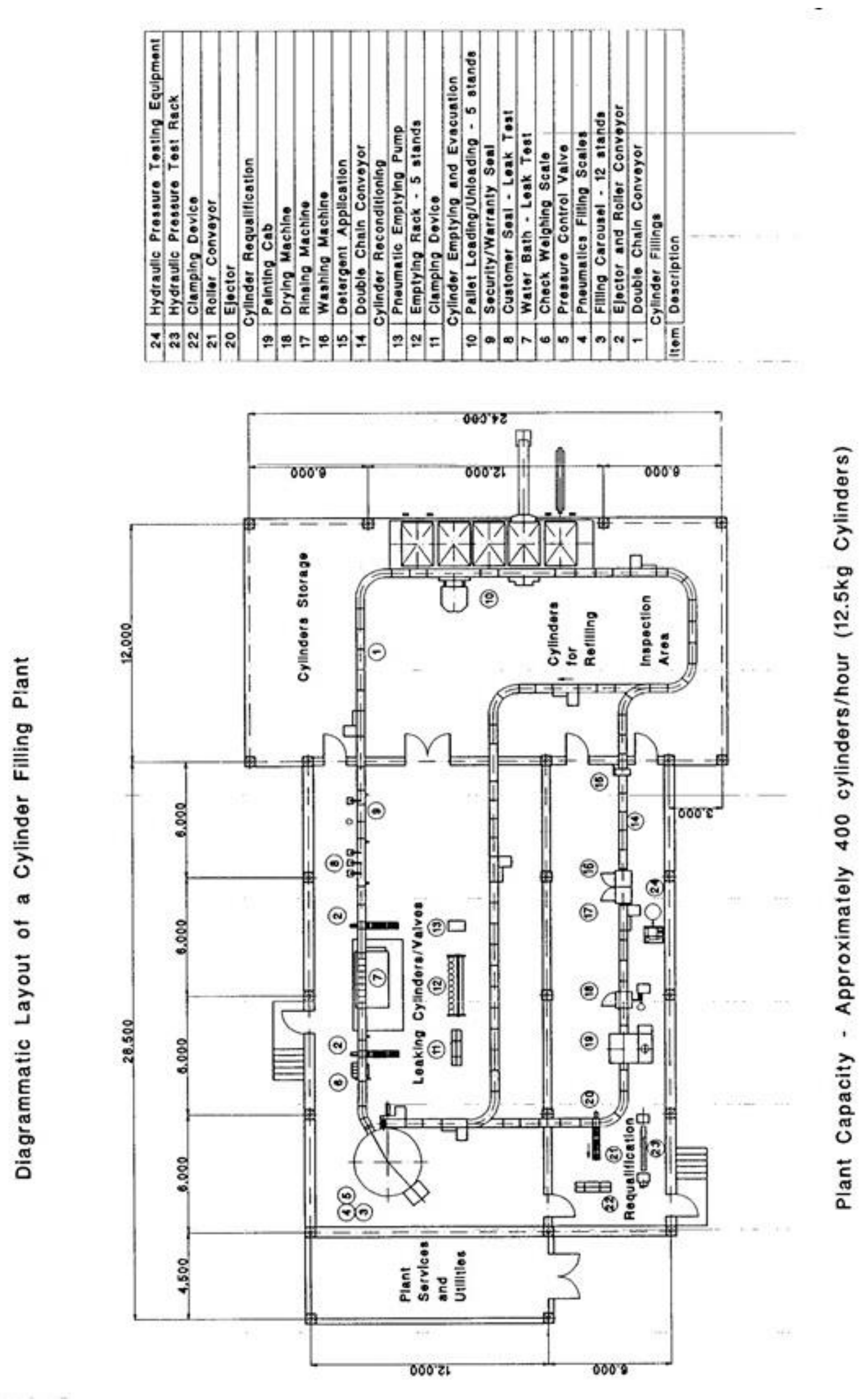
- Requirements set out in the relevant codes of practice, standards and regulations in the country of use

The filling and storage (other than temporary storage) of cylinders are operations which should not be undertaken within the same building.

A typical layout of a filling plant with a 12-scale carousel capable of filling up to 400 cylinders of 12.5kg capacity per hour is shown in *Figure 2.0.*

Figure 2.0
Typical Layout of an LPG Cylinder Filing Plant
(dimensions in metres)

The layout includes areas for cylinder washing/repainting and requalification inspection/testing.



Chapter Three

Overview of the different types of Cylinder Filling Plants

There are several options available when considering what type of filling plant to invest in. In all of these options the ancillary features that are associated with filling plants such as bulk storage of LPG, and the treatment of cylinders as they arrive at the filling plant and leave fit for the market, will all be necessary.

The options for filling can vary depending on circumstances. They include the simple manually operated type, to filling plants that can be stored and transported in containers, to a fully automatic filling carousel.

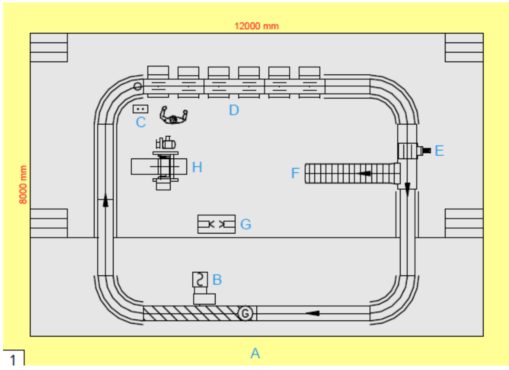
The same strict safety requirements will apply to them all.

3.1 Stand-alone Filling Plants

The simplest form of cylinder filling facility is the stand alone filling plant which operates in isolation.

3.2 In Line Filling Plants

Another of the basic cylinder filling arrangements is achieved by locating the filling heads in a row. This in-line configuration in its simplest form can be just one stand-alone filling head but it is more common to have several them in series or installed on a carousel.



Simple in line filling facility

This design of the filling head is very common and uses either a load cell or mass flow principle to measure the contents of the cylinder.

The filling operation with this type of head can be manual, semi-automatic or fully automatic.

Filling of an industrial cylinder

They are flexible enough to handle cylinders of different sizes and different cylinder valves. They are modular in design allowing units to be added as the demand increases.

There are many combinations of cylinder types, sizes and valves available in the market. These are explained more fully in Section 4.0.

3.3 Containerised Filling Plants

Another option available to fill cylinders, especially in a market where demand has not yet justified the greater investment in a more permanent facility, is to use containerised filling plants.

Containerised filling plant showing filling facility

The basis behind this type of filling plant is that they are prefabricated modular designed plants that can be moved depending on demand. They are also compact and can be fitted on a 50m x 50m piece of land.

Although modular they still contain the key features required and found in more permanent facilities. They will be secured with their own fence and gate house, the facilities will include bulk ISO tank, filling container, workshop and technical room, spaces for storing empty and filled cylinders and fire-fighting equipment.

ISO tank for LPG storage

Containerised plants are an interesting option if the demand for LPG in a country, or region of a country, has not yet reached a point to justify a more permanent facility.

Filling LPG cylinders in a container

Each of the features of a plant are in containers allowing them to be linked as modular units. Even the storage facility can be containerised within an ISO-tank.

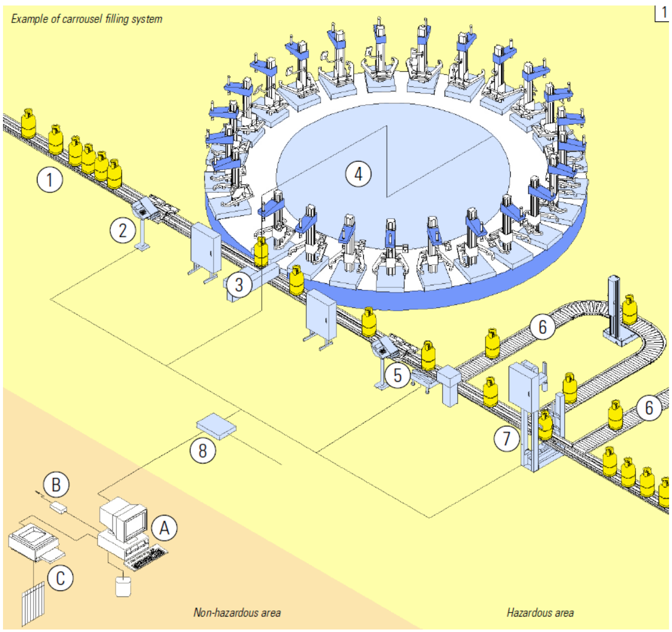
It is important that although the facilities maybe containerised and temporary all aspects of a containerised cylinder filling plant <u>must comply with all the requirements applied to a more permanent arrangement</u>.

This includes location, off site risks, operational and emergency procedures, and all aspects relating to the safe storage, handling and filling of cylinders on site.

Overview of a containerised filling facility

3.4 Automatic Filling Carousels

For high volume markets, where there are perhaps thousands of cylinders to fill every day, the option would be to consider automatic filling carousels. The principal behind carousels is to use filling heads configured in a circular way where the empty cylinder enters the carousel, gets filled as it rotates around and then leaves the carousel filled, at the point where it entered (stage 3 in the diagram opposite).



Schematic showing carousel filling system

The carousel shown here has twenty-four filling heads but it is possible to have fewer heads (e.g. eight) leaving gaps that can be added to later as the demand increases.

Equally the carousel can be larger with up to say seventy two heads. The decision on how many filling heads to deploy will be based on initial and potential demand and the ability to invest.

The heads can be adapted for different cylinders and different valves using a batch system of feed.

Carousels are recognised as being the most effective system for the safe and effective filling of all kinds of LPG cylinders.

They have a high capacity filling capability with up to 2,000 cylinders per hour. The flow through the plant can be semi or fully automatic, depending on valve type, with the option to upgrade later.


A 24-head carousel in operation

With fewer operators the risk of human error diminishes increasing the safety of operation, especially because of the reduction in handling limiting personal injury.

The carousel can also be linked to a computer using the Internet of Things (IoT) to manage data from the cylinders entering and leaving the filling plant.

Modern carousels will be approved against EU directives EU50014, EN50020, EN50082 and EN55022. They will be classified for use in Zone 1 hazardous areas.

Carousels are also known for their accuracy with filling machines and check scales that meet the relevant standards i.e. OIML R 76/EN45501.

Chapter Four

Key Drivers in the Decision-Making Process

4.1 General

The LPG business is capital intensive and the decision to invest in a cylinder filling plant must be taken with care and with a view to future circumstances.

As an LPG market grows it is relatively easy to increase the cylinder population and LPG vehicles but increasing the amount of bulk storage and increasing the filling capacity requires more careful forward planning.

4.2 Key Drivers

Before investing in a facility to fill cylinders there are several things to consider:

4.2.1 Demand location

A key factor influencing the type and size of filling plant will be where the demand for LPG is in the country. In emerging markets this may be difficult to assess and that might influence the choice to look at temporary facilities such as containerised filling. These can be used to sustain a growing market until such time that a more permanent facility can be justified.

4.2.2 Cylinder size and valve configuration

Cylinders can range in size from under 1kg LPG capacity to 50kg (although they are more often referred to as their water capacity in litres).

Steel cylinders come in a variety of different sizes

The introduction of plastics has brightened up the cylinder proposition

Cylinders are most commonly made of steel but the introduction of plastics, for the handle and/or base, and aluminium, are becoming popular alternatives to steel. This is especially the case where weight is an issue.

Composite cylinders also provide an interesting alternative to steel.

Example of composite cylinders

Unlike steel cylinders, composite LPG cylinders are designed to a performance based standard and type approved to that standard. The main standards for type approval are EN12245, EN14427 and ISO11119.3 – these standards are all accepted for type approval of composite LPG cylinders in ADR and in several countries not affiliated with the ADR. In the above-mentioned standards, the cylinder design is approved based on very stringent testing of sample cylinders.

A performance based standard can lead to the production of high quality cylinders, but the composite cylinder production is dependent on high quality repeatable production methods. This is assured through an exhaust QA system that can be certified through standards such as ISO9001 or similar.

As general observation composite LPG cylinders are fully compatible with filling lines for steel cylinders but there needs to be special requirements for inspection, handling and filling. These requirements are not described in any standard and might differ from manufacturer to manufacturer. It is therefore important that the manufacturer provides a full set of documentation for these procedures.

The composite LPG cylinder manufacturer can also be requested to inspect and verify the filling line prior to commencement of filling composite LPG cylinders on it.

Valves can either be side filling or top filling. Some examples are shown here.

Example of a side filling valve

Existing cylinders and valve combinations in an established market will have an influence on the type of filling plant because they present the current demand profile. The more combinations of cylinder size and valve design there are will inhibit the opportunities for full automation.

In some circumstances, it may be more appropriate to have a combination of filling options where cylinders can be batched. That may overcome some of the barriers to automate.

Example of a top filling valve

If the LPG market is new and there is an opportunity to standardise on cylinder sizes and valve combinations, then there will be more opportunities to rationalise and improve efficiencies.

For the manufacture of cylinders, the product certification must be in accordance with the respective national technical standards.

In Brazil this is achieved through ABNT NBR 8460 (steel cylinders), NBR 15057 (cylinders with plastic) and NBR 15574 (cylinders with plastic and metal sealant) and all must be certified through accredited bodies in conjunction with INMETRO – the National Institute of Metrology.

4.2.3 Available Land

Although cylinder filling plants are relatively compact facilities they still require suitable land that presents good access and minimal off-site risk. Sometimes the filling plant will need to be integrated into a larger facility that includes bulk tanker unloading/loading bays or other main oil products storage and distribution. Occasionally the filling plant may have to be incorporated within a refinery complex.

