

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

PRESSURISED BULK STORAGE INSTALLATIONS FOR LPG

PTS 30.06.10.12

AUGUST 2011



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This revision of PTS 30.06.10.12 - Pressurised Bulk Storage Installations for LPG (November 2003) has been updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards.

The previous version of this PTS 30.06.10.12 (November 2003) will be removed from PTS binder / e-repository from herein onwards.

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PREFACE

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The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

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1. INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations for the layout, location, safety and operability aspects of above-ground and mounded storage of LPG in pressure vessels. LPG includes commercial propane, commercial butane and mixtures thereof.

Excluded from the scope of this PTS is the storage of pressurised pentane; for this the Principal should be consulted.

This is a revision of the PTS of the same number dated November 2003; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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

This PTS is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This PTS may also be applied in other similar facilities.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this PTS, 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 PTS 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 PTS 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 word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced by this PTS are listed in (6).

1.5 SUMMARY OF MAIN CHANGES

This PTS is a revision of the PTS of the same number dated November 2003. The revision has been a complete rewrite with changes in numbering and PTS 80.00.10.11 has been added.

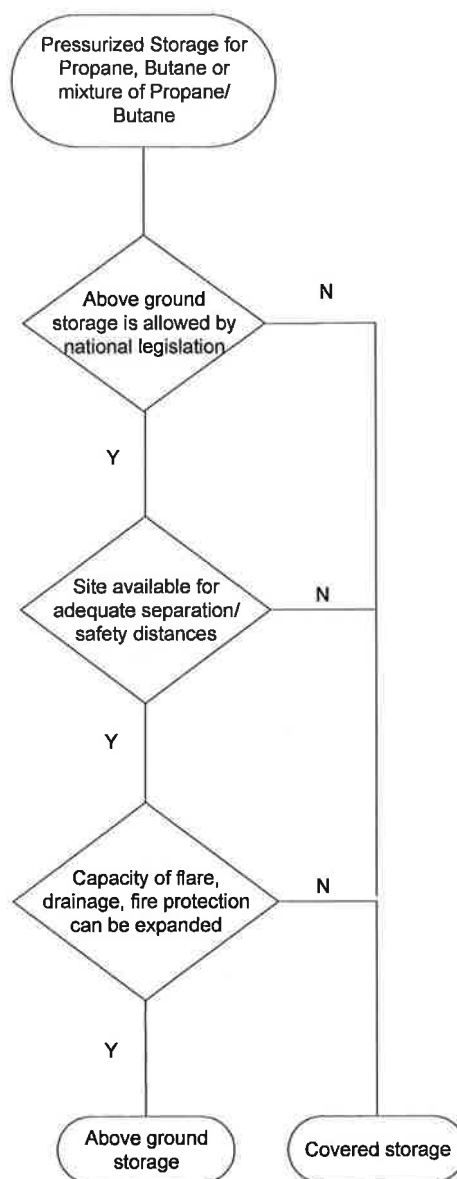
2. TYPES OF STORAGE VESSEL

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

- i. Above ground storage vessels (spheres, bullets)
- ii. Covered storage vessels (mounded or submerged storage)

Mounded storage may provide additional safety compared with above ground storage. For instance, the occurrence of a BLEVE (boiling liquid expanding vapour explosion) is virtually impossible. However, the design aspects of mounded storage projects are in general more complicated than those for above ground spheres or bullets. Particular attention should be given on settlement issues as well as the corrosion protection. Reference is made to EEMUA190 chapter 3. Furthermore, as indicated in the flow chart of storage vessel selection, above ground storage installations require adequate flare capacity, sufficient drainage systems, and extended fire protection systems.

A flow chart for storage vessel selection is provided below:



3. ABOVE-GROUND BULK STORAGE OF LPG IN PRESSURE VESSELS

3.1 LAYOUT AND LOCATION

3.1.1 General

Layout and selection of location shall be in accordance with PTS 80.00.10.11.

3.1.2 Safety Distances

Recommended distances for initial layout studies should be verified by a fire safety/risk assessment on a case-by-case basis taking for the credible accident scenarios. The principle of the safety/risk assessment with respect to the determination of distances is related to the maximum allowable heat radiation flux levels, which can be estimated within the assessment.

The following factors shall be reviewed for determination of a safe distance

3.1.2.1 Vessel capacity

Refer to PTS 80.00.10.11.

3.1.2.2 Radiation flux levels

Refer to PTS 80.00.10.11.

3.1.2.3 Leakage

Refer to PTS 80.00.10.11.

3.1.2.4 Natural Phenomena

Local rules shall be applied to safeguard against natural phenomena, such as, lightning, earthquakes, flooding, hurricane.

