L P Gas Safety Manual

BATCHEN

1. SAFE HANDLING OF LPG

What is LPG ?

LPG is Liquefied Petroleum Gas. It can either be in liquid or gaseous form depending on storage pressure / use.

Why is it called Liquefied Petroleum Gas?

Because it is gas produced by the Petroleum Industry which can be liquefied at normal temperatures by the application of moderate pressure.

What is LPG composed of?

It is a hydrocarbon (i.e. a material whose molecules are composed of Carbon and Hydrogen atoms) which may be a pure component or a mixture of components. Generally it is considered to be Propane, Butane, Propylene or Butylene, or mixtures of any of those four components.

What is Propane and Butane?

Chemically they are members of the paraffin family, which have the general chemical formula C_nH_{2n+2} where n is any number, C is a Carbon atom and H is a Hydrogen atom.

For example the members of this family are:

	Chemical Formula	**Component**	**Molecular Weight**	**Critical Temp. ^{0}C**
n = 1	CH_4	Methane	16	- 82
n = 2	C_2H_6	Ethane	30	+ 32
n = 3	C_3H_8	Propane	44	+ 97
n = 4	C_4H_{10}	Butane	58	+152

Molecular weight is the comparative weight of the same volume of gas. Air has a molecular weight of about 28 and thus Methane (which is the major component of natural gas) is lighter than air but all LPG mixtures are heavier than air.

Critical temperature is the temperature at which gas must be cooled before it can be liquefied by the application of pressure. Thus Methane must be cooled to at least –82^{0}C before it can be liquefied and therefore liquefied natural gas must be stored and transported in refrigerated / cryogenic containers. Propane and Butane will liquefy at any temperature below 97^{0}C and 1520C respectively merely by the application of pressure.

What is Propylene and Butylene ?

Chemically they are members of the Olefin family which have the general chemical formula C_nH_{2n}

	Chemical Formula	Component	Molecular Weight	Critical Temp. ^{0}C
n = 2	C_2H_4	Ethylene	28	10
n = 3	C_3H_6	Propylene	42	91
n = 4	C_4H_8	Butylene	58	149

Thus Ethylene must be cooled below 10^{o}C before it can be liquefied by pressure but Propylene and Butylene need only be cooled to 91^{o}C and 149^{o}C respectively.

Where does LPG come from?

LPG may be separated from natural gas or obtained from crude oil while fractional distillation or may be a by-product of an oil refinery or petrochemical plant.

What is LPG used for?

LPG is used as a fuel for domestic and industrial heating or cooking, as an automotive fuel and as a propellant for aerosols. It is also used as a raw material in the production of petrochemicals.

What are its advantages ?

Its advantages as a heating or cooking fuel are that it is readily transported and stored in a liquid form occupying a much smaller volume than natural gas, which cannot be liquefied at normal temperatures. It is clean burning and since it is composed of a minimum of components, combustion is near complete.

Its advantages as a motor fuel are that it is a high calorific value fuel with good combustion characteristics and with low exhaust emissions. It can, as a result, be used in internal combustion engines even in confined spaces such as stores, terminals, etc. Its near complete combustion also reduces contamination of lubricating oil and minimises engine corrosion.

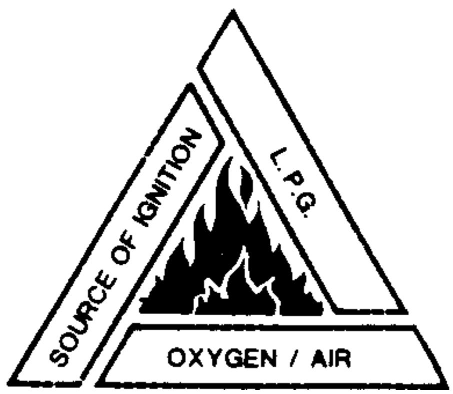
It is used as an aerosol propellant because it is relatively cheap, light in weight and by mixing Propane and Butane can be produced with a variety of vapor pressures as required by the aerosol manufacturer. Unlike fluorocarbons, it does not contribute to the deterioration of the earth's fragile Ozone layer.

2. PROPERTIES OF LPG FOR SAFE HANDLING

Flammability

LPG will burn in either the liquid or vapor form but combustion requires both a source of ignition and a supply of oxygen. These three requirements – LPG, a source of ignition and oxygen – are sometimes called “The internal Triangle”. Remove any one of the three and no combustion can take place.

