

DEP SPECIFICATION

PRESSURISED BULK STORAGE INSTALLATIONS FOR LPG - AT DEPOTS, FILLING PLANTS AND LARGE BULK CUSTOMERS

DEP 30.06.10.16-Gen.

February 2013

DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the layout, location, safety and operability aspects of fixed above-ground, mounded, underground and submerged LPG pressure vessel storage in LPG depots, filling plants and large bulk customers. LPG includes commercial propane, commercial butane and mixtures thereof.

The LPG pressure vessel storage is at ambient temperatures in fixed cylindrical vessels and spheres.

This DEP has no capacity limitation for single vessel size and total storage.

This DEP does **not** cover:

- a) Unloading/receipt and loading/dispatch of vehicles
- b) LPG cylinders or cartridges
- c) Transportable vessels
- d) Refrigerated LPG storage
- e) LPG fuelling and storage at Retail sites.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in distribution/marketing installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
ALARP	As Low As Reasonably Practicable. The point at which the cost (in time, money and effort) of further Risk reduction is grossly disproportionate to the Risk reduction achieved.
Enforcing Authority	The Enforcing Authority is the authority responsible for enforcing national and local health and safety legislation and other relevant statutory requirements. (The Enforcing Authority can either be a national body or a local authority).
Evaporation Area	Safe ground adjacent to LPG storage vessel(s) where LPG can evaporate and disperse safely.
Fire Resisting	A material's ability to resist a fire for specific periods of time, if tested from either side, whilst still retaining properties of insulation, integrity and stability.
Fire Wall	A screen, wall, or dividing partition set up in open air to protect LPG vessels, pipes or equipment from radiated heat and to ensure enough dispersion distance in the event of a leak from a protected vessel.
Hazardous & Toxic Substances	Hazardous and toxic substances are defined as those chemicals present in the workplace which are capable of causing harm. In this definition, the term chemicals includes dusts, mixtures, and common materials such as paints, fuels, and solvents.
High Risk Location	A high population density within 500 m (1640 ft) of the installation, (e.g., blocks of flats) low mobility population (e.g., hospital, home for elderly) or public building such as library, concert hall, school).
Mounded Vessel	A storage vessel partly buried or above ground and covered by a mound of earth or other inert material.
Non-combustible Material	Will not support combustion when tested in accordance with recognised standards.
Over Pressure Shut Off (OPSO)	OPSO is a device fitted in an LPG gas supply system which shuts off the gas supply if over-pressure is detected in the gas supply pipe downstream of the regulator (typically because of regulator failure).
Point of Liquid Transfer	The point at which liquid transfer connections and disconnections are made.
PRV	Pressure Relief Valve
Remotely Operated Emergency Shut Down Valve	A shut-off valve that can be activated remotely to automatically shut when engulfed by fire, deprived of actuating power or some other hazardous condition is detected.
Separation Distance	The horizontal distance between a specified feature and the nearest part of a storage vessel.
Underground Vessel	A storage vessel buried below ground level.
Under Pressure Shut Off (UPSO)	UPSO is a device fitted in an LPG gas supply system which shuts off the gas supply if under-pressure is detected in the gas supply pipe downstream of the regulator.(typically because of pipe failure or empty tank).

Term	Definition
Vessel	A container or tank of over 150 litres (40 gal) water capacity designed and manufactured to a recognised pressure vessel code.
Water Capacity	The water volume (in litres [gal] of water) that will completely fill a vessel.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets (). Other documents referenced by this DEP are listed in (9).

1.5 SUMMARY OF MAIN CHANGES

This is a new DEP.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

2. BASIC PRINCIPLES

2.1 EQUIPMENT

All equipment used in LPG service shall be suitable for use with LPG, type approved, meeting recognised standards and suitable for all operating conditions that the equipment is likely to encounter during its service life.

All fire safe, fail safe or electrical equipment and pipework shall be procured with relevant material certificates which shall be kept as a matter of record.

3. STORAGE VESSELS

3.1 TYPES OF STORAGE VESSEL

LPG at elevated pressure and ambient temperatures can be stored in two different types of vessels:

- Exposed vessels
- Covered vessels: mounded, underground or submerged vessels

Covered vessels may provide additional safety compared to exposed storage. For instance, the occurrence of a BLEVE (Boiling Liquid Expanding Vapour Explosion) is virtually impossible. However, the design aspects of covered storage projects are, in general, more complicated than those for above ground vessels. (See DEP 34.51.11.30-Gen. for guidance).