The land available may constrain the preferred design choice but the decision should always be taken with a view to expansion. Further constraints may appear from local or regional regulations which control the position of dangerous goods storage and handling in areas of sensitive populations.

4.2.4 Size of demand

Another key decision driver will be the number of cylinders that will need to be filled throughout the year. There will be seasonal demand peaks as well as peaks during a 24-hour period that will need to be met.

There will also be future demand growth to be considered and the initial design of filling plant will need to accommodate that.

4.2.5 Industry filling

In some countries, it is not uncommon to have a shared resource where several companies have their cylinders filled in a common facility. This may or not be managed by one of the LPG companies and it could be a way of sharing the investment, especially in new markets.

There may be filling agreements between distributors, however in these cases there must be an explicit agreement and contract, that has the involvement an agreement of the regulator.

This outsourcing is only allowed for the industrial process of cylinder filling. Distribution and marketing of third party branded cylinders is strictly forbidden.

Chapter Five

Location and Layout

5.1 General

The location and layout of a filling plant should primarily be driven by current and projected consumer demand for the cylinders and available land.

Cylinder filling plans of course are handling LPG and will have bulk LPG available on site and so the choice of location will need to take that into consideration.

Some of the activities around a filling plant

The relevant codes, standards and regulatory requirements of the country or state must also be considered when locating a filling plant.

5.2 Entrances and Exits

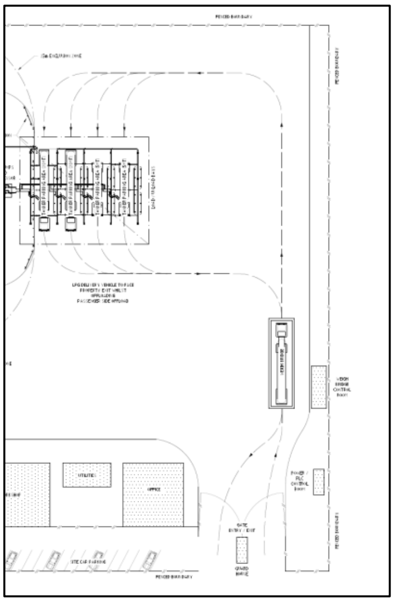
All entrances and exits to filling plants must be tightly controlled to ensure that fire prevention/accident precautions and loss control procedures are strictly enforced.

Strict control is required, especially in hazardous areas, to prevent unauthorised persons/vehicles gaining access to the plant.

When designing the plant, consideration must be given to provide suitable access for fire-fighting and emergency vehicles to all main areas of the facility, e.g. storage, cylinder filling, cylinder storage, bulk vehicle loading/off-loading.

Filling plants must be protected from unauthorised entry by a security fence or a wall at least 1.8m high. There must be at least two means of access/exit from the site in the event of the need for an emergency evacuation and to permit entry by the emergency services.

Where filling plants form part of a secure larger plant, e.g. terminal, storage depot, refinery etc., it may not be necessary to provide a separate security fence.



Plant layout showing traffic flow

The hazardous areas within the filling plant boundary must be defined and designated, taking into consideration any hazard zones surrounding other items of plant/equipment, not associated with the filling plant, that may impinge on the filling plant area.

The site location and layout must be such that during normal operations hazardous areas are kept free of all fixed sources of ignition and that the movement of vehicles loading and unloading cylinders is restricted to clearly defined routes.

Traffic flow through the plant shall be assessed and defined at the planning stage taking into consideration peak demand on the plant.
Wherever possible traffic flow should be one way and separate routing arranged within the plant for the various categories of traffic, i.e. cylinder vehicles, bulk trucks and others. Any reversing of vehicles must be avoided as this creates unnecessary risk.

All vehicles inside the plant must be parked or positioned so that in an emergency situation they can be driven or towed out without the need to reverse.

Vehicles entering hazard zones related to cylinder filling and storage shall be restricted to only personnel who are inducted, trained and authorised to load/unload cylinders.

All other vehicles shall not enter hazardous zones unless specifically authorised e.g. by work permit. Entrance to and exit from the plant should be via separate gates/barriers.

Where appropriate traffic movements should be modelled e.g. by using simulation, to establish the optimum number of cylinders (or pallets) loading/offloading stations, the size and location of parking areas for vehicles waiting to load/offload and the routing of the various categories of traffic that pass through the plant.

Chapter Six

Filling Plant Design

6.1 General

The detailed design of filling plants should be undertaken by the filling plant supplier, and approved by the company responsible for purchasing and managing the plant.

The supplier should guarantee the design in terms of meeting the performance specification drawn up by the purchaser.

The performance specification shall include details of the standards and legislation which should be recognised and complied with in the basic design of the plant.

A typical filling plant layout indicating the various equipment used in cylinder filling operations and its location is shown in Chapter 2.0.

There are standards covering the minimum requirements for the design, location, construction, security, storage, filling and distribution of cylinders and these must be followed in all cases.

These standards define the minimum safety distances and describe the cylinder filling area which should be at least 15 meters away from public thoroughfares and adjacent properties. The basic requirements include having a floor with anti-glare protection and good impact resistance. The area must be provided with marked corridors on the floor for personnel with a minimum width of one meter and corridors leading to the exit with 1.2 meters.

If it is necessary to provide drainage facilities to remove heavy ends, or to remove contamination from cylinders and storage tanks, a drainage and storage system must be provided. This enables the product to be safely accumulated and properly disposed of. The structure must be constructed of a non-combustible material.

The following Table 6.1 illustrates the minimum safety distance requirements in Brazil.

Table 6.1

In Brazil the approval and accreditation is done by the regulatory body, the National Agency of Petroleum (ANP). This

		Table 6.1 – Minimum Safety Distances											
Location		**Safety Distances**											
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Transfer Area	**A**	-	3.0	7.5	7.5	7.5	6.0	15	15	15	15	15	0
Pump or Compressor Area	**B**	3.0	-	3.0	7.5	7.5	6.0	15	15	15	15	15	0
Fixed Vessels (tanks /bulk)	**C**	7.5	3.0	*	7.5	15	7.5	15	15	15	15**	15**	0
Cylinder Storage-full/partially full/empty****	**D**	7.5	7.5	7.5	-	1.5	6.0	7.5	7.5	7.5	7.5	7.5	7.5
Cylinder Filling Area	**E**	7.5	7.5	15	1.5	-	6.0	15	15	15	15	15	0
Flammable Liquid Storage	**F**	6.0	6.0	7.5	6.0	6.0	-	6.0	6.0	6.0	6.0	6.0	7.5
Utility/Services Area	**G**	15	15	15	7.5	15	6.0	-	3.0	3.0	1.5	1.5	15
Operations Support Area	**H**	15	15	15	7.5	15	6.0	3.0	-	3.0	1.5	1.5	15
Administration Area	**I**	15	15	15	7.5	15	6.0	3.0		-			15
Site Boundary	**J**	15	15	15**	7.5	15	6.0	1.5			-		15
Public Place**	**K**	15	15	15**	7.5	15	6.0	1.5				-	15
Fixed Vessels for Decanting***	**L**	0	0	0	7.5	0	7.5	7.5	15	15	15	15	-

*See 4.2 & 4.3
**Refer to table 4 for vessels larger than 120m3
***Valid for vessels <10m3
****Minimum safety distances do not apply to new cylinders (gas free)

is in conjunction with Environmental Agency and the Fire Marshall Department. Unless they approve the design the operation is not approved by the ANP.

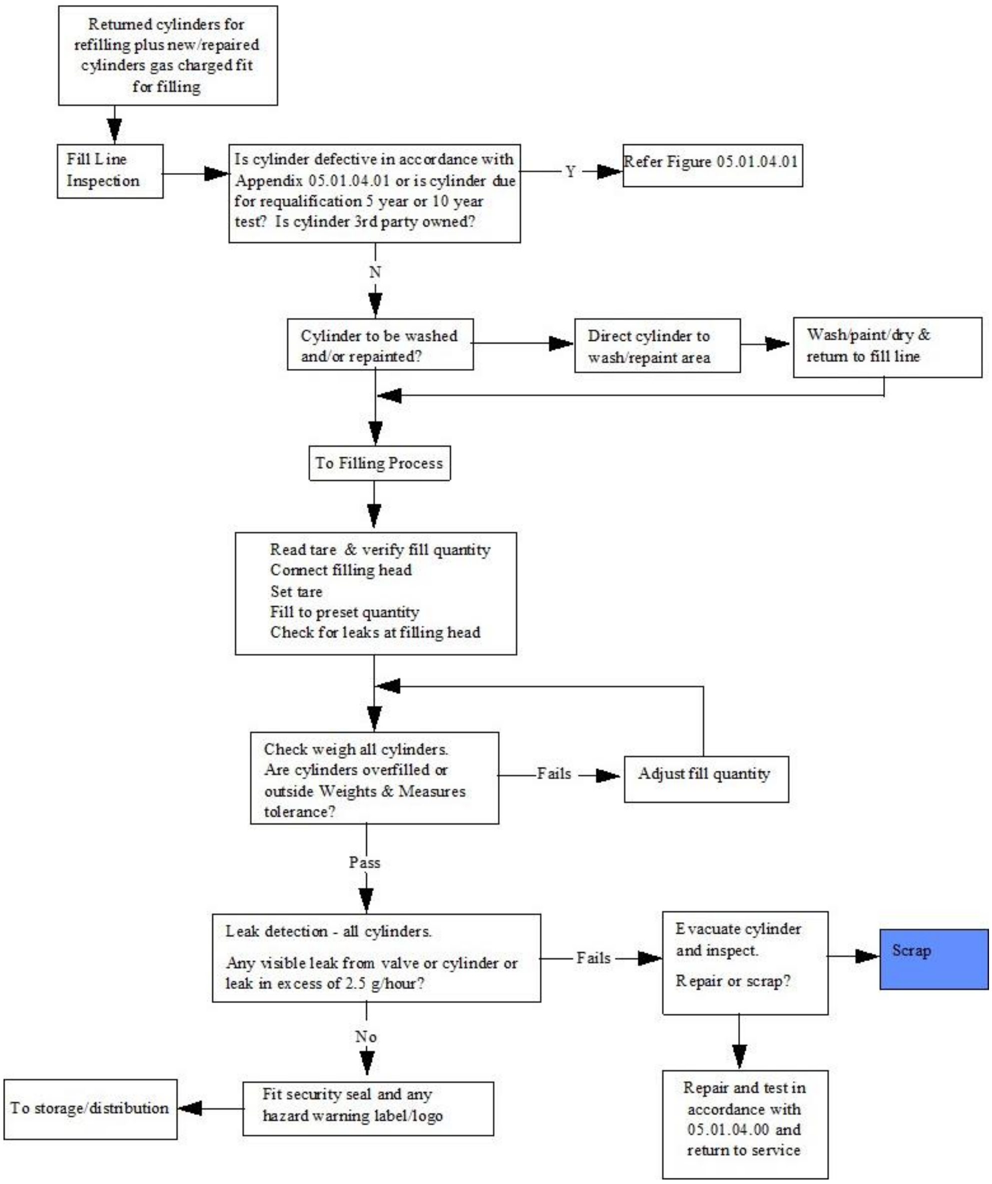
All equipment used in handling LPG, such as transfer pumps, compressors, pipework and fittings etc. must be designed and approved for LPG service over the range of temperature and pressure likely to be experienced in the plant during normal operations.

All cylinder filling machines, conveyors, instrumentation and other equipment used in the cylinder filling process must be intrinsically weather proof so that additional protection is not required during the testing of the fire-fighting system.

The cylinder filling platform must have good natural ventilation to disperse minor gas leaks and be protected from the weather. Employees must also have protection when loading and unloading cylinders. The use of translucent tiles will increase natural light and minimize energy consumption.

A flow diagram of a typical cylinder filling operation is shown in *Figure 6.2*.

Figure 6.2
Flow Diagram - Typical Filling Plant Operations



6.2.1 Inspection station

Provision must be made in the layout of the plant for cylinders to be inspected and the flow of cylinders to be separated into two streams:

(i) Cylinders that are fit and ready for filling
(ii) Cylinders with defects or requiring work e.g. requalification, repainting, re-valving or washing

6.2.2 Cylinder filling

Methods of filling cylinders are:

(i) Filling by weight which is the normal filling plant method
(ii) Filling by volume

It is prohibited to decant LPG between cylinders. There are several safety critical reasons for this. Overfilling might occur, there is a risk of personnel injury through frostbite and flammable mixtures might be created through leakage.

