CALOR LPG INSTALLATION BOOKLET

- L.P.G. Storage Tank Sizing
- Pipe Sizing
- Tank Siting
- Delivery and Access Requirements
- Carbon Footprint
- Cylinder Sizing

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Contents

Bulk Installations

LPG is an acronym for Liquefied Petroleum Gas.The principle sources of LPG are oil or gas fields and petroleum refineries. The two main forms of LPG are commercial butane and commercial propane. LPG may be liquefied by moderately increasing the pressure or by reducing the temperature. Refrigerated storage is used by gas suppliers to store large volumes of LPG. The main form of LPG storage is in special tanks known as 'pressure vessels'. Commonly these pressure vessels are termed 'bulk tanks' or 'cylinders'. Because LPG has a high coefficient of expansion in its liquid phase, the tanks are never completely filled with liquid (tanks are filled to approximately 87% of their water capacity), the remaining '**ullage**' space being taken up with vapour (often referred to as the **vapour space**) to facilitate expansion without allowing the tank to become 100% liquid full (known as **hydraulically full**).

As gas (vapour) is drawn from the tank, the vapour pressure in the tank falls and the liquid boils, producing more vapour and restoring the pressure.

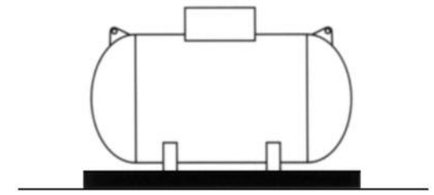
To maintain boiling, the liquid absorbs heat from the metal walls of the tank in contact with the liquid (known as the **wetted surface area**) and from the air surrounding the tank. The available gas 'offtake', therefore, is dependent upon the surface area of the tank, the quantity of liquid within the tank and the temperature.

The low temperature of the liquid (often indicating excess offtake) may be indicated by 'sweating' (where the water vapour in air condenses on the wetted surface area of the tank) and if the offtake is large enough by '**frosting**' (where the condensed water vapour freezes) on the walls of the tank.

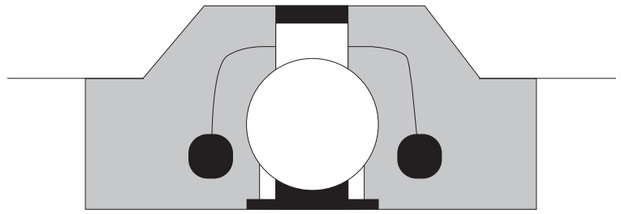
When the liquid temperature rises, for instance in summer, the vapour pressure increases. When the liquid temperature drops, the vapour pressure drops. Under typical Irish conditions, the pressure range will be between 2-9 bar.

The correct design, safe siting, delivery and installation of a bulk tank storage system is the responsibility of the gas supplier. Bulk installations may require planning permission from the local authority. If planning permission is required, the installation should not be undertaken until the application is successful.

There are two types of bulk tank installation that Calor can offer: See Fig. 1



Above ground tank



Semi - mounded tank

Fig. 1

The two options above may involve either single or multiple tanks. The type of bulk tank installation to be undertaken is dependent upon the following factors:

- Customer requirements (application, aesthetics etc.).
- Safety considerations (siting requirements, total storage etc.).
- Required offtake and/or minimum storage capacity.

TANK SIZING

Selecting the appropriate size of tank will depend upon a number of factors, including:

- The maximum required gas rate and pattern of use.
- The physical constraints imposed by the site.
- Access and egress for tank delivery.
- Access and egress for gas delivery.
- The frequency of delivery.

For offtake capacity for various bulk tanks, both commercial and domestic, see Tank Offtake table below.

In order to ensure security of gas supply, the tank should be sized to provide at least **4–6 weeks of gas storage**.

Example:
To convert 500,000 Btu/hr to kW multiply by 0.0002931 = 500,000 x 0.0002931 = 146.55kW

Tank offtake table (u/g = underground)

Maximum continuous propane offtake at 5°C and 25% full

Tank capacity (kg propane)	kW	m3/h	kg/h
230	60	2.3	4.2
600	145	5.66	10.52
1000	187	7.1	13.2
1000 (u/g)	94	3.5	6.8
2000	264	10.2	19
2000 (u/g)	132	5.1	9.5
3000	347	13.4	25
4000	513	19.8	36.9
6500 (u/g)	366	14.2	26.4

VEHICLE ACCESS FOR TANK DELIVERY

Reach distances should be measured from the edge of the access roadway to the centre of the base. Most crane vehicles now have their cranes fitted at the rear of the vehicle and they will normally reverse square to the tank base to obtain maximum lift and stability. (Subject to access and ground conditions).

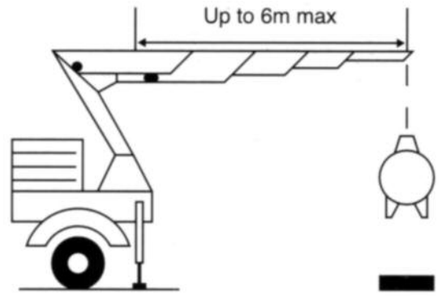


Fig. 2

Fig.2 Please note, for anything beyond 6m, a Calor representative must carry out a site survey

Common tank weights

Tank size (kg propane)	Tare weight + 50kg normal gas charge
230	190kg
600	400kg
1000	585kg
2000	1000kg
3000	1176kg
4000	1882kg

Vehicles should ideally be located a minimum of 1.5 metres from any excavation to avoid the vehicle falling into the opening, or weakening the ground around it.

Carbon Footprint

Carbon footprint is a measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide.

Carbon dioxide (CO_2) is not the only man-made greenhouse gas – it is simply the one that has accumulated the most in the atmosphere and is presently having the greatest warming effect on our planet.

As can be seen from the chart below, LPG has one of the lowest CO_2 emission figures as well as a very high calorific value. The combination of these two statistics makes LPG the ideal fuel solution, giving the best efficiency while maintaining relatively low carbon emissions.

