



OIL INDUSTRY SAFETY DIRECTORATE

**बल्क तरल पेट्रोलियम गैस (एलपीजी) की हैंडलिंग और भण्डारण
हेतु अनुशंसित प्रथाएँ**

ओ आई एस डी- आर पी - 158

**RECOMMENDED PRACTICES ON STORAGE
AND HANDLING OF BULK LIQUEFIED PETROLEUM GAS
(LPG)**

OISD-RP -158

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FOR RESTRICTED CIRCULATION ONLY

OIL INDUSTRY SAFETY DIRECTORATE

Government of India

Ministry of Petroleum & Natural Gas

8th Floor, OISD Bhavan, Plot No. 2, Sector – 73, Noida – 201301 (U.P.)

Website: <https://www.oisd.gov.in> Tele: 0120-2593833

PREAMBLE

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 by Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than three decades of its existence, OISD has developed a rigorous, multi-layer, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stake-holders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!!!

Executive Director
Oil Industry Safety Directorate

FOREWORD

The Oil Industry in India is over 100 years old. As such, various practices have been in vogue because of collaboration/ association with different foreign companies and governments. Standardization in design philosophies, operating and maintenance practices remained a grey area. This coupled with feedback from some serious accidents that occurred in the past in India and abroad, emphasized the need for the industry to review the existing state-of-the-art in designing, operating and maintaining of Oil and Gas installations.

With this in view, the Ministry of Petroleum and Natural Gas in 1986 constituted a Safety Council assisted by the Oil Industry Safety Directorate (OISD) staffed from within the industry in formulating and implementing a series of self-regulatory measures aimed at removing obsolescence, standardizing and upgrading the existing standards to ensure safe operations. Accordingly, OISD constituted a number of functional committees of experts nominated from the industry to draw up standards and guidelines on various subjects.

The present document has been prepared by the Functional Committee on Recommended Practices on Storage and Handling of Bulk Liquefied Petroleum Gas (LPG). This document has been prepared based on the accumulated knowledge and experience of the industry members and various national and international codes and practices.

The figures and photographs used in the document, if any, are representative in nature.

We, at OISD, are confident that the provisions of this standard, when implemented in totality, would go a long way in ensuring safe operation of the target group of locations.

Needless to mention, this standard, as always would be reviewed based on field level experience, incident analysis and environment scanning. Suggestions from all stake holders may be forwarded to OISD.

NOTE

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These documents are intended only to supplement and not to replace the prevailing statutory requirements of PESO, DGMS, Factory Inspectorate or any other Government body which must be followed as applicable.

Wherever Acts/ Rules/ Regulation and National/ International Standards are mentioned in the standard, the same relates to in-vogue version of such documents.

Note 2 in superscript indicate the modification/changes/addition based on the amendments approved in the 18th Safety Council meeting held in August, 2000.

**COMMITTEE ON
STORAGE AND HANDLING OF
BULK LIQUEFIED PETROLEUM GAS (LPG)**

NAME

ORGANISATION

LEADER

Shri B.R.B.Mathur, Engineers India Limited, New Delhi

MEMBERS

Shri R.N.Das, Bharat Petroleum Corpn. Ltd., Mumbai

Shri E.Nandakumar, Cochin Refineries Limited, Cochin

Shri A.C.Agarwal, Indian Oil Corpn. Ltd., Faridabad

Shri S.C.Meshram, Indian Oil Corpn. Ltd.(M.D.), Mumbai

MEMBER-COORDINATOR

Shri S.N.Mathur, Oil Industry Safety Directorate, New Delhi

(In addition to the above, several other experts from the industry contributed in the preparation, review and finalisation of this document.)

ERRATA AND UPDATION (MARCH 2022)

4.4 VESSEL ACCESSORIES

- (e) Liquid level gauging device

Each storage vessel shall have at least two nos independent level instruments, each working on different principles. However, both independent level instruments can also be radar gauges. In addition, one independent high level switch shall also be provided. High level alarm shall be set at the level not more than 85% of the volumetric capacity of the vessel. Audio visual indication shall be at local panel and control room.

Numaligarh Refinery Limited

**RECOMMENDED PRACTICES ON
STORAGE AND HANDLING OF BULK LIQUEFIED PETROLEUM GAS**

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RECOMMENDED PRACTICES ON STORAGE AND HANDLING OF BULK LIQUEFIED PETROLEUM GAS (LPG)

1.0 INTRODUCTION

Liquefied Petroleum Gas, otherwise known as LP Gas or simply LPG, is obtained by refining crude oil in petroleum refineries and fractionating natural gas available from oil and gas fields. The product conforms to the requirements of IS : 4576 - 1978.

There has been a tremendous growth in the use of LPG as domestic fuel as well as in industries. This rapid growth in demand of LPG has led to a substantial increase in the requirement of bulk storage and handling facilities. Because of its flammability and explosive nature, LPG is a hazardous substance (Refer Table-I for safety related properties of LPG). The purpose of this standard is to recognise the potential hazards of LPG and recommend guidelines on safety procedures and practices to be followed in its storage and handling.

2.0 SCOPE

This document covers operation of equipment and facilities connected with storage and handling of LPG at Gas Processing Plants, Refineries and other Bulk Handling installations. It also includes some basic concepts for design and construction of such facilities. It does not include the requirements associated with bottling and other marketing functions or transportation of LPG by trunk pipelines. Also, unless otherwise indicated, it does not apply to refrigerated, underground and mounded storage of LPG.

3.0 DEFINITIONS

(i) Bulk Storage

Bulk storage shall mean provision of storage facilities where more than 1000 litres of LPG is stored in a pressure vessel, e.g. Bullets and Horton Spheres (Refer SMPV Rules).

(ii) Pressure Vessel

Pressure vessel (both static and mobile) means any closed metal container or tank of any shape, intended for storage of LPG which is subjected to internal pressure and having water capacity of more than one thousand litres.

(a) Bullet

A cylindrical pressure vessel with hemispherical or dished ends, laid horizontally.

(b) Horton Sphere


A spherical pressure vessel, supported vertically.

(iii) Water Capacity

Maximum volume of water a vessel will hold at 15 degree C.

(iv) Filling Density

Filling density means the ratio of weight of liquefiable gas allowed in a pressure vessel to the weight of water that the vessel will hold at 15 degree C.

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Keeping in view the industry practice of leaving 5% free space in the vessel, the above definition gets modified to:

It is the ratio of the weight of liquefied petroleum gas introduced in the vessel, so as to leave a free space of 5% by volume at the reference temperature, to the weight of water the vessel will hold at 15 degree C. Thus, the filling density is numerically equal to 0.95 times the density of LPG at the reference temperature.

(v) Reference Temperature

This is the temperature at which the density of liquid LPG is to be evaluated for calculating the filling density. In India, the reference temperature considered for LPG pressure vessels is 55 degree C.

(vi) Vapour Pressure

The vapour pressure is the pressure exerted by the vapour in equilibrium with the liquid in a closed container at a particular temperature. The vapour pressure of LPG depends upon the temperature of the liquid and the composition of LPG.

4.0 PRESSURISED LPG STORAGE

LPG is stored in a pressure vessel. Refer Annexure-A for a LPG storage vessel P&I diagram and Table 1 for safety related properties of LPG.

4.1 APPLICABLE CODES & DESIGN PARAMETERS


- (i) Bulk LPG storage facilities shall be installed in accordance with "The Static & Mobile Pressure Vessels (Unfired) Rules, 1981" as amended from time to time.
- (ii) Bulk LPG storage vessel shall be designed, constructed and tested in accordance with Bureau of Indian Standard Code IS : 2825 or any other code approved by CCE.
- (iii) The design pressure of vessel for bulk LPG storage shall not be less than the vapour pressure of LPG in the vessel at 55 degree C. In case of propane storage, the design pressure shall not be less than the vapour pressure of propane in the vessel at 55 degree C.
- (iv) The design temperature of the vessel shall be in line with the specifications of LPG and statutory requirements.
- (v) The maximum quantity of LPG that can be stored in a pressure vessel shall be governed by the filling density of LPG and shall be such that the vessel shall not be more than 95% liquid full due to expansion of the contents with rise in the temperature to 55 degree C. (Refer Annexure D)
- (vi) OISD-STD-144 on "LPG Bottling Plant Operations" may be referred for more information.

4.2 LAYOUT

For general guidelines, reference shall be made to OISD Standard 118 on "Layouts for Oil & Gas Installations" and OISD Standard 144 on "LPG Bottling Plant Operations". Salient features are given below:

- (i) Each above ground pressure vessel shall be located in accordance with the following :
 - (a) A minimum safety distance shall be maintained as per OISD-STD-118 on "Layouts for Oil and Gas Installations".

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- (b) Vessel shall be in an open space. Pumps shall be in open space or under an open shed.
- (c) Vessels shall not be installed one above the other.
- (d) Bullets shall be oriented so that their longitudinal axes do not point towards other vessels, vital process equipments, control rooms, loading stations and flammable liquid storage tanks.
- (e) LPG storage installations shall be located in specially prepared industrial type fenced compound having at least two exit gates. However, if such storage is situated inside a licensed area, separate fencing is not required. The number of storage vessels in one group shall not exceed six. The aggregate capacity of a storage group shall be limited to 15,000 cu.m.
- (f) In case, there are more than one group of storage vessels, the minimum safety distance between two installations shall be the same as the distance between the vessel and the property line in accordance with OISD-STD-118 on "Layouts for Oil and Gas Installations".
- (g) The top surface of the vessels installed in a group shall be in the same plane.
- (h) Spheres and Bullets shall not be grouped together and shall be provided with separate piping manifold so as to avoid overfilling of a vessel due to gravitation from the other.
- (ii) Because of the pronounced volatility of LPG, dykes usually are not necessary. It is desirable for the grade to be sloped away from the vessel to a safe area in such a manner that the spills from one vessel does not pass through the adjoining vessel.


A kerb wall shall be provided on three sides of the vessel with a pit on the fourth side. Refer OISD Standard 118 on "Layouts for Oil & Gas Installations" for details. The area inside the storage installation shall be kept free from weeds and dry grass.

4.3 FOUNDATION & SUPPORTS

- (i) The materials, principles, methods and details of design and construction of foundation and supports should comply with approved codes and specifications.
- (ii) The grade for the vessel shall preferably be elevated slightly above the surrounding terrain to ensure complete drainage from beneath the bottom of the vessel.
- (iii) Suitable stairs, ladders, walkways and platforms shall be provided allowing easy access for operation/maintenance of valves and equipments. These structural items shall be welded on the pad plates made of the same material as the main equipment. Welding shall be done by qualified welder following approved welding procedures. In a group of storage vessels, inter-connecting walkways with suitable guards shall be provided at the top.
- (iv) Supporting structures shall be fire-proofed so as to support vessel and pipes safely in line with OISD-STD-144.

4.4 VESSEL ACCESSORIES

- (i) All fittings and accessories of the storage vessel shall be conforming to "Static & Mobile Pressure Vessels (Unfired) Rules, 1981".