The basis of safe handling of LPG as far as flammability is concerned is to ensure that it has no contact with either oxygen (air) or a source of ignition.



Thus all storage vessels, piping and equipment must be purged of air (generally by the use of an inert gas such as Nitrogen – see page 9 of 18) before admission of LPG. In addition, equipment must be designed and located to avoid sources of ignition such as electrical sparks, open flames, cigarettes, static electricity or high temperature surfaces. It is worth noting for example that a surface temperature of 460^{o}C may be sufficient to ignite propane under certain conditions (Refer to AS 1596 L.P. Gas Code for design details.)

Notwithstanding all of the above, LPG will only burn if it is mixed with oxygen in the correct proportions. Too much air and the mixture will be too lean to burn (as when a butane cigarette lighter is blown out by a strong puff of breath). Too little air and the mixture will be too rich to burn.

For example, the volume percentage lower and upper flammability limits in air are as follows :

Volume % vapor in air

	Lower flammability	Upper flammability limit
Propane	2.2	9.5
Butane	1.9	8.5
Propylene	2.4	10.3
Butylene	1.7	9.5

Measurement of the flammability of an air / LPG mixture can be achieved with a portable instrument called an Explosimeter, which sucks in a sample of the gas and indicates the result as a percentage of the lower explosive (flammable) limit (L.E.L.). This instrument will register with an air / LPG mixture but will not give accurate results in the presence of an inert gas such as Nitrogen. It must be used only by a fully trained operator.

In summary, the most important requirements to prevent LPG from burning are to keep it separated from air (or oxygen) and a source of ignition. If air is present for any reason, make sure that there is so much of it that the resulting LPG / air mixture is too weak to support combustion.

Volatility

LPG is a very volatile liquid i.e. it vaporises readily. It must therefore be stored under pressure to remain in the liquid form. A measure of the volatility of LPG is its vapor pressure at any temperature. Examples of this are listed below :

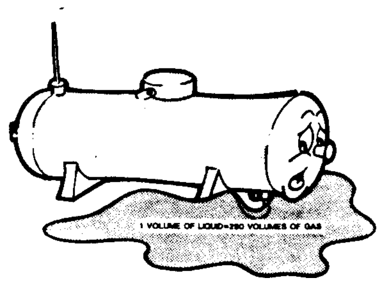
Vapor pressure kPa

Temperature ^{o}C	0	20	40	60
Propane	350	735	1225	1925
Propylene	455	875	1575	2415
Butane	0	98	266	525
Butylene	21	140	350	665

It is obvious that all equipment handling LPG must be designed to withstand the expected pressure plus a margin for safety. Storage tanks and equipment must be protected from overpressure by the installation of pressure relief valves. (Refer to AS 1596 L.P. Gas Code).

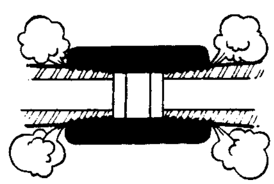
Vapor Formation

LPG is normally stored as a liquid under pressure, but if the pressure is released to atmospheric pressure one volume of liquid will form about 250 volume of vapor. A liquid leak is therefore potentially much more hazardous than a vapor leak.

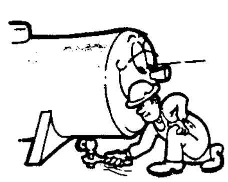


Viscosity

LPG has a much lower viscosity than other fuels and this combined with its storage under pressure means that LPG is one of the most difficult fuels to prevent from leaking.



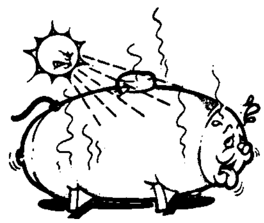
Joints should be welded or flanged wherever possible and screwed joints and unions should be minimised. Special care is required to make sure that threads are clean and sharp before the joint is made and only approved thread compound or P.T.F.E. tape used to make the joint. Leaks can be detected by spraying the equipment with a weak solution of detergent in water. A leak is indicated when a bubble expands.



It is important that any valve with the capacity to discharge to atmosphere (such as a drain valve) be blanked off or plugged so as to reduce the possibility of leakage if the valve does not hold.