Comparisons of CO_2 Emissions and Calorific Values

	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphtha	73.3	264.0
Petroleum Coke	100.80	362.9
Solid Fuels and Derivatives		
Coal	94.60	340. 6
Milled Peat	116.7	420.0
Sod Peat	104	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas	56.8	204.5
Electricity (2005)	176.8	636.5

Note: CO_2 emission factors for electricity vary from year to year depending on the fuel mix used in power generation.
Ref: SEI in Ireland 1990 – 2006.
In NI consult the website ***www.defra.gov.uk/environment*** for Guidelines for Company Reporting on Greenhouse Gas Emissions. Grid Electricity for NI is lower than the ROI value.

Above Ground Tank Installations

To support the weight of the LPG tank(s) including the gas contents a load bearing base is required.

BASE REQUIREMENTS FOR ABOVE GROUND TANKS

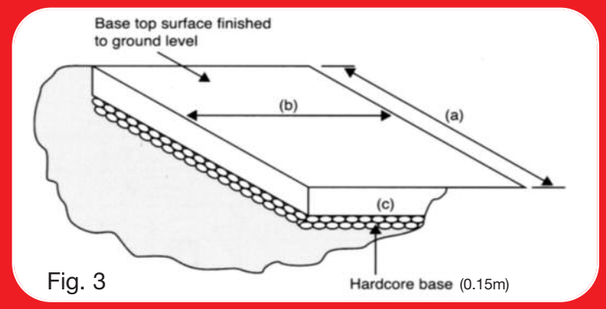


Fig. 3

Dimensions for concrete base

Tank size (kg)	Dimensions (m) length (a) x width (b) x depth (c) (see diagram above)
2 x 230 Churn	2.6 x 1.3 x 0.15
3 x 230 Churn	4.3 x 1.3 x 0.15
1 x 600	2 x 1 x 0.15
2 x 600	2 x 3 x 0.15
3 x 600	2 x 5 x 0.15
1 x 1000	3.3 x 1 x 0.15
2 x 1000	3.3 x 3 x 0.15
3 x 1000	3.3 x 5 x 0.15
1 x 2000	3.8 x 1.2 x 0.15
2 x 2000	3.8 x 3.4 x 0.15
3 x 2000	3.8 x 5.6 x 0.15
1 x 3000	5.7 x 1.2 x 0.15
2 x 3000	5.7 x 3.4 x 0.15
3 x 3000	5.7 x 5.6 x 0.15
1 x 4000	5.5 x 1.6 x 0.15
2 x 4000	5.5 x 4.2 x 0.15
3 x 4000	5.5 x 6.8 x 0.15

NB:

- For a detailed drawing showing compound requirements, please contact Calor Technical Services Department.
- Semi-mounded Tank Civil Drawings are available on request from Calor Technical Services. More information on semi-mounded tanks can be found on page 20.
- Depth of concrete dimensions (c) is subject to suitable sub-base ground conditions.

TANK SITING ABOVE GROUND

Fig.4: Tank siting for a typical 1000kg tank (NTS)

Distance from buildings, boundaries and sources of ignition

LPG capacity (kg)	Max no. of tanks in a group	From buildings boundary, property line or fixed source of ignition (m)	With a fire wall (m)	Distance between tanks (m)
230	3	2.5	0.3	1.0
600	5	3.0	1.5	1.0
1000	3	3.0	1.5	1.0
2000	6	7.5	4.0	1.0
3000	4	7.5	4.0	1.0
4000	3	7.5	4.0	1.0
12000	6	15.0	7.5	1.5

Further advice on grouping of LPG tanks should be obtained from Calor Technical Services Departments.

SEPARATION FROM FLAMMABLE LIQUIDS

If you are siting bulk LPG tanks adjacent to any flammable liquids or liquid storage vessels, please contact Calor Technical Services. Specialist advice should be obtained from Calor Technical Department regarding safety distances from liquid oxygen storage tanks.

Typical flash points for common hydrocarbon liquids/fuels

Fuel	Flashpoint (°C)
Propane	-104
Butane	-60
Gasoline (petrol)	-45
Jet B	-7
Diesel	40-55
Jet A	47
Kerosene (domestic heating oil)	52
Gas oil	70
Light fuel oil	95
Medium fuel oil	105
Heavy fuel oil	115
Crude oil	125
Black oil	144
Castor oil	263

ROI - LPG storage tanks should be 3m from the bund wall of a tank containing a flamable liquid with a Flash Point >60°C. LPG storage tanks should be 6m from any tank containing a flamable liquid with a Flash Point between 22.8°C and 60°C. (IS: 3216 amendment No 1 1989).

NI - LPG storage tanks should be 3m from the tank/bund containing a flammable liquid with a flash point between 32-65°C for flammable liquid tanks containing up to 3,000 litres. For tanks containing over 3,000 litres of flammable liquid the safety distance is 3m to the bund wall or diversion wall and 6m to the tank. (COP 1: Part:1 2004).

USE OF A FIRE WALL

The purpose of a fire wall is to protect the tank(s) from the effects of thermal radiation from a nearby fire and to ensure that there is an adequate distance from fixed sources of ignition, where normal separation distances cannot be achieved.

If you want to reduce your safety distances through the use of a fire wall, please seek expert advice from Calor Technical Services.

OVERHEAD POWER CABLES

Above ground tanks must not be sited directly beneath electrical power cables.

- Where the voltage in the cables is less than 1kV, the tank(s) must be sited a minimum of 1.5m from an imaginary line drawn vertically downwards from the power cable.

- Where the voltage is 1kV and above, this distance must be increased to 10m.

Where there is any doubt as to the cable voltage, guidance should be obtained from the local power supply company.

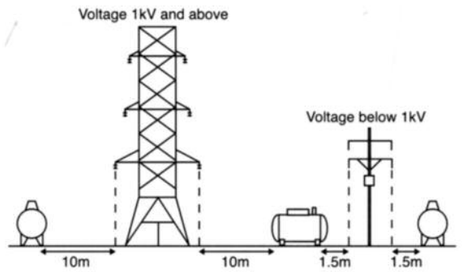


Fig 5. Separation distances from overhead power cables.

SCREENING

Screening an above ground tank is permitted providing that the screen:

- Is located on one side of the tank only.
- Does not impede natural ventilation around the tank(s).
- Is either evergreen shrubs or non-flammable ranch type fencing.
- Does not obstruct the delivery driver's line of vision when filling the tank.
- Is located at least 1m away from tanks of less than 1000kg capacity (for NI this is less than 2.2 tonne LPG capacity). For larger tanks seek advice from Calor Technical Services.