The following points shall be considered in the selection of storage type:

1. Exposed storage visibility to the public and regulatory bodies leading to the perception of increased risk.
2. For storage in excess of 5,000 m³ (1,320.860 US gal) water capacity, spheres would normally be used.
3. Bullets are portable in that they can be cheaply installed, easily removed and relocated to other sites in response to changing Distribution Logistics requirements.
4. Covered storage has lower maximum incident consequences.
5. Covered storage often permits lower separation distances.
6. Covered storage is more expensive to install than exposed storage.
7. The Regulatory regime of inspection can make the inspection of covered storage costly.
8. Availability of firewater for fixed and/or mobile sprays.
9. Availability of a professional fire fighting service.
10. Suitability of the land (including water table) for covered storage.

3.2 LOCATION, GROUPING AND SEPARATION

3.2.1 General

This DEP provides separation distances for LPG storage between vessel shell and adjoining property that may be developed in Table 1, flammable liquids storage (Table 2) and liquid oxygen storage (Table 3).

Above ground tanks shall be located in the open air according to the separation distances required in local legislation, but with a minimum separation distance as listed in Table 1. If local legislation does not exist, the separation distances in Table 1 shall be applied. Ensure that there is a good airflow around the tank. Where more than one vessel is installed they shall be separated by a distance of $\frac{1}{4}$ of the sum of the diameters of adjacent vessels with a minimum distance of 1 m (40 in).

Mounded or underground tanks shall be located in a way that maximizes the ventilation around the pressure relief valves and manhole, according to the separation distances required in local legislation, but with a minimum separation distance of 3 m (10 ft) from any vessel fitting and a minimum distance of 1 m (40 in) between vessels.

All separation distances in Table 1 are based on tank installations that are fully compliant with this DEP with a minimum of joints and flanges in pipe work and a rigorous asset integrity management regime applied.

Layout and selection of location shall be in accordance with Table 1 below for separation from buildings and boundaries. More detail of separation distances from other facilities can be found in the following sections in DEP 80.00.10.11-Gen.

5.2.8.1	Bulk Road Vehicles; that includes Figure 5.3.
5.8.2.2	LPG Bulk Transfer; that includes Figures 5.4, 5.5.
5.8.2.3	Jetties
5.2.10	Pressurised LPG storage; that includes Figure 5.6.

Table 1 Separation distances from Buildings and Boundaries (SI and USC units)

Minimum Distances							
Water Capacity per Container		Mounded or Underground Containers		Aboveground Containers		Between Containers	
US gal	m ³	ft	m	ft	m	ft	m
2001-30 000	>7.6-114	50	15	50	15	5	1.5
30 001-70 000	>114-265	50	15	75	23	¼ of sum of diameters of adjacent containers	
70 001-90 000	>265-341	50	15	100	30		
90 001-120 000	>341-454	50	15	125	38		
120 001-200 000	>454-757	50	15	200	61		
200 001-1 000 000	>757-3785	50	15	300	91		
>1 000 000	>3785	50	15	400	122		

NOTE: Based on NFPA 58 Table 6.3.1 (consistent with API STD 2510 Table 1).

Table 2A Separation distances - flammable liquids and LPG vessels (SI units)

Flashpoint of Flammable Liquid	Minimum Separation LPG vessel up to and including 60 tonnes LPG capacity	Minimum Separation LPG vessel over 60 tonnes LPG capacity
< 32°C (e.g., petrol)	6 m to bund wall	15 m to bund wall
Flashpoint 32°C to 65°C (e.g., kerosene, diesel fuel, gasoil) Tank size up to 3,000 litre of flammable liquid	Separation distance for LPG vessel (Table 1) or 3 m to the flammable liquid tank/bund whichever is the lesser.	6 m to tank, bund wall or diversion wall
Flashpoint 32°C to 65°C (e.g., kerosene, diesel fuel, gasoil) Tank size over 3,000 litre of flammable liquid	3 m to bund wall or diversion wall and 6 m to tank.	15 m to tank, bund wall or diversion wall

NOTE: Source UKLPG Code of Practice 1, Bulk LPG Storage at Fixed Installations Part 1:2009.