Filling machine accuracy should meet the more restrictive requirements of either the local Weights and Measures Authority or the tolerances given in *Table 6.2.2*:

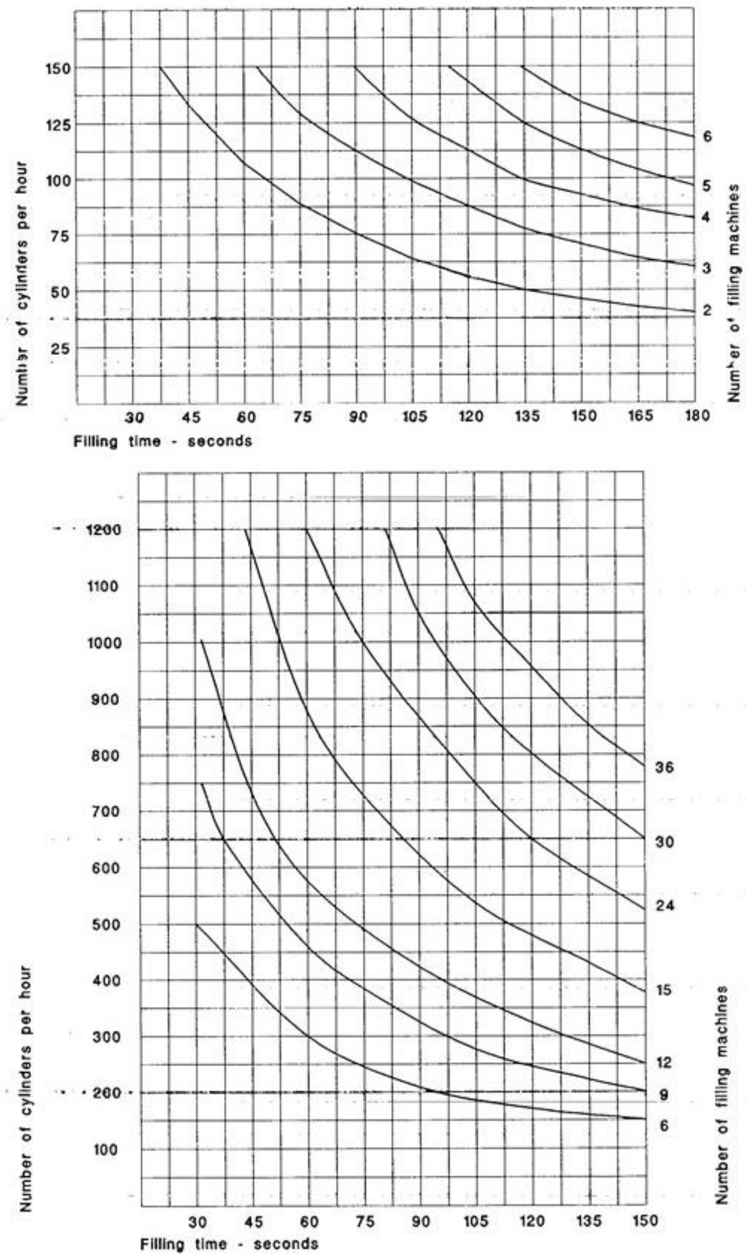
Table 6.2.2
Typical Filling Tolerances for LPG Cylinders

Cylinder Type LPG Capacity (kg)	Filling Tolerance (kg)
6kg Propane 7kg Butane	+ 0.1/- Nil
11kg Propane 13kg Butane	+ 0.2/- Nil
46kg Propane	+ 0.4/- Nil

Cylinders are usually filled on filling scales mounted on a carousel or mounted in-line at fixed locations. *Figure 6.2.2* gives an approximate indication of the filling capacities of in-line and carousel systems.

Figure 6.2.2

Typical Filling Scale Capacities



Carousels are normally fitted with automatic units for moving cylinders from the supplying conveyor onto the filling scale and for moving filled cylinders back onto the conveyor line.

Filling scales are available in a variety of forms but generally it should be possible to set tare and fill quantities either manually at the scale or via a control console.

Manual mechanical filling head for top filling valve

A basic requirement of a filling scale is that automatic cut-off on the fill quantity is achieved by pre-setting the tare and fill quantity. It should not be a requirement for an operator to stop filling when a scale reading or pointer indicates that the fill quantity has been reached.

LPG vapour, or other flammable gases, must not be used as the actuating medium for the operation of filling valves/heads. Pneumatic systems should utilise air or an inert gas.

Filling heads must be fail safe, i.e. no leakage must occur in the event of failure of the actuating medium, and be designed to fit the cylinder valve without causing damage to the valve or allowing leakage to occur during filling and when not in use.

Filling machines must be regularly checked for accuracy in accordance with the manufacturer's recommendations, e.g. at the start of each shift based on check weighing.

6.2.3 Check weighing and overfill detection

To ensure cylinders are not over/under filled all cylinders should be check weighed after filling on a suitable scale with an accuracy and repeatability of at least 0.1% (1 in 1000).

The check weigh station in conveyor systems should include devices to lift the cylinder off the conveyor, to delay the arrival of oncoming cylinders and to move cylinders that have been checked onto the conveyor.

The liquid mass in the cylinder must be checked and measured to ensure that the tightest tolerance allowed for marketing to the consumer is met.

Overfill can also be identified by proprietary level detection devices. Devices of this type can include the use of a beam which is interrupted when liquid is detected and therefore can only be effectively used in situations where cylinders of the same dimensional specification are batched for filling. These devices can only be relied upon to indicate significant overfilling and do not substitute check weighing.

Check weighing scales should be checked for accuracy in accordance with the scale manufacturer's instructions. It should be done against known standard weights representative of typical filled cylinder weights prior to the commencement of each shift and the results recorded.

6.2.4 Leak detection

Leak detection systems should be capable of detecting leaks from all sources on the cylinder of at least 2.5 g/hour.

Modern systems can identify leaking cylinders through the use of gas detectors.

After filling it is also recommended that the base of the cylinder be inspected thoroughly.

For large throughput plants, and for plants requalifying cylinders, one system for detecting leaks of this magnitude is a water bath with a sufficiently long immersion time at the inspection station, e.g. not less than five seconds.

Fully submerged leak detection bath integrated with chain conveyor

Leak detection using a soap solution, applied manually using a brush or spray to valves and the bung connection, can be used in plants operating with small throughputs.

This method does not check the cylinder however and a visual inspection of the cylinder body should be made for signs of leakage through pin holes in welds etc.

Filling plant manufacturers now offer automated leak detection units.

The following checks for leaks must to be made:

(i) On the valve:

- Cylinder valve/bung connection
- Valve main seal
- Valve customer seal (service connection) at cylinder pressure
- Pressure relief valve
- Spindle gland in handwheel valves with the valve open but not back seated
- Valve body

(ii) On the cylinder

- Cylinder valve/bung connection
- Body of the cylinder for leaks

6.2.5 Auxiliary equipment

Filling plant manufacturers supply a wide range of equipment designed to carry out the following operations:

- Removal and replacement of valve caps
- Greasing of cylinder bungs external threads to take valve caps
- Removal and replacement of valve security seals (plastic caps and inserts)
- Fitting shrink wrap plastic warrantee seals around valves
- Detection of distorted shrouds and base rings

6.2.6 Cylinder maintenance and requalification

Companies carrying out requalification work on LPG cylinders must have the necessary licences and approvals from the relevant authorities to carry out this type of work. That will include handling dangerous gases, disposal of effluents (from the internal washing of cylinders) and the scrapping of cylinders.

Where it is required, the facilities for washing, painting, re-valving and re-qualification of cylinders need to be installed.

Cylinders that require that attention should be identified and segregated at the inspection station and directed to the appropriate area. Those operations have to be carried out off the main conveyor in designated areas.

Where it is considered necessary, any washing and painting facilities may be incorporated in the main conveyor system or in a line parallel to it.

Painting and washing facilities must include the necessary features to prevent damage to the environment, e.g. filter systems, excess paint disposal, contaminated water treatment. All local Environmental and Health and Safety at Work legislation must be respected.

All filling plants must be equipped with suitable facilities for evacuating defective cylinders and recovering liquids and vapour. In small plants, located in areas where venting of vapour to the atmosphere is judged to be acceptable, cylinders may be discharged via a suitable vent system at high level.

All plants must be capable of gas freeing cylinders, and be capable of testing and confirming those cylinders as gas free. Usually an “obstructed valve test” or “whisper test” is used, where a de-gassed cylinder is injected with a small amount of LPG vapour or inert gas through the open cylinder valve, and the “whisper” of escaping gas confirms the cylinder is empty.

All cylinders which require additional work must be confirmed gas free prior to that work commencing.

All filling plants should have facilities for changing valves without damaging the cylinder, e.g. suitable clamps to hold cylinders during the valve changing operation, torque wrenches for fitting valves, tightness test facilities for valve and bung joint etc.

Hot work repairs to cylinders, including shot or grit blasting, zinc metal spraying and the use of machinery, e.g. shroud and base ring straightening (although there is equipment available to undertake straightening without heat), which does not comply with the hazard zone safety requirements, must not be carried out in cylinder filling areas or within other hazardous zones.

Sites where hot work is carried out must be located outside hazardous areas.

When performing maintenance, repair and requalification on composite LPG cylinders, the instructions and manuals from the manufacturer must be observed and followed.

6.2.7 LPG piping and fittings

Any LPG piping within plants must comply with the local or regional requirements.

All product piping shall be colour coded and fire-fighting water and other services installed against appropriate standards.

All valves must be marked or labelled to indicate their service and function.

All piping must be protected from accidental damage by appropriately locating it or by installing mechanical protective means.

The liquid piping system should include a liquid return to the main storage tank(s) with an automatic pressure control valve fitted in the return line from the filling machines to prevent vaporisation of LPG in the fill line.

A shut-off valve and non-return valve should be fitted in the liquid return.

A remotely controlled fire-safe and fail-safe emergency shut-off valve must be located in the liquid supply pipeline or close to the point of entry into the cylinder filling building/structure with actuation points positioned at strategic locations, e.g. locations which are usually manned, throughout the plant.

LPG bulk storage facility

Consideration should be given to inter-connecting the emergency valve’s actuation system into the fire alarm and general emergency shut-down system of the plant.

An appropriate filter should be fitted in an easily accessible location in the liquid pipeline upstream of the filling machines.

The overall filtration system of the plant, from product receipt via main storage tank(s) to cylinder filling, should be assessed at the design stage to ensure satisfactory product quality when filling cylinders.

It is recommended to install a drive-away protection system with bulk trucks that prevents a major leak that would follow an unplanned departure of the vehicle.

Drive-away couplings result in the breakage of the coupling instead of rupturing the hose.

6.2.8 Cylinder handling systems

The best method of handling filled and empty cylinders from the filling area to the transport loading bays and storage areas should be assessed taking into consideration traffic flow in the plant, the means and size of the transport units used, the planned distribution system, the possible use of pallets, (refer 8.4), the possible use of ground level and overhead conveyor systems, etc.

6.2.9 Fire-fighting, emergency shut-down system and alarms

All cylinder filling plants must have an integrated system for handling all emergencies, that may arise in the plant, that is adequate in terms of hardware and operational procedures. The requirements for the above are referred to throughput this Guide.

These emergencies may range from a gas leak, through to a local fire and must include extreme weather events (electrical storms, flooding, bush fires or snowstorms).

6.2.10 Electrical continuity, earthing and bonding

All items of plant and equipment involved in the filling, emptying and gas charging of LPG cylinders, or which may otherwise be responsible for generating static charges, must be bonded and earthed with a resistance to earth that does not exceed 10^6 ohms.

There must therefore be good electrical continuity between the LPG piping system and earth via the filling machines, evacuation equipment, cylinders and conveyors etc. and the resistance to earth should be periodically checked as part of the routine maintenance procedures to ensure that the above resistance is not exceeded.

It's most important to ensure the integrity of the grounding system during transfers from bulk vehicles and storage tanks.

Precautions should be taken, such as the use of conductive or anti-static gloves, conductive or anti-static flooring and footwear, to prevent the possible insulation of personnel handling cylinders during filling, emptying and gas charging operations.

Typically, clean concrete floors and footwear made of conductive rubber are considered suitable for the above operations.

Arrangements must be made to control the temperature in the building that houses the electrical equipment and to protect it from excess temperature conditions.

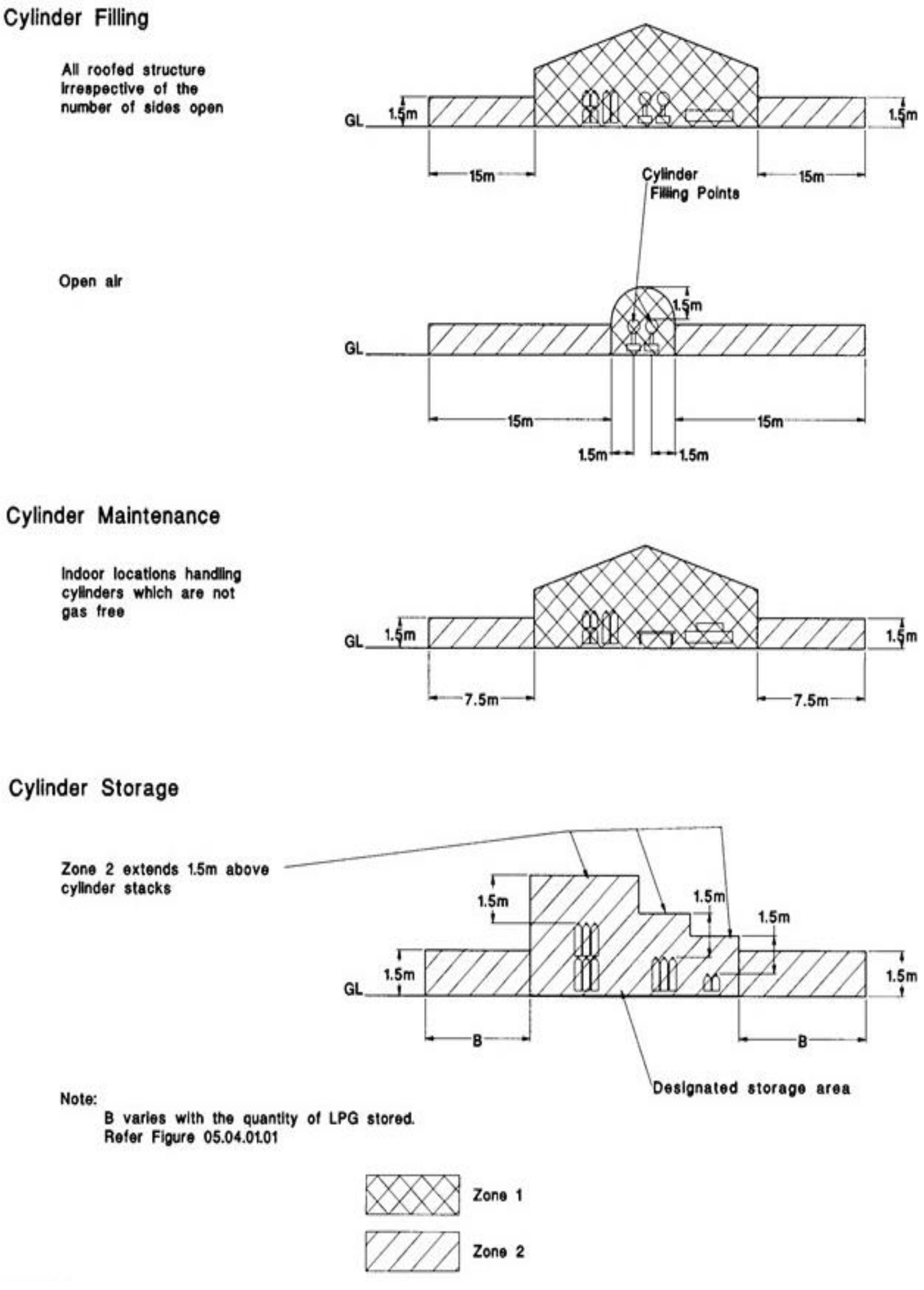
The building should also be designed to prevent the possible entry of animals and vermin that might damage the wiring and other equipment.