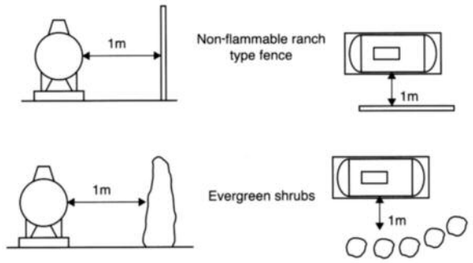


Fig 6. Screening distances.

Note: Chemical weed killers (such as Sodium Chlorate) or any other weed killing method which is a potential source of ignition should not be used in the separation areas.

Gas delivery – Access Requirements

TANKER DETAILS

- Minimum width of entrance 4m
- Minimum height clearance of entrance 4m
- Working clearance around tanker during delivery is 3m
- Minimum turning circle 19.5m
- 8 tonne tanker gross weight 18 tonnes
- 12 tonne tanker gross weight 26 tonnes
- Maximum hose length 27m

SAFETY REQUIREMENTS

• Normally, gas deliveries to domestic and small commercial customers are made with eight (8) tonne capacity tankers and to larger commercial, industrial and metered supplied sites with twelve (12) tonne capacity tankers.

• It is very important that when deciding on the tank site location that there is safe and ongoing unrestricted access to deliver the tank, to carry out maintenance and for the gas delivery tanker to fill the tank safely.

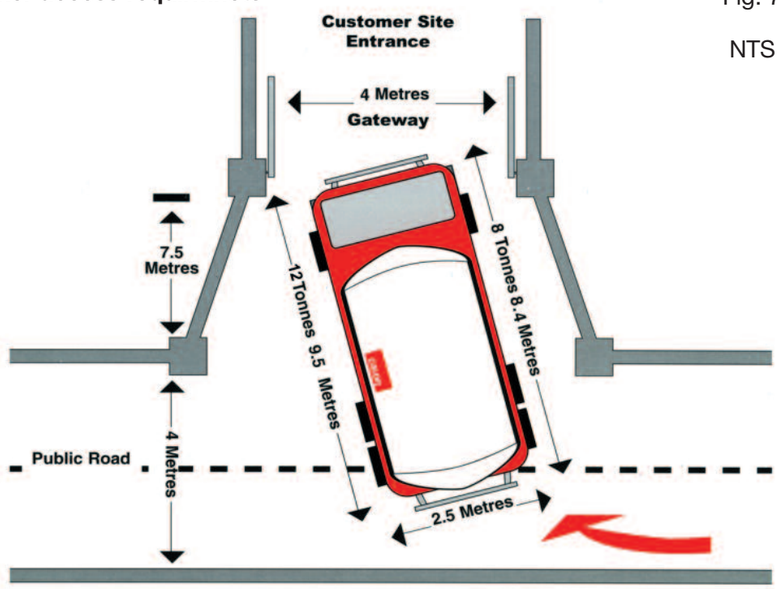
• When making a delivery it is important that the tanker can be parked in a safe area, on a reasonably level hard standing, away from ignition sources and does not cause unnecessary obstruction to traffic.

• It is an important safety requirement that during the filling operation the tanker driver has a clear view of the tanker and the tank that is being filled, and that there is an unrestricted access route available to traverse between the tanker and the tank.

Tanker access requirmnets

Fig. 7

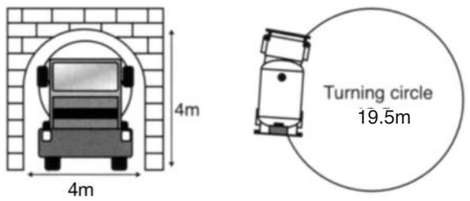
NTS



BULK DELIVERY VEHICLES

	Vehicle access	
Bulk delivery vehicle access	**8 tonne capacity rigid tanker**	**12 tonne capacity**
Overall length	8.4m	9.5m
Overall width	3.4m	3.4m
Maximum gross weight	18 tonnes	26 tonnes
Height clearance	4.00m	4.00m
Road width	4m	4m
Turning circle radius	19.50m	19.50m
Gateway and short passages	4m	4m
Hose length	27.00m	27.00m
Required clearance between road tanker and tank	This is dependent on the size of the tank, minimum 3m	

Fig. 8



Tanker Arch access and turning circle requirements.

Domestic Tank and Pipework Installation

Fig. 9 **Domestic Tank Installation**

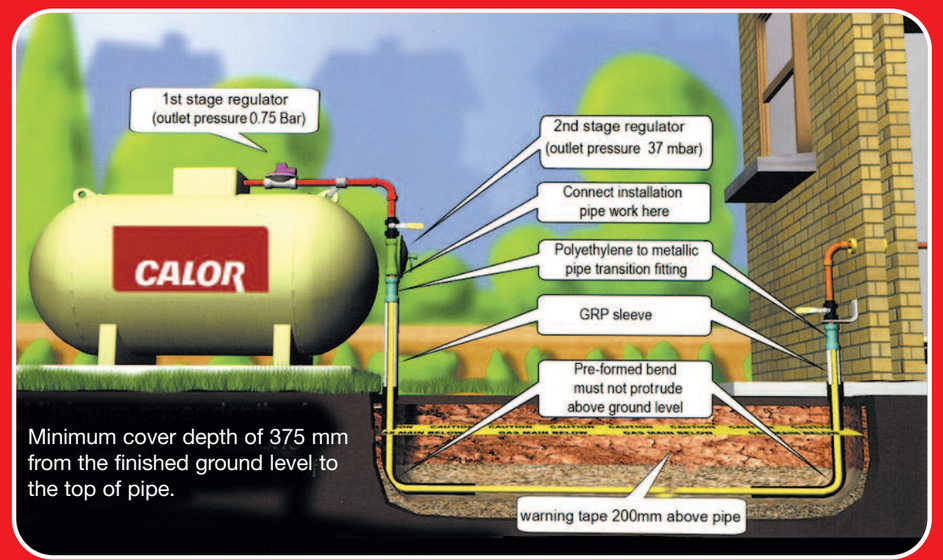
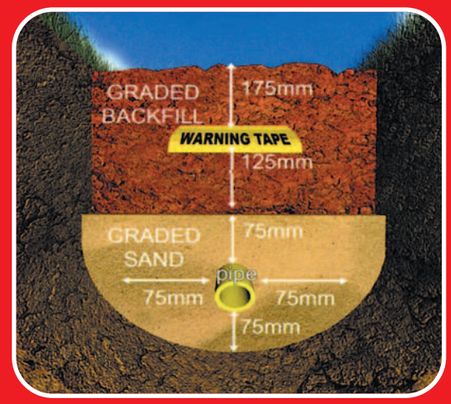
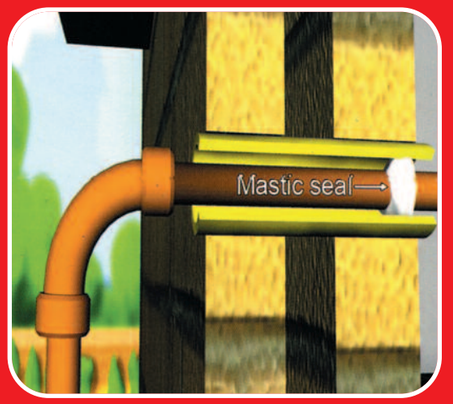