Liquid Expansion

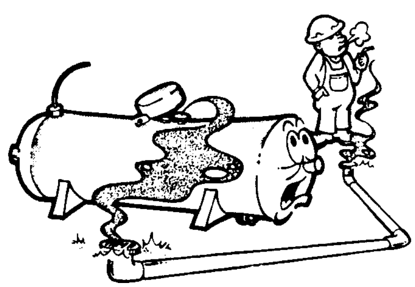
LPG in the liquid phase expands due to increasing temperature to a much greater extent than other fuels and a tank filled with liquid at a low temperature could be dangerously overpressured if the heat of the day expands the liquid. This may cause relief valves to discharge liquid or may even rupture the tank. One litre of liquid when mixed with air can form 12.5 m^3 of flammable vapour.



Storage containers therefore should never be filled more than approximately 85% full (refer to AS 1596 L.P. Gas Code for further details). Similarly, sections of pipe or equipment which can be blocked off at each end may become overpressured due to liquid expansion and must be protected by a hydrostatic relief valve discharging to a safe place.

Vapor Heavier than Air

Vapor released to the atmosphere is heavier than air as indicated on page 1 of 18. Consequently it is unsafe to discharge vapor anywhere near an open drain because it may travel along the drain and emerge somewhere near a source of ignition.



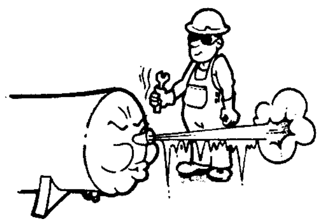
If vapor must be released to the air for any reason it must be released under controlled conditions, in small amounts, and at an elevated level away from a source of ignition. The aim should be to quickly dilute the LPG with air to form a mixture, which is too lean to support combustion. Never release LPG to the atmosphere by cracking flange or breaking a joint unless it is possible to stop the flow in an emergency by shutting a valve.

Pure LPG is Colourless and Odorless

LPG looks like water in the liquid form and like steam in the vapor form but as the vapor expands it quickly becomes invisible. Pure LPG has no smell so special organic sulphur compounds are normally added so that leaks can be detected by smell. In the case of LPG used for aerosol propellants, where unpleasant smell cannot be tolerated, special leak detection equipment is installed.

Cooling Due to Release of Pressure

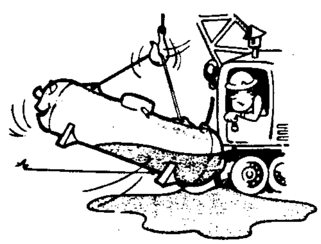
Liquid LPG causes cooling when it vaporises. The heat required to convert liquid to vapor is relatively low (about 1/5 of that required to convert water into steam) and can be supplied by the equipment which is itself cooled in the process. This cooling could, in some cases, reach the point where steel equipment becomes brittle and ruptures. For this reason an empty tank should be pressured with vapor before the admission of liquid.



The vaporisation of liquid can also cause severe burning, cooling skin sufficiently to cause frostbite. If LPG contacts skin, remove the liquid immediately and wash the affected area with water for at least 15 minutes and take medical advice. Protective clothing, gloves and safety glasses should be worn when working on equipment containing LPG.

LPG Liquid is Very Light

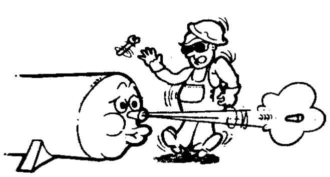
LPG liquid weighs only about half as much as the same volume of water but nevertheless storage tank foundations should be constructed on the assumption that the vessel will at some time be filled with water for testing purposes.



LPG tanks must not be transported when they contain liquid, unless they have been specially designed and constructed for the task. Normal tanks must be emptied of liquid before being lifted. Accidents have happened due to the liquid causing the tank to be unbalanced, resulting in damage to fittings and consequent escape of gas.

"Elastic" Vapor

LPG vapor behaves similarly to other vapors such that an increase in pressure causes a reduction in volume.



Fittings on tanks should never be tightened to fix leaks while the vessel is pressured. Vapor pressure, even when low can exert considerable force when applied to even a small area and failure of a fitting may cause it to be propelled at high velocity.

No Lubricating Qualities

LPG in its pure form has no lubricating qualities and this, combined with low viscosity, means that rubbing surfaces should be constructed of materials which do not generate friction and heat when in contact.