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- (ii) Each storage vessel shall be provided with the following :

Inspection manhole	1 No.
Pressure relief valves	2 Nos.
Bottom nozzle for liquid inlet and outlet	1 No.
Pressure gauge	1 No.
Liquid level indicator	2 Nos.
Temperature measuring device	1 No.
Vapour inlet and outlet nozzle	1 No.
High level alarm switch	1 No.

- a) One number of Inspection manhole at the top

- (b) Spheres and bullets shall have a single nozzle at the bottom for inlet as well as for outlet. The nozzle shall be full welded pipe, stress relieved along with the vessel and shall extend minimum three (3) metres from the shadow of the sphere / bullet. A fire safe remote operated (shutdown) valve (ROV) shall be provided on this bottom nozzle at a distance of at least three (3) metres from the shadow of sphere/bullet. The nozzle pipe shall have a slope of 1.5 degrees.

There shall not be any other flanges, manhole, instrument tapping on this nozzle upto the ROV or on sphere/bullet bottom. In order to avoid stress on the nozzle due to relative settling of support and sphere, supporting the bottom nozzle from the vessel support legs should be considered. The top vapour zone of the vessel shall be provided with nozzles for vapour outlet and re-circulation which shall also be provided with fire-safe ROVs (Refer OISD Standard 144).

All the fittings shall be suitable for use at not less than the design pressure of the sphere/bullet and for the temperature appropriate to the worst operating conditions. The remote operated valves on the sphere/bullet connected lines shall be fire-safe type. The flange joints of these valves shall either have spiral wound metallic gasket or ring joints. Plain asbestos sheet gasket shall not be used.

Flange connections shall be a minimum of ANSI-300 lb flange class. All fittings shall be minimum 20 mm in length.

- (c) Bottom water draw off/drain valve


Two valves, with suitable distance piece between them, shall be provided between ROV and the first isolation valve. The first drain valve from the vessel should be of quick shut-off type valve while the second valve should be throttle type (Globe Valve) ^{Note 2}. The material for the drain pipe and related fittings shall be suitable for cryogenic application.

- (d) Sampling Valve

Two valves with suitable distance piece between them shall be provided between ROV and the first isolation valve for avoiding icing problem in the upstream valve.

- (e) Liquid level gauging device

The storage vessel shall have minimum two different types of level indicators and one independent high level switch. One level indicator shall be float type and the other may be differential pressure type in case of spheres. DP type level transmitter shall either be sealant filled type or LP side tubing heat traced. Magnetic float type gauge is recommended for bullets in place of differential pressure type. High level alarm shall be set at the level not more than 85% of the volumetric capacity of the vessel. Audio visual indication shall be at local panel and control room.

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(f) Pressure Gauge

Minimum of one pressure gauge, duly calibrated, shall be provided in the vapour space at the top.

(g) Temperature Gauge

One temperature gauge shall be provided in the liquid space at the bottom of the vessel.

(h) Pressure relief valve

- (i) Minimum of two pressure relieving valves shall be provided in the vapour space at the vessel top in accordance with the design code of the vessel.
 - (ii) Relief Valves shall be spring loaded. Weight loaded relief valves shall not be permitted.
 - (iii) Each safety relief valve (having 100% relieving capacity) shall be set to start-to-discharge at a pressure not in excess of 110 percent of the design pressure of the vessel and shall have a total relieving capacity sufficient to prevent the maximum pressure in the vessel of more than 120 percent of the design pressure.
 - (iv) Each safety relief valve shall be provided with isolation valve between it and the vessel. Each valve shall be of adequate capacity to allow full required capacity flow through it. Suitable provision to avoid accidental closing of the isolation valve is recommended.
 - (v) Relief valves shall be fitted with extended vent pipes having outlets at least 3 meters above the top of the vessel and atleast 3.5 meters above the ground level when not connected to flare system.
 - (vi) Relief valves shall be tested for correct operation not less than once in a year or as per the statutory requirements and a record of such tests shall be maintained.
 - (vii) For additional information, OISD Standard 106 on "Pressure Relief and Disposal System" may be referred.
- (i) Inside of bottom crown of sphere should be painted with anti-corrosive paint to protect it from corrosion.


4.5 COMMISSIONING AND DECOMMISSIONING

4.5.1 COMMISSIONING

(a) The following inspections / checks shall be carried out :

- (i) Check that all foreign matters have been removed and the vessel interior is cleaned before boxing it up.
- (ii) Check that all relief valves have been installed after due testing and calibration.
- (iii) Check that all other fittings and instruments are calibrated.
- (iv) Check that valves are installed after necessary inspection and removal of blinds.
- (v) Check that all safety facilities such as water sprays, fire protection equipment etc. have been provided and are in working condition.
- (vi) Ensure that pressure testing of the vessel has been carried out as per appropriate code mentioned in para 4.1 and a certificate to that effect from the approving authority is obtained.

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- (b) Leak testing of the vessel and fittings shall be carried out with nitrogen, carbon dioxide or water at a pressure of 7 kg/sq.cm. When using nitrogen/ carbon-dioxide for leak testing, leak can be located with soap and water.
- (c) If nitrogen/carbon-dioxide is used for leak testing, it is sufficient to vent the vessel and proceed with LPG filling operation ensuring a pressure of 1.5 kg per sq.cm.(g).
- (d) If water was used for leak testing, then water can be displaced with LPG vapour, fuel gas or natural gas prior to LPG filling operation.
 - (i) As water is displaced by equivalent volume of LPG vapour/fuel gas/natural gas, a constant watch on the pressure and level of water shall be maintained.
 - (ii) Care shall be taken to drain the residual mixture of water and gas.
 - (iii) Similar care shall be taken when filling the vessel with LPG and venting the natural gas to a suitable flare/venting system.

4.5.2 DECOMMISSIONING

The following inspections/checks shall be carried out :

- (a) Water purging has the disadvantage that it can dissolve about 150 parts per million (by wt.) of gas at ambient temperature and pressure. Thus, there is a hazard in releasing the purge water into drains. Immediate flushing with fresh water minimise this hazard. Alternatively, the water may be released to a safe disposal system.
- (b) For displacement purging with no mixing, the inert gas volume will approximately be equal to that of the vessel. For dilution purging with thorough mixing, the volume of inert gas required will be about five times the vessel volume. To inhibit mixing and thereby excessive consumption of purge gas, ensure that the densities of the purge gas and the gas to be purged are widely different. Thus, Carbon dioxide (SG: 1.52) is useful for removing air (SG: 1.00) and Nitrogen (SG: 0.97) for removing propane (SG: 1.52) or butane (SG:2.01).
- (c) In the case of an inert gas purged vessel, precautions should be taken when entering the vessel for inspection and repair. Personnel should be provided with breathing apparatus or better, the vessel be air purged. The interior of the vessel shall be checked for breathable atmosphere and to ensure that the LPG concentration is below 5% of the LEL. (Refer OISD Standard 112 on Safe Handling of Air-Hydrocarbon Mixtures and Pyrophoric Substances). Preferably, a running air hose may be provided during the initial period.
- (d) When opening up a LPG storage vessel in which a stock containing sulphur has been stored, deposits of pyrophoric iron sulphide may be found. They must be kept wet until they are removed. If allowed to get dried, these deposits may ignite automatically in presence of air.(Refer OISD Standard 112 on "Safe Handling of Air-Hydrocarbon Mixtures and Pyrophoric Substances").
- (e) During every hydro-testing, all nuts and bolts of manhole cover of sphere/bullet should be replaced.

- 4.5.3** If air is required to be displaced from a storage vessel during commissioning, then purging with inert gas like nitrogen or carbon dioxide is required to be carried out to lower the oxygen content of the vessel atmosphere to less than two percent (2%) before admitting LPG. The residual oxygen content of a vessel which is being put into service or the residual

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combustibles in one which is being decommissioned, are limits which must be scrupulously observed for the sake of safety.

4.6 INSPECTION & TESTING

- (i) A pressure vessel shall be maintained according to the requirements for which it was designed or fabricated as mentioned in para 4.1.
- (ii) The reasons for inspection and testing are to determine the physical condition of the vessel and the type, rate and causes of deterioration. These informations shall be documented after each inspection. Such data will enable the management in maintaining safety, enhancing continuity of operation and predicting future repair/replacement requirements.
- (iii) Frequency of such inspection and testing by a competent person at a pressure marked on the pressure vessel shall be at intervals of not more than five years.
- (iv) For details on inspection and testing, refer OISD Standard 128 on "Inspection of Unfired Pressure Vessels".
- (v) Precautions shall be taken against fire or explosion due to pyrophoric deposits in a vessel. (Refer OISD Standard 112 on Safe Handling of Air-Hydrocarbon Mixture & Pyrophoric Substances).
- (vi) Vessel shall be isolated using blinds of a suitable rating. It shall be drained, purged, cleaned and gas tested before entering.
- (vii) Work shall be carried out only after obtaining appropriate work permit. (Refer OISD Standard 105 on "Work Permit System" (Rev.I)).

4.7 PAINTING

Storage vessels and their supports shall suitably be painted externally to prevent corrosion.

4.8 INSULATION


In order to protect the vessel from overheating during the initial period of fire, it is recommended that the storage facility be provided with fire proofing in line with OISD-STD-144.

5.0 ANCILLIARIES

5.1 PUMPS

- (i) Pumps may be centrifugal, reciprocating or other types, designed for handling of LPG and safely withstand the maximum pressure which could be developed by the product and / or transfer equipment. Pumps shall conform to API 610.
- (ii) Pumps shall be fitted with suitable leak proof glands like mechanical seals. Glands fitted with double mechanical seals are recommended.
- (iii) Pumps shall have a by-pass valve and other suitable protection against over pressure on the delivery side.
- (iv) Check valves shall be installed on the delivery side of all centrifugal pumps.
- (v) The electrical motor drive and switchgear shall be of flame proof type according to area classification as per OISD Standard-113 on "Classification of Areas for Electrical Installations at Hydrocarbon Processing and Handling Facilities". Belt drives shall be of the anti-static type.

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5.2 COMPRESSORS

- (i) Compressors shall be suitable for handling LPG and designed to safely withstand the maximum outlet pressure to which these will be subjected. Compressors shall conform to API 618 & API 619.
- (ii) A suitable size scrubber or liquid knockout drum shall be installed upstream of the vapour compressor. It shall be equipped with a gauge glass, a drain and high liquid level shut down device. The drain shall be connected to a safe disposal system.

5.3 PIPING

- (i) Piping shall conform to the provisions of ANSI B 31.3.
- (ii) Furnace butt welded or spiral welded pipes shall not be used.
- (iii) Only seamless pipes are to be used.
- (iv) Pipe joints should be welded as far as practicable with full penetration weld. Number of flanged or threaded joints should be kept to a minimum.
- (v) Low point drains and high point vents shall be plugged or capped suitably.
- (vi) Buried piping should be protected against physical damage and corrosion with suitable sleeves, properly sealed at both the ends, at road crossings.
- (vii) The design, material and construction of hoses shall be suitable for LPG (Refer OISD Standard- 135 on Inspection of Loading/ Unloading Hoses for Petroleum Products).

5.4 VALVES


Steel valves conforming to relevant API standards shall be used. Cast iron valves should not be used.