Fig. 10 **Buried Pipe Detail**



75mm of sand bed around pipe.

Fig. 11 **Pipe Through Wall Detail**



Sleeve through wall must be of a material impermeable to gas and corrosion resistant

Important: Refer to Technical Specifications for Tank Siting and Installation Details.

Pipe Sizing

Effective capacity of steel pipe for LPG

Length(m)	8mm		15mm		20mm		25mm	
	Heat Input		Heat Input		Heat Input		Heat Input	
	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h
3	9,90	0,38	82,5	3,18	165,0	6,40	363,0	14,0
6	6,80	0,27	55,0	2,12	115,5	4,50	247,5	9,60
9	5,70	0,22	44,0	1,70	90,6	3,50	181,5	7,40
12	4,80	0,19	38,5	1,50	77,0	2,97	165,0	6,40
15	4,40	0,17	33,0	1,30	66,0	2,55	143,0	5,50
18	4,00	0,15	29,7	1,15	60,5	2,30	132,0	5,10
21	3,70	0,14	27,5	1,06	56,5	2,19	121,0	4,70
24	3,50	0,13	24,6	0,96	52,8	2,04	110,0	4,20

NOTE: The heat input is based upon propane at low pressure of 37 mbar and 2.5 mbar maximum pressure drop over the length of the pipe.

Effective capacity of copper tube for LPG

Length (m)	6mm		10mm		15mm		22mm		28mm	
	Heat Input		Heat Input		Heat Input		Heat Input		Heat Input	
	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h
3	2,20	0,09	16,94	0,66	28,82	1,116	155,54	6,0	309,1	11,928
6	1,54	0,06	11,0	0,42	19,58	0,756	101,20	3,95	172,0	6,643
9	1,32	0,05	9,24	0,361	15,40	0,594	81,40	3,14	161,7	6,240
12	1,10	0,04	8,14	0,315	13,42	0,522	70,40	2,78	140,8	5,434
15	0,88	0,04	7,26	0,281	11,66	0,450	62,0	2,40	126,5	4,882
18	0,88	0,04	6,60	0,261	10,12	0,395	55,44	2,14	108,9	4,203
21	0,66	0,03	6,16	0,238	9,68	0,397	50,16	1,93	101,6	3,927
24	0,66	0,03	5,72	0,221	8,21	0,350	46,20	1,78	94,6	3,651

NOTE: The heat input is based upon propane at low pressure of 37 mbar and 2.5 mbar maximum pressure drop over the length of the pipe.

Effective capacity of polyethylene pipe size for LPG

Heat input		Maximum length (25mm OD)	Maximum length (32mm OD)
kW	m3/h	metres	metres
28,6	1,104	72	213
30,8	1,189	62	184
33,0	1,274	54	160
35,2	1,358	47	140
37,4	1,443	42	125
39,6	1,528	37	111
41,8	1,613	33	100
44,0	1,698	30	90

NOTE: The heat input is based upon propane at low pressure of 37 mbar and 2.5 mbar maximum pressure drop over the length of the pipe.

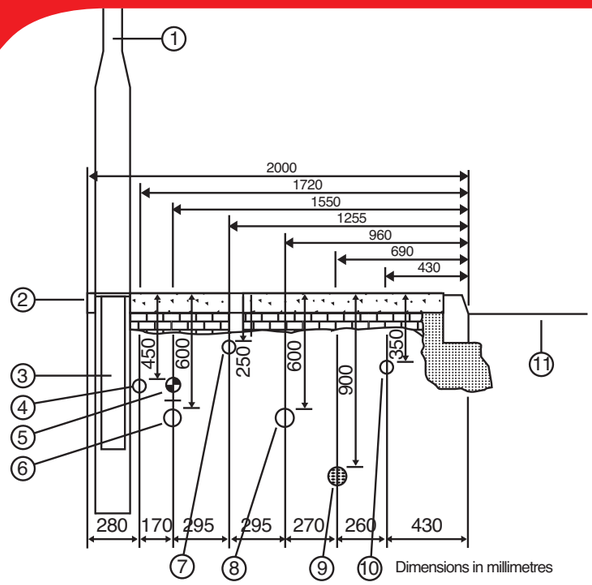
Please contact Calor Technical Services for larger pipe work sizes not provided in tables above.

LAYING THE PIPEWORK

Under no circumstances should an LPG distribution main or service be installed beneath a foundation or in an unventilated void. PE pipework installed above ground must be protected against damage and sunlight.

The minimum depth of cover required for various pipe locations is detailed below. A clearance of 250mm should also be maintained from all other services (e.g. electricity cables, pipes etc.).

Location of pipe	Depth of cover (metres)
Customer's gardens	0.375
Paved footway	0.60
Carriageway	0.75
Verge	0.75
Open field/agricultural land	1.10



WITH REFERENCE TO UNDERGROUND GAS PIPEWORK DISTANCES FROM BUILDINGS, PLEASE SEEK EXPERT ADVICE FROM CALOR TECHNICAL DEPARTMENT.

Fig 12: Typical arrangement of mains in a 2m footpath.