6.3 Area Classification and Electrical Installations

The following comments apply both to cylinder filling plants and cylinder storage facilities.

Figure 6.3 indicates the extent of the hazard zones normally associated with cylinder filling plants and storage areas and their classification.

Figure 6.3
Area Classification – Cylinder Filling and Storage



All electrical equipment used in these areas must be constructed to an appropriate national or international standard and classified as suitable for operation in the specified hazard zone.

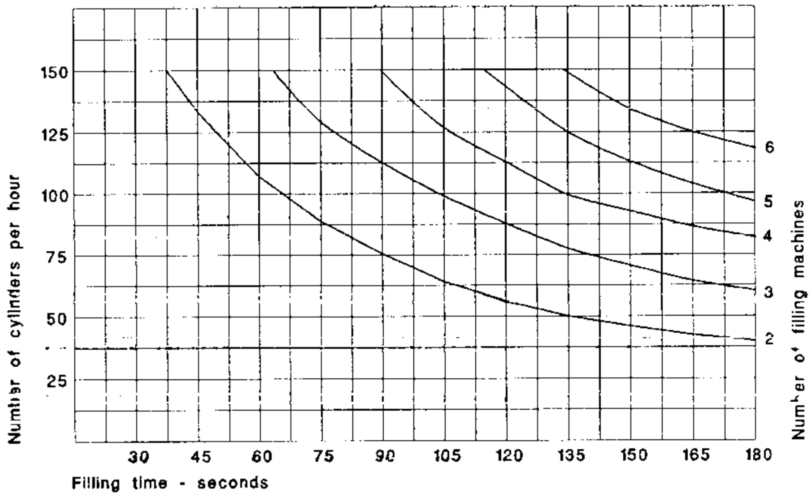
All fork lift trucks operating in hazardous areas are to comply with Section 8 of IP Model Code of Safe Practice, Part 15, *Area Classification Code for Petroleum Installations.*

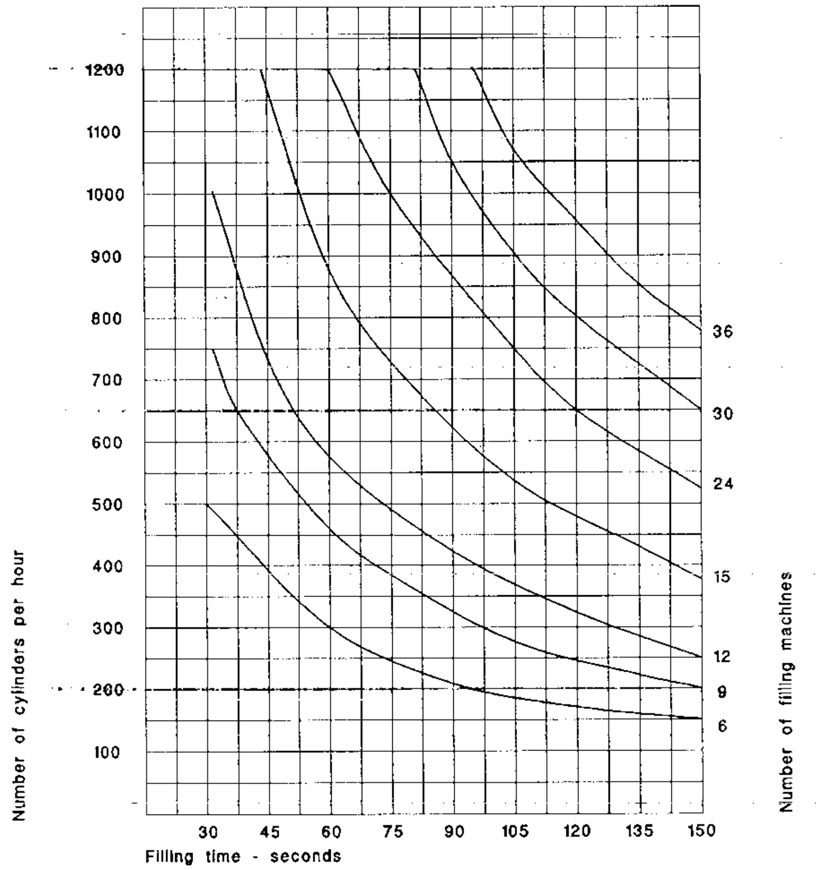
Reference should also be made to Guidance Note PM 58, UK Health and Safety Executive *Diesel engined fork lift trucks in hazardous areas.*

Vehicles loading/unloading cylinders that enter hazardous areas must conform to all requirements for operating in those environments.

Figure 6.3a

Approximate Filling Scale Capacities - Carousels and In-line





The following table applies to both full and nominally empty cylinders, i.e. cylinders containing only vapour. Refer to 6.6 for definitions of indoor and outdoor locations. Indoor storage locations are as defined in CS4 and summarised in 6.6.2. It should be noted that any variation to the requirements of 6.6.2, in the design of the building or a specially designed storage area within a building, could change the extent of the hazardous area detailed in *Table 6.3*.

An example of this is where buildings or rooms, not intended for the storage of LPG, are connected to the LPG storage area. In this case the hazard zone would need to be extended to cover all the inter-connected areas.

Table 6.3 Area Classification of Cylinder Filling and Cylinder Storage facilities

Description of the plant/equipment constituting the hazard	Extent of the hazardous area	Area classification
Cylinder Storage Cylinders stored in the open air	Within the storage area up to a height of 1.5 m above the top of the stack or beneath any roof over the storage place Outside the storage area, or the space covered by any roof, up to 1.5 m above ground level within the distance set out for a fixed source of ignition in Figure 6.3	Zone 2 Zone 2
Cylinder Storage Cylinders within a building conforming to 6.6.2	Within the building or specially designed area within a building. Outside any doorway, low level vents or any opening into the store, up to 1.5 m above ground level at the distance to a fixed source of ignition as given in Figure 6.3. See also *Figure 6.3a. Refer Note (1).*	Zone 2 Zone 2
Cylinder Filling Indoor Location Outdoor Location **Cylinder Maintenance** Cylinder maintenance room (indoor location)	Entire room Outside room to within 15 m of filling room (1) Within 1.5 m of filling point Within 16.5 m of filling point Entire Room Within 7.5 m of maintenance room (1)	Zone 1 Zone 2 Zone 1 Zone 2 Zone 1 Zone 2

Note (1) The definition assumes that the hazard Zone 2 is in the open.

6.4 Hazardous Areas and Zones

A *hazardous area* is a defined as a three-dimensional space in which a flammable atmosphere is expected to be present at varying frequencies depending upon the operation carried out in the area. *Hazardous areas* are subdivided into three zones:

- Zone 0 - That part of a hazardous area in which a flammable atmosphere is continuously present or present for long periods

- Zone 1 - That part of a hazardous area in which a flammable atmosphere is likely to occur in normal operation

- Zone 2 - That part of a hazardous area in which a flammable atmosphere is not likely to occur in normal operation and when it does will exist only for a short duration

The IP Model Code of Safe Practice, Part 15, Area Classification Code for Petroleum Installations, 1.5.4 also defines the amount of flammable product, in this case LPG vapour, released into the atmosphere during the course of normal operations as *the grade of release.*

Three *grades of release* are defined in terms of their likely frequency and duration:

- Continuous Grade Release - A release that is continuous or nearly so or that occurs for short periods which occur frequently

- Primary Grade Release - A release that is likely to occur periodically or occasionally

- Secondary Grade Release - A release that is unlikely and in any event, will do so only infrequently and for short periods

As a guide, releases which occur during normal operation from a source for more than 1000 hours per year should be considered *continuous* and *primary* if it is likely to be present for between 10 and 1000 hours per year.

A release that is likely to be present for less than 10 hours per year and for short periods only should be considered *secondary.*

Typically, any releases involved in cylinder filling and maintenance will be *primary* and *secondary* in cylinder storage areas.

For outdoor facilities, as defined in 6.6 below, there is a direct relationship between the *grade of release* and the *hazard zone* to which the release gives rise, i.e.

- Continuous grade normally leads to Zone 0

- Primary grade normally leads to Zone 1

- Secondary grade normally leads to Zone 2

It should be noted that the above only applies when the ventilation is adequate. Poor ventilation may result in a more stringent *hazard zone* and therefore restrictions on operations and a requirement for electrical equipment to higher standards. Refer section 6.6 regarding ventilation.

6.5 Buildings and Structures

Buildings should be constructed to allow for continuous ventilation (forced or natural), be made of fire resistant materials and the design should provide a suitable working environment taking into consideration the local climatic conditions. Where the climatic conditions permit, filling plant buildings should have totally open sides to provide unobstructed natural ventilation.

Where it is essential to use enclosed or partially enclosed buildings there must be an adequate level of ventilation through the filling area and adjoining buildings, refer 6.6 below.

Where the filling plant is enclosed, special attention shall be given to the provision of gas detection and emergency exits. The structural and ventilation requirements for enclosed cylinder filling buildings are those set out in CS4 for cylinder storage in specially designed buildings. Ventilation must always be sufficient to meet the general requirements of 6.6.

All structures must comply with the appropriate local building regulations, and the relevant LPG code, standards and regulations of the country.

Platforms and floors should be constructed in mass concrete, or other suitable non-combustible materials, to withstand the impact of LPG cylinders and/or pallets (refer 6.2.10).

Pits and channels in floors shall be avoided as far as possible. If they are necessary, e.g., for conveyors etc., they must be well ventilated and free draining to a suitable location in the open air.

Cellars, voids or other open spaces are not to be located below platform or floor level within the defined hazardous areas.

Floors should be sloped to allow water used in fire-fighting, and water used during cleaning operations, to readily run to the drain.

Arrangements should be made to maintain a comfortable environment for personnel operating plant. The introduction of a humidification system may not only improve working conditions in some circumstances it also reduces the risk of static electricity.

In some countries, there may be requirements to assess the working conditions in respect to physical, ergonomic, biological or chemical risks associated with the transfer, storage filing and distribution of LPG cylinders.

The use of personal protective equipment (PPE) and the application of other relevant preventative programmes should also be mandatory to protect personnel and the environment. These include the provision of rest periods and monitoring of hydration, especially for personnel undertaking heavy work.

Depending on the number of employees it may be necessary in some countries to establish teams to review health, safety/security and environmental issues.

The *Table 6.5* below sets out the Brazilian NR4 Ministry of Labour, Ordinance 3214/78 and updates.

Table 6.5
(extracted from the Brazilian NR4 Ministry of Labour, Ordinance 3214/78)

		Number of employees on site							
Risk Level	Technical Personnel	50 to 100	101 To 250	251 To 500	501 To 1,000	1,001 To 2,000	2,001 To 3,500	3,501 To 5,000	Over 5,001 #
1	Safety Supervisor				1	1	1	2	1
	Safety Engineer						1*	1	
	Assistant Nurse						1	1	
	Nurse							1*	
	Doctor					1*	1*	1	1*
2	Safety Supervisor				1	1	2	5	1
	Safety Engineer					1*	1	1	1*
	Assistant Nurse					1	1	1	1
	Nurse							1	
	Doctor					1*	1	1	
3	Safety Supervisor		1	2	3	4	6	8	3
	Safety Engineer				1*	1	1	2	1
	Assistant Nurse					1	2	1	1
	Nurse							1	
	Doctor				1*	1	1	2	1
4	Safety Supervisor	1	2	3	4	5	8	10	3
	Safety Engineer		1*	1*	1	1	2	3	1
# for each group above 4000 personnel, for each fraction above 2000 personnel									

6.6 Ventilation

The level of ventilation provided in filling plants and cylinder storage facilities must be such that:

- The rate of air change (air movement) is sufficient to dilute releases of LPG from identified leak sources such that a flammable atmosphere will not occur in normal operations outside the established *hazard zone,* e.g., around the head of a cylinder filling machine

- The ventilation is sufficient to disperse an accumulation of LPG vapour built up over time such that the extent and categories of the established *hazard zones* of the facility and adjoining areas are not affected

- The concentration of LPG vapour does not exceed the recommended occupational hygiene limits for personnel working in the facility

In *Table 6.3*, cylinder filling and cylinder storage facilities are defined for area classification purposes as either outdoor or indoor.