5.5 THERMAL PRESSURE RELIEF SYSTEM

Any equipment or section of pipeline in which liquid LPG may be trapped e.g. between shut off valves, should be protected against excessive pressure developed by thermal expansion of the contents by providing suitable thermal pressure relief valve(s). If pressure relieving devices discharge to atmosphere, the discharge should be arranged in a safe manner.

5.6 FITTINGS

- (i) Steel flanges and flanged fittings conforming to relevant API/ANSI specifications shall be used. Slip on or weld neck flanges should be used. Screwed flanges for sizes 50 mm or smaller may be used. Steel flanges should conform to the applicable provisions of ANSI B 16.5.
- (ii) Steel screwed fittings and couplings shall conform to ANSI B 16.11. Steel unions shall have ground metal to metal seats. Gasket type unions shall not be used.
- (iii) Plugs shall be of steel. Cast iron or brass plugs shall not be used.
- (iv) All flanges will be connected for bonding for electrical continuity.

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6.0 BULK HANDLING AND TRANSFER

6.1 BULK HANDLING FOR MOVEMENT BY ROAD

LPG is moved by road in tank trucks. The tank truck shall be designed, constructed and tested in accordance with the Static and Mobile Pressure Vessels (Unfired) Rules, 1981. A sketch showing General arrangement of LPG Tank Truck is enclosed as Annexure-B.

6.1.1 FACILITIES

(a) Loading –

Each loading station shall consist of the following :

- (i) A filling line with an isolation valve and excess flow check valve.
- (ii) A vapour return line with an isolation valve connected back to the storage vessel from which the loading pump is drawing LPG.
- (iii) Suitable loading arm/flexible hoses (Ref.OISD-STD-135 on Inspection of Loading/ Unloading Hoses for Petroleum Products) shall be provided at the end of filling and vapour return lines for connecting to the tank truck vessel.
- (iv) Weigh bridges of suitable capacity / mass flow meters shall be provided for custody transfer of product by weight.
- (v) A check valve shall be provided in the vapour return line.

A typical sketch of loading facilities is shown in Annexure-C.

(b) Unloading -

Unloading of LPG from tank truck is carried out with vapour compressors using pressure differential method of liquid transfer. The compressor shall be placed at the unloading point with the following facilities:


- (i) Vapour line with isolation valves
- (ii) Product transfer line with isolation valves
- (iii) Weigh bridge of suitable capacity

A typical sketch of unloading facilities is shown in Annexure-E.

6.1.2 SAFETY PRECAUTIONS

1. Transfer of LPG to or from a tank truck requires special attention as accidental movement of vehicle may cause rupture in the transfer equipments.
2. No source of ignition must be allowed in the area where product transfer operations are carried out.
3. Fire extinguishers shall be placed near the tank trucks during transfer operations.
4. The first operation after positioning the truck should be to provide proper earthing. Earthing shall be disconnected just before the release of the truck.

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5. Before removing plugs or caps, always crack open to allow for release of trapped LPG and further to ensure that the valves are effectively sealing.
6. Hoses should be handled with care and inspected periodically (Refer OISD Standard 135 on Inspection of Loading / Unloading Hoses for Petroleum Products).
7. While disconnecting hoses/pipes, connections should be loosened only slightly at first to allow release of trapped pressure, if any.
8. Do not expose hands, face or clothing to liquid LPG. Always use personal protective equipments while making or breaking the connections to avoid cold burns.
9. Gas detection system shall be provided in line with OISD-STD-144.
10. The master switch shall be put off immediately after parking the truck in position. No electrical switch on the truck shall be turned " on" or " off" during the transfer operation.
11. No repairs shall be made on the truck while it is in the loading area.
12. New tank trucks vessels or vessels received after repair shall be purged before loading as mentioned under the Item 4.5 "Commissioning and Decommissioning".
13. It is recommended that the receiving vessel having a pressure of less than 1 Kg/sq.cm.g should not be filled. Such vessel should be checked for oxygen content/explosive mixture and purged, if necessary.
14. Venting and purging of LPG during transfer operation normally should not be carried out in open atmosphere. It should be piped to a suitable flare system. Where such facility does not exist, vent pipes shall be provided to carry the vented product to a safe distance and released at a height not less than three metres above the highest point of any building, shed or structure within 15m radius. Snuffing steam facility may be provided for the vent line.
15. Filling/transfer operations should be stopped immediately in the event of -
 - (i) Uncontrolled leakage occurring
 - (ii) A fire occurring in the vicinity
 - (iii) Lightning and thunder storm


6.1.3 PROCEDURES FOR OPERATION

(a) LOADING OPERATIONS


1. Check for following in a tank truck before accepting it for filling:

- (1) Two safety valves are provided on the vessel.
- (2) Fixed tube gauge is provided.
- (3) Excess flow valve is provided.
- (4) Pressure gauge is provided.
- (5) Temperature gauge is provided.
- (6) Fire screen between cabin and vessel is provided.

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- (7) 2 Nos. of 10 Kgs. DCP Fire Extinguishers are provided.
 - (8) Spark arrestors of approved quality are fitted.
 - (9) No leakage in exhaust silencer pipe exists.
 - (10) Manufacturer's name plate with date of testing is fitted on the vessel.
 - (11) Valid Explosive Licence is available.
 - (12) Approved drawings of vessel are available.
 - (13) Blind flanges/caps are provided on vessel.
 - (14) Earthing cable is provided.
 - (15) Bonding between vessel and chassis is satisfactory.
 - (16) Bonding between flanges in manifold is satisfactory.
 - (17) Excess flow valve and control valve are available on water drain line.
 - (18) Bonding point is available.
 - (19) Third party inspection/test certificates for vessel/fittings are available.
 - (20) Liquid / vapour line valves are in good condition.
2. Move truck to the loading bay/weigh bridge and record the weight of the empty tank truck.
 3. Stop the truck on a leveled ground and place check blocks at front and rear wheels.
 4. Stop the engine and switch off all electrical equipments.
 5. All persons should leave the driver's cabin.
 6. Make bonding connections of the vehicle at specified point to the fixed grounding system.
 7. Connect loading and vapour lines suitably with the loading point. Crack open valves on loading & vapour return lines and inspect hoses & connections for leakage. Loading should start only when the system is leak free.
 8. Start the loading pump.
 9. The quantity loaded into the truck can be determined by -
 - (i) Liquid level
 - (ii) Weighment
 - (iii) Positive displacement meter
 10. Liquid level may be determined by roto-gauge or fixed liquid level gauge. Percentage volume to be filled should be pre-determined (see Annexure-D and Tables-2 & 3).

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11. Where weigh bridge is used, it is necessary to determine the density of the product being loaded to avoid excess filling in terms of volume. The weigh bridge shall be periodically calibrated and stamped by Weights & Measures Authorities.
12. Whether a gauging device is used or a weigh bridge is employed for filling operation - when the liquid content is approximately within 5% of the safe filling level, the operator should position himself so that he is in control of the shut off valve and starts to close the valve as the safe filling level approaches.
13. When the filling operation is in progress, the pressure within the tank truck vessel should be observed to ensure that it does not approach the start-to-discharge pressure of the relief valve. Filling rate may be regulated as required.
14. The couplings may then be removed and plugs/caps replaced on the tank truck valves. Re-check tightness with soap solution.

(b) Unloading Operations

1. Operations described under Item 1 through 6 in para 6.1.3(a) should be carried out.
2. Liquid line and vapour line of the tank truck should be connected to the respective hoses fixed to the unloading point.
3. Test the connections for leaks by slightly opening the valves for pressurising. When satisfied, valves on the tank truck and the receiving vessel should be opened.
4. Start the evacuation compressor. Vapours will be sucked from the receiving vessel and will be discharged into the vapour space of the tank truck vessel creating pressure differential thereby pushing the liquid from the tank truck vessel to the receiving vessel.
5. Care should be exercised to see that the pressure created within the delivering vessel does not reach or exceed the set pressure of the relief valve.
6. An authorised person of the company should supervise the transfer operation and respond immediately in the event of an emergency.
7. After the liquid has been expelled, the vapour recovery operation may be started. Care should be taken not to bring down the pressure of the delivering vessel below 1.5 Kg/cm.sq.g.
8. Operations described under Item 14 in para 6.1.2 should now be carried out.

A filling line with excess flow check

6.2 BULK HANDLING FOR MOVEMENT BY RAIL

LPG is moved in Tank Wagons by the Railways. These wagons are designed by RDSO and are fitted with various devices as shown in Annexure F.


6.2.1 FACILITIES

(a) Loading

Each loading point shall consist of the following:

- (i) A filling line with excess flow check valve and an isolation valve.

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- (ii) A vapour line with a check valve and an isolation valve to be connected back to the vessel from which LPG is drawn.
- (iii) Flexible hoses to be connected with the filling and the vapour return lines.
- (iv) A check valve to be provided at the end of flexible hose with the filling line.

A typical sketch of loading facility is shown in Annexure-C.


(b) Unloading

Unloading of LPG from tank wagons shall be done with the help of compressor. The compressor is used to create a differential pressure between the receiving and discharging vessels by withdrawing vapors from the receiving vessel and forcing it at high pressure into the discharging vessel thereby establishing a smooth flow. The content of tank wagons can be ascertained by weighment on weigh bridge before and after emptying or, alternatively, the quantity can be determined based on wagon gauge readings and differential in storage tank gauge readings before and after receipt, wherever physical weighment is not possible.

6.2.2 SAFETY PRECAUTIONS

1. Do not allow the locomotive to come on the weigh bridge due to its capacity limitation.
Sufficient number of dummy wagons may be used to avoid loco coming closer to the gantry.
2. In the event of leak :
 - a) Stop the loading pump.
 - b) Stop the movement of loco on the adjoining rails.
 - c) Switch off all internal combustion engines that may be running in the nearby area.
 - d) Stop hot jobs, if any, in the nearby area.
 - e) Stop all the vehicular traffic in the vicinity.
 - f) Start water monitors to form a blanket covering the leak and the wagon/piping from which LPG is coming out.
 - g) Call fire engine with crew to standby till the emergency exists.
 - h) Stop all the maintenance jobs in the area.
 - i) Depressurise the system before attending to the leak.
 - j) Take immediate steps to decant the wagon, if the leak is from wagon.
 - k) Clear the area of all the people except those who are required to meet the emergency situation.
 - l) Cut off power supply in the area where leak is detected.
3. The first operation after positioning the wagon shall be to provide for proper earthing. Earthing shall be disconnected just before the release of the wagon.

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4. For connecting and disconnecting hoses, it is advisable to use non-sparking type of tools.
5. After the wagons are placed on weigh bridge and before the loco is detached, the hand brakes on each and every wagon should be applied.
6. Like-wise, before the wagons are moved from the weigh bridge, release brakes on all the wagons.
7. Do not use footwear with protruding nails.
8. Ensure that the lower portion of flapper bridge at wagon side is fitted with rubber or wooden padding.
9. Ensure that coir matting/rubber sheet is spread on the platform.
10. Ensure that electrical continuity of the system is intact.
11. Ensure that all fittings on the wagons are checked physically.
12. Hoses should be hydraulically tested atleast twice a year (six monthly) (Refer OISD-STD-135 on "Inspection of Loading / Unloading Hoses for Petroleum Products").
13. Excess flow check valve will stop the flow of LPG in case the flow is in excess due to accidental rupture of hoses etc. Close the isolation valve at grade level.
14. During the loading/unloading operation, the operator must be present near the wagons.
15. During unloading operation, after the liquid transfer is over, the wagon pressure shall not be reduced below 1.5 Kg/sq.cm.(g).