Formation of Hydrates

It is important that piping or equipment which has been pressure tested with water is completely dried before the admission of LPG. This prevents the possible formation of hydrates which may cause blockages rather like snow. This is most likely to occur at points in equipment where pressure drops occur such as points of reduced cross-sectional area.

Asphyxiation

LPG is not poisonous in itself but may cause asphyxiation as it excludes air. Obviously tanks must be completely cleared of gas before they can be entered safely (see page 15 of 18)

Summary of Properties of LPG

1. Flammable
2. Volatile
3. Liquid forms lots of vapor
4. Leaks readily
5. Liquid expands with temperature
6. Vapor heavier than air
7. Can cause asphyxiation
8. Cools on release of pressure
9. Not much heat needed to vaporise
10. No lubricating qualities
11. Liquid is light weight
12. Vapor is ‘elastic’
13. LPG plus water forms hydrates
14. Colourless and odorless (unless odorised)

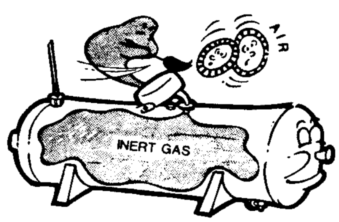
The essence of LPG Safe Handling is to prevent uncontrolled liquid or gas escapes.

3. PREPARING A STORAGE TANK OR EQUIPMENT FOR LPG SERVICE

Note : **The following work should only be carried out by a person experienced in the handling of LPG   In some States, such persons are required to be licensed.**

One of the most important conditions for the safe handling of LPG is the elimination of air from tanks and equipment (see page 3 of 18). It is important both to reduce the possibility of a flammable mixture and to prevent excess pressure condition in the storage tank. Note that the pressure exerted by any air present is added to that of the LPG to give the total pressure within the vessel. On hot days the added air pressure may be sufficient to cause the tank relief valve to lift and the LPG vapor to discharge to the atmosphere.

The elimination of air from the vessel prior to the admission of LPG is called purging and is generally done with an inert gas such as Nitrogen.



In general terms if a vessel full of air at atmospheric pressure is pressurised with an inert gas to a pressure of 100 kPa and subsequently discharged, the gas remaining in the vessel will be 50% air and 50% inert gas. If this mixture is again pressured with an inert gas to 100 kPa and discharged to atmosphere, the gas remaining in the tank will be 25% air and 75% inert gas. The table below gives the percentage of inert gas in the tank after a number of purges.

	% Air Remaining	**% Inert Gas Remaining**
Purge No.1	50.0	50.0
Purge No.2	25.0	75.0
Purge No.3	12.5	87.5
Purge No.4	6.25	93.75
Purge No.5	3.13	96.87
Purge No.6	1.56	98.44

It is generally considered that air is substantially removed by purging four times at 100 kPa. However, an experienced operator may reduce this by adding Nitrogen and withdrawing air at such a rate that mixing of the two is minimised.

Note : One standard cylinder of Nitrogen of capacity 6.8 m^3 will pressure a 9 KL tank to 100 kPa. Other sizes of tank will require proportional amounts of nitrogen.

The process may be quickened by purging with an inert gas at a higher pressure. The following tables list the composition of gas in the tank if the pressure is raised to 300 kPa and discharged to atmospheric pressure.

	% Air Remaining	% Inert Gas Remaining
Purge No.1	25.0	75.0
Purge No.2	6.25	93.75
Purge No.3	1.56	98.44

It is generally considered that air is substantially removed by purging twice at 300 kPa.

Note: Three standard cylinders of Nitrogen each of capacity 6.8 m^3 will pressure a 9 KL tank to 300 kPa. Other sizes of tank will require proportional amounts of nitrogen.

The next step after purging a tank of air is to purge it of inert gas using LPG. This must be done under strictly controlled conditions by an experienced operator and always bearing in mind the following:

1. The gas discharged after purging with LPG will be progressively more flammable after each purging so discharging of gas must not be done in a confined space or close to a source of ignition.

2. Gas discharge after each purging must be discharged at an elevated level (at least 6 metres above ground level) and at such a rate that when mixed with air the resulting mixture is too lean to support combustion. This cannot be checked using an explosimeter (referred to on Page 4 of 18). The Explosimeter does not function correctly in the presence of an inert gas. An instrument called a Tankscope Gas Indicator can be used to give the percentage of hydrocarbon vapor in the mixture of LPG inert gas and air.

