

PETROLEUM AND NATURAL GAS REGULATORY BOARD

NOTIFICATION

New Delhi, the _____

G.S.R.____.In exercise of the powers conferred by section 61 of the Petroleum and Natural Gas Regulatory Act, 2006 (19 of 2006), the Petroleum and Natural Gas Regulatory Board hereby makes the following Regulations, namely:-

1. Short title and commencement.

(1) These Regulations may be called the Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for LPG Storage, Handling and Bottling Facilities) Regulations, 2016.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. Definitions.

(1) In these regulations, unless the context otherwise requires,

- a. "Act" means the Petroleum and Natural Gas Regulatory Board Act, 2006;
- b. "Board" means the Petroleum and Natural Gas Regulatory Board established under sub-section (1) of section 3 of the Act;
- c. "Approved Type" means any equipment which has specific approval for use under specified conditions by competent authority or authorized person as the case may be.
- d. "Area Classification" means it is a method of classifying an area zone wise/ group wise based on the presence of explosive gas/ vapour - air mixture vis-a-vis the requirement of precautions for construction and use of electrical apparatus.
- e. "Bonding" means Bonding is the process by which two electrical conducting bodies are connected using a conductor to maintain electrical continuity to prevent sparking between two conducting bodies.
- f. "Bulk Vessels" means a pressure vessel used for more than 1000 liters water capacity for storage or transportation of LPG.
- g. "Bullet" means a horizontal cylindrical pressure vessel used for storage or transportation of LPG by rail/ road.
- h. "Compressed Gas" means any permanent gas, liquefiable gas or gas dissolved in liquid under pressure or gas mixture which in a closed container exercises a pressure either exceeding 2.5 kg/sq.cm. abs @ 15 °C or a pressure exceeding 3.0 kg/Sq.cm. abs @ 50 °C or both.
- i. "Cylinders" means a portable LPG container upto 1000 liters water capacity used for both domestic and industrial purposes.
- j. "Design Pressure" means the saturated vapour pressure at design temperature.
- k. "Explosive mixture" means a mixture of combustion agent (oxidizing product-gas, vapour, liquid or solid) and a fuel (oxidisable product - gas, liquid or solid) in such proportions that it could give rise to a very rapid and lively oxidization reaction liberating more energy than is dissipated through conduction and convection.
- l. "Earthing" means the provision of a safe path of electrical current to ground, in order to protect structures, plant and equipment from the effects of stray electrical current, and electrostatics discharge.

- m. "Filling Ratio" is the ratio of weight of LPG in a container to the weight of water the same container can hold at 15 °C.
- n. "Fire safe" as applied to valves, it is the concept of controlling the leakage to an acceptable level after damage encountered during and after the fire achieved by dual seating.
- o. "Fire proofing" means an insulation that provides a degree of fire resistance to protect substrates like vessels, piping and structures for a predetermined time period against fire.
- p. "Flammability" is the percentage of volume of any flammable vapour in air-vapour mixtures capable to form an explosive mixture.
- q. "Flammable (or Inflammable)" means any substance which when tested in a specified manner will ignite when mixed with air on contact with a flame and will support combustion.
- r. "Gas-Free" means the concentration of flammable or toxic gases or both in a pressure vessel or pipeline is within the safe limits specified for persons to enter and carryout hotwork in such vessels/ pipelines.
- s. Hazardous area: An area shall be deemed to be a hazardous area, where
 - i. Petroleum having flash point below 65°C or any flammable gas or vapour in a concentration capable of ignition is likely to be present.
 - ii. Petroleum or any flammable liquid having flash point above 65°C is likely to be refined, blended, handled or stored at or above its flash point.
- t. "Horton Sphere" means a spherical pressure vessel used for storage of LPG.
- u. "Hot Work" means an activity which may produce enough heat to ignite a flammable air-hydrocarbon mixture or a flammable substance.
- v. "Kerb Wall" means a wall of appropriate height and size constructed of suitable material and designed to contain the LPG spillage and to direct it to a safe location around the storage vessel.
- w. "Liquefied Petroleum Gas (LPG)" means a mixture of certain light hydrocarbon predominately C3 & C4, derived from petroleum & natural gas which are gaseous at normal temperature and atmospheric pressure, may be condensed to a liquid state at normal ambient temperature by the application of moderate pressure and conforming to IS : 4576 or IS: 14861.
- x. "Purging into Service" is the replacement of air in a closed system by an inert substance and replacement of the later by combustible gas, vapour, or liquid.
- y. "Purging out of service" is the replacement of normal combustible content of a closed system by an inert substance, and replacement of the later by air."Shall" means the provisions that are mandatory;
- z. "Should" means the provisions that are recommended but not mandatory;
- aa. "Tare Weight" means the weight of the cylinder together with any fitting permanently attached to it including the weight of valve.
- bb. "Maximum Working Pressure" is saturated vapour pressure at design temperature.
- cc. "Water Capacity" means the maximum volume of water in liter that the a container can hold at 15 °C.

(2) Words and expressions used and not defined in these regulations, but defined in the Act or in the rules or regulations made there under, shall have the meanings respectively assigned to them in the Act or in the rules or regulations, as the case may be.

3. Application.

Definitions, layout, design, LPG tank trucks, pipelines, bulk handling, operating procedures, bottling operations, maintenance, inspection, safety management system, fire protection

facilities, competence assurance, emergency management plan, gas monitoring system of LPG Storage, Handling and Bottling Facilities shall be in accordance with the requirements of these regulations.

4. Scope.

- (1) Requirements of these regulations shall apply to all existing and new LPG Storage, Handling and Bottling Facilities.
- (2) These regulations covers the minimum requirements for engineering and safety considerations in layout, design, LPG tank trucks, pipelines, bulk handling, operating procedures, bottling operations, maintenance, inspection, safety management system, fire protection facilities, competence assurance, emergency management plan, gas monitoring system of LPG Storage, Handling and Bottling Facilities.

5. Objective.

These standards are intended to ensure uniform application of design principles in layout, material and equipment selection, construction etc., adoption of standard operating procedures, proper maintenance, inspections, competence assurance for safe operation of the LPG Storage, Handling and Bottling Facilities and shall primarily focus on safety aspects of the employees, public and facilities associated with LPG Storage, Handling and Bottling.

6. The standard.

- (1) Technical standards and specifications including safety standards (hereinafter referred to as standards) for LPG Storage, Handling and Bottling Facilities are as specified in Schedule-I which cover layout, design, LPG tank trucks, pipelines, bulk handling, operating procedures, bottling operations, maintenance, inspection, fire protection facilities, competence assurance, emergency management plan, gas monitoring system and safety management system.
- (2) Technical standards and specifications including safety standards (hereinafter referred to as standards) for capacity up-to 100 MT and maximum bottling of 20 MT per day on design, layout, storage, loading / unloading, operation LPG storage, handling and bottling are specified in Schedule – 2. Further, schedule – 2 also specifies the additional minimum safety requirements on design, layout, storage, loading / unloading, operation at LPG installations having Bulk Storage (a) exceeding 100 MT but limited to 300 MT for aboveground storage and also for (b) 450 MT in mounded Or in combination of aboveground and mounded storage of LPG with total bottling quantity not exceeding 35 MT per shift. of 8 hrs. For LPG Storage, Handling and Bottling Facilities exceeding either of the above limits, Schedule – 1 shall be applicable.
- (3) Technical standards and specifications including safety standards (hereinafter referred to as standards) for Refrigerated LPG Storage facilities are as specified in Schedule – 3 which covers the minimum safety requirements for Design, Layout, Operation, Maintenance etc.

7. Compliance to these regulations

- (1) The Board shall monitor the compliance to these regulations either directly or through an accredited third party as per separate regulations on third party conformity assessment.
- (2) Any entity intending to set up LPG facilities, installation shall make available its detailed

plan including design consideration conforming to these Regulations to PESCO for their approval.