6.2.3 OPERATING PROCEDURES

(a) LOADING OPERATION

1. Place the wagon on weigh bridge taking care to see that all the four wheels are properly accommodated on the platform. Engage hand brakes.
2. Ask loco to move away and exhibit caution sign at suitable distance away from the wagons on both ends.
3. Switch off loco engine, if parked nearby.
4. Note down wagon numbers and placement time.
5. Take loading advice.
6. Note the time of receipt of advice.
7. Connect earthing lugs to the wagons.
8. Lower the flapper bridge slowly on the wagon.
9. Open the lid of the wagon.
10. Take the tare weight reading and set the pointer of the scale to zero. Compare this with the marked tare weight on the wagon.

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11. Connect the filling hose and vapour return line hose to the wagon. Ensure that the flare connection valves are closed.
12. Ensure that the header is charged with LPG and the bulk loading pump is running.
13. Open the tanker filling line valve and vapour return line valve.
14. Open the LPG isolation valve, located near the weigh scale.
15. Check the system for leaks.
16. Open the valve on the vapour return line. Now slowly open the valve on the filling line. Increase the valve opening and gradually open the valve fully.
17. If everything is satisfactory, gradually throttle valve on return line.
18. Keep a check on the weigh scale readings. As soon as it shows the required weight of LPG to be filled, close the LPG isolation valve near the weigh scale.
19. Close the wagon filling and vapour return lines valves and also valves on filling and vapour return lines at the loading point.
20. Recheck final weight and record it. It shall be ensured that final gross weight should not exceed the permissible axle load of the wagon.
21. Open the valve on flare line connection to both feed line and vapour return line. Thus, the hoses are depressurised. Then, close the flare line connection valves.
22. Disconnect the filling and vapour return line hose connections from the wagon. Replace and tighten the plugs on filling and vapour return lines.
23. Close the top cover of the wagon and seal it properly. Remove earthing connections.
24. Prepare the gate pass.
25. Release the hand brake of the wagon.
26. Release all the wagons on the loading points in the lot.

(b) Unloading Operations


1. Ascertain that the liquid discharge valve and the vapour valve within the tank wagon cover are in the closed position.
2. Open the port covers in the side of the domeshell, if exist. Unscrew the plugs in the outlets of the vapour valve and the liquid valves using a box wrench. This must be done slowly.
3. If there is any sound of escaping vapour or if there seems to be pressure behind the plugs, the pressure must be allowed to relieve itself past the threads before the plugs are entirely disengaged.
4. If the vapour discharge continues or if there is evidence of a liquid discharge, the valves should be retightened.

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5. With the plugs removed, screw pipe nipples into the outlets of the valves after first having applied a modest quantity of sealant to the male threads, keeping the sealant away from the end of the thread. Tighten nipples with a pipe wrench.
6. Connect the two liquid transfer unloading swing arms or hoses to the nipples attached to the liquid discharge valves. Connect the vapour or equalizing swing arm or hose to the nipple attached to the vapour valve. In most of the cases, these connections will be made by means of either a ground joint union or a hose coupling.
7. In the event, a ground joint union is used, no gasket will be required. If a hose coupling is employed, ensure that the appropriate gasket is in place. Make sure that they are secured tightly by appropriate means.
8. After the vapour and liquid hoses have been connected and before any valve is opened, the valves on the tank wagon are crack opened in order to apply pressure to the hoses as a test for leaks.
9. If any leak appears, the valve should be immediately closed and corrective measures applied.
10. Recheck the lines and connections to make sure that they are connected correctly.
11. After the liquid and vapour lines have been secured and tested, both liquid education valves should be opened slowly and completely. Then, open all other valves in the liquid line working from the tank wagon to the storage tank.
12. Open the storage tank filling valve slowly, be careful not to open this valve too far if the tank wagon pressure is in excess of the storage tank pressure or the tank wagon excess flow check valves may get closed.
13. If the tank wagon pressure is higher than that in the storage tank, do not open the valves in vapour line or operate the compressor. When the rate of liquid flow drops to an unsatisfactory level with the storage tank filling valve wide open, open the vapour valves between the tank wagon and the storage tank.
14. At this point, make sure that the control valves at the compressor are in a position which allow the compressor to draw vapours from the storage tank and force it into the tank wagon, then start the compressor.
15. When the tank wagon is held at a pressure of 2.0 to 2.5 Kg/sq.cm. above the storage tank pressure, the tank wagon should be emptied into the storage vessel.
16. A flow of gas instead of liquid through the sight-flow glass in the unloading line indicates that the wagon is empty of liquid. Recheck this by opening the sample valve in the tank wagon dome.
17. When the tank wagon is emptied of all liquid, stop the compressor and close the liquid valves beginning at the storage tank and progressing to the tank wagon.
18. If the facilities are so arranged that vapours may be removed from the tank wagon, the pipeline at the compressor should be arranged so that the compressor will draw vapour from the tank wagon and force it into the storage tank. The sequence of piping line-up during unloading liquid LPG and vapour LPG is shown in Annexure - E.
19. In this operation, the vapour should be discharged below the surface of the liquid in the storage tank to hasten the liquefaction and, in turn, help prevent excessive pressure in the storage tank.

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20. Restart the compressor and when the tank wagon pressure is reduced to about 1.5 - 2.0 Kg/ sq.cm., stop the compressor and close all the valves in the vapour line.
21. After bleeding off the pressure in the hoses, disconnect both the liquid and vapour lines. Replace all the plugs in the tank wagon valves and the unloading fittings.
22. Recheck sample valve, gauging device and thermometer well to determine that they have been returned to their original condition and are closed tight. Lower the dome cover carefully and lock it in place with the locking pin or secure by appropriate means.
23. Remove bonding connections.
24. Reverse or remove and replace the "Flammable" placard with "Dangerous - Empty" placard, if applicable.
25. Remove the "Stop - Tank Wagon Connected" sign and wheel blocks.
26. Any defect observed in the tank wagon should be noted on the appropriate forms and routed in accordance with acceptable procedure.
27. Notify the railways in writing about release of wagon and ensure that it is removed from the siding promptly.
28. Gauge the storage tanks, within the plant, which have received the LPG to determine that the liquid level is appropriate.
29. In the event of LPG received on weight basis, the tank wagon may require weighing following the completion of the unloading operation.

6.2.4 DEGASSING OF SICK/LEAKY TANK WAGONS

(a) Recommended Procedure

In the degassing system recommended for LPG wagons, vacuum cycle purging technique should be followed as outlined below :

- Vessel should be evacuated repeatedly by a vacuum pump.
- Vapour should be discharged through high rise vent, keeping the steam on.
- Maximum possible vapours should be sucked out in first step depending on the capacity of vacuum pump/compressor. As per RDSO, vessel can sustain the full vacuum also.
- Between the two vacuum cycles, nitrogen/inert gas should be used for breaking the vacuum.
- Cycle should be repeated till the LPG concentration is found below the end point of LPG (for butane, it is 4% by volume when purging is done by nitrogen). Periodically, samples should be drawn from suitable location and analysed for LPG concentration.
- Finally the vessel should be flushed with air to displace the nitrogen. Barrel should be tested finally with explosive meter to ensure that hydrocarbon concentration is below 10% of LEL.

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(b) Alternate Procedure

Alternately, wagons may be degassed by steaming or filling with water. However, it should be ensured that wagon is made water free after degassing.

6.3 BULK HANDLING FOR MOVEMENT BY SEA

Transportation of LPG in bulk by tankers may be carried out under fully-pressurised, semi-pressurised (semi-refrigerated) or fully refrigerated at atmospheric pressure conditions.

Pressurised Ships

The cargo is carried in a number of cylindrical pressure vessels (or cargo tanks) capable of withstanding the maximum pressure likely to be met in service (usually 17 bars).

Semi-Refrigerated Ships

The pressure of the cargo is very much reduced by lowering its temperature to about 0 deg.C by the process of refrigeration and tanks containing the cargo need not be so strong as those of pressurised ships. The tanks are thermally insulated.

Fully Refrigerated Ships

The cargo is carried at atmospheric pressure and the cargo tanks are "box-shaped" as opposed to cylindrical/ spherical in case of pressurised/semi-refrigerated tankers for better utilisation of ship's space.


Pressure ships usually range from very small capacity upto 2000 cum. capacity. The capacity of semi-refrigerated ships usually ranges from 1000 to 15000 cu.m. Fully-refrigerated tankers could be made very much larger and for any given size, much lighter.

6.3.1 CARGO CARRIER DESIGN & CONSTRUCTION

International Maritime Organisation (IMO) code for the construction and equipment of ships carrying liquefied gases in bulk, covers ships contracted on or after October 31, 1976. The IMO code for existing ships carrying liquefied gases in bulk covers ships built before the application date of the new ship code. Put together these codes are known as the IMO gas codes. The international code for the construction and equipment of ships carrying liquefied gases in bulk, with the short title of the International Gas Carrier (IGC) code, applies to ships contracted on or after July 1, 1986. With its revised and clarified wording, this IGC code includes all the updated requirements of the previous gas codes for new ships. The ISG code has been incorporated into the 1974 Safety of Life at Sea (SOLAS) Convention and in 1986 became mandatory for all Flags whose governments are signatories to the SOLAS Convention.

Some of the factors to be taken into consideration, which effect the design and construction of ships carrying gas, are :

- (a) Types of cargo to be carried
- (b) Condition of the carriage (i.e. fully pressurised, semi-refrigerated or fully refrigerated)
- (c) Type of trade, which in turn, determines the degree of cargo handling flexibility required by the tanker.
- (d) Terminal facilities available when loading or discharging the vessel.

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- (e) Cargo containment systems (IMO code identifies five different types).
- (f) Materials of construction (Fully refrigerated LPG cargoes must have tanks capable of withstanding temperatures down to (-)55 degree C. Alloy steels such as fully killed fine grain carbon manganese steel, sometimes alloyed with 0.5% Nickel are used.)
- (g) Tank insulation (for refrigerated cargo)
- (h) Tanker layout and safety features
- (i) Survival capability and tank location

As specified by IMO codes, gas carriers are required to undergo five different types of survey and have the certificates of fitness issued or endorsed. The certificate of fitness signifies that a minimum standard of constructional safety has been achieved. In order for a tanker to comply with code throughout its life time, it must be subjected to re-inspection to maintain its validity.