6.6.1 Outdoor locations

Outdoor locations are those which are in the open, without restriction to the natural ventilation of the site. Restricted ventilation may be caused by walls, roofs or other structures. The ventilation of the site is unobstructed, with continuous air change taking place, and the movement of air caused by wind or convection. This process is referred to as natural ventilation.

6.6.2 Indoor locations

Indoor facilities are those in which the ventilation is obstructed, e.g. by a roof over the site, walls, adjoining structures etc. and therefore the rate of air change is less than that in outdoor locations. Ventilation may be natural or artificial, e.g. by fans or extractors or a combination of natural and artificial. Not less than 12 air changes per hour are required to ensure an adequate level of ventilation in typical filling plant buildings.

Ventilation should be designed such that there are no stagnant areas in the building in which vapour could accumulate forming an explosive mixture.

Ventilation in filling plants and in cylinder storage areas shall be sufficient to avoid the persistence of a flammable atmosphere that would result in the generation of a Hazard Zone 0.

In general filling plants, which have two or more sides permanently open, are considered as naturally ventilated areas equivalent to open areas and that no additional ventilation, i.e. artificial ventilation, is required. These terms are defined in the IP Model Code of Safe Practice, Part 15, Area Classification Code for Petroleum Installations, Chapter 6.

Gas detectors must be fitted where the likelihood of gas escape is greatest whether due to equipment or operational failure and should be linked to trigger the emergency system when activated. These locations would include points of gas transfer where hose rupture may occur, filling connectors, inspection and test points.

6.7 Fire-fighting Facilities

6.7.1 General

The plant's fire-fighting system must be interlinked to activate the fire pumps, the fogging system and water hydrants, and disconnect any equipment and motors as well as activate the emergency alarm.

All fire-fighting facilities installed on an operating site must be maintained by the site operators at all times.

Simulated firefighting exercises

The emergency system must also be able to be operated remotely through emergency pushbuttons distributed at strategic locations. These pushbuttons must not be located where access to them might be restricted in the event of an emergency.

Monthly fire drills must be carried out together with two simulated annual emergency drills. These drills should involve emergency services whenever possible in order to facilitate familiarisation with on-site fire protection equipment and access to fire water etc.

Local fire-fighting authorities should be consulted, at the design stage, on the extent and layout of the proposed fire-fighting facilities and location and duration of the onsite/offsite water supply.

The consultation process may form part of governmental or local authority planning regulations. Where no such regulations exist consideration should be given to prior consultation with the appropriate authorities taking into consideration the role and input required from the local emergency services.

An *Emergency Response Plan (ERP),* which includes details of the on-site and, where appropriate, off-site emergency procedures for dealing with emergencies shall be prepared which describes the basis and preparation of on-site and off-site emergency plans and other related requirements.

It is advisable to have a mutual assistance plan between any neighbouring companies to act jointly in case of emergencies and in some cases with interconnected firewater network systems.

On-site emergency plans should be drawn up for all LPG plants and personnel should be allocated tasks that must be undertaken in the event of an emergency. Personnel must be adequately trained in the tasks allocated to them and given copies of the ERP with reference to their own contribution to the execution of the plan.

A plan of the fire-fighting facilities indicating the location of essential features such as control valves, pump starters, alarms, monitors, hose boxes etc. and alarm/ESD system should form part of the ERP.

The following gives general guidance on the main fire-fighting facilities for cylinder filling and storage areas.

6.7.2 Water for fire-fighting

An assessment should be made at the design stage to ensure LPG cylinder filling facilities have an adequate supply of water available to them to protect the cylinder filling/storage areas as well as the remainder of the plant, e.g. bulk storage, bulk vehicle loading/offloading, etc.

Fire water nozzle

The quantity of water required for fire protection shall be based on the amount of water required to control and to cool adjacent exposed facilities in the worst-case scenario.

A water supply of sufficient quantity to comply with the local regulations, or for at least 60 minutes application at the maximum flow rate, should be available at the site to all filling plants in the following categories:

- All plants, irrespective of their size of inventory, where there are regular and frequent product movements, e.g. at least two bulk transfers per week

- Plants in which the total fixed storage capacity (total inventory) is greater than 15,000 litres for installations in which storage vessels are not fitted with remotely operated ESD valves in the liquid outlet pipe

- Plants with inventories greater than 55,000 litres in which storage vessels are fitted with remotely operated ESD valves in the liquid outlet pipe

Small cylinder filling plants which do not fall into the above categories should have an adequate water supply to deal with any fire-fighting purposes.

LPG facilities at cylinder filling sites at which a water supply is available shall be primarily protected in the following manner:

- Bulk storage vessels - fixed spray system, or passive coating or a combination thereof
- Road/rail loading/off-loading - fixed spray system
- Cylinder filling and leak testing areas - fixed spray system
- Cylinder filling plant cylinder movement and maintenance areas - monitors/hose streams or fixed spray systems
- Cylinder storage areas - monitors and/or hose streams.

The operation of fixed spray systems may be manual or automatic, i.e. activated by spot heat and gas detectors.

Cylinder filling and leak testing areas in filling plants must be protected by a fixed water spray (drenching) system in which water is applied evenly to the exposed surfaces of all cylinders in the filling area at a rate of not less than 8.5 litres/m^2/min. of cylinder surface area, based on the maximum number of cylinders likely to be present in the locations.

Fixed water spray systems must also be used to protect cylinders located in other covered sections of the filling plant and maintenance areas, (e.g. on conveyors before and after filling, in temporary storage awaiting maintenance etc.) in enclosed or partially enclosed buildings in which hose streams or monitors cannot effectively be used. Road tanker unloading areas must also have fire water protection.

Road tanker unloading bay with fire water system

The fire-water main must be equipped with hydrants located not more than 60 metres apart. Sufficient hydrants must be provided for the cylinder filling and cylinder storage areas to be covered by at least two hose streams from different directions in all weather conditions.

The hydrant system must also provide back up for those areas primarily protected by fixed sprays.

Water curtains may be used as safety barriers between sections of plant to limit the effects of heat radiation.

6.7.3 Portable fire extinguishers

The minimum requirement for first aid fire extinguishers is as follows:

- Cylinder filling area. One 9kg dry powder extinguisher for every 50 m^2 of floor area with a minimum of three
- Cylinder storage area. one 9kg dry powder extinguisher for every 100 m^2 of floor area with a minimum of two

6.8 Emergency Access and Escape

Consideration must be given at the planning stage of all projects to providing suitable access to and within the site for the emergency services for fire-fighting and evacuation of injured personnel.

In planning access and escape routes the consequences of the range of typical major incident scenarios developed for a hazard analysis must be applied to a facility.

At least two routes providing free access for the emergency services into the site, or to suitable locations from which the incident can be effectively handled, and at least two other escape routes for site personnel and where appropriate vehicles and other mobile equipment must be defined.

Any one of the major incident scenarios must not have the effect of blocking any of the access and escape routes.

The deployment of the emergency services and the implementation of plant evacuation procedures should form a part of the emergency response plan.

Chapter Seven

Filling Plant Operations

7.1 General

The full range of normal and emergency operations to which the cylinder filling plant may be subjected to should be clearly set down in an operating manual, a copy of which must be available to all plant personnel.

The operating manual should cover the following but not limited to:

- Product handling procedures
- Cylinder filling procedures for all key processes- cylinder sorting, washing, filling, leak detection, weight check, etc.
- Cylinder requalification procedures
- Quality control procedures (cylinders, valves, LPG)
- Safety and emergency procedures
- Materials handling
- Instructions for operating and maintaining all equipment used by the plant
- Operation and maintenance of the means of transport controlled by the plant, i.e. including third party cylinder transport
- Management of any modifications to equipment or installations and other issues
- Administrative and accounting procedures

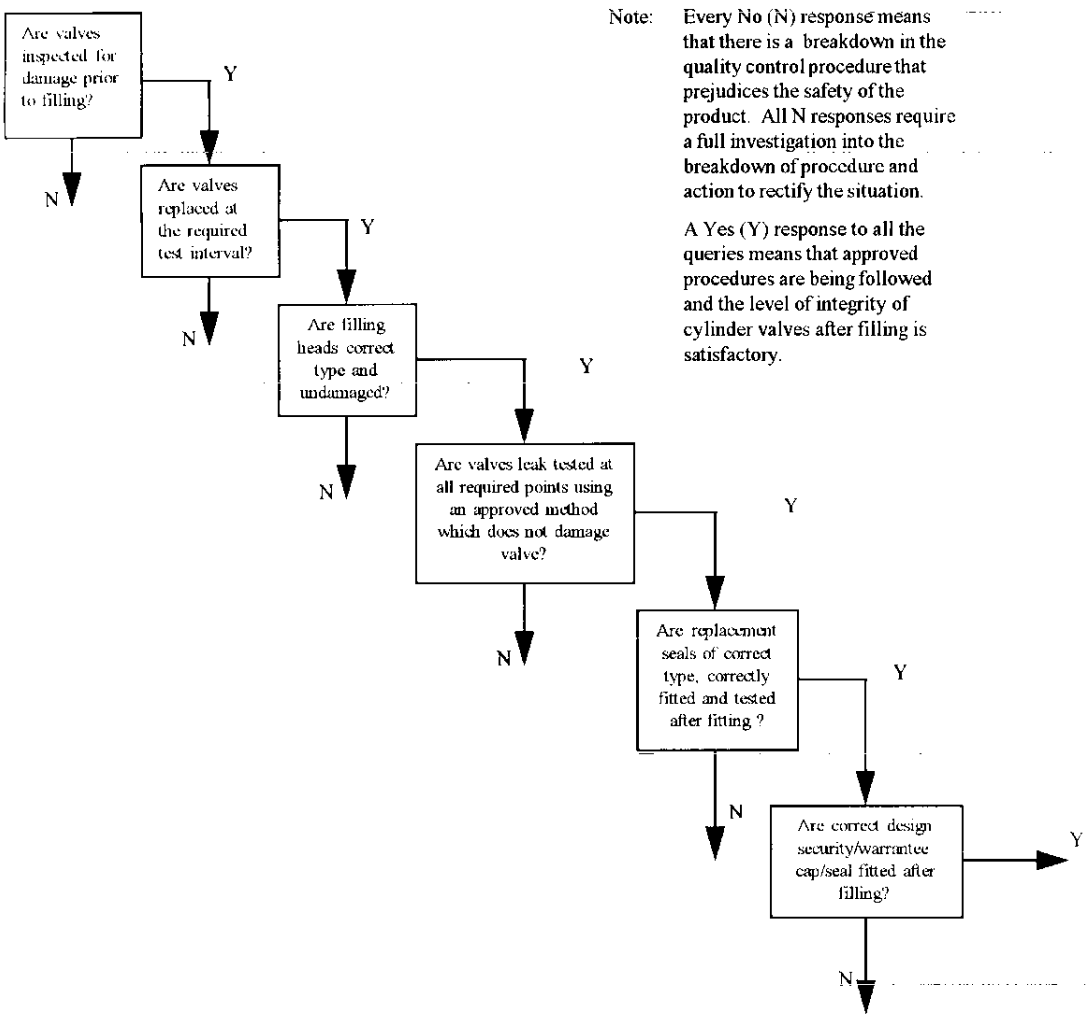
Job descriptions should be drawn up for all plant personnel who must be fully trained and qualified in the tasks allotted to them.

The staff of each plant must include at least one *competent person.* A brief description of the task should be displayed at the workplace.

All cylinder filling plants must have an emergency response plan in place and where necessary the plan shall be drawn up in co-operation with the local authorities.

Figure 7.1 illustrates a tool for use by management and others when carrying out operational audits, to verify that the essential components of the *cylinder valve* quality control system, with regard to operations in cylinder filling plants, are in place. A negative response to any of the questions in the flow chart indicates a breakdown of control and a possible hazardous situation.

Figure 7.1
A Management Guide to Valve Integrity



7.2 Quality Control

Quality control procedures covering the following requirements should be put in place:

- Product quality, i.e. routine procedures to ensure that the LPG filled into cylinders is not contaminated and is in line with the current product specification. Checks on product contamination should include drainage of water, heavy ends and solid particles. Where necessary product should be filtered prior to filling into cylinders. Product should not be marketed containing solid particles larger than 5 microns. All product immediately received ex-refinery shall be checked for H_2S contamination, using lead acetate paper, prior to offloading into fixed storage

- Container quality, i.e. the checks carried out on every cylinder entering the plant to ensure that it is fit for filling. Only cylinders which have passed pre-filling inspection requirements should be filled

- The fitness for purpose of filled cylinders shall be verified by a series of checks before the cylinder leaves the filling plant (refer *Figure 7.2*). These include a check on the weight of all filled cylinders to confirm that the quantity of LPG offered for sale is within the legal limit and that the cylinder is not overfilled, a leak test on all cylinders and valves - including the customer seal - to ensure that cylinders offered for sale are leak free. (A leak is defined as a loss of 2.5 g/hour or more from all sources on a cylinder). All security caps and warrantee seals must be confirmed as being in place and, where appropriate, valve protection caps are securely fitted

- Each time the cylinders return to the distribution network, before and after they are filled, they must undergo a series of checks and controls to ensure the physical integrity, the quality of the product/service in order to protect the safety of the consumer

- It is important to note that these checks should be carried out by experienced employees, properly trained by personnel who can determine the fitness for purpose of the cylinders for filling and/or separation of those that must be referred for maintenance, re-qualification or destruction

- In Brazil, each filling station has a mandatory inspection certificate according to the ABNT NBR 8866 standard. This certificate is obtained through the accreditation of Product Certification Body (OCP). Periodic audits are carried out to maintain this certification. Distributors cannot fill cylinders without this certification

- When cylinders are returned to the filling plant, they must be checked to ensure the brand(s) belong to the rightful owners, they must be checked to ensure they are 'in date' and all other relevant visual checks done before filling

- Any sealing plastic residue and labels should be removed and the cylinder should be thoroughly externally washed. Where necessary cosmetic repainting of the cylinders should be carried out

- The cylinders of other brands must be separated for return to their rightful owners

- Hazard warning information must be securely in place on the cylinder, legible, and in the correct language

- Approved filled cylinders should be labeled to identify their location and date of filling for traceability and a seal confirming weight assurance and suitability of the filler. It is recommended that the materials for these seals and labels be environmentally friendly

- The tare value is fundamental for the filling of the cylinder by weight, therefore a specification with tolerances defined according to local legislation must be applied. This marking must be clear and visible, with appropriate shapes and sizes to maintain readability, even after repainting

- Any cylinders subjected to requalification must have this information revalidated

- To protect the cylinder brand, under the Brazilian Resolution ANP No. 49/2016 LPG distributors are required to only fill and market LPG cylinders carrying their own brand.