3.1.2.5 Safety distances for above-ground pressurised LPG storage facilities vessels

Refer to PTS 80.00.10.11.

3.1.2.6 Relief valve fire

Refer to PTS 80.00.10.11.

3.1.3 Piping

Only piping directly associated with the storage vessels shall be located within the storage area (refer to 3.2.4, Figure 3 and Figure 4).

Active and passive fire protection for piping shall be in accordance with PTS 80.47.10.30.

For the purpose of deflecting solar radiation, shields may be considered to prevent vapour locks.

3.1.4 Grading and ground finish

Spills shall be drained away from equipment as quickly as possible, to ensure that escaped product cannot collect under vessels or remain in their immediate vicinity. To facilitate the flow of escaped product and prevent its penetration into the soil, the ground shall be finished with concrete paving sloping towards the perimeter drain channels.

For further information, refer to PTS 34.14.20.31.

For storage vessels in dedicated LPG service always having an adiabatic flash fraction larger than 0.1 (the fraction on a mole base going to vapour when flashed from process conditions to 1 bar (abs) together with a resulting adiabatic flash temperature 20 °C or more below the lowest ambient temperature, the concrete paving together with the perimeter drain channels can be omitted. The content of the vessel will vaporise sufficiently without a danger of a pool fire. Omission of the sloping floor and the liquid collecting trench should therefore be considered (refer to PTS 80.47.10.30).

3.1.5 Separation between the vessel and the pipe manifold

There shall be a positive separation/deflection, e.g. a wall of 0.6 m maximum height, between the storage vessels and the pipe manifold/track to prevent the flow of any leakage from one to the other. Deflection walls may be considered between vessels to prevent product escape from one vessel from flowing under another (see Figure 1).

3.1.6 Confinement

Bund walls interfere with the ventilation of the site and impede the vapourisation/dispersion of escaped products and shall not be used.

3.1.7 Surface drainage

Surface drainage shall be in accordance with PTS 34.14.20.31.

3.2 VESSELS

3.2.1 Types of vessels

Pressure vessels for above ground storage of LPG shall be one of the following types:

- Horizontal cylindrical vessels
- Vertical cylindrical vessels
- Spherical vessels

3.2.2 Applicable codes

LPG storage vessels shall comply with one of the following PTS Specifications:

- PTS 31.22.10.32 Pressure Vessels (amendments/supplements to PD 5500)
- PTS 31.22.11.32 Unfired Pressure Vessels (amendments/supplements to EN 13445)
- PTS 31.22.20.31 Pressure Vessels (based on ASME Section VIII)

Unless otherwise specified by the Principal, the Manufacturer shall be responsible for obtaining the required certificates of acceptance for the storage vessels from the appropriate authorities.

3.2.3 Design temperature and pressure

3.2.3.1 Maximum Operating Temperature (MOT)

The MOT is the highest temperature attained by the commercial product in the storage vessel under normal operating conditions. The MOT is therefore the maximum temperature on receipt into storage or the assessed temperature for the relevant climate, whichever is the higher.

The assessed temperatures are 35°C, 40°C and 45°C for temperate, tropical and desert climates respectively. If assessed temperatures have been established by local regulations or by the design code specified by the Principal, then these shall be used for design purposes.

3.2.3.2 Maximum Operating Pressure (MOP)

The MOP is the vapour pressure of the commercial product concerned (refer to Table 1) corresponding to the MOT.

3.2.3.3 Design Pressure (DP)

The DP shall be as per PTS 01.00.01.30. The DP is defined for the top of the vessel; hence the maximum liquid static head shall be taken into account to determine sizing/strength of the lower parts of the vessel.

The use of a vapour return line and/or top spray filling (refer to 3.2.4.6) is recommended as a means of limiting excessive back-pressure build-up in vessels during the filling operation. Vapour return systems also prevent vacuum from developing during discharge. If such systems are not used, then the DP should be checked to ensure that the back-pressures

generated when filling are adequately covered, in order to avoid product loss through spurious relief.

The relationship between temperature and vapour pressure of commercial propane, commercial butane and propane/butane mixtures is shown in Figure 2.

3.2.3.4 Upper Design Temperature (UDT)

The UDT is the temperature corresponding to the DP. More information on the definition is given in PTS 01.00.01.30.

3.2.3.5 Lower Design Temperature (LDT)

Lower Design Temperature (LDT) is the lowest temperature at which equipment may be subject to its design pressure. PTS 30.10.02.31 and PTS 01.00.01.30 shall apply. These PTS shall also be referred to with respect to the allowable maximum pressure at low temperatures.