6.3.2 FACILITIES IN THE TANKER

The cargo handling equipments in a tanker usually comprise of :

Cargo pumps (submersible and booster)

Compressors

Condensers

Heat Exchangers


Vapourisers

Cargo heaters

The deep well pump supplies liquid to the booster pump to send the product ashore. In pressurised ship, liquid is withdrawn by pressurising the tank through vapour compression from other tanks. All semi and fully-refrigerated tankers are provided with cargo heaters to enable the vessels to discharge into pressure storage ashore and a booster pump if the discharge pressure is significantly above 9 bars. Each cargo tank is provided with the following equipments:

- a) Two cargo pumps, one each on either side of the longitudinal bulk head.
- b) Liquid discharge line from the tank dome, connected to the main liquid line.
- c) All emergency pump trunk way.]
- d) A liquid loading line connected to the main liquid line.
- e) Two liquid level indicating devices one on each side. These usually consist of a float attached to a self winding tape which moves up and down, either on guide wires or inside a guide tube. The liquid level is read off the tape through a gas-tight window at the top of and outside the tank.
- f) Two sets of purge lines at the top and bottom of the tank. These are used to distribute inert gas or vapour for gas-freeing or gassing-up of the cargo tanks.
- g) A vapour line for withdrawal of vapour to the compressor.

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- h) Sample tubes.

Safety Devices

- (a) Atleast two safety valves in each cargo tank
- (b) High and Low level alarms
- (c) Overfill alarm. When actuated, this will shuttle main loading valve and sound an alarm.

However, the design of the tankers with regard to provision of facilities, equipments, accessories and safety features must be in accordance with the IMO requirements.

The electrical equipments of all gas tankers are subject to the requirements of the Flag Administration, the Classification Society and of IMO. The certified safe electrical equipment found on gas tankers are :

- (i) Intrinsically safe
- (iii) Flameproof
- (iv) Pressurised or purged
- (v) Increased safety

6.3.3 TRANSFER PIPEWORK


The following facilities on transfer piping between Terminal and Shore tanks should be provided:

- (a) ROVs at both the ends of transfer line. (Additional ROV at critical locations in the pipe line route.)
- (b) Relief valves on liquid line to surge vessel with an audible alarm system connected to high safe venting system
- (c) Physical protection against impact to vent/drain pipes
- (d) Protection of pipeline against corrosion, particularly when the pipeline passes under public road way, which is likely to be water-logged
- (e) Pipe work passing public road way be designed to acceptable public highway authority standard in terms of roadway axle weights

6.3.4 TERMINAL FACILITIES

Transfer of LPG from ship to terminal and vice versa is accomplished using hoses or loading arms. If terminal authorities supply the cargo transfer hoses, it is recommended that NFPA section 59 regulation 4.5 be followed and complied with. However, if the hoses are ship hoses, these should conform to section 5 of IMO (IGC).

Provision of vapour return facility depends on economics, transfer rates, distance of jetty from storage tanks, product pressures and temperatures etc.

	<p style="text-align: center;">OISD – RP – 158</p> <p style="text-align: center;">RECOMMENDED PRACTICES ON STORAGE AND HANDLING OF BULK LIQUEFIED PETROLEUM GAS (LPG)</p>	<p style="text-align: right;">Page No. 21</p>
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In case of pressurised gas transfer, it is observed that the pumping rate falls off gradually due to back pressure of the shore tank. A suitable vapour recovery system or reliqifaction of the gas from the receiving tank is well considered.

6.3.5 ANCILIARY EQUIPMENTS

- (a) These include pipe work, valves, relief valves, rotating equipment (pumps, compressors), exchangers, instrumentation, gas detection systems etc.
- (b) Transfer line inerting facilities such as inert gas generation combined with water base foam generator and pipeline pig system or water storage with corrosion inhibitor chemical dosing transfer and supply facilities.
- (c) Nitrogen cylinders with attendant facilities for hose purging/testing and alternate supply to ROVs and other instruments.
- (d) The following agents may be incorporated in terminal fire control system :
 - (i) Water
 - (ii) Foam
 - (iii) Dry chemical powder

6.3.6 UNLOADING OPERATIONS

It is essential that the ship and terminal operators are familiar with the basic characteristics of each other's facilities, are aware of the precise division of responsibilities and are able to communicate effectively during the time they are together involved in the joint operation of cargo handling.

6.3.7 COMMUNICATION


Reliable and effective communications, irrespective of whether they are directly between the tanker and the terminal or indirectly via third party, are pre-requisites of safe and efficient cargo operations before the tanker comes alongside and during the period of cargo operations and until the tanker departs. Terminal communication should be compatible with tanker's system.

6.3.8 PRE-CARGO TRANSFER DISCUSSIONS

Before any cargo transfer operation is commenced, it is imperative that the intended procedures are thoroughly discussed and a meeting held between the responsible personnel from the tanker and the terminal. The purpose of the meeting is primarily to make both sides fully conversant with the characteristics of the tanker and shore cargo handling systems, the envisaged operational and safety procedures and requirements and the parameters to be adhered to during the transfer.

The content of the meeting will depend on a wide variety of circumstances but the following broad outlines form the basis of such meetings :

- (a) The names and roles of terminal and ship personnel who will be responsible for cargo transfer operations may be noted.
- (b) The terminal representatives shall check that pre-arrival instructions to the ship on cargo, cargo disposition and cargo conditioning have been carried out. They also shall check that all necessary tanker equipments inspection and tests have been performed.

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- (c) Similarly, the tanker's officers shall satisfy themselves that the relevant terminal equipment and inspection checks have been carried out satisfactorily.
- (d) Terminal representatives and customs and/or independent surveyors, where necessary, will be informed of the cargo tank data e.g. temperature, pressure, whether free of cargo, liquid heel or arrival dip, composition of tank vapour and quantity of cargo on board.

6.3.9 SHIP/ShORE SAFETY CHECKLIST

Checklist for Ship/Shore safety is given in Annexure -G.

6.3.10 DISCONNECTION OF HOSE/ UNLOADING ARM

On completion of unloading operation the tanker discharge pipeline need to be purged to push liquid LPG to the receiving tank. Purging may be done by LPG vapour, inert gas or water as per the design of the system. However, before disconnecting hoses or unloading arm, it is to be ensured that there is no liquid LPG left between the tanker main valve and shore isolation valve. Product from this length of pipeline is to be safely vented.

6.3.11 CALCULATING THE QUANTITY OF LIQUID ON BOARD

Before commencement of tanker discharge operation, tank readings for temperature, pressure liquid level etc. are jointly agreed by the shore and tank representatives. The corrections applied to assess the quantity of cargo on board are :

- (i) Trim correction - to make allowance for the liquid level indicating devices not centrally located.
- (ii) Shrinkage factor - for correction of volume at 15 deg.C.
- (iii) Low sounding trim corrections to allow for the wedge shaped volume.

Volume at 15 Deg.C =	Corrected Volume X VRF
Quantity at 15 Deg. C =	Volume at 15 Deg. C X Density at 15 Deg. C

(VRF is ascertained by ASTM-IP Table - 54).

7.0 SAMPLING AND DRAINING

7.1 SAMPLING

(a) Standard for Sampling and Testing of LPG


Sampling of LPG for different analytical tests shall be carried out in accordance with the guidelines given in IS 1448.

(b) Safety During Sampling

In handling LPG samples, the following safety precautions shall be followed :

- (i) Special sampling bombs shall be used for LPG sampling. The coefficient of thermal expansion of LPG is sufficiently high to develop very high pressure on heating. Arrangement of rupture disc or any other suitable safety relief device may be incorporated in the sampling bomb.

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- (ii) Sampling bombs shall be inspected periodically and tested hydrostatically at regular intervals. Record of such inspection/test shall be maintained.
- (iii) Necessary caution must be exercised to eliminate rough handling of sampling bombs.
- (iv) Discharge of LPG from sampling bomb can cause static electricity. Sample bombs must, therefore, be earthed effectively before and during discharge of sample.
- (v) Sampling normally involves venting product into the atmosphere. Therefore, absence of source of ignition must always be confirmed before and during sampling of LPG.
- (vi) LPG samples shall be collected only in open/ventilated areas and the person taking the sample shall stand on the windward side.
- (vii) Liquid LPG coming in contact with skin produces very severe burns due to frost bite. The sampler, therefore, must wear protective goggles, hand gloves, shoes etc. while taking samples.
- (viii) Samples, after collection, shall be properly labeled.
- (ix) Sampling of LPG should preferably be done in bombs with provision of pre-charge at one end. This will not only eliminate the possibility of undesirable presence of air in the bomb, which may become a safety hazard, but also minimises flashing of sample during collection, thereby providing a truly representative sample.

7.2 DRAINING

1. Effects of Water in LPG system

Presence of water in LPG is detrimental as it may lead to following undesirable situations :


- (i) If water in the product is in sufficient quantity, it may cause rust and corrosion to the vessel which may not otherwise be affected by the product in any way.
- (ii) Water in the system, which is subjected to freezing temperatures, may prevent the operation of internals of valves, which in turn, may obstruct transfer of product by formation of ice-block.
- (iii) Ice formation may also lead to regular freeze up by plugging the orifice and stopping flow of gas. Additives like methanol or propylene glycol may be added to LPG to prevent water deposition and/or hydrate formation.

2. Safety during Water Draining

In view of the effects of water in LPG as above, regular checking of storage vessels for presence of water and its draining is essential. Following precautions shall be followed in carrying out water draining operation :

- (i) While draining water from storage vessels, it shall be ensured that two valves are provided on the drains connection with a suitable distance piece between them.
- (ii) In the draining assembly, the valve nearer to the vessel shall be opened first and draining controlled by gradually opening the valve farther from the vessel. On completion of draining operation, the valves shall be closed in the reverse sequence.

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- (iii) It shall be ensured that the drain outlet is at a safe distance from the vessel so that accidental ignition of any escaping vapour would not expose the vessel to flame impingement.
- (iv) It is important not to attempt removal of the entire quantity of water as considerable liquid LPG may escape in the process. At the first sign of appearance of LPG, the operation shall be stopped. Escape of LPG may lead to formation of ice block at the valve seat, preventing closure of valve. This will result in escape of uncontrolled vapour to the atmosphere causing a very serious hazard.

8.0 ODORISATION

LPG is an odourless gas, heavier than air. Any leakage developed from a source of LPG can go undetected, thereby creating a grave safety hazard. Therefore, if LPG is to be distributed as a utility gas to the consumers, it shall be odourised by addition of a warning agent of such characteristics that it is detectable by a distinct odour down to a concentration in air of not over one fifth of the lower limit of flammability.

Ethyl mercaptan is the commonly used odorant for LPG because of its distinctive smell. The assessment of odour level and the amount of ethyl mercaptan to be dosed are determined as per the guidelines given in IS 1448 (P : 75) - 1968.

8.1 SOME SAFETY RELATED PROPERTIES OF ETHYL MERCAPTAN

Ethyl mercaptan is extremely flammable. It causes irritation. Prolonged inhalation may cause nausea and headache; may temporarily desensitize olfactory system (smelling sensation).

The properties of ethyl mercaptan are furnished below :

Boiling Point	= 36.2 deg.C
Explosive Limits	= 2.8 to 18.2%
Flash Point	= Less than 27 Deg.C
Auto ignition temperature	= 299 deg.C
Threshold Limit Value (TLV)	= 0.5 ppm


Vapour Pressure at 37.8 deg.C	= 1.12 Kg/cm sq.(abs)
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Personal protective equipments like hand gloves, aprons and respiratory protection shall be used when working with ethyl mercaptan.