- (3) If an entity has laid, built, constructed, under construction or expanded the LPG facilities based on some other standard or is not meeting the requirements specified in these Regulations, the entity shall carry out a detailed Quantitative Risk Analysis (QRA) of its infrastructure. The entity shall thereafter take approval from its highest decision making body or its Board for non-conformities and mitigation measures. The entity's Board approval along with the compliance report, mitigation measures and implementation schedule shall be submitted to PNGRB within six months from the date of notification of these Regulations.

8. Default and Consequences.

- (1) There shall be a system for ensuring compliance to the provision of these Regulations through conduct of technical and safety audits during the construction, commissioning and operation phase, .
- (2) In case of any deviation or shortfall in compliance to these Regulations, the entity shall be given time limit for rectification of such deviation, shortfall, default and in case of non-compliance, the entity shall be liable for any penal action under the provisions of the Act or termination of operation or termination of authorization.

9. Requirements under other statutes

It shall be necessary to comply with all statutory rules, regulations and Acts in force as applicable and requisite approvals shall be obtained from the relevant competent authorities for LPG Storage, Handling and Bottling Facilities.

10. Miscellaneous

- (1) If any dispute arises with regard to the interpretation of any of the provisions of these Regulations, the decision of the Board shall be final.
- (2) The Board may at any time effect appropriate modifications in these Regulations.
- (3) The Board may issue guidelines consistent with the Act to meet the objective of these Regulations as deemed fit.

Schedule 1

Technical Standards and Specifications including Safety Standards for LPG Storage, Handling and Bottling Facilities

- Schedule-1A LAYOUT & DESIGN**
- Schedule-1B LPG TANK TRUCKS: REQUIREMENTS OF SAFETY ON DESIGN/FABRICATION AND FITTINGS**
- Schedule-1C PIPING SAFETY IN INSTALLATION AND MAINTENANCE OF LPG CYLINDERS MANIFOLD**
- Schedule-1D OPERATING PROCEDURES : BULK LOADING AND UNLOADING**
- Schedule-1E BOTTLING OPERATIONS**
- Schedule-1F OPERATION, MAINTENANCE AND INSPECTION**
- Schedule-1G SAFETY MANAGEMENT SYSTEM**
- Schedule-1H FIRE PROTECTION FACILITIES**
- Schedule-1I GAS MONITORING SYSTEM**
- Schedule-1J COMPETENCE ASSURANCE AND ASSESSMENT**

SCHEDULE-1A
LAYOUT & DESIGN

1.1 General

The layout of the LPG facilities including the arrangement and location of plant roads, walkways, doors and operating equipment shall be designed to permit personnel and equipment to reach any area affected by fire rapidly and effectively. The facilities within the premises shall permit access from at least two directions.

The general principles of layout of LPG storage, handling, and bottling facilities have been detailed. The various facilities within LPG installation shall be located based on Table-I and Table-II.

1.2 LOCATION & SEPARATION DISTANCES:

1.2.1 LOCATION

While assessing the suitability of any site for location of LPG installation, the following aspects shall be considered:

- i. The location of residential quarters, other industries, railways, roads, waterways, overhead power lines, places of public assemblies etc. This shall be covered in risk analysis study of the proposed site. The study shall also be used to plan for emergency measures.
- ii. Adequate availability of water from a reliable source or alternate arrangements proposed.
- iii. The topographical nature of the site with specific reference to its effect on the accidental release of LPG.
- iv. The availability of space for future extension of LPG facilities, if any, shall also comply with the safety norms.
- v. The meteorological data of the location including predominant wind direction & velocity, high flood level, temperatures, cyclone, earthquake etc.

1.2.2 SEPARATION DISTANCES

The separation distances for above ground storage vessels as given in Table- I & II are the distances in plane between the nearest point on a vessel other than the filling/ discharge line and a specified feature, e.g. adjacent vessel, site boundary etc.

1.3 LAYOUT

The following aspects shall be considered while establishing layout of LPG storage vessels. Bullets or spheres are used for above ground storage of LPG.

- i. The access of mobile fire fighting equipment to the storage vessels shall be at least from two sides.
- ii. Longitudinal axis of static storage vessels (bullets) shall not be pointed towards other vessels, vital equipments e.g. LPG cylinder sheds, tank lorry/tank wagon gantries, LPG pump house and buildings wherein control panels for fire and gas detection/ actuation panels are situated.
- iv. c. Storage vessels should be located preferably in downwind of potential ignition sources at lower elevation.
- v. No foreign material / combustible substances shall be stored in storage area.
- vii. Storage vessels shall be laid out in single row in each group.
- viii. Storage vessels shall not be located one above the other.

1.4 LPG STORAGE FACILITIES

1.4.1 Confinement / Grading

- i. Kerb wall shall be provided around all sides of the storage vessel with concrete flooring of the ground under vessel and extending upto minimum distance of $D/2$ or 5M whichever is higher and at least 5 M (min.) from the edge of the storage vessel with a slope of 1:100 (min.).
- ii. Grading of the ground underneath should be levelled and directed to an area connected with water seal away from the storage vessel.
- iii. Kerb wall height shall be minimum 30 cm but shall not exceed 60 cm otherwise evaporation of spilled LPG may get affected.
- iv. Spillage diversion area shall be located at a distance where the flames from fire will not impinge on the vessel. This distance shall be equal to the diameter n of the nearest vessel or minimum 15 M whichever is more. No accumulation of LPG should be possible underneath the storage vessel in any condition.
- v. In case of mounded vessels, a kerb wall of appropriate height and size and designed to contain the LPG spillage and to direct it to a safe location at appropriate distance shall be provided.

1.4.2 Piping

Only piping associated with the storage vessels shall be located within the storage areas or between the storage area and the manifold system.

1.4.3 Surface Drainage

In order to prevent the escape of spillage into the main drainage system, surface water from the storage area and from the manifold area shall be directed to the main drainage through a water seal to avoid the spread of LPG. In case, plant drain is discharging in the storm drain going outside the plant, water seal shall be provided at interconnecting sump inside the plant.

1.4.4 Grouping

Vessels shall be arranged into groups, each having a maximum of six vessels. There shall be minimum spacing as specified in Table-I between adjacent vessels. Each group shall be separated by roads on all four sides for easy access and emergency handling.

- 1.4.5 Spheres and bullets shall be treated as separate groups with minimum 30 M distance between two groups. This inter distance shall be measured between the vertical shadow of adjacent vessels of the concerned groups.

- 1.4.6 Top surfaces of all the vessels installed in a group shall be on the same elevation. Separate manifolds with independent pumping facilities should be provided for groups with dissimilar elevation. In case manifold from two groups with dissimilar elevation are interconnected, these shall be connected though fail safe like 3 way valves or equivalent system e.g. logic controlled / interlocked valves to prevent migration of LPG from vessels with higher elevation to the vessels at lower elevation due to gravitation and overfilling of vessel at lower elevation.