3.2.3.6 Minimum Metal Temperature (MMT)

Minimum Metal Temperature (MMT) is the lowest temperature that equipment may possibly attain; MMT is further described in PTS 30.10.02.31. This temperature is not related to its design pressure conditions (as LDT does).

3.2.3.7 Vacuum conditions (external pressure)

Provisions to cope with vacuum conditions are required where ambient temperatures can be expected to fall below the Atmospheric Boiling Point (ABP) of the commercial product stored, or where very high liquid withdrawal rates are applied without an adequate vapour return system. In these cases, which normally only apply to butane storage, vessels shall be designed for full vacuum.

Table 2 provides details of the pressure in a vessel containing pure n-butane at low temperatures, which shall be considered in the design.

3.2.4 Connections

3.2.4.1 General

The number of nozzles on vessels, particularly below the liquid level, shall be minimised.

Nozzle flanges shall be in accordance with ASME B16.5.

Nozzles to which product transfer piping, product drains and pressure relief systems are connected shall be at least DN 50.

Flanges in piping under vessels shall be avoided for safety reasons (flame impingement in the event of fire).

3.2.4.2 Bottom connections

For details, see Figure 3.

There shall be only one bottom connection, which may be used for filling, withdrawal and draining. The connecting pipe shall be welded and not flanged to this nozzle. The vessel nozzle shall include this pipe and shall terminate at the weld between the nozzle and the first valve. All joints in this bottom pipe up to and including the first valve (ESD valve) shall be welded and fully radiographed. The minimum size of the bottom pipe shall be DN 100. The pipe thickness shall be as determined by the pressure vessel code but shall be not less than Schedule 80 or, for pipes larger than DN 100, Schedule 40. Due to the fact that the pipeline is welded, it may be more vulnerable to mechanical damage during engineering work.

The product line shall be:

- as short as possible and sloping downwards from the vessel to the pump suction;
- provided with a water drain system upstream of the operational valve(s) (but downstream of the ESD valve, see Figure 3) at the manifold (refer to (3.2.4.3));
- shall provided with an ESD valve (refer to (3.4.2)).

This ESD valve shall be welded to the product line and located downstream of the separation/deflection wall.

Where the pump's net positive suction head (NPSH) requirements are critical, consideration shall be given to using a full bore ball valve.

Only in locations subjected to moderate/severe earthquake conditions (refer to PTS 34.00.01.30) or where local regulations dictate, shall the ESD valve be internally mounted. In this case (refer to Figure 4), the product line shall be:

- provided with a shut-off valve directly downstream of the ESD valve. This shut-off valve may be fitted with an actuator and be remotely controlled, but should also be capable of being manually operated.
- provided with a flanged tee, to accommodate an elbow between it and a DN 50 valve to provide a bypass in case of malfunction of the internal ESD valve.

NOTE It is recommended to have the by-pass installed fully welded with the by-pass valve in the locked closed position (to be approved by local authorities).

- fire-insulated at all flanges immediately beneath the vessel. It is however recommended to install the bypass permanently by using a welded connection with a locked valve (to be approved by Authorities) see Figure 4.

3.2.4.3 Drain system

A drain connection shall be provided for each storage vessel and shall consist of a nozzle not larger than DN 50 (schedule 80) welded to the bottom line (see Figures 3 and 5), to which a fire-safe ball valve not larger than DN 50 (upstream drain valve), shall be connected.

The drain system shall meet the following requirements:

- Having two manual shut-off ball valves separated by at least 600 mm of adequately supported piping with a slope towards the drainage direction to ensure that both valves are never simultaneously blocked open by ice. In fact, the separation is so that if flashing of LPG at the second valve freezes, the valve in the open position is far enough away that it is still operable and can operate the drain.
- The two drain valves shall be positioned so that a single operator can operate both valves simultaneously.
- The downstream drain valve shall be a DN 20, quick-acting, spring-loaded type (spring-to-close) valve, which will operate as a dead man's handle.
- The discharge point shall be lined up to flare or a vent in a safe location via a knock out vessel. The size of the knock out vessel is to be determined by the rate of draining and the volume of the piping contents between the bottom of the storage vessel and the drain connection.

Knockout drums and associated equipment shall be designed in accordance with PTS 80.45.10.10. Additional details on separation equipment may be found in PTS 31.22.05.11.

A vent to atmosphere may be considered only if there are no flare facilities or if a connection to flare would be impractical due to long distances. A risk assessment and dispersion analysis must be carried out in order to determine if the use of a vent to atmosphere is acceptable. In this case, a DN 20 pipe shall follow the downstream drain valve into a small separator vessel with discharge to atmosphere at a safe location (more