Key:

1. Lamp Standard
2. Boundary
3. Outside stop valve
4. Low voltage electrical (alternative position)
5. Low voltage electrical
6. High voltage electrical
7. Cable TV
8. Gas
9. Water
10. Telecommunications
11. Carriageway

Semi-Mounded Tank Installations

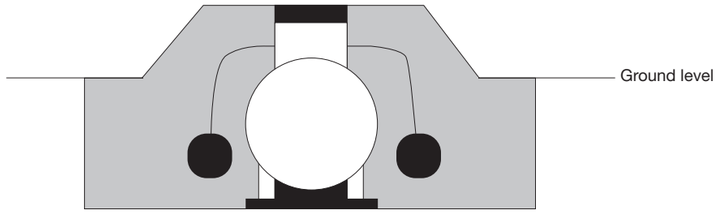


Fig. 13 Semi-mounded tank

To improve the aesthetic appearance of bulk LPG tanks and allow reduced separation distances, the option is often taken to install semi-mounded tanks.

Semi-mounded tanks are specially prepared to ensure the risk of corrosion is minimised and are available as standard in 1000kg and 2000kg propane capacities.

Larger tank designs are available on request from Calor Technical Services.

TANK SITING

Potential installation sites for semi-mounded tanks should be vetted by a competent person at the planning stage to ensure that no services (gas, water, electricity, telecommunications, drains, sewers, cesspits etc.) pass through the proposed tank excavation area.

It is essential that tanks are **not sited in areas prone to flooding**. The local Water Authority or Environmental Agency should be consulted for information regarding the proposed site. In addition, areas of heavy clay soil may require the provision of adequate drainage.

The top of the valve box of a semi-mounded tank must be a minimum of 450mm above the natural ground level. This should ensure that the valve box does not become ‘flooded’ causing regulator malfunction, which can affect the gas supply.

Semi-Mounded Tank Installations

GROUNDWORK

SUPPLY PIPEWORK
Back fill material should preferably be river washed sand.

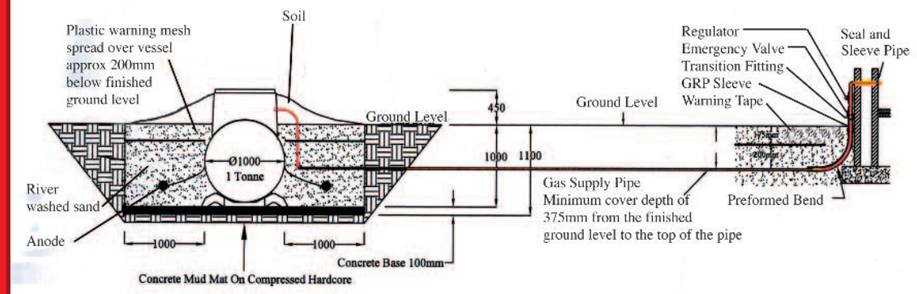


Fig. 14 Semi-mounded tank installation detail

Excavation for semi-mounded tanks

Ground conditions can vary significantly and not all locations are suitable for underground LPG storage. As a result Calor cannot accept any responsibility for any groundwork. This includes temporary or permanent earthwork support found necessary or foundations that may be required. It is recommended that a suitably qualified and experienced engineer be employed to undertake a geological site survey and provide the appropriate advice on all the groundwork and foundations necessary.

Due to the dangers involved with carrying out excavation work, all persons who are involved in such work, or working in them, must be suitably trained and competent.

There is various legislation concerning persons working on, or in excavations. The emphasis is on an awareness of hazards and the methods adopted to eliminate or reduce the risk to an acceptable level. All excavations must be assessed by a competent person to ensure they are safe to work with, both above and below ground level.

Groundwork has to be properly planned and carried out to prevent accidents. Typical hazards that require guarding against are:

- Collapse of the sides.
- Materials falling in whilst persons are working in the excavation.
- People or vehicles falling into the excavations.
- Underground services or installations.
- Undermining of nearby structures.
- Flooding.
- Exhaust gases from vehicles etc.

The density of liquid phase LPG is approximately half that of water, and consequently semi-mounded LPG tanks will float if the location becomes flooded with water. Buried tanks in waterlogged ground will be subject to a flotation force of 1000kg per cubic metre of tank volume and without adequate anchoring have been known to surface, bringing the pipework with them.

The excavation for semi-mounded tanks needs careful planning. Excavations can have an effect on neighbouring buildings, foundations and structures.

Due to the possible future effects of excavation work on foundations or structures, it is recommended that semi-mounded LPG tanks be sited wherever practical away from buildings or structures. If there is no other suitable location within the confines of the premises, the edge of the excavation should be located no closer than 2 metres to any foundation unless a geological survey is carried out by a competent person.

Detailed installation drawings can be obtained from Calor Technical Services.

Semi-mounded tank siting

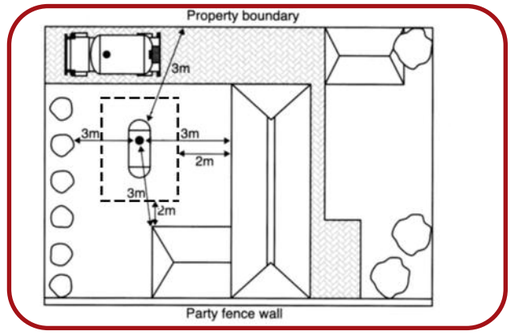


Fig 15: Typical domestic tank siting for a semi-mounded 1000kg tank (NTS)