1.5 LPG BULK LOADING / UNLOADING FACILITIES

- 1.5.1 LPG tank lorry loading/ unloading gantry shall be covered and located in a separate block and shall not be grouped with other petroleum products.
- 1.5.2 LPG loading/ unloading rail gantries shall have separate rail spur and be grouped separately at least 50 M from other rail shunting facilities.
- 1.5.3 Space for turning with minimum radius of 20 M for tank lorries shall be provided commensurate with the capacities of the tank trucks.
- 1.5.4 LPG tank wagon loading/ unloading shall be restricted to a maximum of half rake, not exceeding 600 tonnes. If full rake loading/ unloading is envisaged this shall be done on two separate rail gantries separated by a minimum distance of 50M.
- 1.5.5 Maximum number of LPG tank lorry bays shall be restricted to 8 in one group. Separation distance between the two groups shall not be less than 30 M.
- 1.5.6 For adequate permanent protection for tank lorry discharge, Pipeline Island shall be provided. The minimum width of such pipeline island shall be 1 M.
- 1.5.7 The layout of the unloading location shall be such that tank truck being unloaded shall be in drive out position.
- 1.5.8 The weigh bridge of adequate capacity shall be provided and proper manoeuvrability for vehicles.
- 1.5.9 Tank truck shall be loaded/ unloaded with suitable arrangement for cold flaring of hose or loading/ unloading arm content, if used at the end of the operations.
- 1.5.10 LPG tank truck parking area (Bulk/ Packed) shall be located in a secured area with entry/ exit gates. Parking area shall be provided with adequate no. of hydrants / monitors to cover the entire parking area. Parking area including entry / exit gates shall be under close supervision / CCTV monitoring. Proper slotting/ marking shall be done for safe parking of bulk and packed lorries in the parking area.

1.6 LPG BOTTLING FACILITIES

- 1.6.1 LPG bottling facilities shall be located at a safe distance from other facilities with minimum ingress of traffic and upwind direction with respect to bulk storage. There shall not be any deep ditches excluding storm water drains in the surrounding areas at least within 15 M from storage sheds to avoid settling of LPG vapour.
- 1.6.2 LPG Bottling section shall be of single storey. Antistatic mastic flooring conforming to IS-8374 shall be provided in the LPG filling shed/ cylinder storage including valve changing shed to avoid frictional sparks. The shed shall be supported by RCC columns alternatively structure steel columns shall be covered with concrete or fire-proofing material upto full height of columns. Anti static mastic coating upto 1.5 m (Min.) shall be done of the supporting columns of the shed.
- 1.6.3 The bottling operation shall be carried out in the filling shed. Separate sheds for filled cylinders storage and valve changing cum degassing, if any, shall be provided. Valve changing unit without evacuation can be provided in filling shed itself. Empty cylinders storage area shall be properly segregated from filling machines by 5 M (Min.). Cylinders shall always be stacked vertically with maximum stack height of 1.5 m.
- 1.6.4 LPG cylinder filling machines and other related testing facilities shall be provided in sequential order.
- 1.6.5 Degassing shall be carried out at PESO approved facilities.
- 1.6.6 Cylinder storage shall be kept on or above grade and never below grade in cellar or basement.
- 1.6.7 Filled cylinders shall not be stored in the vicinity of cylinders containing other gases or hazardous substances.

- 1.6.8 Escape routes shall be specified and marked in LPG sheds for evacuation of employees in emergency.
- 1.6.9 There shall be sufficient no. of crossovers to avoid trapping of personnel in LPG sheds by conveyors, cylinders and other facilities. Further, sufficient no. of escape routes shall be provided.
- 1.6.10 All steps forming part of the escape routes shall be minimum 1.2 M with treads 30 cms (minimum) and maximum rise of 15 cms.

1.7 PROTECTION OF FACILITIES

- 1.7.1 Properly laid out roads around various facilities shall be provided within the installation area for smooth access of fire tenders etc. In case of emergency.
- 1.7.2 Proper industry type boundary wall at least 3 M high with 0.6 M barbed wire on top shall be provided around the installation unless the bottling plant is protected as a part of refinery complex.
- 1.7.3 Emergency exit with proper gate shall be provided in the earmarked zone.
- 1.7.4 In case provision for green belt is made, the same shall be segregated from hazardous area by 1 M high wall / chain link fencing. Alternatively, it shall be treated as a part of hazardous area.

1.8 UTILITIES

- 1.8.1 Utilities consisting of fire water pumps, admin. Building, canteen, motor control centre, DG room, air compressors, dryers etc. shall be separated from other LPG facilities and located as per the separation as specified in Table-I.

TABLE - I

INTERDISTANCE FOR LPG FACILITIES

	1	2	3	4	5	6	7	8
1. LPG Storage vessels	*	#	30	30	50	30	15	60
2. Boundary/property line/ group of bldgs. Not associated with LPG installation	#	**	30	30	50	30	30	**
3. Shed-LPG	30	30	15	30	50	30	15	60
4. Tank truck gantry - LPG	30	30	30	30	50	50	30	60
5. Tank wagon gantry	50	50	50	50	50	50	30	60
6. LPG/other rail spurs	30	30	30	50	50	50	30	60
7. Pump house/Comp.house (LPG)	15	30	15	30	30	30	**	60
8. Fire Pump House/ storage tank60	**	**	60	60	60	60	60	-

Notes :

1. All distances are in metres. All distances shall be measured between the nearest points on the perimeter of each facility. except in case of tank vehicle loading/unloading area where the

distance shall be measured from the centre of each bay and for storage vessels where the distance shall be measured from the nearest point on the vertical shadow of the vessel.

2. Notation :
 - # - Refer Table – II
 - * 1/4 of sum of diameters of adjacent vessels or Half the diameter of the larger of the two adjacent vessels, whichever is greater.
 - ** Any distance for operational convenience.
3. Distance of stabling line shall be as per minimum Railway Standards.
4. Distance of stabling line shall be as per Railway guidelines.

TABLE - II
DISTANCE BETWEEN LPG STORAGE VESSELS AND PLANT BOUNDARY/GROUP OF BUILDINGS NOT ASSOCIATED WITH LPG INSTALLATION

Capacity of each vessel (Cu.Mt. of water)	Distance (in metre)
10-20	15
> 20-40	20
>40-350	30
>350-450	40
>450-750	60
>750-3800	90
> 3800	120

2.0 GENERAL DESIGN CONSIDERATIONS

2.1 GENERAL

This section describes the design and safety features required in a typical LPG Storage, Handling and Bottling Facilities.

2.2 LPG STORAGE VESSELS

The minimum requirements w.r.t. design considerations and various fitting to be provided. LPG storage vessels shall be as under :

2.2.1 Mechanical Design

- i. The storage vessel shall be designed in accordance with the codes i.e. ASME SEC. VIII or IS-2825 or PD - 5500 or equivalent duly approved by CCE. Design shall take into account the Static and Mobile Pressure Vessels (Unfired) Rules 1981 also.

A single code shall be adopted for design, fabrication, inspection and testing i.e. ASTM and European (PD) Standard shall not be combined.

- ii. Material shall be in line with design code. ASTM A516 Gr. 60 shall be used for refinery service (BS-5500 shall not be used for the same) and for marketing installation where H₂S is not present ASTM A 516 Gr. 70 or A 537 CLASS 1 can be used. Micro-alloyed steel

containing Ni, Mo, Va shall not be considered. Maximum specified tensile stress shall not be more than 80,000 psi.

- iii. Design temperature: (-) 27°C to (+) 55 °C.
- iv. Design Pressure: Minimum 14.5 Kg/ cm²g on top at 55 °C.

Marketable LPG conforming to IS: 4576 can have a maximum vapour pressure of 16.87 Kg/ Sq.cm.g at 65 °C temperature. LPG with higher vapour pressure are not expected to be stored in bottling installations.

The recommended design pressure and temperature shall be treated as MINIMUM requirement and other design consideration and Statutory requirements shall also be considered.

- v. Other Design Considerations
 - a. Corrosion Allowance: minimum 1.5 mm
 - b. Radiography : Full
 - c. Stress Relieving : 100% irrespective of thickness.
 - d. Wind pressure : as per IS: 875
 - e. Earthquake pressure : as per IS:1893
 - f. Hydro test pressure : As per Design Code

Where ever extreme climatic conditions or security reasons warrants, suitable alterations in design can be made with approval from statutory bodies.