3. Do not discharge purge gas from the tank at a high rate, at a low level or during a still day when the gas will have little opportunity to disperse itself as a lean mixture.

4. LPG admitted to a vessel must be in the vapor phase. The admission of liquid LPG may cause severe chilling of the tank at the point of entry due to rapid vaporisation. This may cause a steel tank to become brittle, with increased potential for cracking.

5. Nitrogen is lighter than LPG vapor so it is advisable to admit LPG vapor to the bottom of the tank and draw off vapor from the top of the tank. It is also advisable to admit LPG vapor at one end of the tank and draw off vapor from the opposite end to improve removal of Nitrogen.

6. Discharge must be controlled by operation of a valve, which can be immediately shut if flammable mixtures are detected. It is not satisfactory to discharge vapors by cracking flanges or breaking joints.

The following table gives the percentage of air and inert gas remaining after each successive purge with LPG vapor assuming the vessel had previously been purged four time with inert gas at 100 kPa:

	% Air Remaining	% Inert Gas Remaining	% LPG Remaining
Initial Composition	6.25	93.75	--
Purge No.1	3.13	46.87	50.0
Purge No.2	1.56	23.4	75.0
Purge No.3	0.78	11.72	87.5
Purge No.4	0.39	5.86	93.75
Purge No.5	0.20	2.93	96.87

It is generally considered that purging five times at 100 kPa with LPG vapor is sufficient. However, an experienced operator might reduce this by adding LPG at such a rate that mixing with Nitrogen is minimised.

Note: Approximately 2 kg of propane is required per kilolitre of tank capacity to give 100 kPa tank pressure.

Once again, the process may be quickened by purging with LPG at a higher pressure say 300 kPa.

Assuming a storage tank is purged twice with an inert gas to a pressure of 300 kPa, and subsequently with LPG vapor to a pressure of 300 kPa the composition of gas in the tank after each LPG purge will be:

	% Air Remaining	% Inert Gas Remaining	% LPG Remaining
Initial Composition	6.25	93.75	--
Purge No.1	1.56	23.44	75.0
Purge No.2	0.39	5.86	93.75
Purge No.3	0.09	1.46	98.45

It is generally considered that purging three times with LPG to a pressure of 300 kPa is satisfactory.

Note: Approximately 6 kg of propane are required per kilolitre of tank capacity to give 300 kPa tank pressure.

4. TAKING A STORAGE TANK OR EQUIPMENT OUT OF LPG SERVICE

The essential requirement is to remove LPG liquid and vapor from the tank or equipment safely and this achieved by :

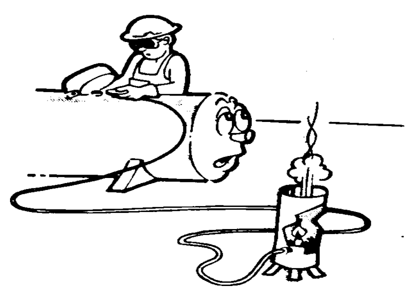
1. The removal of as much liquid and vapor as possible by consuming the LPG for its intended purpose.

2. If this is not possible, the removal of as much liquid and vapor as possible into a road tanker or other transportable container.

3. The removal of the remaining liquid or vapor by flaring off or discharging vapor to atmosphere, each under controller conditions. Never discharge liquid to atmosphere under any circumstances. Flaring is preferable because LPG is immediately burned under controlled conditions. Once again, this should only be done by experienced operators, in possession of a license, if required.

Flaring Off

Flaring off is achieved by burning the remaining liquid or gas in a burner of approved design with all necessary controls.



The burner must be located sufficiently far away from the tank and other combustible material to avoid ignition. A guide would be a minimum of 15m from either for a burner of up to 500 Mj/hr capacity. Larger burners require greater distances and in any case frequent inspections should be made during flaring to ensure that the tank or other combustible material is not affected by the radiant heat emitted by the flare.