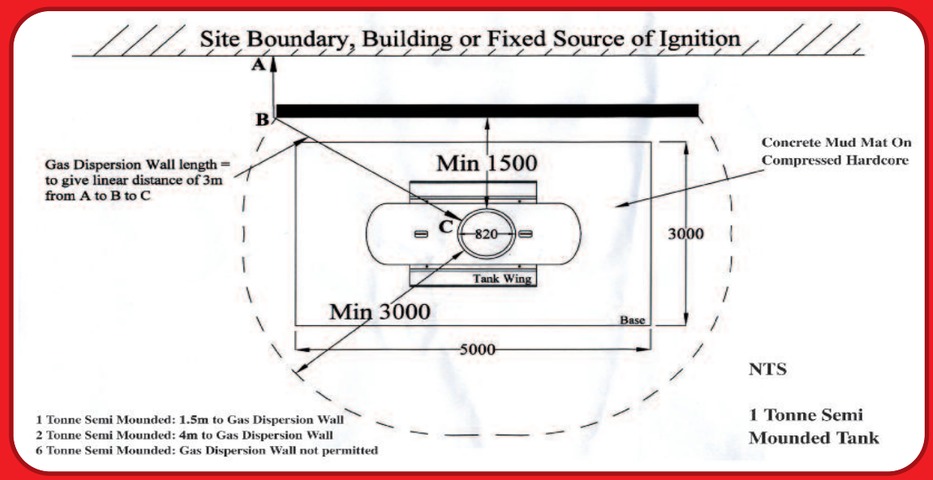
Distances from buildings, boundaries and sources of ignition

Minimum safety distance from buildings boundaries or fixed source of ignition (m)

Tank size (kg)	To Tank surface	To valve assembly		Distance between tanks (m)
		Without gas dispersion wall	With gas dispersion wall	
1000	2*	3	1.5	1
2000	3	7.5	4	1

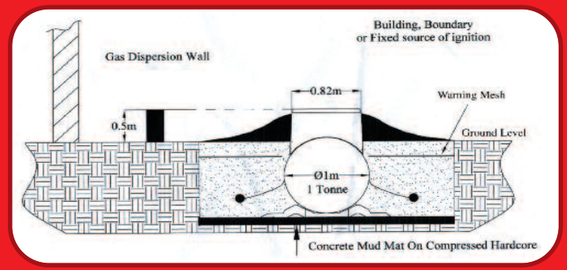
*Separation distance is stated as 1m, but due to effects of excavation on building structure, it is recommended that this distance be increased to 2m.

NB: Expert advice on 6500kg semi-mounded tank installations is available from Calor Technical Service.



Above: Fig 16. 1000kg semi-mounded tanks showing reduced separation distances due to gas dispersion wall.

Right: Fig 17. Schematic layout of a semi-mounded tank installation using a gas dispersion wall to reduce the required separation distance from a building.



GAS DISPERSION WALLS

Gas dispersion walls further permit the reduction of separation distances for semi-mounded tanks. They differ from a fire wall in that they are not required to protect the tank(s) from thermal radiation from an external fire, but to ensure any potential gas escape from the valve box area can be safely dispersed or diluted before reaching an ignition source.

A gas dispersion wall should be constructed of a length such that the distance measured from the valve assembly, around the wall, to the property, boundary or fixed source of ignition is not less than the separation distance required if the wall were not present.

Gas dispersion walls should be imperforate, substantially constructed from brick, concrete or solid masonry and should not be less than 0.5m in height. They should only be used on one side of the tank. They should not be sited as to direct or facilitate the draining of water onto the LPG tank and should not impede natural ventilation.

Cylinders

Multi cylinder installations are an ideal alternative to bulk tank installations as a means of supply where the site may be restricted in terms of the available space for gas storage or tanker access.

The cylinders are generally arranged in two sets – ‘service’ and ‘reserve’ – and linked by a pressure regulator/changeover valve. This valve automatically switches the supply from the ‘service’ to the ‘reserve’ cylinders when the gas cylinders are nearly empty without any noticeable interruption of the gas supply.

If the cylinder supply comprises four or more cylinders connected to an automatic changeover device, the ‘Gas Safety (Installation and Use) Regulations’ (applicable in NI only) state that an Over Pressure Protection Shut Off device (O.P.S.O.) must be provided.

When sizing gas cylinders there are three main considerations:

- What is the maximum gas rate of the appliance(s)?
- If there is more than one appliance, what diversity factor is appropriate?
- What is the pattern of use?

Cylinder offtake tables

Maximum continuous propane offtake

Cylinder size (propane kg)	kW	m^3/h	kg/h
34	24	0.93	1.75
47	34	1.28	2.48

CYLINDER SIZING

The procedure for determining the correct number and size of cylinders is as follows:

1. Calculate the total gross heat input rate of all the appliances in kW.
2. To allow for diversity and heating efficiency, the total appliance gas rate should be multiplied by a ‘coincidence’ factor (typically 0.7).
3. Use the Calor cylinder offtake table (see above table) to determine the appropriate number and size of cylinders.
4. If more than one cylinder is required (for either offtake or total storage reasons), divide the total appliance input by the offtake rate (kW or kg/h as long as units are consistent) to determine the number required.

Note: To ensure there is adequate storage, it is advisable to provide an equal number of additional cylinders as a reserve.

CYLINDER SITING

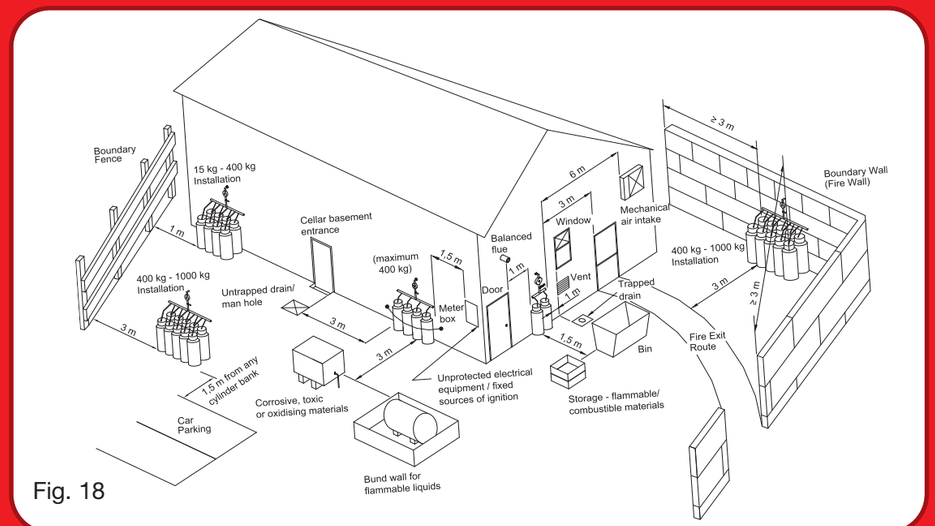


Fig. 18

Minimum horizontal separation distance required between various features or hazards and a cylinder installations.