2.2.2 In case of mounded storage, following shall also be considered in designing of storage vessels :

The specific consideration shall be given in design of vessel to

- a) Internal vapour and hydraulic pressure
 - b) External loadings on the vessel
 - c) Internal vacuum
-
- i. The dimensions (diameter and length) of the vessel shall be decided based on site conditions, soil mechanics, type of fabrication facilities available and other design considerations.
 - ii. Mounded vessel(s) shall be placed on a firm foundation and installed so as to prevent movement or floatation. The sub-soil water, rainwater or any other surface water should not be allowed to percolate in to the mound. The foundation should be constructed such that in the longitudinal direction of a vessel slope of at least 1:200 is maintained to facilitate draining of the vessel. Reference may be made to attached Drawing-1 and Drawing-2.
 - iii. Site conditions and soil mechanics shall be deciding factors for selection of the type of foundation in a given situation. The preferred type of foundation is a continuous sand bed, supporting the vessel over its full length
 - iv. The foundation shall have sufficient load bearing capacity and all the factors affecting the foundation shall be considered while designing the same. The factors should not be limited to the following:
 - a. The load of the vessel during normal operations and also during hydro test when the specific gravity of liquid is 1 (one) instead of that of LPG.
 - b. The earth/sand cover
 - c. The settlement behavior of the foundation which include
 - i. Overall settlement

- ii. Differential settlement which causes bending of the vessel
 - iii. Differential settlement which causes sloping of vessel
- v. The sand bed beneath the vessel shall be of adequate elevation not less than 0.76 meter to facilitate drainage from liquid outlet pipe by gravity. In this case, bottom connection shall be permitted on mounded vessel(s) with an access to connections by providing an opening or tunnel with 1.2 m minimum diameter and a 0.9 m minimum clear area. Bottom connections shall be considered as part of the vessel where these extend beyond the mound and shall be designed for the forces that can act on the connection.
- vi. Proper provision shall be made for encountering the consequences of the settlement of the vessel. The surrounding of the bottom connection should be filled with such material that can absorb such settlement.
- vii. Where submersible type of pumps is provided for individual vessel, conditions stated at "a" above shall not apply. In such cases drainage of water shall be made by using dip pipe with top connected drain valves. The first valve on this pipeline shall be provided as close to vessel as possible and shall be kept close condition in normal operating conditions.
- viii. The mound shall protect the vessel from the effects of thermal radiation and shall be sufficiently robust to remain in place in the event of jet flame impingement.
- ix. Mound shall be of earth, sand or other non-combustible, non-corrosive material such as Vermiculite or Perlite and shall provide at least 700 mm minimum thickness of cover for the vessel.
- x. The mound surface shall be protected against erosion by rain or wind by providing a suitable protective cover of prefabricated stone, open concrete tiles, etc..
- xi. Water ingress into the mound shall be minimized by providing impervious layer of suitable material. However, a continuous impermeable cover shall not be installed, to prevent the possibility of gas accumulation inside the mound. Proper drainage and slope on top of the mound shall also be provided.
- xii. Longitudinal axis of vessels (any number) in a mound shall be parallel to each other with ends in line.
- xiii. Where more than one row is installed the adjacent ends of the vessel in each row shall be separated by not less than 3 meter.
- xiv. The valves and appurtenances of mounded vessel(s) shall be accessible for operation or repair, without disturbing the mound.
- xv. Provision shall be made to monitor the settlement of the mound/ vessel by providing permanent reference points. A minimum of three reference points shall be provided to ascertain uniform/ differential settlement and also identify possible vessel bending (One each near the vessel ends and one in the middle.)
- xvi. Maximum permissible differential settlement shall be determined at the project design stage. Procedures shall be developed to regularly monitor the settlement throughout the lifetime of the vessel and records maintained thereof.
- xvii. Provision shall be made for inserting portable CuSO_4 reference electrode on top of the mound for measurement of PSP at 12 - O Clock position of the vessel. This shall be protected to prevent water ingress in the mound.
- xviii. The external surface of the vessels which is covered by mound should be suitably treated to protect it from corrosion. Methods of protection shall include surface coatings (suitable for design conditions as specified above) and cathodic protection (Impressed current system). General guidelines are given in Annexure - I, NACERP-0169, "Control of External Corrosion on Underground or Submerged Metallic Systems" and T-10D-17/T-6A-63 ON "Pipe Line Rehabilitation Coatings" may also be referred.
- xix. Holiday detection of the coated surface shall be carried out to ensure defect free coated external surface using suitable Spark Holiday Detector.
- xx. The cathodically protected system shall be isolated from the unprotected structures /surfaces by installing monolithic joints i.e. one each on liquid and vapour lines. A suitable

isolation shall also be provided on utility pipelines such as air line to ROV, metallic structures, instrument lines etc.

- xxi. Reference points on inner surface of the vessel shall be marked for NDT, for subsequent inspections.

2.2.3 Fittings

- i. Spheres/ bullets other than underground shall have a single nozzle at the bottom for liquid inlet as well as outlet. The nozzle shall be full welded pipe, stress relieved along with the vessel and shall extend minimum 3 meters from the shadow of the sphere/ bullet. A remote operated shutdown valve (ROV) shall be provided on this bottom nozzle at a distance of at least 3 meters from the shadow of sphere/ bullet. The nozzle pipe shall have a minimum slope of 1.5° to horizontal.
- ii. There shall not be any other flanges, manhole, and 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 storage vessel, suitable supports for the bottom nozzle shall be provided.
- iii. The top vapour zone of the vessel shall be provided with nozzles for vapour outlet, recirculation wherever applicable. These lines shall be provided with fire safe ROV. ROVs for vapour / recirculation lines should be provided at the ground level with an isolation valve at top. In case, ROV is provided at top of the vessel, there is no need to provide an isolation valve.
- iv. Fire safe ROVs shall also be provided on liquid line & vapour line of TLD, Tank wagon gantry and on the entry of liquid lines at LPG filling shed at a safe location. These shall be provided with QB detector & sprinkler nozzles to cool the complete ROV uniformly.
- v. Nozzles for two independent level indicators, a high level switch, two safety relief valves, pressure gauge and a manhole shall be provided on top.
- vi. All the fittings shall be suitable for use at the design parameters of the storage vessels and for the temperatures appropriate to the worst operating conditions. The remote operated valves on the storage vessel connecting pipelines shall be fire-safe type conforming to API 607 or equivalent.
- vii. The flange joints of these valves shall either have spiral wound metallic gaskets or ring joints. Plain asbestos sheet / reinforced gaskets shall not be used. Gasket used shall conform to ASME B16.20 or IS : 7719 or equivalent. The studs used shall conform to ASTM A 194 Gr 2H / ASTM A 193 Gr B7 or equivalent.
- viii. Flange connections shall be of minimum of 300 lb rating conforming to ANSI B16.5 class 300 or equivalent. All tapings or openings shall be of minimum 20 mm thickness.

In case of mounded storage, following shall also be provided.

- ix. The top vapour zone of the vessel shall be provided with nozzles for vapour outlet, recirculation wherever applicable. These lines shall be provided with fire safe ROV. ROVs for vapour / recirculation lines should be provided at the ground level with an isolation valve at top. In case, ROV is provided at top of the vessel, there is no need to provide an isolation valve
- x. In case of provision of liquid outlet from the top of the vessel, the line shall extend upto bottom.
- xi. In case of liquid line from the bottom of the vessel, the minimum distance of 3 m from the vessel to ROV shall be maintained. The nozzle pipe shall have a slope of minimum 1.5° .
- xii. Minimum two nos. of manhole shall be provided on top of the vessel.

2.2.4 Instruments

- i. The storage vessel shall have minimum two independent level indicators and one

independent high level switch. High level alarms shall be set at not more than 85% level of the volumetric capacity of the vessel. Audio visual indication shall be at local panel & control room. On actuation of high level alarm, the ROVs of the affected vessel shall close.