- In Brazil, a distributor may only fill transportable LPG cylinders carrying another brand under special circumstances. For example, when the LPG distributor has been previously contracted with another distributor, within the limits and locations established in that legal instrument. This does not exempt the brand owner in case of loss, according to the law.

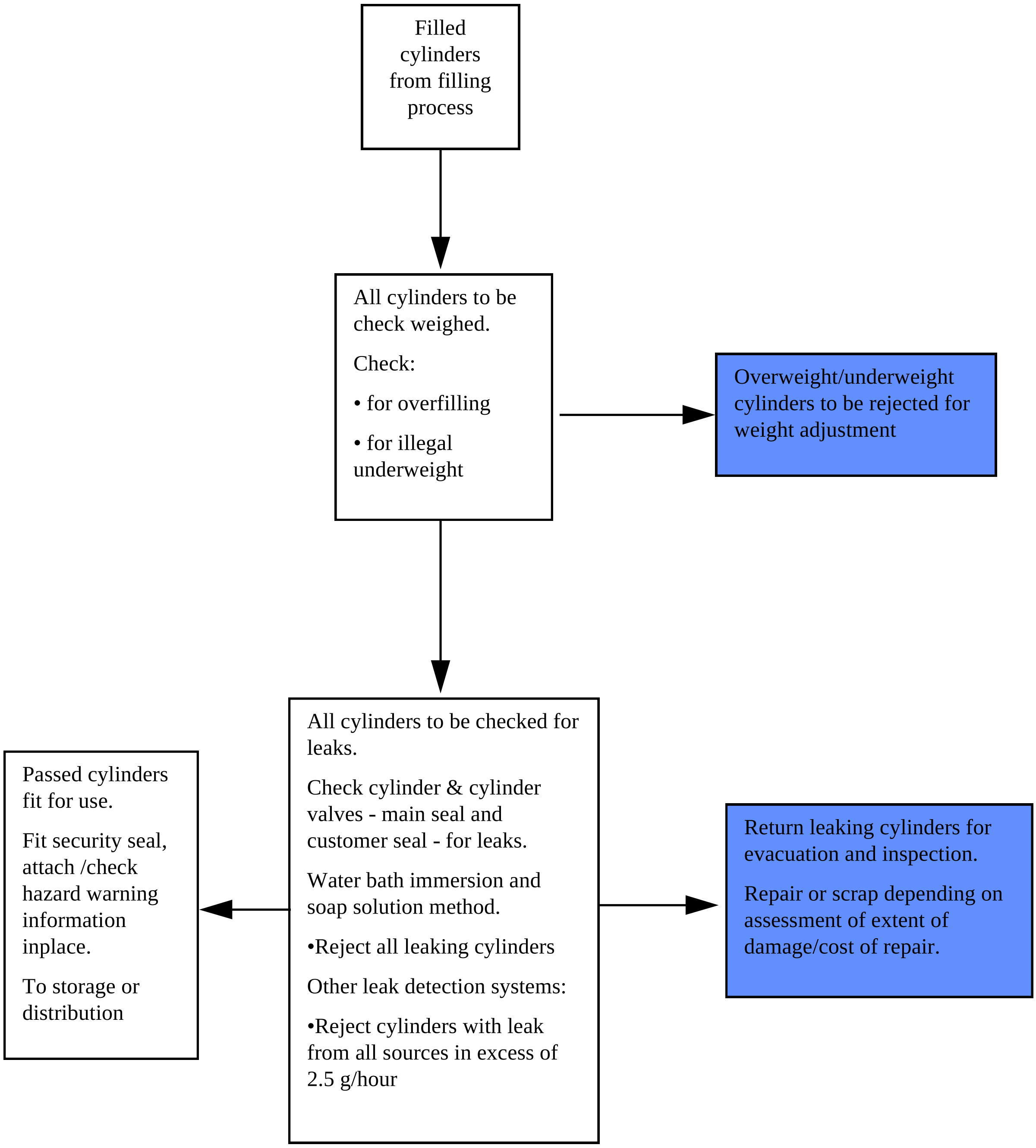
- Through the Brazilian Self-Regulatory Code, which was signed in 1996, LPG distributors must have facilities to refill and re-qualify transportable LPG cylinders of their respective brand. There must be no refilling of competitor brands. Those cylinders received must be exchanged with their respective owners.

- The identification mark on the LPG cylinder serves to meet the requirements of the ANP and the principles of the Code of Consumer Protection, ensuring the civil liability of the distributor to the consumer.

- This identification also serves to meet the responsibilities demanded to inspect and requalify cylinders, as well as controlling the other responsibilities of the distributors such as the cylinder population under their control.

- The LPG distributor is responsible for visual inspection, re-qualification, preventive and corrective maintenance and destruction of all LPG cylinders carrying his brand and under his responsibility.

Figure 7.2
After Filling Checks on Cylinders



7.3 Emergency Shut-Down Systems and Alarms

All filling plants must have a clearly defined emergency shut-down system which stops the transfer of liquid and vapour between storage and filling plant and *vice versa.*

The scope, location, means of operation and operational effects of the emergency shut-down and alarm systems must be included in the on-site emergency plan.

The operation, maintenance and periodic checking of the systems shall be written up as a procedure and included in the plant operating manual.

As a minimum, a cylinder filling plant shall incorporate the following:

- A remotely operated fail safe and fire safe emergency (ESD) valve located in the LPG (liquid) pipeline prior to its entry into the plant with actuation points at manned locations in the plant, e.g. filling scales, check weighing etc. Consideration must be given to the location of the ESD valve opening controls and the provision of interlocks to prevent the valve being opened during an emergency or when closed during maintenance of the plant. (Consideration should also be given to linking the shutdown of the ESD valve, alarm, fire pump start-up, opening up fire main and pump motors in a single system)

- A non-return valve in the liquid return line

- Emergency stops, to shut down the LPG pump motor(s), located at manned stations in the plant. (Refer above regarding linking of emergency systems)

- Emergency stops to shut down carousels and other mechanised cylinder handling equipment, e.g. conveyors, tilting tables etc. (Refer above regarding linking of emergency systems)

- Audible emergency alarm system. (Refer above regarding linking of emergency systems)

In LPG plants, the preference is for the ESD system, alarm and start-up of the fire-fighting system to be linked such that the activation of the alarm will shut-down ESD valves and start the main fire pumps and open any remotely operated valves in the fire-water main.

Where an LPG plant forms part of a larger complex storing other hazardous products, a detailed assessment should be made of the benefits and disadvantages of linking the alarms and ESD systems of the two areas before a decision is made to go ahead.

Alarms may be activated manually, normally push-button, or by sensing devices, e.g. gas detectors, heat sensors.

Manual systems should be located at easily accessible and clearly defined points throughout the site in areas which are regularly manned. Consideration should be given to positioning an alarm actuation point outside the plant.

Alarms must be clearly audible over the area likely to be affected by an emergency in the LPG plant. The method of communicating with the emergency services should be agreed and procedures put in place to ensure a rapid and appropriate response to calls for assistance.

It is essential that neighbouring businesses or residential areas be engaged in in any emergency response planning, including recognition of the various alarms in use.

Consideration should be given to liaising with the emergency services to conduct simulation exercises to plan for a real event.

7.4 Fire-fighting/Prevention and Plant Evacuation

Emergency procedures covering identification of personnel involved in handling emergencies, mustering points, preparation and use of fire-fighting equipment, liaison with the local emergency services, site personnel training/joint training exercises and site evacuation should be drawn up as an emergency response plan, for handling emergencies affecting the plant and exposed offsite areas. The procedures must be clearly written up and be available for use at plants.

The emergency response plan must meet the requirements of local legislation and be based on a systematic evaluation of the plant design and operating procedures. It should take into account failure modes and their consequences, the likelihood of failures occurring and the emergency resources available.

The safety of emergency personnel and any necessary offsite actions, e.g. road closures, warnings to local residents, etc., should also be considered in the plan.

Evacuation routes and safe assembly areas for personnel not involved in the emergency procedures should be identified in the plan and marked on the ground. Evacuation routes must be kept clear of obstructions at all times.

An audible, and where necessary visual, alarm system must be installed capable of covering the total area of the plant, and sensitive surrounding areas.

Chapter Eight

Storage and Distribution of Cylinders

8.1 General

Standards for the storage of cylinders in depots and other locations are outlined in the UK's Health and Safety Executive publication, Chemical Safety 4 (CS4) *The keeping of LPG in cylinders and similar containers*. Companies marketing LPG can obtain a copy of this publication for inclusion in their LPG Manual.

In CS4 the definition of the physical properties of the commercial grades of butane and propane relate to the UK (BS 4250. Part1).

The UK HSE publications CS8 *Small scale storage and display of LPG at retail premises* and CS6 *The storage and use of LPG on construction sites* are referred to in CS4.

8.2 Safe Location of Cylinder Storage Areas

The requirements for the storage of cylinders in association with filling plants is covered in CS4. Generally all storage at filling plants should be in the open air. Where cylinders are stored in buildings at filling plants, it only should be a temporary arrangement, e.g. off-loaded awaiting filling or filled prior to loading.

Paragraph 7 of CS4 applies only to the UK but local legal requirements controlling the storage of LPG must always meet local requirements.

The area classification of outdoor areas and buildings used for storing LPG cylinders is given in 6.3.

8.3 Storage and Handling

The following applies to the storage and handling of LPG cylinders at all locations:

Cylinders are normally stored using one of the following methods:

- Free standing with cylinders stacked one above the other with the bottom of the upper cylinder sitting on the shroud of the lower

- Set out on standard flat pallets stacked vertically with the bottom of the upper pallet sitting on the shrouds of the cylinders on the lower pallet

- Stored in purpose built pallets designed to stack one above the other with the locating device on the frame of the upper pallet registering on the stacking/locating device of the lower pallet

- Stored in purpose built cages, generally for use at retail premises

Cylinders should preferably be stacked vertically with the valve in the vapour space. Cylinders with pressure relief valves (PRV's) must be stacked vertically with the PRV in direct connection with the vapour space.

For the storage and distribution of composite LPG cylinders, the instructions and manuals from the manufacturer must be observed and followed.

The maximum amount of LPG that may be stacked in a vertical column are given in *Table 8.3*. Despite the recommendations given below it is important that the stack height is within the safe operating lift of the FLT and that the proposed stacking arrangement does not contravene local legislation.

The amounts for flat pallets and non-palletised stacks are taken from CS4. Note that the reference to pallets in CS4 is to the flat type.

Table 8.3 Amount of LPG that may be stacked vertical columns

Cylinder water capacity kg	Amount of LPG in any vertical column		
	Purpose built stacking pallets kg	Flat pallets kg	Non-palletised kg
Up to 6	Refer Note 1 below	35	30
from 6 to 15		75	45
from 15 to 20		80	50
from 20 to 55		110	55

Note 1 - the stack height of purpose made pallets must not exceed the maximum recommended by the manufacturer nor must the height exceed the maximum safe lift height of fork lift trucks working with the pallets. Stacks must not be higher than 5m above ground level

Cylinders must be stored vertically with the valve in an upright position. Guidelines from Brazil are shown in *Tables 8.3a & 8.3b* below. The maximum limit for each lot shall be determined by the potential for the heat load equivalent to the amount of 480 cylinders of 13kg, (i.e. 6,240kg of LPG) stored in any types and sizes of cylinders over an area of up to 20m2. More than one lot of cylinders must have a minimum gap of 1m between them. These storage areas for cylinders must comply with the safety requirements set out in *Table 6.1*.

Table 8.3a

Stacking of LPG Cylinders		
Mass of LPG Liquid in Cylinder	**Full LPG Cylinders**	**Partially Full or Empty Cylinders**
Less than 5kg	Max. stack height is 1.5 m	Max. stack height is 1.5 m
5 kg to less than 13kg	Up to 5 cylinders	Up to 5 cylinders
13kg	Up to 4 cylinders	Up to 5 cylinders
For LPG cylinders containing more than 13kg, vertical storage only and no stacking		

Table 8.3b

LPG Cylinders on Pallets				
	Mass of LPG Liquid in Cylinder			
	5kg	**12kg**	**20kg**	**45kg**
Max. allowable stacking in storage	2 pallets	6 pallets	2 pallets	2 pallets
Max. allowable stacking during transport	1 pallet	4 pallets	1 pallet	1 pallet
Max. no. of LPG cylinders/pallet (full, partially full or empty)	240	35	42	29

Pallets used for transporting cylinders must be approved by the manufacturer to be certified suitable in terms of safety and stability for the proposed operation. All restrictions in the use of pallets in transporting cylinders, whether by the manufacturer or others, must be fully observed.