Minimum Separation - Metres	Feature or hazard
1,0	Window Door Air vent Balanced-flue Trapped drain
1,5	Parked motor vehicle Fixed sources of ignition Unprotected electrical equipment Flammable/combustible materials
3,0	Untrapped drain or sealed gully Bund wall for bulk flammable liquid storage Opening to cellar/basement Corrosive, toxic or oxidising materials
6,0	Mechanical air intake

Note 1 Any opening into chimneys or air intakes shall be at least1,0 m above the level of the top of any cylinder.
Note 2 Other opening above any cylinder shall beat least 0,3 m above the level of the top of the cylinders.

Cylinders shall be sited more than 3 m from any heat source likely to raise temperature of the cylinder contents above40°.
Above diagram and table extracted from IS820.

Propane cylinders must **NOT** be installed in any of the following positions:

1. Propane cylinders must be stored and used outdoors only.
2. Propane cylinders must not be stored in any cellar, basement or sunken area.
3. Propane cylinders must not be installed less than 1m measured in the horizontal plane from the nearest cylinder valve, or less than 300mm measured vertically above the cylinder valve(s), from:
   - Fixed sources of ignition.
   - Openable windows.
   - Unprotected electrical equipment.
   - Excessive heat sources.
   - Readily ignitable materials etc.
   - Apertures in the property, e.g. ventilation ducts, airbricks, flue terminals etc.
4. Propane cylinders must not be installed within 3m (R.O.I.)/2m (N.I.), measured in the horizontal plane, from untrapped drains or unsealed gullies, or openings to cellars, unless an intervening gas dispersion wall (not less than 250mm high) is provided.
5. Propane cylinders must not be installed within 3m of any corrosive, toxic or oxidising materials, unless a fire resistant barrier is interposed.

Properties of Propane

PROPERTIES OF PROPANE

Freezing point at atmospheric pressure	-186°C
Boiling point at atmospheric pressure*	-42°C
Vapour pressure at 15°C	7.5 barg
Specific gravity of gas (air=1)	1.5
Specific gravity of liquid (water=1)	0.512
Calorific Value	95MJ/m³
	(26.4kWh/m³
	50MJ/kg
	(13.9kWh/kg)
	25.5MJ/litre
	(7.1kWh/litre)
Latent heat of vaporisation at boiling point	0.43MJ/kg
Specific heat of gas	1.55kJ/kg/°C
Specific heat of liquid	2.43kJ/kg/°C
Density of gas	1.85kg/m³
Density of liquid	512kg/m³
Volume of gas produced per mass of liquid	0.54m³/kg
Volume of gas produced per unit volume of liquid	274
Volume occupied per mass of liquid	1957 litres/tonne
Volume of air to burn unit volume of gas	24
Volume of oxygen to burn unit volume of gas	4.8
Ignition temperature	460-580°C
Maximum flame temperature	1980°C
% gas in gas/air mixture for maximum flame temperature	4.4
Limits of flammability (% gas in gas/air mixture)	2.0-11.0
UN number	1978

*Metric units relate to Metric Standard Conditions of 15°C and 1013.25 mbar (dry)

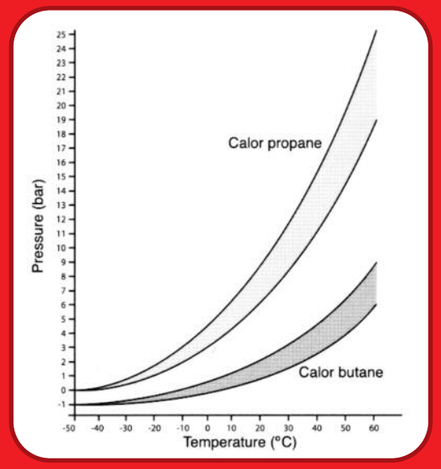


Fig 19. Temperatures/vapour pressure chart for Propane and Butane

Commonly used conversions for Propane

1litre of Propane liquid = 7.1 kW

1 m³ of Propane vapour at 37 mbar = 3.652 litres of propane liquid

Properties of Butane

PROPERTIES OF BUTANE

Freezing point at atmospheric pressure	-140°C
Boiling point at atmospheric pressure*	-2°C
Vapour pressure at 15°C	2 barg
Specific gravity of gas (air=1)	2.0
Specific gravity of liquid (water=1)	0.575
Calorific Value	121.5MJ/m³
	(33.8kW/m³)
	49.2MJ/kg
	(13.7kWh/kg)
	28.2MJ/litre
	(7.8kWh/litre)
Latent heat of vaporisation at boiling point	0.39MJ/kg
Specific heat of gas	1.61kJ/kg/°C
Specific heat of liquid	2.34kJ/kg/°C
Density of gas	2.45kg/m³
Density of liquid	575kg/m³
Volume of gas produced per mass of liquid	0.41m³/kg
Volume of gas produced per unit volume of liquid	233
Volume occupied per mass of liquid	1743 litres/tonne
Volume of air to burn unit volume of gas	30
Volume of oxygen to burn unit volume of gas	6.25
Ignition temperature	410-550°C
Maximum flame temperature	1996°C
% gas in gas/air mixture for maximum flame temperature	3.5
Limits of flammability (% gas in gas/air mixture)	1.9-8.5
UN number	1011

*Metric units relate to Metric Standard Conditions of 15°C and 1013.25 mbar (dry)

Please note all information contained in this booklet is correct at time of print. The above information is referenced from Irish Standards for Gas Installations, LPGas Association Codes of Practice and The Institute of Gas Engineers Publications, London.

This installation booklet is intended as a guide only and does not supercede any legislative requirements.

Legislation

REPUBLIC OF IRELAND

IS 3216: Code of Practice for the bulk storage of LPG and amendments.
IS 3213: 1987 Code of Practice for the storage of LPG cylinders and cartridges.
IS 813: 2002 Domestic Gas Installations.
IS 820: 2000 Non-domestic gas installation.
IS 329: 2003 Gas Distribution Mains.
IS 265: 2000 Installation of Gas Service Pipes Parts 1 & 2.

NORTHERN IRELAND

LPGA Code of Practice No.1:
Bulk LPG storage at fixed installations.
Part 1 – Above Ground Vessels.
Part 2 – Small bulk propane installations for domestic purposes.
Part 4 – Buried/Mounded Vessels.