8.2 HANDLING ETHYL MERCAPTAN

Vapour pressure of ethyl mercaptan increases rather rapidly with temperature. It is, therefore, recommended that the drums containing ethyl mercaptan be kept cool and away from direct exposure to heat/sunlight before they are opened.

A useful device for transfer of ethyl mercaptan from a drum consists of a dip pipe assembly equipped with mercaptan tight bung or fittings. The dip pipe should reach the bottom of the drum if the drum is not kept tilted. An inert gas is used to apply pressure on the drum to force out mercaptan through the dip pipe. The system shall have a suitable relief valve to avoid accidental rupture of the drum due to high pressure built up. Alternately, a suitable pump may be used for transferring ethyl mercaptan from a drum into a dosing vessel.

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8.3 EQUIPMENT FOR ETHYL MERCAPTAN SERVICE

1. Material of Construction of Ethyl Mercaptan containers

Stainless steel and copper free steel alloys are the preferred materials of construction of equipment for mercaptan service. Aluminium is also acceptable provided the pressure rating of aluminium is sufficient to meet the actual requirement.

Iron or carbon steel is less acceptable as there is the hazard of formation of iron-sulphur complexes which are pyrophoric. They can be used if proper steps are taken to suitably condition them.

Copper or copper bearing alloys shall not be used for mercaptan service as mercaptan readily attacks and contaminates them.

2. Pumps for Mercaptan service

Because of the odour of mercaptan, only hermetically sealed pumps shall be used.

3. Piping and Fittings

- (i) Seamless stainless steel piping is recommended for mercaptan. Threaded fittings can be used provided they meet the service requirement ratings. A fluoroplastic tape sealant is recommended.
- (ii) Flexible connections shall be seamless stainless steel with pipe nipples welded to each end or fluoroplastic tube with neoprene cover.
- (iii) Relief valves shall be full nozzle, disc type, closed bonnet carbon steel body with 304 stainless steel trim and stainless or aluminized steel spring.
- (iv) For transfer valves, stainless steel ball valves with fluoroplastic seats and 316 stainless steel trim or their equivalent are recommended.
- (v) Rigid connection should be welded or flanged joint type.
- (vi) Fluoroplastics and asbestos are satisfactory material for gasketing.
- (vii) For pressure gauges, stainless steel diaphragm type is recommended with stainless steel socket and tip.

8.4 DISPOSAL


(i) Drum Disposal

Initially, it shall be ensured that the drums are emptied of mercaptan as completely as possible. The empty drums then can be washed with water and detergent, followed by wash with a 5% bleach solution. After again washing with copious amount of water, the drums will be ready for disposal.

(ii) Treatment of Leaks and Spills

Leaks and spills of mercaptan can be treated with commercially available masking agents (e.g. Aldor and Neutroleum Alpha etc.) to make them odourless. Large mercaptan spills shall be covered with sand or activated carbon or any other absorbing material, which are then buried or incinerated. The area over the spill should then be washed with ordinary household bleach solution and then thoroughly with water. Dry bleaching powder should never be used in treating mercaptan spills. A violent reaction could occur.

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9.0 ELECTRICAL AND INSTRUMENTATION

9.1 ELECTRICAL

- (i) Electrical installation, equipment and wiring shall conform to "Classification of Areas for Electrical Installations at Hydrocarbon Processing & Handling Facilities" - OISD-STD-113.
- (ii) All motors, in addition to the control gears at MCC, shall have local start/stop facilities.
- (iii) Motor terminal boxes should be sealed with cold setting plastic compound.
- (iv) Although LPG storage vessels do not require lightening protection, ground rods shall be provided for vessels supported on non-conductive foundations. Similar ground rods shall be provided for loading/unloading gantries.
- (v) Transfer facilities at loading/unloading gantries shall be grounded and bonded as a protection against static charges (Refer OISD-RP-110 on Static Electricity).
- (vi) Work permit shall be obtained before carrying out any maintenance work (Refer OISD-STD-105: WORK PERMIT SYSTEM).

9.2 INSTRUMENTATION

Following instruments shall be fitted :

A. Storage Vessel


- (i) Pressure gauge - at the top of the vessel in vapour space with remote indication/alarm.
- (ii) Temperature - One in the liquid space gauge at the bottom.
- (iii) Pressure - 2 Nos. (Minimum) relief valves
- (iv) Liquid level - 2 Nos. (minimum) gauges
- (v) Quick closing emergency shut-off valves on inlet/outlet and vapour return line - valves should be interlocked for emergency operation manually from a safe distance and automatically through control panel.
- (vi) High liquid level switch (Float type) - Alarm, connected to control room for annunciation.
- (vii) Liquid level transmitter and indicator - Local and remote, connected to control room for indication.
- (viii) High temperature switch - Alarm, to control room for annunciation.

B. Handling and Storage Area

Explosive Gas - Detectors	Remote Annunciation with two levels of alarm at pre-determined LEL
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- (ii) Fire alarm

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C. Transfer System

- (i) Pressure gauges - At suction and delivery side of pumps and compressors.
- (ii) Excess flow check valves
- (iii) Thermal relief valves
- (v) High pressure switch - alarm and shutdown


10.0 SAFETY AND FIRE PROTECTION

10.1 SAFETY

- (i) Safety precautions/regulatory signs and signs prohibiting smoking/naked lights shall be displayed generously.
- (ii) No vehicular traffic will be permitted inside the storage and handling area. When required, vehicles fitted with approved spark arrestors shall only be allowed with valid vehicle entry permit.

10.2 FIRE PROTECTION


- (i) Fire protection facilities shall be provided as per OISD Standards 116 or 117 as the case May be.
- (ii) Fire protection facilities shall be designed to fight two major fires at two locations simultaneously.
- (iii) Water spray system shall be provided in storage vessels, loading / unloading gantries and LPG transfer pump/compressor areas as per NFPA 15. Such system shall be automatically actuated by temperature responsive device and also shall have provision for manual operation.
- (iv) Adequate number of portable fire extinguishers of dry chemical type shall be provided at strategic points.
- (v) Gas detection and alarm system shall be provided.
- (vi) Fire drills shall be conducted at regular intervals and the observations recorded.

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11.0 REFERENCES

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3. The Static and Mobile Pressure Vessels (Unfired) Rules – 1981.
4. Liquefied Petroleum Gases – by A.F. Williams & W.L. Lom, 2nd Edition. Eillis Horwood Ltd., England.
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6. API Standard 25, 4th Edition, December 1978 – Design and Construction of LP Gas Installations.
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11. IS:875 – 1964 – Code of Practice for Structural Safety of Buildings : Loading Standards.
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14. IS:1448 – Method of Test of Petroleum and its Products.
 - a) IS : 1448 (P:119) – 1960 Doctor Test.
 - b) (P:70) - 1968 Residue in LPG.
 - c) (P:71) - 1979 Vapour Pressure of LPG.
 - d) (P:72) - 1968 Volatility of LPG.
 - e) (P:73) – 1968 Hydrogen Sulphide in LPG.
 - f) (P:74) – 1968 Dryness of LPG
 - g) (P:75) – 1968 Odour of LPG
 - h) (P:76) – 1968 Density of LPG.
15. NFPA 59 – LP Gases at Utility Gas Plants, 1979.
16. API RP 510 – January 1979 – Maintenance Inspection, Rating and Repair of Pressure Vessel.
17. Guide for Inspection of Refinery Equipment – Chapter VI, Pressure Vessels – 3rd Edition 1976, API Publication.

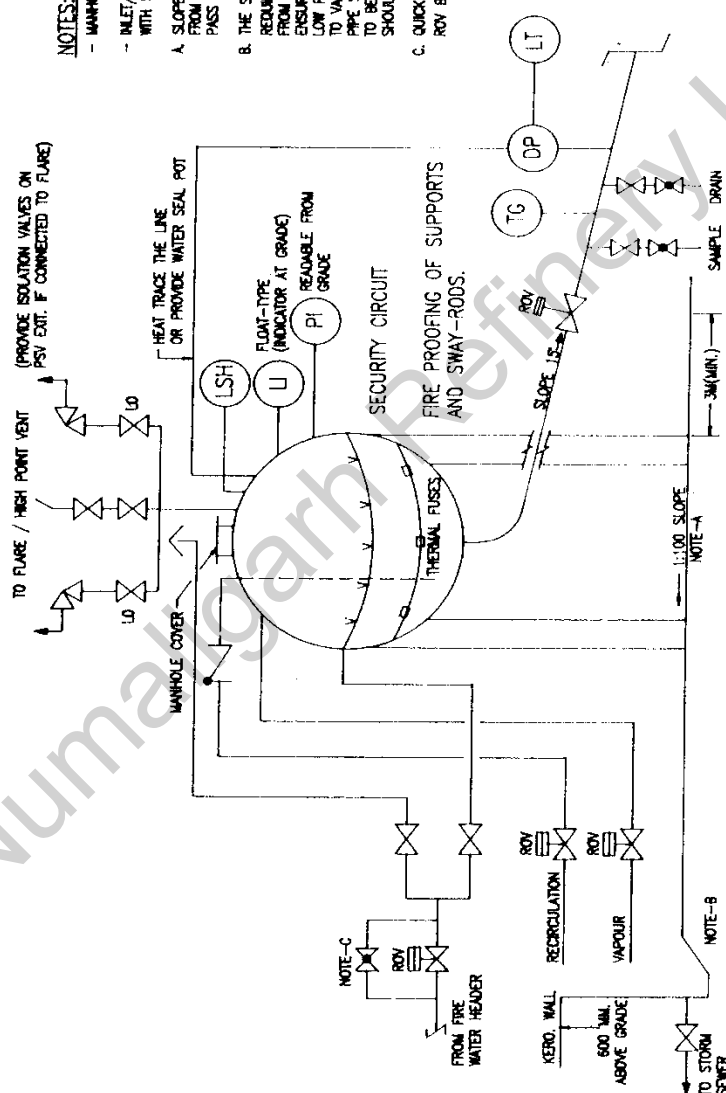
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19. OISD – STD – 105 on Work Permit System.
20. OISD – STD- 106 on Pressure Relief and Disposal System.
21. OISD- STD – 112 on Safe Handling of Air – Hydro – Carbon Mixtures and Pyrophoric Substances.
22. OISD-STD-116 on Fire Protection Facilities for Petroleum Refineries and Oil Gas Processing Plants.
23. OISD-STD-117 on Fire Protection Facilities for Petroleum Depots and Terminals.
24. OISD-STD-118 on Layouts for Oil and Gas Installations.
25. OISD-STD-128 on Inspection of Unfired Pressure Vessels.
26. OISD-STD-135 on Inspection of Loading/Unloading Hoses for Petroleum Products.
27. OISD-STD-144 on Liquefied Petroleum Gas (LPG) Bottling Plant Operations.