- ii. Differential pressure (DP) type gauge should not be used for level measurement.
- iii. Each storage vessel shall have at least two safety relief valves with isolation arrangement set at different values and at not more than 110% of design pressure of the vessel and each having 100 % relieving capacity adequate for limiting the pressure build up in the vessel not more than 120% of design pressure. In case of mounded vessel, the full flow capacity of each SRV on mounded vessel(s) shall be minimum 30 % of the capacity required for an equivalent size of above ground vessel.
- iv. The relieving load for the safety valves shall be based on fire condition and no credit shall be taken for fire proofing on the vessel, if provided.
- v. The discharge of safety valves shall be connected to flare system, wherever available. In this case, safety valves shall have lock open (or car seal open) type isolation valves on both sides of safety valves.
- vi. In case of non availability of flare system, the discharge from safety valve shall be vented vertically upwards to atmosphere at an elevation of 3 meter (minimum) from the platform for effective dispersion of hydrocarbons. In this case, isolation valve on down stream of safety valve is not required. A weep hole with a nipple at low point shall be provided on the vent pipe in order to drain the rain water which may get accumulated otherwise. Weep-hole nipples shall be so oriented that in case of safety valve lifting and consequent fire, the flame resulting from LPG coming out from weep-hole does not impinge on the sphere or structure. A loose fitting rain cap with a chain (non sparking) fitted to vent pipe shall be provided on top of safety valve.

2.3 LPG LOADING/ UNLOADING FACILITIES

2.3.1 Each loading station shall consist of the following :

- i. Excess flow check valve & non return valve shall be provided in LPG loading lines.
- ii. A vapour return line with an isolation valve connected back to the storage vessel/suction line with NRV.
- iii. Properly designed loading arm or LPG hoses shall be provided at the end of filling and vapour return lines for connecting to the tank truck vessel. The loading arm shall be provided with break away couplings. Loading arm shall be of approved type and be tested as per OEM recommendations.
- iv. The hose - coupling / flange joint shall be of Class 300 lb rating with metallic gasket. The hose coupling shall be provided with a cap or blind flange by which the nozzle can be closed when not in use.
- v. Weigh bridges of suitable capacity for road / rail movements and mass flow meters for pipeline transfers shall be provided. The mass flow meters shall be certified for its use with LPG.
- vi. A check valve shall be provided in the vapour return line.

2.3.2 Unloading of LPG from tank truck is carried out with vapour compressors using pressure differential method of liquid transfer.

- i. Each unloading station shall consist of the following:
 - a. Vapour line with isolation valves
 - b. Excess flow check valve & non return valve shall be provided in LPG unloading lines with isolation valves

- c. Weigh bridge of suitable capacity
- ii. Properly designed unloading arm or LPG hoses shall be provided for connecting to the tank truck vessel. The unloading arm shall be provided with break away couplings. Unloading arm shall be of approved type and be tested as per OEM recommendations.

2.3.3 Additionally following shall be ensured.:

- i. Suitable provision shall be made for evacuation of LPG from bulk storage vessels to tank truck or another vessel to empty the vessel in case of emergency or for statutory testing.
- ii. Tank truck shall be loaded/ unloaded with suitable arrangement for flaring of hose content at the end of the operations.
- iii. In case, LPG hose are used, it shall conform to IS: 9573 for design and testing requirements for use with LPG.
- iv. The hose - coupling / flange joint shall be of 300 lb rating with metallic gasket. The hose coupling shall be provided with a cap or blind flange by which the nozzle can be closed when not in use.

2.4 CYLINDER FILLING FACILITIES

- i. The cylinder filling area shall be completely open type and covered from top with roof designed to ensure good natural ventilation. RCC roofing shall not be used.
- ii. The filling area shall not be on upper floors of building or in cellars unless specifically required on account of extreme weather conditions.
- iii. As far as possible, the floor area shall not have any channels or pits. Where these are necessary for conveyors or other equipment like weigh machine etc., suitable gas detection system shall be provided. Additionally, proper ventilation system through ducts fitted with blowers shall be provided to release LPG outside of the shed at safe location. The whole of the LPG filling shed flooring shall be provided with mastic flooring.
- iv. All carousels & leak detectors including electronic shall be of approved type.
- v. Adequate lighting shall be provided in the cylinder filling area. Emergency lighting shall also be provided at critical places.
- vi. Water drains from the cylinder filling area where they enter an outside drainage system, shall be provided with vapour seals.
- vii. Proper access shall be made available for other fire fighting equipment i.e. fire tender, etc.
- viii. Cylinder storage area requirement shall be worked out based on the stacking pattern of filled and empty cylinders as per Gas Cylinder Rules.
- ix. The filling machines shall be provided with auto cut-off system so that LPG supply is cut off when the desired quantity of product has been filled in the cylinders. The filling pressure shall not be more than the design pressure of the cylinders i.e. 16.9 kg/sq.cm.g.
- x. Filling machines in a carousel/ stationary filling machines shall meet the requirements as per Legal Metrology rules .
- xi. On-line check weighs scales with a maximum least count of 50 gms shall be provided.
- xii. Electronic leak detectors shall be provided Alternatively Compact Valve Tester to check valve and 'O" ring shall be installed on line.
- xiii. Water test bath or electronic leak detectors shall be provided to detect body and bung leak cylinders.
- xiv. Vapour extraction system at strategic locations near carousel, cylinder evacuation unit, valve changing unit, degassing shed and at locations where leakage of LPG is expected to accumulate shall be provided. Further, it shall be interlocked with filling machine so that filling does not start without vapour extraction unit being functional.

2.5 UTILITIES

2.5.1 Compressed air

- i. The quality of instrument air shall conform to the requirements as recommended by the manufacturers of instruments/ equipment:
- ii. If one compressor is envisaged to run normally, another standby compressor of 100% capacity shall be provided. When more than one compressor running is envisaged, 50% standby capacity shall be provided.

2.5.2 Service Water

- i. Service water is required for the cylinder washing equipment and leak check bath, compressor cooling and in hose stations for washing etc.
- ii. Water may be provided at a pressure of about 3 Kg/sq.cm.g. If one pump is envisaged to run normally, another pump with 100% capacity shall be provided as a standby. Where more than one pump running is envisaged, 50% capacity as standby shall be provided.

2.5.3 Emergency Power

The installation shall be provided with battery / diesel generating set for operating the essential systems such as the instrumentation and safety systems (gas detectors, automatic fire water sprinkler system) and minimum lighting during the grid power failure.

2.6 LPG PUMPS

- i. LPG Pumps shall be 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 or equivalent.
- ii. Check valves shall be installed on the delivery side of all centrifugal pumps.
- iii. LPG Pumps shall be provided with suction and discharge pressure gauges, a high point vent to safe height or flare, and a suction strainer.
- iv. Double Mechanical seal with seal failure alarms shall be provided.
- v. A pressure switch taken from discharge end actuating a low pressure alarm shall be provided in a manned control station for taking immediate action
- vi. Pumps shall be designed to build a discharge pressure such that the pressure at the carousel filling machine is at least 5.0 kg/sq.cm.g. above the vapour pressure at the operating temperature.
- vii. Pumps shall have a by-pass valve and other suitable protection against high discharge pressure on the delivery side.
- viii. The electrical motor drive and switchgear shall conform to area classification as per IS -5572. Belt drives shall be of the anti-static type.