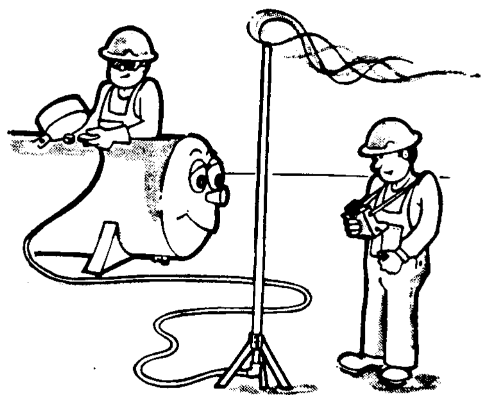
When the burner flame size has diminished, indicating a reduction in tank pressure and therefore a reduction in LPG remaining in the tank, Nitrogen can be added to the tank to assist in the removal of LPG. When the flame finally extinguishes itself it may be concluded that the mixture of LPG and Nitrogen remaining in the tank is not capable of supporting combustion, provided that thorough mixing has been achieved. However, it is recommended that Nitrogen flow be continued for some time to ensure that no pockets of LPG remain.

Discharging to Atmosphere

Discharging to atmosphere can be done safely only if the following minimum precautions are taken:

1. Discharge must be at an elevated level (at least 6 m above ground level) and at such a rate that the resulting mixture with air is too lean to support combustion as checked with an Explosimeter.

   Testing with the Explosimeter should be done in the area beneath the vent, downwind to the limit of the safe area. Any reading above 5% of the lower explosive limit is cause for concern and discharging must be reduced or stopped until the gas is discharged. An experienced (and licensed, if required) operator must be present at all times to ensure that safe conditions are being maintained.



2. Discharge should not be carried out in confined spaces, near sources of ignition, on still days, at low elevations or when the resulting mixture with air exceeds 5% of the lower explosive limit.

Purging with Inert Gas

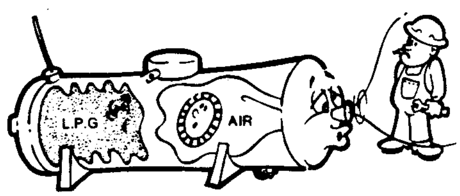
With the tank pressure is reduced to atmospheric pressure, by either flaring or discharging to atmosphere, the remaining LPG vapor must be removed by purging with an inert gas. The principles are similar to those for purging a tank into service, except that the inert gas should be admitted to the top of the vessel and the gas withdrawn from the bottom of the tank at the opposite end to the inert gas inlet. Discharge must be at an elevated level. The table below gives the composition of the gas in the tank, if purged to a pressure of 300 kPa.

	% LPG Remaining	% Inert Gas Remaining
Purge No.1	25.0	75.0
Purge No.2	6.25	93.75
Purge No.3	1.56	98.44

Note: The same precautions must be taken as listed above for discharging LPG vapor to atmosphere because the mixture of LPG, inert gas and air may still be flammable.

Three purges with an inert gas to a pressure to 300 kPa reduces the LPG remaining in the tank to an acceptable level for the admission of air to rid the tank of inert gas. This may be done by purging three times with air to a pressure of 300 kPa or blowing air through the tank until the inert gas is all removed. Note that it is desirable when purging to admit the gas at one end of the vessel and to discharge at the other end to avoid having pockets of gas lying undisturbed.

Note also that it is hazardous to remove any opening from a tank until the pressure is completely reduced to atmospheric. Even a small pressure exerts a substantial force when applied to an area and a fitting may be propelled with considerable velocity if the pressure is not zero.



Warning: It is also very hazardous to open a tank to atmosphere until it is completely purged of LPG because atmospheric temperature changes may suck air into the vessel to form a flammable mixture. A source of ignition could then cause combustion of an explosive violence due to the confinement of the flammable mixture within the vessel. Four litres of liquid LPG if vaporised in a 50 kilolitre storage tank, has the energy equivalent of about 6 kg of TNT!

5. TANK ENTRY, LEAKS & REPAIR OF LEAKS

The above procedures describe the requirements for taking a tank out of service. However, before a tank is entered the following procedures must be followed:

1. The tank must be isolated from other tanks or piping by the insertion of blanks or spades or alternatively by two closed valves with a third valve installed between them which is opened to the atmosphere (Double block and bleed).

2. The contents of the tank must be analysed at a number of locations inside the tank to ensure that neither LPG nor inert gas is present and that there is sufficient air present to support life. A permit to enter must be prepared and signed by a qualified responsible person who has assured him or herself that the vessel is safe to enter.

3. All Statutory requirements must be followed. The most important of these are listed below, but the regulations in each State should be studied in detail and complied with:

   (a) A constant supply of fresh air to be passed through the tank during occupation.