- NOTES:**
- MANHOLE AT TOP ONLY
 - INLET/OUTLET NOZZLE STRESS-RELIEVING WITH SPHERE
 - A. SLOPE IN SUCH A WAY THAT SPILLAGE FROM ROV (INLET/OUTLET) FLANGE DOES NOT PASS UNDER SPHERE
 - B. THE SHALLOW SUMP DEPTH TO BE MAXIMUM REQUIRED FOR GRAVITY FLOW OF LIQUID FROM SUMP TO STORM SEWER. THIS SHALL ENSURE SMALLER SUMP WIDTH AND LOW FLAME HEIGHT. THE CAPACITY OF SUMP TO VARY DEPENDING ON LPG INLET/OUTLET PIPE SIZE FOR 12" PIPE SIZE SUMP CAPACITY TO BE 50 M³ AND FOR 24" PIPE SIZE IT SHOULD BE 200 M³.
 - C. QUICK OPENING TYPE VALVE IN FIRE WATER ROV BYPASS.

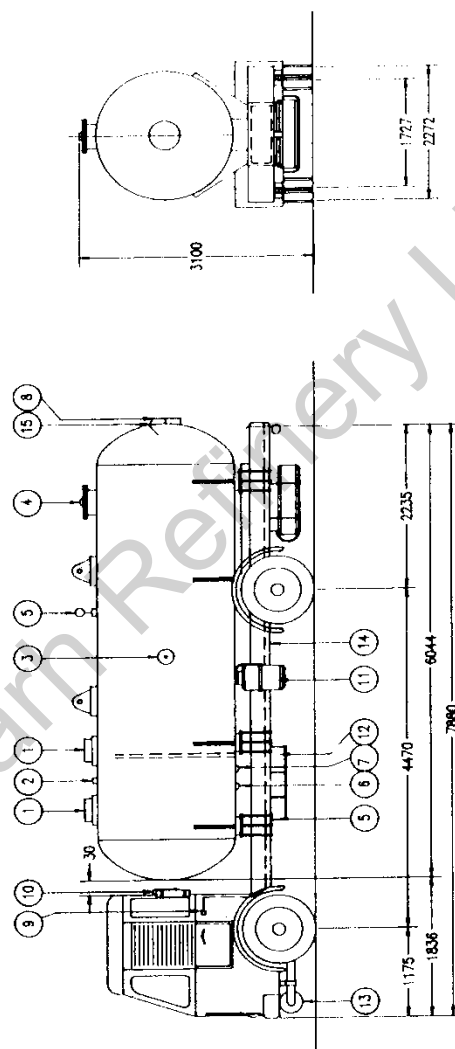


ANNEXURE – A

LPG STORAGE VESSEL
P & I DIAGRAM



GENERAL ARRANGEMENT OF LPG TANK LORRY (6 T. CAPACITY)



- | | | | |
|---|---|--|--------------------------------------|
| 1. SAFETY RELIEF VALVES FOR VESSEL | 10. FIRE EXTINGUISHER (DRY POWDER CHEMICAL) | DESIGN PRESSURE | - 15.96 kg/cm ² |
| 2. ULLAGE GAUGE | 11. FIRE EXTINGUISHER (DRY POWDER) | HYDRAULIC TEST PRESSURE | - 29.94 kg/cm ² |
| 3. ROTOGAUGE | 12. FUEL TANK WITH STEEL GUARD | DESIGN TEMPERATURE | - 55°C |
| 4. MANHOLE | 13. FLAME TRAP | RADIOGRAPHY 100% STRESS RELIEVING REQUIRED | |
| 5. PRESSURE GAUGE WITH EXCESS FLOW VALVE | 14. WIRING FOR TAIL LIGHT IN CONDUIT PIPE | EMPTY WEIGHT | - 3814 kg |
| 6. LIQUID INLET/OUTLET BYPASS LINE VALVES WITH EXCESS FLOW CHECK VALVES | 15. WELL FOR THERMOMETER | WATER CAPACITY | - 12662 Ltr |
| 7. VAPOUR RETURN LINE VALVE WITH EXCESS FLOW CHECK VALVE | | DESIGN CODE | ASME SECT. VIII DIV.1 LATEST EDITION |
| 8. MARKING PLATE | | | |
| 9. MASTER CUT-OFF SWITCH | | | |

ANNEXURE -- B



A TYPICAL LPG TRANSFER SYSTEM FOR FILLING TANK TRUCK/WAGON

NOTES:-

ESDV : EMERGENCY SHUT DOWN VALVE REMOTE OPERATED

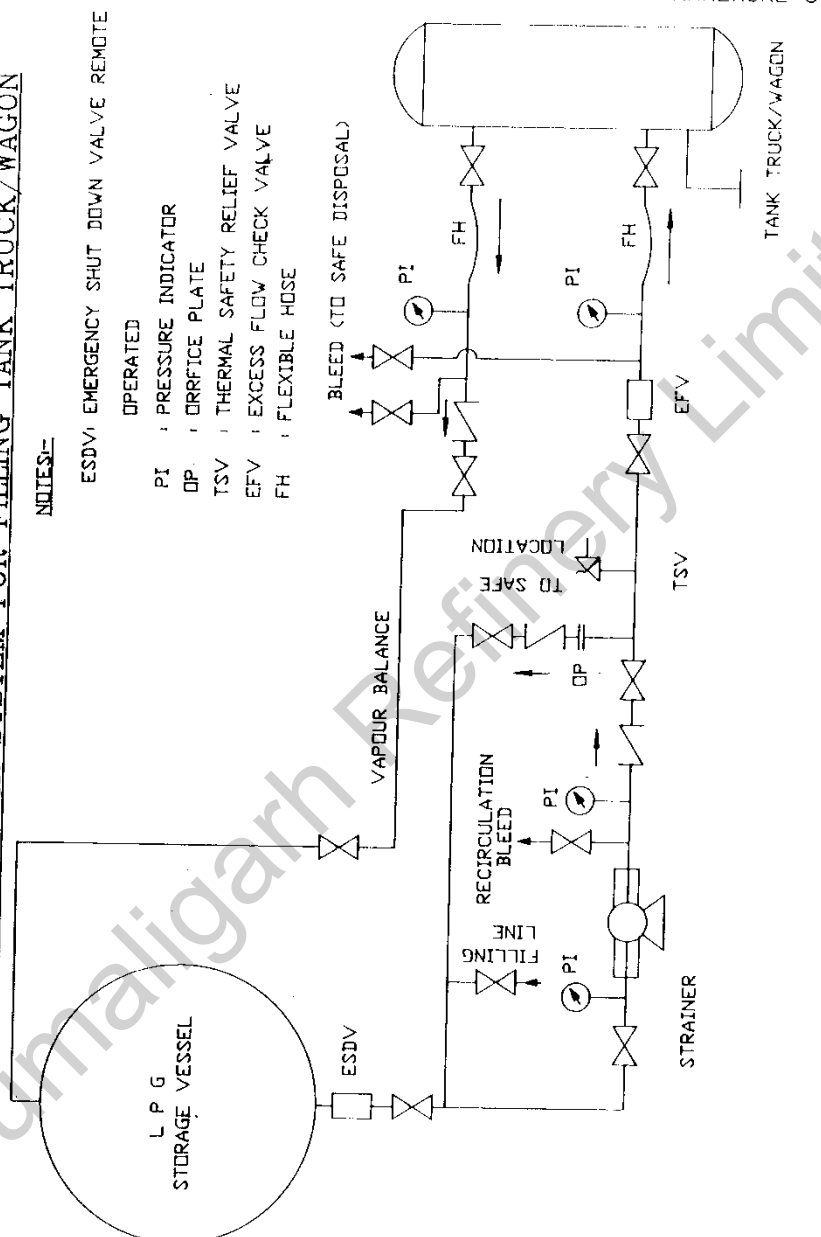
PI : PRESSURE INDICATOR


OP : ORRIFICE PLATE

TSV : THERMAL SAFETY RELIEF VALVE

EFV : EXCESS FLOW CHECK VALVE

FH : FLEXIBLE HOSE



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ANNEXURE-D**SAFE FILLING OF LPG VESSEL**

LPG has relatively high coefficient of expansion. If sufficient vapour space is not left in the vessel, pressure inside the vessel would shoot up rapidly once the vessel becomes liquid full. Hence care is exercised in limiting the filling of storage vessel to the filling density of LPG. The filling density is defined so as to leave a guaranteed free space of five percent at the reference temperature of 55 degree C. As per Static and Mobile Pressure Vessels (unfired) Rules - 1981, the design pressure of a vessel shall not be less than the vapour pressure of the gas in the vessel at 55 degree C.

The following information are required to work out the safe filling capacity of a storage vessel.

- i) Water capacity of the vessel (WC)
- ii) Density of liquid LPG
- iii) Filling density (FD)
- iv) Ullage factor (U)

$$FD = \frac{WC \times U \times \text{Density of LPG at 55 degree C}}{WC}$$

$$= U \times \text{Density of LPG at 55 degree C}$$

a) Safe maximum quantity of LPG that can be filled by weight - FDxWC

b) Safe maximum quantity of LPG at 15 degree C that can be filled by volume percent of water capacity

$$= \frac{FD \times 100}{\text{Density of LPG at 15 degree C}}$$

c) Safe maximum quantity of LPG at t degree C that can be filled by volume percent of water capacity

$$= \frac{FD \times 100}{\text{Density of LPG at t degree C}}$$

$$= \frac{FD \times 100}{\text{Density of LPG at 15 degree C} \times \text{VRF}}$$