2.7 LPG VAPOUR COMPRESSOR

- 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 or API 619 or equivalent.
- ii. The belts used in shall be of antistatic type & fire resistant.
- iii. Compressor shall be provided with the following features as a minimum :

- Pressure gauges in suction and discharge.
 - Temperature gauge in discharge
 - Discharge safety valve and a vent valve, their outlets leading to flare/ safe height outside the shed.
 - Low Suction Pressure Trip
 - Suction strainer
 - High Discharge Pressure Trip
 - High Temperature Trip
 - Check valve in discharge
 - A discharge to suction recycle valve for achieving capacity turndown during startup.
- iv. A suitable size scrubber or liquid knockout drum shall be installed upstream of the vapour compressor. It shall be equipped with a gauge glass, safety relief valve, a drain and high liquid level shut down device.

2.8 PIPING

- i. Piping shall be designed for handling of LPG.
- ii. Piping shall conform to the provisions of ANSI B 31.3.
- iii. The material shall conform to API 5L Gr. B / ASTM A106 Gr B or eqv.
- iv. Seamless pipes shall be used. Furnace butt welded or spiral welded pipes shall not be used.
- v. Pipe joints should be welded with full penetration weld. Number of flanged or threaded joints should be kept to a minimum.
- vi. Low point drains and high point vents shall be plugged or capped suitably.
- vii. Buried piping shall be protected against physical damage and corrosion with suitable sleeves, properly sealed at both the ends, at road crossings.
- viii. Comprehensive test including hydro test shall be carried out once every 5 years. NDT

2.9 THERMAL PRESSURE RELIEF SYSTEM

Any equipment or section of piping in which liquid LPG may be trapped e.g. between shut off valves, shall be protected against excessive pressure developed by thermal expansion of the LPG by providing suitable thermal pressure relief valve(s). If pressure relieving devices discharge to atmosphere, the discharge shall be done in a safe manner. The set pressure for Thermal safety valve shall not exceed the design pressure of piping.

2.10 VALVES

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

2.11 FITTINGS

- i. Steel flanges and flanged fittings conforming to API 105 Class 300 (forged) or eq. 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 or equivalent. 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 shall be connected for bonding for electrical continuity.

2.12 EVACUATION FACILITY FOR DEFECTIVE CYLINDERS

- i. The cylinder evacuation facility shall consist of :
 - Cylinder emptying vessel (s)
 - Compressor
 - Four way valves or equivalent
 - Cylinder rack, header to be provided with pressure gauge and a strainer with isolation valves.
 - The LPG line exit cylinder evacuation area to be provided with a non-return valve before joining the main LPG return header.
 - Independent earthing connections.
- ii. Each of cylinder emptying vessels mentioned above shall be equipped with the following :
 - Pressure gauge
 - Level gauge
 - high level alarm switch set at 85 % with trip / switchover arrangement.
 - Pressure relief valves,
 - Vent valves discharging to 1.5 m above the shed.
 - Other trims like drain valve, utility connection.

2.13 PURGING OF NEW CYLINDERS/ TANKERS

- i. The new LPG cylinders containing air shall be evacuated with a vacuum pump. The evacuation facility shall consist of :
 - Vacuum pump (water/ oil / air cooled type)
 - Purging manifold
 - Vacuum receiver fitted with vacuum gauge, vent and drain.
 - LPG vapour header
 - Purging adapters
 - Vacuum pump with suction strainer
 - Pressure regulator, relief valves
- ii. Purging of tankers/ vessels shall be done using either Nitrogen or by filling water and displacing with LPG vapours.

2.14 EQUIPMENT FOR ETHYL MERCAPTAN SERVICE

2.14.1 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 of desired pressure rating can also be used. Use of Iron or carbon steel shall be avoided as there is the hazard of formation of iron-sulphur complexes which are pyrophoric. Copper or copper bearing alloys shall not be

used for mercaptan service as mercaptan readily attacks and contaminates them.

2.14.2 Pumps for Mercaptan service

Only hermetically sealed pumps shall be used.

2.14.3 Piping and Fittings

- i. Seamless stainless steel piping shall be used. 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.
- 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 stainless steel (SS316) trim or their equivalent are recommended.
- v. Rigid connection should be welded or flanged joint type.
- vi. Fluoroplastics shall be used for gasketing.
- vii. For pressure gauges, stainless steel diaphragm type is recommended with stainless steel socket and tip.
- viii. Provision for analysis in line with IS:4576 or IS14861 as applicable shall be made.

2.14.4 Selection of Electrical Equipment

- i. Electrical equipment shall be selected, sized and installed so as to ensure adequacy of performance, safety and reliability. The equipment in general shall conform to relevant Indian Standards and shall be suitable for installation and satisfactory operation in the service conditions envisaged.
- ii. All electrical equipment shall be selected considering the system neutral earthing.
- iii. Electrical equipment including for lighting system shall conform to hazardous area classification and be selected in accordance with IS:5571. These shall be tested by agencies such as CMRI, ERTL, CPRI or independent test laboratory of country of origin for such equipment. Indigenous Flameproof equipment shall comply with relevant BIS standard as per requirements of statutory authorities. All equipment used in hazardous area shall be approved by Chief Controller of Explosives.
- iv. For details on hazardous area classification, enclosure protection etc., National Electric Code (SP 30) 5, IS/IEC 60079 Part 1 to Part 11, , IS:5571, 5572,) Petroleum Rules, 2002 shall be referred.

2.15 Installation Lighting

- i) Sufficient lighting shall be provided so as to enable plant operators to move safely within the accessible areas of installation and to perform routine operations. In the event of normal power failure, emergency lighting shall be provided.
- ii) Normal lighting system shall be on 415/ 240V AC supply, whereas emergency lighting will be either on 220V or 110V DC.
- iii) Lighting requirements provided during the failure of power supply for Normal lighting are intended broadly,
 - a. to facilitate carrying out of specified operations, for safe shutdown of the installation.
 - b. to gain access and permit ready identification of fire fighting facilities such as fire water pumps, fire alarm stations etc.
 - c. Escape route for safe evacuation of operating personnel.

- iv) Under normal operation, both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting shall be transferred to emergency source until the start of D.G. set within 15 seconds. Critical lighting (D.C. supply based) shall be normally kept 'ON'. During power failure, battery bank shall be used to provide power.
- v) Low pressure sodium vapour lamps shall not be installed in hazardous areas.
- vi) The illumination levels in different areas shall be as per good engineering practice. Depending on the nature of job activities to be carried out the suggested minimum illumination levels for various areas are as below :

Area or Facility		Average Maintained Illumination Level, lux
Operating areas (Filling, storage, repair sheds, control areas)		100 - 200
Compressor houses at or near equipment		200
Stairways, platforms and walkways		60
Outdoor operational areas (Process areas, pipe racks, heat exchanger, flare etc.)		60
Outdoor Non-operational areas (At grade)		10
Tank farms		20
Main / Secondary roads		20
Pump houses, Sheds, Switches		100
Switchgear Room & UPS Room		150-200
Cable cellar Room		70
Battery rooms & transformer bays		100-150
Toilets and locker rooms		150
Control Room	General lighting/laboratories	400
	Rear of instrument panels, aux. and panel	200-300
	Outside, near entrances	150

- vii) The lighting fixtures on various circuits shall be suitably interlaced so that failure of any one circuit do not result in complete darkness.
- viii) Switches controlling the lighting fixtures and exhaust fan shall be installed outside the battery room.
- ix) Switches of lighting panels installed in hazardous area, shall have a pole to break the neutral in addition to the poles for phases.
When the means of isolation is located in a non-hazardous area, the switch shall break all poles including neutral or alternatively may break only live poles, the neutral being isolated by a removable link.

2.16 Installation Earthing

- i. Installation earthing design shall be carried out in accordance with the requirements of Indian Electricity Rules and IS : 3043. All earth connections should be visible for inspection to the extent possible.
- ii. All electrical equipment shall be suitably earthed. Earthing system shall cover the following:
 - Equipment earthing for personnel safety.