Table 2B Separation distances - flammable liquids and LPG vessels (USC units)

Flashpoint	Minimum Separation LPG vessel up to and including 60 tons LPG capacity	Minimum Separation LPG vessel over 60 tons LPG capacity
Flashpoint less than 90°F	20 ft to bund wall	50 ft to bund wall
Flashpoint 90°F to 150°F (e.g., kerosene, diesel fuel, Gasoil) Tank size up to 800 US gal of flammable liquid	Separation distance for LPG vessel (Table 1) or 10 ft to the flammable liquid tank/bund whichever is the lesser.	20 ft to tank, bund wall or diversion wall
Flashpoint 90°F to 150°F Tank size over 800 US gal of flammable liquid	10 ft to bund wall or diversion wall and 20 ft to tank.	50 ft to tank, bund wall or diversion wall

NOTE: Source UKLPG Code of Practice 1, Bulk LPG Storage at Fixed Installations Part 1:2009.

Table 3A Separation distance - liquid oxygen and LPG vessels (SI units)

LPG vessel water capacity	LPG vessel nominal capacity	Liquid oxygen capacity	Separation distance
Up to 265,000 litres	Up to 120 tonnes	Up to 566,000 litres	6 m
Up to 4,500 litres	Up to 2 tonnes	More than 566,000 litres	7.6 m
4,500 to 265,000 litres	2 to 120 tonnes	More than 566,000 litres	15 m
Above 265,000 litres	Above 120 tonnes	All capacities	Perform full risk assessment

NOTE: Source NFPA 58 Table 6.4.5.8.

Table 3B Separation distance - liquid oxygen and LPG vessels (USC units)

LPG vessel water capacity	LPG vessel nominal capacity	Liquid oxygen capacity	Separation distance
Up to 70,000 gal	Up to 130 tons	Up to 150,000 gal	20 ft
Up to 1,200 gal	Up to 2.2 tons	More than 150,000 gal	25 ft
1,200 to 70,000 gal	2.2 to 130 tons	More than 150,000 gal	50 ft
Above 70,000 gal	Above 130 tons	All capacities	Perform full risk assessment

NOTE: Source NFPA 58 Table 6.4.5.8.

3.2.2 Ground

The ground underneath or next to connection into LPG vessels or LPG ancillary equipment shall be concreted or compacted and free from depressions, pits, culverts or drains. LPG vessels shall not be installed in a stacked manner; one on top of the other. If all connections are grouped at one end of the vessel, it may only be necessary to compact or concrete under the connections.

The ground inside the required separation distances shall be substantially level and as flat as possible (except under the vessel where it shall be sloped away approximately 1:50 such that any spillage of LPG can evaporate and disperse safely in an area not under the vessel).

Care shall be taken to avoid siting vessels in locations where the surrounding ground slopes towards vulnerable features, e.g., other vessels, buildings, filling plants, drains, etc., even though these may be outside normal separation distances.

Adjacent vessels shall be spaced according to specific site conditions and what is necessary for safe installation, testing, maintenance and removal.

3.2.3 Spillage planning

LPG spillage containment (e.g., evaporation areas) shall be installed for:

- Any propane vessel of 56,250 litres (14,850 gal) water capacity or greater, with connections below the liquid level, unless plugged or blanked off. Any Butane vessel of 11,250 litres (2,970 gal) water capacity or greater, with connections below the liquid level, unless plugged or blanked off.

Spillage containment areas shall be safely sited away from boundaries, occupied buildings and ignition sources. The ground below the vessel and its connections shall slope and be compacted or concreted to avoid pools of liquid building up and to direct escaping LPG to the safe evaporation area which shall never be closer to LPG vessels than 3 m (10 ft). Low walls (usually 500 mm (1 ft 8 in) or less) can also act as an effective channel.

3.2.4 Natural phenomena

Local regulatory design rules shall be applied to safeguard against natural phenomena, including:

- Lightning – Protection is not usually needed in temperate countries, but may be required in tropical countries or those with a high frequency of lightning strikes.
- Earthquakes – Supports and foundations shall be designed to meet local seismic conditions.

- c) Flooding – Try to avoid siting vessels where there is a known flood risk. Prevent flotation by securely anchoring vessels. Underground vessels shall be securely anchored where there is a high water table.
- d) Cyclones/Hurricanes – Where prevalent, consideration shall be given to the effect of high wind loading.