In setting out a storage area and gangways, attention must be given to the need for easy access to all parts of the store for operational and emergency purposes. Gangways must be wide enough for manhandling cylinders and for easy manoeuvring of mechanical handling equipment and, where appropriate, pallets.

When moving cylinders, they should not be rolled on their sides but on their base rings or carried manually using the handles provided or on suitably designed mechanical handling equipment, e.g. powered or gravity conveyors, handling trolleys, fork lift trucks, etc. Refer to section 6.3 regarding restrictions on FLT's operating in hazardous areas. All mechanical handling equipment shall be operated in accordance with the manufacturer's instructions and only by suitably trained personnel.

8.4 Palletised Systems

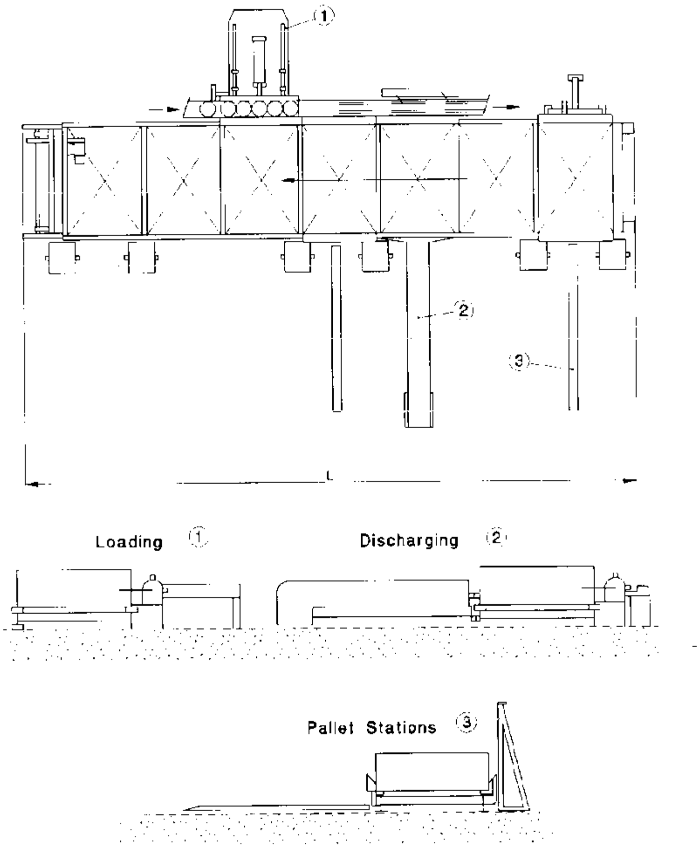
Where large numbers of cylinders of the same size are handled in consideration should be given to palletisation of the distribution system from the filling plant through the distribution channel to the retailer.

This type of handling can only be introduced following agreement with the distributors, dealers and retailers.

A typical palletisation system at the filling plant consists of a pallet conveyor or pallet track, stations for laying down and picking up the pallets (similarly through the distribution channel) and cylinder loading and unloading devices. Refer to *Figure 8.4* below

Example of a palletising system

Figure 8.4
Schematic Palletised System



- Pallets, filled with empty cylinders returned for filling, are placed on the pallet track at the 'laying down station' using a Fork Lift Truck (FLT). The pallet is then moved to the unloading device which removes the cylinders from the pallet, one row at a time, and positions them on the filling line conveyor to commence the filling process. The unloading device is generally equipped with a mechanical pallet side opener, a hydraulic ram to push the cylinders out of the pallet and onto the filling line and various interlocks to ensure correct positioning of the pallet. Pallets are moved along the pallet track, after they have been emptied, to the position for loading with filled cylinders

- Filled cylinders leaving the plant on the filling line conveyor are automatically loaded into pallets pre-positioned on the pallet conveyor. Interlocks ensure the correct number of cylinders are lined up in the right location ready for loading and a hydraulic/pneumatic ram pushes a row of cylinders into the pallet until it is fully loaded. The pallet side is then locked into position and the pallet moved by FLT to the transport vehicle or storage area

The design of palletisation systems should be assigned to approved suppliers.

To prolong the asset life and protect the strength of the pallet all components should be galvanised to reduce corrosion risk.

Palletised system

8.5 Distribution by Road

Distribution from filling plants and large volume deliveries between storage depots and to consumers. Road vehicles used in cylinder distribution may be rigid, semi-trailer or draw-bar trailer configuration depending upon local legislation and must comply with the following:

- Although a compression ignition type engine is preferred there are circumstances where spark ignition engines can be used with the necessary precautions (NFPA 58) and they must be fitted with a spark arrester

- The cab of the vehicle should preferably be separated from the load compartment by the back of the cab

- The load compartment must be of open, preferably caged, construction

- Means must be provided to secure the load of cylinders while in transit

- Means to ensure the vehicle is prevented from moving during loading or unloading operations (braking interlocks, wheel chocks or similar)

- Cylinders must be loaded upright, with the valve and pressure relief valve in the vapour space

- A 2.5kg dry powder fire extinguisher must be installed in the cab and at least two 9kg dry powder extinguisher fitted in an easily accessible position on the vehicle's chassis or body

- Where windows are fitted in the back of the cab they must be of wired or laminated glass and not capable of being opened

- The vehicle's fuel tank must be protected from impact by mechanical means or its location

- Cab heaters, other than those operated from the vehicle's engine, must not be installed

- The battery must be fitted with terminal guards and an easily accessible cut-off (isolation) switch installed in the supply cable

- Gas detection equipment should be considered to identify potential gas leaks

All vehicles entering the plant must be properly maintained and in a safe condition to enter a zone 2 hazardous area and undertake deliveries of LPG cylinders.

Vehicles which clearly demonstrate faults which could prejudice the safety of the vehicle and its load should not be loaded, e.g. vehicles with excessive tyre wear, unsafe wiring, leaking fuel tanks and damage to the chassis/body.
There must be appropriate check procedures in place to control the fitness for purpose of all vehicles engaged in the distribution of LPG cylinders.

Vehicles are not to be loaded more than their maximum gross vehicle weight or the limits on individual axles.

All vehicles must carry hazard warning signs as required by local legislation which must include signs for use in the event of a vehicle breakdown.

The following *Table 8.5* is used in Brazil and sets out some requirements for vehicles involved with LPG distribution.

Notes referring to *Table 8.5* below:

1. Brazilian Law reference only
2. Brazilian State Law reference only
3. Brazilian State Law reference only
4. Brazilian State Law reference only
5. Placard or Sticker can be black and white, or coloured
6. Link to Brazilian Legislation only
7. Forbidden at the point of sale (Trucks cannot be point of sale)

Table 8.5

Summary Table (1.)	**Motorcycle with Sidecar**	**Motorcycle with Trailer**	**Tricycle**	**Truck with 3.5MT GVM**	**Truck with 16.0MT GVM**
Transport of LPG Cylinder in Vertical Position Only. (For 20kg LPG cylinder, horizontal transport is allowed)	Yes, with max. at 13kg LPG	Yes (2.)	Yes	Yes	Yes
Permissible Stacking of LPG Cylinders during Transport	Only permitted if lateral support is provided (3.)	Only permitted if lateral support is provided (3.)	Only permitted if lateral support is provided (3.)	Only of lateral and rear protection and support is provided. Use chains or straps to secure	Only of lateral and rear protection and support is provided. Use chains or straps to secure
Transport of LPG Cylinders of 20kg to 45kg	Prohibited (4.)	Yes	Yes	Only of lateral and rear protection and support is provided. Use chains or straps to secure	Only of lateral and rear protection and support is provided. Use chains or straps to secure
Identification on side of vehicle – painted, sticker or magnetic (5.) must show: - Business Name - Business Address - Agent No. (6.) / Licence Number	Yes, at side or rear of side-car	Yes, at side or rear of trailer	Yes, at side or rear of tricycle	Yes	Yes
Emergency Card	No	No	No	Yes, if LPG load exceeds 333kg	Yes, if LPG load exceeds 333kg
Transport Manifest	No	No	No	Yes, if LPG load exceeds 333kg	Yes, if LPG load exceeds 333kg
Company Details / Identification	Yes	Yes	Yes	Yes	Yes
Risk Identification (similar to HAZCHEM Code)	No	No	No	Yes, if LPG load exceeds 333kg	Yes, if LPG load exceeds 333kg
Commercial Delivery Document with Customer Details	Yes	Yes	Yes	Yes	Yes
Delivery Schedule with Stock Balance (7.)	Yes	Yes	Yes	Yes	Yes

Appendix One

LPG Properties and Hazards

1.1 **LPG** comprises Commercial Propane, Commercial Butane, Propylene and Butene and mixtures thereof. They are hydrocarbon gases that can be changed into a liquid and changed back into a gas by the simple application and release of pressure.

1.2 **Density** – LPG vapour is heavier than air and tends to gather at low areas such as drains, pits, cellars and other depressions. As a colourless liquid, LPG occupies around 0.4% of its vapour volume, but is about half the density of water and will float on water before vaporising

1.3 **Cooling effect** – LPG liquid vaporises and cools rapidly; it can therefore inflict severe cold burns if it came in contact with bare skin

1.4 **Non-toxic** – LPG is not toxic. However it has an anaesthetic effect when mixed in high concentrations with air. The greater the concentration (i.e. as available oxygen declines), the greater the risk of asphyxiation

1.5 **Smell** - What people know and recognise as the 'LPG smell' is usually added to LPG before distribution. This smell can be detected if the LPG content of air is as little as 0.4% (or just 20% of the lower limit of flammability). However, odour is not the only means of detection. Large leaks will also be obvious through hissing or condensation or frosting around the leak; small leaks will show up as bubbles if detergent mixed with water is applied to the suspected leak area. **NEVER try to detect leaks with a naked flame or other kinds of ignition!**

1.6 **Flammability** – LPG can ignite when it forms between 2 and 10% of a vapour/air mixture, so the risks associated with poor handling, storage or usage should be obvious. Uncontrolled ignition of LPG can cause serious fires or explosions (i.e. if ignited within a confined space). A fire started some distance from an LPG leak can very quickly travel back to the source of the leak itself. An LPG cylinder involved in a fire may overheat and rupture violently. The power and intensity of an LPG fire or explosion should never be underestimated

1.7 **Liquid Expansion** – LPG liquid has a high coefficient of expansion. Tanks, cylinders, pipelines and equipment must be protected against the high pressure resulting from liquid expansion with temperature rise.

Table A1 overleaf shows some typical physical properties of LPG

Table A1

Typical Characteristics of Propane and Butane **PHYSICAL PROPERTY**	**COMMERCIAL PROPANE**	**COMMERCIAL BUTANE**
Litres/tonne of liquid at 15ºC Litres/kg of liquid US barrels/tonne	1,965 – 2,019 1.96 - 2.02 12.4 – 12.7	1,723 – 1,760 1.72 - 1.76 10.8 – 11.1
Relative density (to water) of liquid at 15ºC	0.50 - 0.51	0.57 - 0.58
Ratio of gas to liquid volume at 15ºC and 1015.9 mbar	274	233
Relative density (to air) of vapour at 15ºC and 1013.25 mbar	1.40 - 1.55	1.90 - 2.10
Volumes of gas/air mixture at lower limit of flammability from 1 volume of liquid at 15ºC and 1015.9 mbar	12,450	12,900
Boiling point ºC	Minus 45	Minus 2
Vapour pressure at 0ºC barg	4.5	0.9
Vapour pressure at 15ºC barg	6.9	1.93
Vapour pressure at 38ºC barg	14.5	4.83
Vapour pressure at 45ºC barg	17.6	5.86
Upper limit of flammability, % v/v	10.0	9.0
Lower limit of flammability, % v/v	2.2	1.8
Gross calorific value MJ/m^3 dry	93.1	121.8
BTU/ft^3 dry	2,500	3,270
MJ/kg	50.0	49.3
BTU/lb	21 500	21 200
Net calorific value MJ/m^3 dry	86.1	112.9
BTUu/ft^3 dry	2,310	3,030
MJ/kg	46.3	45.8
BTU/lb	19,900	19,700
Latent heat of vaporisation kJ/kg at 15 °C Latent heat of vaporisation BTU/lb at 60 °F	358.2 154	372.7 160

Appendix Two

Calculation for Maximum Fill Quantity

A.2.1 Calculation of Safe Filling by Weight

The safe fill weight is given by:

Q_f = 0.97* x V x g_l - (allowance for tare and filling errors)

*(some countries use 0.85)

Where: Q_f = maximum safe fill, kg

V = water capacity of the cylinder, litres

g_l = density of LPG at the assessed temperature, kg/litre

Densities of commercial LPG's vary considerably and in the above equation, the lowest value in the product specification range should be taken to ensure safe filling at all times. Where the proper facilities exist, it is possible to control the density by mixing product. This can give great cost savings in marginal cases, e.g. 14.5kg versus 15kg into a 30 litre cylinder.

The actual safe fill quantity used in filling operations in which the quantity is expressed as a mass should be rounded down to not less than the nearest 0.1kg e.g. a calculated safe fill of 11.19kg would become 11.1kg.

A.2.2 Calculation of Safe Filling by Volume

The safe filling volume is given by:

V_f = 0.97* x V x g_i / g_L - (filling and tare weight errors)

*(some countries use 0.85)

Where: V_f = maximum safe fill volume, litres

V = water capacity of cylinder allowing for internal fittings, litres

g_i = density of LPG at assessed temperature, kg / litre

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

A.2.3 Fill Errors

Measured tare weights should be rounded down as a margin of safety for use in safe calculations as shown in Table A.2.3 below. Rounding down means reducing the tare weight scale reading to the nearest scale division (of a typical cylinder filling machine) stated in the table, e.g., a tare weight scale reading of 5.186kg would be recorded as 5.15kg whilst a reading of 5.10kg would not be rounded down.