- System neutral earthing, and
 - Protection against Static and Lightning discharges.
- iii. The earthing system shall have an earthing network with required number of earth electrodes connected to it. The following shall be earthed:
- System neutral
 - Metallic non-current carrying parts of all electrical apparatus such as transformers, switchgears, motors, lighting / power panels, terminal boxes, control stations, lighting fixtures, receptacles etc.
 - Steel structures, loading platform etc.
 - Cable trays and racks, lighting mast and poles.
 - Spheres, Bullets etc.
 - Electrical equipment fencing (e.g. transformer, yard etc.)
 - Cable shields and armor.
 - Flexible earth provision for wagon, truck.
- iv. Where installed, lightning protection shall be provided as per the requirements of IS:2309.
- v. The resistance values of an earthing system to the general mass of earth should be as per Indian Electricity Rules as below :
- For the electrical system and equipment a value that ensures the operation of the protective device in the electrical circuit but not in excess of 4 Ohms.
 - 10 Ohms in the case of all non-current carrying metallic parts of major electric apparatus or any metallic object.
 - The resistance to earth shall not exceed 7 Ohms and the resistance to any part of the fitting to the earth plate or to any other part of fitting shall not exceed 2 Ohms.
 - All joints in pipelines, valves in installations, and associated facilities and equipment for LPG shall be made electrically continuous by bonding or otherwise; the resistance value between each joint shall not exceed 1 Ohm.
- vi. The earth conductor shall be adequately sized to carry the applicable maximum earth fault current without undue temperature rise. All joints shall be protected against corrosion.
- vii. All the electrical equipment operating above 250 volts shall have two separate and distinct connections to earth grid.
- viii. The main earthing network shall be used for earthing of equipment to protect it against static electricity.
- ix. An independent earthing network shall be provided for lightning protection and this shall be bonded with the main earthing network below ground, minimum at two points.
- x. Every Sphere/ bullet shall be electrically connected with the earth in an efficient manner by not less than two separate and distinct connections. The connections and the contacts required shall have as few joints as possible. All joints shall be riveted, welded or bolted and also soldered to ensure both mechanical and electrical soundness.

Schedule-1B

3.0 LPG TANK TRUCKS: REQUIREMENTS OF SAFETY ON DESIGN/ FABRICATION AND FITTINGS

Transportation of LPG by road is regulated by Department of Explosives through The Petroleum Rules 1976 and The Motor Vehicle Act 1988. Transportation of LPG in bulk is regulated through The Static and Mobile Pressure Vessels (unfired) Rules, 1981 and The Motor Vehicle Act, 1988.

3.1 DESIGN CRITERIA

Pressure vessels used for transportation of LPG shall be designed and fabricated in accordance with The Static and Mobile Pressure Vessels (Unfired) Rules 1981, IS: 2825 or equivalent codes .

3.1.1 MAXIMUM FILLING VOLUME

Minimum vapour space or the maximum quantity of LPG filled in any vessel shall be limited to the filling density of LPG and shall be such that the vessel should not become liquid full due to expansion of the content with the rise in temperature to 55 deg. centigrade. This requirement shall be applicable irrespective of the ambient temperature of the product at the time of filling. (Generally it is filled maximum up to 85% of the volume)

3.2 VESSEL DESIGN

3.2.1 Design Pressure:

Vapour pressure of LPG conforming to IS:4576 at a maximum anticipated service temperature of 55 deg. C. to be considered. The minimum design pressure shall be 14.5 kg/sq.cmg. In addition, 3g effect to take into account acceleration/deceleration shall be considered while designing of the vessel.

3.2.2 Design Temperature:

The design temperature of the vessel shall be in line with the specification of LPG and as per statutory requirement.

3.3.3 Vessel Design Code:

- i. Vessel shall be designed, fabricated and tested in accordance with requirements of Class I pressure vessels conforming to IS:2825, PD-5500, ASME SEC. VIII or equivalent codes accepted by Statutory Authority. The vessel shall be designed to withstand shocks normally encountered during transport including those set up by the movement of the contents of the vessel such as acceleration / deceleration of a minimum of 3g to be calculated considering that the vessel is full with LPG at 55 deg. C. Saddle supports and other attachments shall also be designed according to the fabrication code.
- ii. Joints: Joints shall be as required by the code with all undercuttings in shell and head material fabricated as specified therein.

All longitudinal shell welds shall be located in upper half of the vessel and shall be staggered when assembling the cylindrical shell from two parts by means of a circumferential joint. The distance between two such staggered joints shall be at least 5 times the thickness of the thicker plate or as

specified by code as adopted.

3.3.4 Material Specifications

Material used in the manufacture of pressure parts of the vessel shall be in accordance with that specified in IS: 2825, PD-5500, ASME SEC. VIII or equivalent code as adopted. A single code shall be adopted for materials, fabrication, inspection and testing.

3.3.5 Vessel Plate Thickness

The nominal thickness of the plate material used in fabrication shall not be less than the sum of minimum calculated thickness as per the fabrication Code and corrosion allowance (CA), if necessary and in addition, adequate thinning allowance in case of formed heads. For mobile vessels (for which CA may not be necessary) an allowance of at least 0.5 mm. shall be included in place of CA to safeguard against wear and tear. The nominal plate thickness shall also be not less than the minimum calculated thickness and the under-tolerance as allowed in material specification and in addition the thinning allowance as mentioned above. The minimum actual thickness of the finished formed head shall be physically verified by the Inspecting Authority to ensure that it is not less than the required thickness, as explained above. This shall be indicated in the final certificate issued.

3.3.6 Connecting Joints/Nozzles and Manhole:

Connecting joints / nozzles and manhole shall be constructed in accordance with the applicable design and fabrication code.

3.3.7 Baffle Plates:

Every vessel over 5 cu.m water capacity shall be fitted with baffle plates to minimize the surge, the design of which should facilitate complete internal inspection.

Baffle plates shall be provided as follows:

- i. Over 230 cms in length shall be provided with baffles, the number of which shall be such that the linear distance between any two adjacent baffles or between any tank head and the baffle nearest it, shall in no case exceed 150 cms.
- ii. Each baffle shall have adequate strength to sustain without undue stress or any permanent set a horizontal force equal to the weight of so much of the contents of the tank as may come between it and any adjacent baffle or tank head, applied as a uniformly distributed load on the surface of the baffle or tank head. Baffles shall be formed with a curvature of 200 to 300 cms radius.
- iii. Each baffle shall have at least 2/3rd of the cross-sectional area of the tank. Baffles shall have suitable openings at top and bottom, Openings at bottom should allow access to the other side. Baffles shall be attached to the shell by means of suitably spaced cleats (min. 8 nos.) of minimum size 150 x 150 x 6 mm thick. The weld between baffle to cleat and cleat to the shell shall meet the applicable design code requirements. No vessel supports or baffle or baffle cleat shall be welded directly to the vessel. All such supports shall be attached by means of pad of the same material as the vessel. The pad thickness shall not be less than 6 mm and shall not exceed the thickness of the shell material.
- iv. Each pad shall extend atleast 4 times its thickness in each direction beyond the weld attaching the

support. Each pad shall be formed to an inside radius not greater than the outside radius of the vessel at the place of attachment. Each pad corner shall be rounded to a radius of at least 1/4th width of the pad and not greater than ½ the width of the pad. Weep holes and tell-tale holes if used shall be drilled or punched before the pads are attached to the tank. Each pad shall be attached to the tank by filler material having the properties conforming to the similar filler material used for welding of the vessel.

Baffle shall be located away from SRV to facilitate ease of access for fitment / removal and safety of SRV.