3.2.5 Bunded enclosures

LPG vessels shall not be sited inside the bunded enclosure of vessels holding:

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

3.2.6 Siting cylinders near to vessels

LPG cylinders shall not be stored within 15 m (50 ft) of bulk vessels.

When LPG or other flammable liquid cylinders are filled in structures or buildings close to LPG tanks the following separation distances must apply:

- 10 m (33 ft) from above ground tanks
- 5 m (16 ft 6 in) from underground tanks

These distances do not apply if the quantity of LPG in cylinders is less than 300 kg (660 lb) e.g., fork lift truck supply.

3.2.7 Horizontal vessel direction

Arrange horizontal LPG vessels so that they are in parallel and do not point towards other vessels containing dangerous substances, nearby occupied buildings or important equipment.

3.2.8 Vessel numbers

Not more than 6 above ground LPG vessels shall be in a single group. Any vessel in one group shall be separated from the nearest vessel in another group by the separation distance to a public place in Table 1, unless a fire wall is built between the two groups. Within a group of vessels the distance between adjacent vessels shall be $(D1 + D2)/4$ where D is the diameter of the vessel, with a minimum separation distance of 1.5 m (5 ft).

3.2.9 Overhead electric power cables

LPG vessels, vaporisers, pumps and gas/air mixing plant, etc., shall not be located directly beneath electrical power cables. LPG vessels shall be sited:

- At least 1.5 m (5 ft) from a line drawn vertically down from a cable carrying less than 1 kV.
- This distance shall be increased to 7.5 m (25 ft) for cables carrying 1 kV or more.
- Or a competent engineer, usually from the local electricity supplier, judges each installation on its own merits and gives written approval.

3.2.10 Flammable liquids

Vessels containing a flammable liquid with a flashpoint of 65 °C (150 °F) or less shall be sited not less than the separation distances given in Table 3.

3.2.11 Liquid oxygen/other hazardous / toxic substances

LPG and liquid oxygen vessels shall be sited according to the separation distances in Table 3. LPG vessels shall be separated from other vessels holding toxic or hazardous liquids stored under pressure by at least 15 m (50 ft). If the total storage capacity of these materials is greater than 120 tonnes, a full risk assessment shall be performed.

3.3 FIRE WALLS

3.3.1 Purpose

Fire walls shield the public and other vulnerable equipment from thermal radiation caused by fire and ensure an adequate vapour dispersion distance to boundaries, buildings and sources of ignition in the event of an LPG leak occurring. They enable the use of shorter separation distances than would be normally possible.

3.3.2 Siting

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

- They shall be sited no closer than 1.5 m (5 ft) from the nearest point of the vessel.
- Separation distances may be reduced to the distance from the storage vessel around the ends of the fire wall to a public place as defined in Table 1.
- A fire wall for a vessel up to 2,500 litre (660 gal) water capacity may form part of a building.

3.3.3 Construction

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

- a) Capable of resisting fire for 60 minutes.
- b) Totally within the boundary of the LPG storage area.
- c) For vessels up to 2,500 litres (660 gal) water capacity, as high as the top of the vessel or highest piece of high pressure or liquid pipework or fitting connected directly to the vessel and may form part of a building or site boundary.
- d) For vessels over 2,500 litres (660 gal) water capacity, at least 2 m (78 in) high or as high as the top of the vessel, or highest piece of high pressure or liquid pipework or fitting connected directly to the vessel, whichever is the greater.

3.4 DESIGN

3.4.1 Summary

The mechanical integrity of an LPG vessel cannot be assured unless it complies with the approved design standards and reflects the intended usage, i.e., environmental conditions, process needs, vacuum and low temperature use, etc.

Typically, pressure vessels are made to standard designs in each country. Where possible, only the nozzles and connections required for the service should be fitted to the tank. However, on occasions, it may be necessary to use a standard tank and blank or plug surplus connections.

3.4.2 Standards/Applicable codes

LPG vessels shall be designed, manufactured, inspected and tested in accordance with DEP 31.22.00.31-Gen.

Specifically, they shall comply with or exceed the following:

1. Where vessels will be used for butane, propane and mixtures thereof at different times, the standards shown for propane shall be followed EXCEPT for minimum safe operating pressure, which shall follow the butane recommendation.
2. Welded steel construction.
3. Cylindrical shape with semi-ellipsoidal or hemispherical ends, or spherical.