LPGA Code of Practice No.7:
Storage of full and empty LPG cylinders and cartridges.

COP 22 LPG piping systems: Design and Installation.

LPGA Code of Practice No.24, Part 1:
Use of propane cylinders at residential and similar premises.

LPGA Code of Practice No.24, Part 6:
Use of propane cylinders at commercial and industrial premises.

LPGA Code of Practice No.25:
LPG central storage and distribution systems for multiple customers.

The above documents are a sample of legislation within ROI & NI. This is not an exhaustive list, for further information please contact Calor Technical Services in Dublin/Belfast.

CONVERSION TABLES

VOLUME FLOW RATE

	Litres/s	Litres/hr	US gal/s	US gal/hr	UK gal/s	UK gal/hr	ft3/s	ft3/hr	m3/s	m3/hr
Litres/s	1	3600	0.2642	951.12	0.22	792	0.03532	127.152	0.001	3.6
Litres/hr	0.000277778	1	0.000073	0.2642	0.000061	0.22	0.00001	0.03532	0.000000278	0.001
US gal/s	3.785	13626	1	3600	0.8327	2997.72	0.1337	481.32	0.003785	13.626
US gal/hr	0.001051389	3.785	0.000278	1	0.000231	0.832700	0.000037	0.1337	0.000001	0.003785
UK gal/s	4.546	16365.6	1.201	4323.6	1	3600	0.1605	577.8	0.004546	16.3656
UK gal/hr	0.001262778	4.546	0.000334	1.201	0.000278	1	0.000045	0.1605	0.000001	0.004546
ft3/s	28.32	101952	7.4805	26929.8	6.229	22424.4	1	3600	0.02832	101.952
ft3/hr	0.007866667	28.32	0.002078	7.4805	0.00173	6.229	0.000278	1	0.000008	0.028320
m3/s	1000	3600000	264.172	951019.200	219.969	791888.4	35.31	127116	1	3600
m3/hr	0.277777778	1000	0.073381	264.172	0.061103	219.969	0.009808	35.310000	0.000278	1

ENERGY

	J	kJ	MJ	GJ	Btu	kcal	kWh	therm	thermie
J	1	0.001	0.000001	0.000000001	0.0009478	0.0002388	0.000000278	0.000000000478	0.0000002389
kJ	1000	1	0.001000	0.000001	0.947800	0.2388	0.000278	0.00000478	0.000239
MJ	1000000	1000	1	0.001	947.82	238.85	0.2778	0.009478	0.238903
GJ	1000000000	1000000	1000	1	947820	23885	277.8	9.478	238.902958
Btu	1055.1	1.0551	0.001055	0.000001055	1	0.252	0.002931	0.00001	0.0002521
kcal	4186.8	4.1868	0.004187	0.000004187	3.968300	1	0.001163	0.00003968	0.0010002
kWh	3600000	3600	3.6	0.0036	3412.1	859.84	1	0.03412	0.8600506
therm	105510000	105510	105.510000	0.10551	100000	25200	29.307	1	25.205598
thermie	4186000	4186	4.186	0.004186	3967.1	999.7	1.163	0.0396737	1

MASS FLOW RATE

	kg/s	kg/hr	lb/s	lb/hr	US ton/s	US ton/hr	UK ton/s	UK ton/hr	tonne/s	tonne/hr
kg/s	1	3600	2.20462	7936.632	0.0011023	3.96828	0.00098421	3.54316	0.001	3.6
kg/hr	0.0002778	1	0.0006124	2.20462	0.0000003	0.0011023	0.0000003	0.00098421	3.6	0.001
lb/s	0.453592	1632.9312	1	3600	0.0005	1.8	0.0004643	1.67148	0.0004536	1.632924
lb/hr	0.000126	0.453592	0.0002778	1	0.0000001	0.0005	0.0000001	0.0004643	0.0000001	0.0004536
US ton/s	907.184	3265862.4	2000	7200000	1	3600	0.8928571	3214.286	0.907184	3265.862
US ton/hr	0.2519956	907.184	0.5555556	2000	0.0002778	1	0.000248	0.8928571	0.000252	0.907184
UK ton/s	1016.0461	3657765.9	2240	8064000	1.12	4032	1	3600	1.01640461	3657.766
UK ton/hr	0.282235	1016.04608	0.6222222	2240	0.0003111	1.12	0.0002778	1	0.0002822	1.0160461
tonne/s	1000	3600000	2204.6244	7936647.913	1.1023122	3968.324	0.9842073	3543.1464	1	3600
tonne/hr	0.2777778	1000	0.6123957	2204.624	0.0003062	1.1023122	0.0002734	0.9842073	0.0002778	1

POWER

	Btu/hr	W	kW	MW	kcal/hr
Btu/hr	1	0.2931	0.0002931	0.000000293	0.252
W	3.4121	1	0.001000	0.000001	0.859800
kW	3412.1	1000	1	0.001	859.8
MW	3412000	1000000	1000	1	8598000
kcal/hr	3.9683	1.163	0.001163	0.00000116	1

VOLUME

	Litres	US gal	UK gal	ft3	m3
Litres	1	0.2642	0.22	0.03532	0.001
US gal	3.785	1	0.8327	0.1337	0.003785
UK gal	4.546	1.201	1	0.1605	0.004546
ft3	28.32	7.4805	6.229	1	0.02832
m3	1000	264.2	220	35.31	1

Contact Us

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Registered in Dublin
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Calor Gas Northern Ireland Limited
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Company Reg. No: NI08192
Registered in Northern Ireland
Registered Office: Airport Road West
Belfast, BT3 9EE

You can also e-mail us at: info@calorgas.ie

If you are an existing customer and you wish to place an order for gas, please call:

Belfast	All gas orders	028 9045 8888
Dublin	Bulk gas orders	01 855 5451
	Cylinder gas orders	01 459 7777
Cork	Bulk gas orders	021 4509691
	Cylinder gas orders	021 4661269

Calor Contact

If you have any questions, contact your Calor Contact on the number below:

Name:

Tel:

**If there are no contact details please telephone Calor Customer Services Dept.:
Dublin (01) 4505000, Belfast (028) 90455588**

Notes