Table A.2.3 Fill Error

CYLINDER LPG CAPACITY, kg	ROUND DOWN FACTOR, kg
Up to 10kg	0.05
Above 10kg and up to 20kg	0.10
Over 20kg	0.20

A.2.4 Fill Tolerances

Typical filling tolerances are shown in Table A.2.4 below. Local regulations may require other tolerances to be adopted. When calculating the safe fill quantity the positive tolerance is to be deducted in the equation.

Table A.2.4 Fill Tolerances

CYLINDER LPG CAPACITY, kg	ROUND DOWN FACTOR, kg
Below 15kg	+ 0.10/ -nil
15kg and above	+ 0.20/ -nil

Note: +/- tolerances may be adopted for cylinder fill quantity (e.g. +/- 0.1kg) where permitted by local regulations.

Appendix Three

Description of Steel Cylinder Defects

DEFECTS	DESCRIPTION
BULGE	Visible swelling of the cylinder
DENT	A depression in the cylinder that has neither penetrated nor removed metal, and its width at any point is greater than 2% of the external cylinder diameter. See Fig A.3.1 below
GOUGE	A sharp impression where metal has been removed or re-distributed
INTERSECTING CUT OR GOUGE	The point of intersection of two or more cuts or gouges
DENT CONTAINING CUT OR GOUGE	A depression in the cylinder within which there is a cut or gouge. See Fig A.3.5 below
CRACK	A split or rift in the cylinder shell
LAMINATION	Lamination may show itself in the form of crack or bulge
ISOLATED CORROSION PITS	A pitting of metal occurring in isolated areas. A concentration not greater than 1 pit per 500 mm^2 of surface area
AREA CORROSION	Reduction in wall thickness over an area not exceeding 20% of the cylinder surface
GENERAL CORROSION	A reduction in wall thickness over an area exceeding 20% of the cylinder surface. See Fig A.3.2 below
CHAIN PITTING OR LINE OR CHANNEL CORROSION	A series of pits or corroded cavities of limited width along the length or around the circumference
CREVICE CORROSION	Crevice corrosion occurs in the area of the intersection of the foot-ring or collar with the cylinder
DEPRESSED BUNG	Damage to the bung, which has altered the profile of the cylinder
ARC OR TORCH BURNS	Burning of the cylinder base metal, a hardened heat affected zone, the addition of extraneous weld metal, or the removal of metal by scarfing or crating
FIRE DAMAGE	Excessive general or localised heating of a cylinder usually indicated by: a)Charring or burning of paint; b)Fire damage of the metal; c)Distortion of the cylinder; d)Melting of metallic valve parts; e)Melting of any plastic components, e.g. data ring, plug or cap. See Fig A.3.3 below
Weld Leaks	Pinhole leaks in welds

Source: ISO 10691:2004 (The rejection limits will be found in this ISO document)

Fig. A.3.1 Examples of dent defects

Fig. A.3.2 Examples of corrosion defects – General (right) and Corrosion pits (left)

Fig. A.3.3 Examples of fire damage

Fig.A.3.4 Example of Collar damage

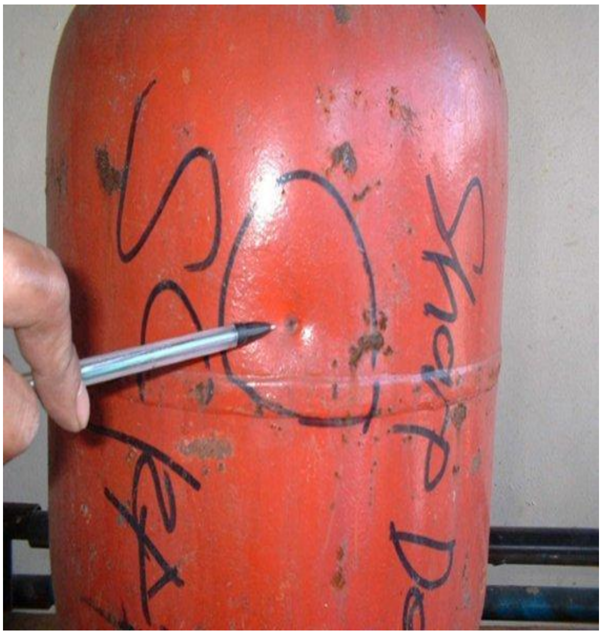


Fig.A.3.5 Example of gouge defect

Appendix Four

Procedures for Gas-freeing Cylinders

A.4.1 Emptying of Liquid

Evacuate liquid from the cylinder using a compressor and holding tank before pumping back to main storage.

A.4.2 Gas Free

Reduce the vapour content to less than 1% of the lower flammable limit by volume in air. The gas content should be measured by an explosimeter (flammable gas detector) which is regularly calibrated for accuracy according to the manufacturer's instructions. Cylinders which have been gas freed should be clearly identified and controlled by a system which prevents mixing of gas free and non-gas free cylinders. Any cylinder which is gas-freed and then not immediately processed should be re-certified gas-free before reprocessing. Proper care should be taken to avoid contamination of the environment by wastewater, oily residues, odour emissions, etc. Gas-freeing can be achieved by one of the following methods:

A) Using Steam

- Remove the valve using the proper tool for the valve type.
- Invert the cylinder over a collecting system to drain out any heavy ends which might be present.
- Insert a steam probe of about half the bung diameter into the cylinder. The cylinder and steaming equipment should be electrically bonded and earthed since steam jets generate static electricity.
- Continue steaming for at least 15 minutes.
- Check and certify that the cylinder is gas free using an obstructed valve test or "whisper" test.

  NOTE: If the cylinder contained heavy ends, a flammable atmosphere could re-generate in the cylinder after the above procedure. If the presence of heavy ends was suspected, cylinders should be re-checked for the gas free condition 15 minutes after the first test.

B) Using Water

- Remove the valve using the proper tool for the valve type.
- Invert the cylinder over a collecting system to drain out any heavy ends which might be present.
- Fill the cylinder with water and allow to stand until no more bubbles are seen.
- Empty out the water into a suitable collecting system for treatment.
- Re-fill the cylinder with fresh water and allow to stand for 24 hours.
- Empty out the water into a suitable collecting system for treatment.
- Check and certify that the cylinder is gas free.

Appendix Five

Procedures for De-denting of Cylinders

This procedure should only be done by qualified personnel. After gas freeing (see Appendix Four):

- Charge the cylinder with nitrogen to a maximum of 5.5 bars. A pressure relief valve should be fitted into the nitrogen supply line.
- Gently apply flame from an oxygen-LPG torch to the dent. The flame should be neutral since an oxygen rich flame will burn the metal of the cylinder.
- Maintain the flame until the dent is seen to move out.
- Remove the flame and if necessary dress the surface with light blows using a wooden mallet.
- Allow the cylinder to cool in still air.

The temperature for de-denting should be about 850^{o}C. The temperature can be assessed from the colour of the steel during heating using the table below. Cylinders heated to above this temperature can be damaged by cracking. Overheated cylinders should be scrapped.

The actual pressure of nitrogen required to remove a dent at this temperature will vary with the size and shape of cylinder and this can be found by experience. The maximum pressure should not exceed 5.5 bars.

COLOUR	TEMPERATURE RANGE ^{0}C
Dark cherry red	700 - 750
Cherry red	750 - 825
Bright cherry red	825 - 875
Bright red	900 - 950
Orange	950 - 1000
Light orange	1000 - 1050
Lemon	1100 - 1200
White	1200 - 1300

Appendix Six

Procedure for Requalification of Cylinders

A.6.1 Interval Between Periodic Requalification

The following criteria should be addressed when determining the interval between periodic requalification in applying procedures such as ISO 10464 and EN 1440 for requalification:

A.6.1.1 Whether the cylinders are designed, manufactured and tested to internationally recognised standards, e.g. ISO22991, a national standard or an equivalent

A.6.1.2 Whether there is a system of external protection against corrosion, which is being maintained

A.6.1.3 Whether the cylinders are being filled in accordance with the criteria contained in an internationally recognised standard, e.g. ISO 10691, a national standard or an equivalent

A.6.1.4 Whether the cylinders are filled with LPG of a quality in accordance with a specification/standard acceptable to a competent body, such that internal corrosion is not caused

A.6.1.5 Whether the cylinders are under the control of filling plant responsible for their distribution, filling and maintenance

A.6.1.6 When criteria A.6.1.1 to A.6.1.5 inclusive is fulfilled, a 15 year interval could apply but subject to the approval of a competent authority.

A.6.1.7 When criteria A.6.1.1 and A.6.1.2 are fulfilled, a 5 year interval could apply.

A.6.1.8 When criteria A.6.1.1 and A.6.1.2 and at least one of either, A.6.1.3, A.6.1.4, or A.6.1.5 are fulfilled, a 10 year interval could apply.

In Brazil, the requalification standard is NBR 8865 with the initial term being 15 years and then every 10 years for all transportable steel containers manufactured according to ABNT NBR8460

A.6.2 Internal Visual Inspection

A.6.2.1 **Preparation of Cylinders**

- The cylinders should be emptied of liquid and de-pressurised in a safe and controlled manner before proceeding. De-pressuring is confirmed using an obstructed valve test or “whisper” test.
- Cylinders with inoperative or blocked valves should be brought to a place for safe de-pressuring and valve removal.
- Valves should be removed from cylinders for inspection and maintenance.

A.6.2.2 **Procedure**

- Where necessary, residual liquid, loose scale, and any other foreign matter should first be removed from the interior. Cylinders should then be inspected internally for any sign of corrosion or other defects that may affect their integrity, using a safe inspection lighting system with appropriate internal illumination.
- Cylinders showing signs of internal corrosion, unless these signs are just surface rust, should be scrapped.
- If cleaning is required care should be taken to avoid damaging the cylinder walls. Cylinders should be re-inspected after cleaning.

A.6.3 Hydraulic test

A.6.3.1 Test Fluid

- A fluid should be used as the test medium, e.g. water

A.6.3.2 Preparation of Cylinders

- The cylinders should be emptied of liquid and de pressurised in a safe and controlled manner before proceeding.
- Cylinders with inoperative or blocked valves should be brought to a place for safe valve removal.
- Valves should be removed from cylinders for inspection and maintenance, or replacement.
- If the cleaning method involves the wetting of the outside surface, the outside surface should be completely dried before commencing the hydraulic test procedure.

A.6.3.3 Test Equipment

- All rigid pipework, flexible tubing, valves, fittings, and components forming the pressure system of the test equipment, should be designed to withstand a pressure of 1.5 times the maximum test pressure of any cylinders to be tested. Flexible tubing should have characteristics to prevent kinking.
- Pressure gauges should be used to read the cylinder test pressure with an accuracy of at least 2%. They should be checked at regular intervals and in any case not less frequently than once a month. The design and installation of the equipment, and the cylinders connected to it should ensure that no air is trapped in the system.
- All joints within the system should be leak tight.
- A device should be fitted to the test equipment to ensure that no cylinder is subjected to pressure in excess of its test pressure by more than the tolerance given.

A.6.3.4 Procedure

- The test pressure should be established from the marking on the cylinder.
- More than one cylinder may be tested at a time as long as they all have the same test pressure.
- Before applying pressure, the external surface of the cylinder should be in such condition that any leak can be detected. The cylinder should be positioned so that welds are visible during the test.
- The pressure should be increased gradually in the cylinder until the test pressure is reached.
- The test pressure should not be exceeded by more than 10% or 2 bar, whichever is the lesser.
- The test pressure should be held for the time necessary to carry out the test.
- If there is a leakage in the pressure system, it should be corrected and the cylinders retested.
- Cylinders that do not leak or show any permanent distortion should be deemed to have satisfied the requirements of the hydraulic test.
- Any cylinders that fail should either be rejected or, in the case of cylinders which leak through pinholes at the weld, be examined by a competent person to determine whether they can be repaired by welding.

References

WLPGA – Guidelines for Good Safety Practices in the LPG Industry

WLPGA – Guidelines for Good Business Practices in the LPG Industry

WLPGA – Guide to Cylinder Management

ISO 22991 - Gas cylinders -Transportable Refillable Welded Steel Cylinders for Liquefied Petroleum Gas (LPG) – Design and Construction

ISO 10691 - Gas Cylinders – Refillable welded steel cylinders for liquefied petroleum gas (LPG) -- Procedure for checking before, during and after filling.

EN 1439 - LPG equipment and accessories - Procedure for checking LPG cylinders before, during and after filling

ISO 10464 - Gas Cylinders – Refillable welded steel cylinders for liquefied petroleum gas (LPG) --Periodic Inspection and Testing

BS 5355: 1976 - Specification for filling ratios and developed pressures for liquefiable and permanent gases

EN 1442 - LPG equipment and accessories - Transportable refillable welded steel cylinders for liquefied petroleum gas (LPG) -- Design and construction, European Committee for Standardisation

EN 1440 - LPG equipment and accessories - Transportable refillable welded steel cylinder for LPG -- Periodic requalification,
European Committee for Standardisation

UK LPG Association - Code of Practice 12 Recommendations for the Safe Practice in the Design and Operation of LPG Cylinder Filling Plants

UK's Health and Safety Executive

Kosan Crisplant (www.kosancrisplant.com)

Siraga (www.siraga.com)

Brazil - ABNT NBR 15186 - LPG Storage, bottling and distribution base - Design and construction

Brazil - ABNT NBR 8866 - Transportable Recipients for Liquefied Petroleum Gas (LPG) - Visual selection of the conditions of use in the cylinder plants – requirements

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