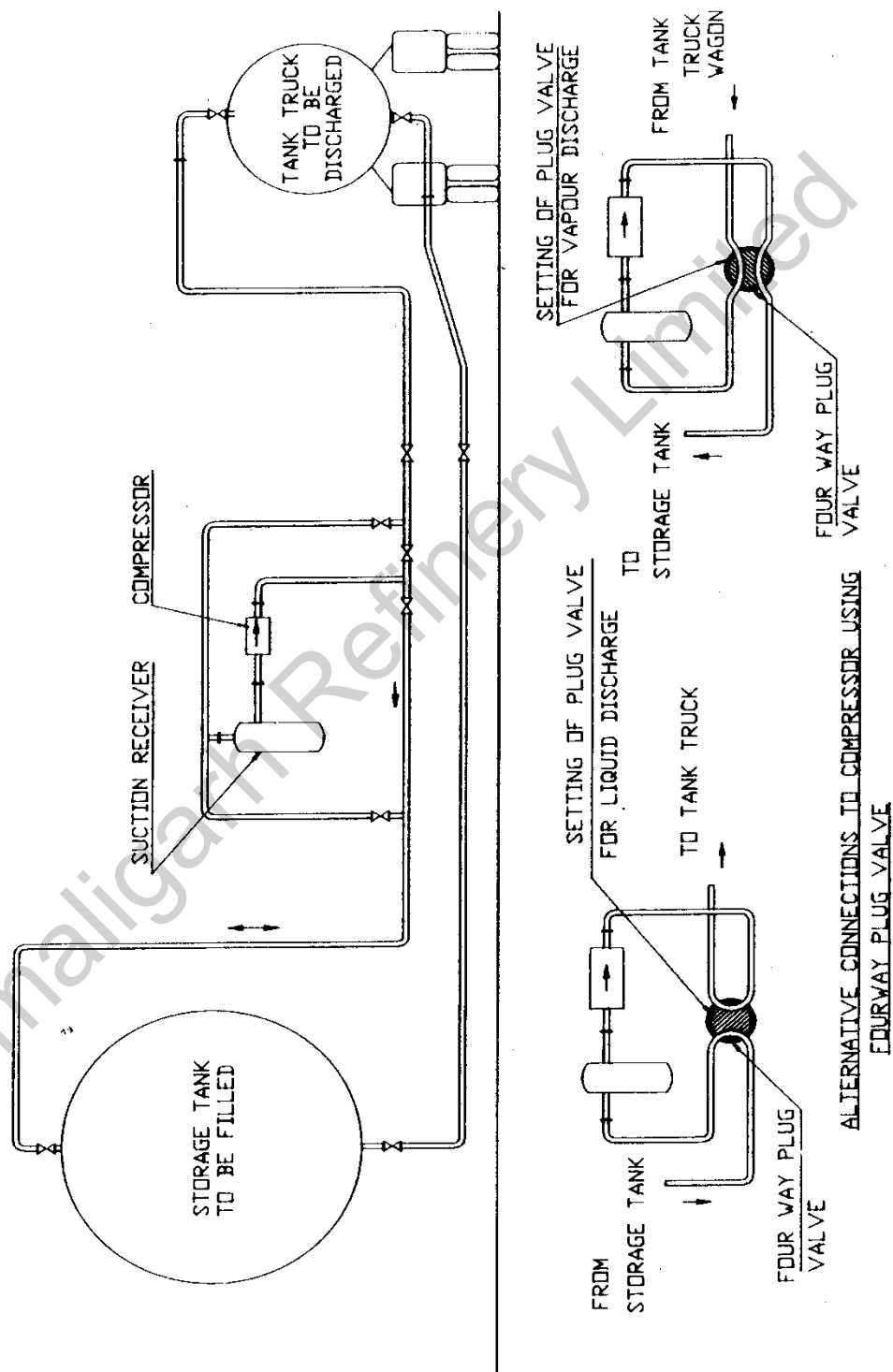
Where : FD = Filling density

WC = Water capacity in ltrs. at 15 degree C
(may be taken as total weight of water in Kg.)

VRF = Volume reduction factor for density of LPG at
t degree C as per ASTM Table 54.

ANNEXURE-E

SCHEMATIC DIAGRAM SHOWING T/T UNLOADING OPERATIONS USING PRESSURE DIFFERENTIAL METHOD OF LIQUID TRANSFER



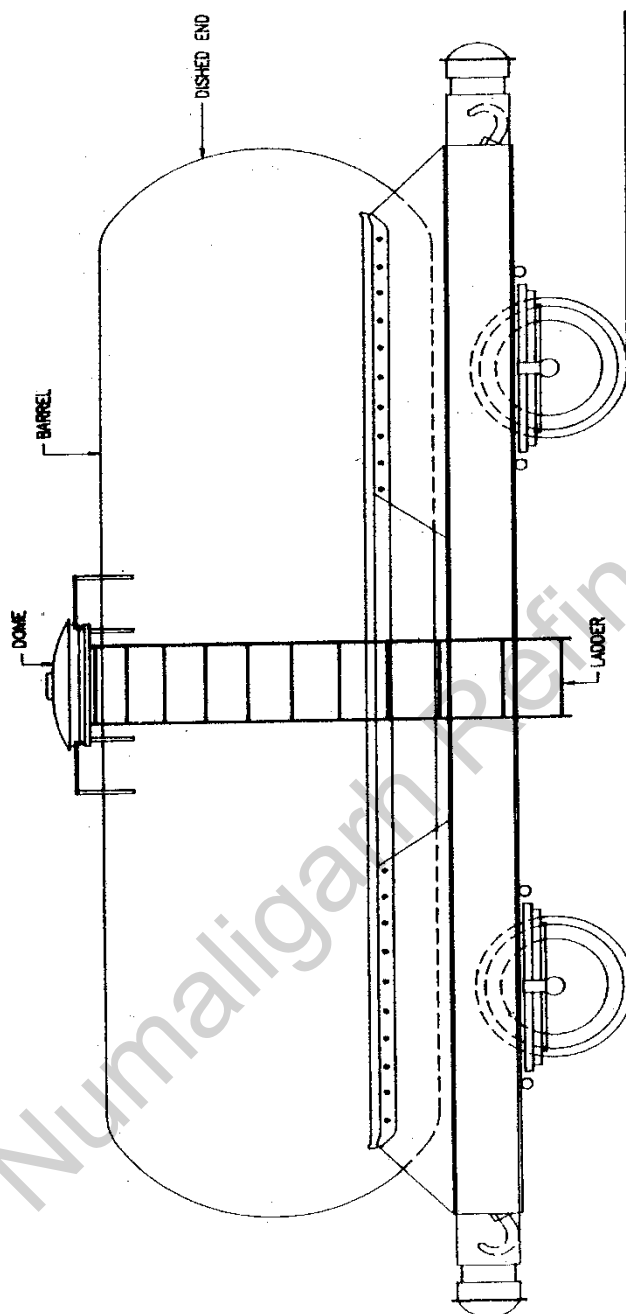
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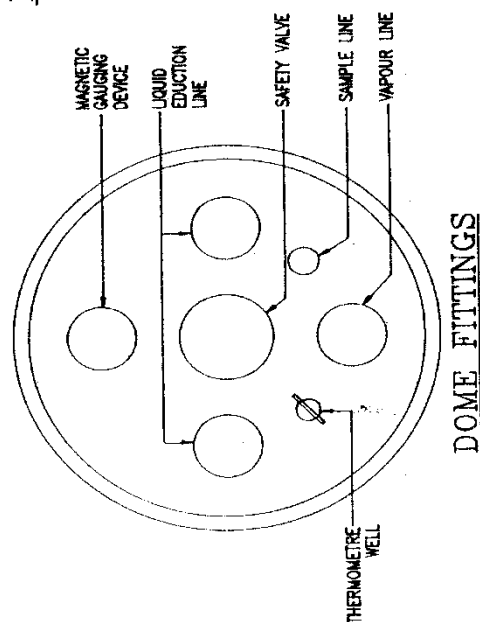
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ANNEXURE – F




L P G TANK WAGON



DOME FITTINGS

DOME FITTINGS:	
	NO.
1. LIQUID EDUCTION LINE & VALVES	2
2. VAPOUR	1
3. EXCESS FLOW CHECK VALVE	4
4. MAGNETIC GAUGING DEVICE	1
5. SAFETY VALVE	1
6. SAMPLING VALVE	1

TYPICAL LPG TANK WAGON

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ANNEXURE-G**LIQUEFIED GAS-CARGO TRANSFER CHECK LIST**

(Items to be checked before cargo transfer begins)


SHIP: _____ DATE: _____

PORT & BERTH: _____ TIME: _____

S.NO	CHECK POINT	FOR SHIP	FOR SHORE
1.	Has information on cargo and ship-shore connection been supplied ?		
2.	Is the agreed ship-shore communication system operative ?		
3.	Are fire and other emergency procedures agreed ?		
4.	Are local regulations being observed ?		
5.	Has safe access been provided and warning notices posted ?		
6.	Are moorings secure and agreement reached on the use of tension winches ?		
7.	Are emergency towing-off wires correctly positioned ?		
8.	Is the ship ready to move under its own power ?		
9.	Are smoking restrictions in force and notices posted ?		
10.	Are naked light restrictions being observed ?		
11.	Are portable electrical equipment cables disconnected ?		
12.	Are all hand torches and portable R/T sets of approved type ?		
13.	Are ship's main transmitting aerials and radar switched off and earthed ?		

Contd....


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S.NO	CHECK POINT	FOR SHIP	FOR SHORE
14.	Some doors and ports have to be closed : are they actually shut ?		
15.	Are all air conditioning intakes correctly trimmed and window type units closed ?		
16.	Is the water main ready for immediate use ?		
17.	Is the water spray system ready for immediate use ?		
18.	Are dry powder and all other fire fighting appliances correctly positioned and ready for immediate use ?		
19.	Is necessary protective clothing available or being worn ?		
20.	Are void spaces properly inerted ?		
21.	Is the required ventilation equipment in operation ?		
22.	Is the cargo system set for the operation ?		
23.	Are all remote control valves in working order ?		
24.	Are cargo tank relief valves correctly set and in good order ?		
25.	Are the required cargo pumps and compressors in good order ?		
26.	Is reliquefaction or boil-off control equipment in good order ?		
27.	Is gas detection equipment set for the cargo, calibrated and in good order ?		
28.	Are cargo system gauges and alarms correctly set and in good order ?		
29.	Are scuppers plugged and suitable drip trays in position ?		

Contd...

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Numaligarh Refinery Limited

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S.NO	CHECK POINT	FOR SHIP	FOR SHORE
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- | | | | |
|-----|--|--|--|
| 30. | Are cargo and bunker hoses in good condition and properly rigged, have certificates being checked ? | | |
| 31. | Are unused bunker connections blanked and bunker tank lids closed ? | | |
| 32. | Are unused cargo connections (including inert gas line) securely blanked ? | | |
| 33. | Are automatic shutdown systems working properly ? | | |
| 34. | Does shore know the closing rate of ship's automatic valve at operating temperature ; does ship have a similar details of shore system ? | | |
| 35. | Are all personnel (including supernumeraries and new arrivals) aware that cargo transfer is to begin ? | | |
| 36. | Have all personnel been allocated emergency stations ? | | |
| 37. | Are non-essential personnel clear of the cargo area ? | | |
| 38. | Are those directly involved aware of the agreed cargo transfer sequence ? | | |

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REMARKS :

We have checked with each other the items on the above check list and have satisfied ourselves that the entries we have made are correct to the best of our knowledge.

CHECKED BY _____
(For Ship)

(For Terminal)


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TABLE
SAFETY RELATED PROPERTIES OF LPG
(Water is included for comparison purpose only)

PARAMETER	COMMERCIAL PROPANE	COMMERCIAL BUTANE	WATER
Boiling Point, Degree C at 1 ata	- 45	- 7	+100
Vapour pressure, Kg./sq.cm. abs. at 15 degree C.	7.3	2.4	0.017
Limits of flammability% vol.,H/C in Air			
Upper	10.0	9.0	
Lower	2.2	1.8	
Gas to liquid volume ratio at 15 degree C.	255	232	
Volumes flammable mixture per unit volume of liquid	11591	12889	
Ignition temperature, Degree C.	450-550	420-540	
Co-efficient of expansion fraction / Degree C.	0.003	0.002	0.0002 (liquid)
Co-efficient of compressibility (liquid), fraction/Kg.sq.cm	-4 2 x 10	-4 2 x 10	-5 4.9x10
Gas density, Kgs/cu.m. at 15 degree C and 1 ata*	2.0	2.5	
Liquid density, Kgs/cu.m. at 15 degree C.	510	580	1000

* air = 1.29 Kg.m⁻³