   (b) A suitable breathing apparatus to be worn by the person entering the tank.

   (c) A safety harness to be worn by the person entering the tank, to which is attached a rope, the free end of which is held by a person outside the tank, who must be capable of recovering the person inside the tank in an emergency.

   (d) One person to be on watch external to the tank at all times.

LEAKS

AS 1596 L.P. Gas Code requires that all piping be pressure tested before assembly and tested again on assembly with the equipment.

Leaks can be detected by smell or for liquid leaks by evidence of frosting where the leak occurs.

Small leaks can be detected by spraying the suspected area with a weak solution of detergent in water. A leak is visible when a small bubble becomes larger.

Tanks and equipment should be tested for leaks after pressuring with LPG vapor and again after the admission of liquid.

REPAIR OF LEAKS

It is recommended that joints be welded or flanged wherever possible. However, if screwed joints are unavoidable, it is essential that all threads be clean and sharp before mating. Thread seal of P.T.F.E. tape should be used sparingly to avoid contamination of equipment.

It is important that equipment be depressurised before attempting to fix leaks in threaded joints. Tightening the joint under pressure is seldom successful and may result in a serious accident if the fitting fractures as a result of excess tightening. It is particularly important to depressurise a liquid joint before tightening because fracture of a liquid joint potentially much more hazardous than a vapor joint fracture.

6. EMERGENCY MEASURES

The response to an emergency will be dictated by the circumstances at the time and the following information can be considered to be only a guide.

LPG is escaping but has not been ignited

Small Leak : If the leak is obviously a small one which is being quickly dissipated into the atmosphere so that it is too lean a mixture to support combustion, isolate the equipment from its source of LPG and depressure it in a safe manner.

Large Leak : If the leak is large and a vapor cloud is spreading it will need only a source of ignition to cause it to burn or explode (see page 4 of 18).

(1) Clear the area of all personnel
(2) Call Police and Fire Brigade on emergency number

If expert advice is available and the circumstances are appropriate, an alternative course of action might be:

(1) Clear the area of personnel not directly concerned with the emergency.
(2) Clear the area of any source of ignition.
(3) Try to stop the flow of LPG by activating emergency shut down systems if available. A water spray may be effective in dissipating the vapor while attempting to stop the flow.
(4) Call Police and Fire Brigade on emergency number.

LPG is escaping and is burning

(a) If burning is not hazardous to personnel or equipment

(1) Call Police and Fire Brigade on emergency number.
(2) Do not extinguish flame. Try to cut off the source of LPG always approaching from upwind.
(3) If necessary, keep equipment cool with water sprays.

(b) If flame is impinging on storage tank or equipment

Flame impingement on a storage tank is potentially the most hazardous of all circumstances because it may cause softening and weakening of the tank shell resulting in the rupture of the tank with the consequent possibility of a boiling liquid expanding vapor explosion (B.L.E.V.E.) A B.L.E.V.E. of an LPG tank poses a severe hazard to the surrounding area.

The immediate evacuation of all personnel to a safe distance should receive highest priority since tank rupture may happen very quickly depending on the extent of flame impingement.

It is not possible to accurately predict safe distances because the circumstances in each case are likely to be different but the following table is a guide to distances from a tank at which there would be a 1% probability of the explosion being lethal and at which there would be a 1% probability of first degree burns (taken from TNO Mexico City Report 1985)

Tank Size	1% Lethal Probability	1% Probability of First Degree Burns
180 kl	375 m	600 m
55 kl	220 m	340 m
48 kl	200 m	310 m
35 kl	190 m	290 m

The possibility of injury by flying debris also needs consideration and once again it is not possible to give accurate safe distances but debris from tanks has been found upto 500 m from the site of explosion.
If expert advice is available and the circumstances are appropriate, an alternative course of action might be:

1. Clear the area of personnel not directly concerned with the emergency.

2. Call Police and Fire Brigade on emergency number.

3. Keep the tank cool by spraying with water. It is more important to keep the vapor space cool than the liquid because the boiling liquid tends to keep that section cooler.

The decision to adopt this course of action needs full consideration of the factors outlined on page because of the danger to the hose operators.

4. Stay clear of the ends of the tank because the circumferential joint is the weakest and any rupture may possibly blow the ends off the tank before splitting the longitudinal seam.