3.3.8 Safety Appurtenances

LPG tank truck is provided with them following openings/nozzles:

- (i) Safety Relief valves
- (ii) Excess flow check valves in the liquid and vapour lines and pressure gauge nozzle.
- (iii) Pressure gauge (Provided in the vapour space of the vessel)
- (iv) Temperature gauge (Provided in the liquid space)
- (v) Roto-gauge (to measure the percentage of liquid in the vessel.
- (vi) Manhole with cover.
- (vii) Fixed level gauge
- (viii) Drain point at the bottom.
- (ix) Liquid/Vapour manifold

a. Safety Relief Valve (SRV)

Each tank truck is provided with two or more SRVs for providing the relieving capacity under excess pressure. The SRVs are mounted on the top surface of the vessel either in the recessed fittings or at the shell level with head projecting out. In the event of an accident causing the tank truck to fall off the road and topple, there is a possibility that Safety Relief Valves which projects out can hit against a hard surface and get damaged or even come out of the nozzles as adequate protection as envisaged in the rules has not been provided. To prevent this from happening, the following measures shall be adopted:

- i. The SRV of an LPG tank truck shall be provided in a recessed cup formation. Alternatively, it may be equally protected by providing a guard all rounds as per the CCE approved procedure for modification.
- ii. SRV shall be replaced by a new SRV every ten years. If found defective during any of the earlier yearly inspections, it shall be replaced earlier.
- iii. Unstamped (Uncertified) SRVs shall not be used.
- iv. At the time of yearly inspection/each opening, the threads of the valve and coupling shall be checked by an Inspection Agency/Competent Person using "Go/No Go" gauges. SRV shall be tightened to the required torque specified for its size so as to obtain minimum engagement of 5-6 threads by hand tightening and another 1-2 threads by spanner tightening. LPG tank trucks shall carry SRV certificates issued by Inspection Agency/Competent Persons which apart from test date and set pressures shall also include the following information :
 - a) The number of threads engaged in its coupling.
 - b) The number of threads outside its coupling.
 - c) Torque applied for tightening.
 - d) Identification mark of SRVs.

b. Internal Excess Flow Check Valves (IEFCVs.)

- i. Each liquid/vapour pipeline and pressure gauge nozzle shall be provided with internal excess flow check valve duly type approved by PESO.
- ii. IEFCVs before fitment, shall be checked using "Go/No Go", gauges and shall be tightened to the required torque specified for the size to obtain minimum engagement of 5-6 threads through hand tightening and another 1-2 threads by spanner tightening.
- iii. , IEFCV shall be examined for its proper operation along with SRV, once a year by competent person.
- iv. IEFCV shall be checked for its rated capacity every five years.
- v. Each IEFCV shall be replaced by a new IEFCV every ten years. If found defective during operation or any of the earlier inspection, it shall be replaced at that time itself i.e., earlier than ten years.

c. Pressure Gauge

The functional parts of EFCV of pressure gauge shall remain within its coupling. In addition, the pressure gauge if not provided in recessed cup shall be adequately protected with a shroud.

d. Fixed Level Gauge / Drain Nozzles

With experience these fittings have been found to be redundant. Therefore, to minimize the openings in the tanker, these fittings shall be plugged (After necessary amendment to the SMPV Rules, 1981). Plugging shall be approved by Competent Persons/Inspection Agency.

e. Roto Gauge

These fittings shall be housed in a recessed cup formation, when fitted on longitudinal sides of vessel to avoid any accidental damage to bleed valve or seal. The rotogauge shall also be protected with a provision of hinged cover of 5 mm thick plate.

f. Liquid / Vapour Piping

The pipes shall conform to the ASTM A-106B, schedule 80 standards. Liquid/Vapour piping shall be single piece and the end flanges shall be of ASA-300 rating. Metal jacketed gasket shall be used for the piping system. In addition, sturdy guard shall be provided between the propeller shaft and the elbow of the piping. Adequately strong arrangement shall be provided to fix the piping rigidly to the bullet/chassis to minimise the effect of vibrations.

g. Height Barrier

Whenever cabin height is less than the height of the vessel and fittings on top of it, a height barrier shall be provided all along the width of the cabin in the form of a cage either 50mm diameter pipe or 50 X 50 X 3 MM angle frame on the top of vessel and within the height regulation of Road Transport Authority.

h. Mounting

U-Bolts used for mounting of the mounting of the pressure vessel on the chassis shall conform to ASTM 193 B7 and the nuts to A194 Gr.2H. The number and size of bolts should be as per the design requirements for the particular chassis and load thereon.

3.3.9 Other Considerations

- i. Openings for liquid and vapour low and pressure gauge etc. in the truck shall be protected by suitable excess flow check valves mounted in the openings of the vessel. Openings of less than 1.5 mm need not have such a valve.
- ii. Valves or accessories situated at the rear of a vehicle shall be protected by the rear cross member of the frame of the vehicle against damage.
- iii. All piping, fittings, pumps and meters permanently mounted on the vehicle shall be designed to withstand the most severe combined stresses imposed by the following, namely:
- iv. The maximum design pressure of the vessel.
- v. The superimposed pressure of the shock loading caused by road movements.
- vi. All piping, fittings and equipment shall be adequately protected to minimize accidental damage which may be caused by road accidents or overturning. All trucks should be provided with suitable height barriers on the drivers cabin if the height of the vessel exceeds the cabin height.
- vii. The engine and exhaust system together with all electrical generators, motors, batteries, switch gears and circuit breakers shall be efficiently screened from the vessel or the body of the vehicle by a fire-resisting shield or by enclosure within an approved fire resisting compartment.
- viii. When the equipment referred in 3.3.8 above is mounted forward of the rear of the driving cabin the cabin can be considered to act as an acceptable shield, provided the back, the roof and the floor of the cabin are of fire resisting construction for the full width of the cabin, without any openings in the back or roof, and that the back extends downwards to the top of the chassis.
- ix. When the cabin construction does not conform to the requirements mentioned above, a separate fire resistant shield should be installed extending upwards without any openings from the top of the chassis to the top of the vessel.
- x. In any case where windows are provided in the shield, they should be fitted in fire-resistant framing with wired glass or other heat resistant material and shall not be capable of being opened.
- xi. When the equipment referred in 3.3.8 above is mounted to the rear of the cabin, it shall be contained wholly within an approved fire-resistant compartment.
- xii. In any case where the fuel used to propel a vehicle gives off a flammable vapour at a temperature less than 65 degree C, the fuel tank shall not be behind the shield unless the following requirements are complied with namely:
- xiii. The fuel tank is protected by stout steel guards or by the frames of the vehicle.
- xiv. The fill pipe of the fuel tank of the vehicle is provided with a cover having locking arrangements.
- xv. Fuel feed apparatus placed in front of the fire-resisting shield is used to lift the contents of the fuel tank.
- xvi. The electrical systems shall have the same safety features as detailed above.
- xvii. Tyres shall be of the "anti-skid" type.
- xviii. There shall be a clear space of at least 15 cm. between the rear of the cabin and the front of the vessel.
- xix. The rear of the vessel shall be protected by a robust steel bumper and this bumper shall be:
 - a. attached so that collision stresses will be transmitted to the frame work of the vehicle or, in the case of an articulated vehicle to the frame work carrying the wheels of the vessel.
 - b. situated at least 7.5 cm to the rear of the rearmost part of the vessel providing complete cover to the body.
 - c. extended on each side of the vehicle to at least cover the maximum width of the vessel.
- xx. The maximum weight of the liquefied gas for which the vehicle is designed should not exceed the difference in weight between the unladen weight of the vehicle and the maximum gross weight permitted for that class of vehicle under the appropriate transport regulations or CCOE licensed capacity whichever is less.
- xxi. The vessel shall be conspicuously marked to show the product which is being carried.
- xxii. Two portable ISI marked 9 kg. DCP fire extinguishers shall be provided on each vehicle, one on each side and should be accessible from outside the cabin and another DCP extinguisher should be kept in the driver's cabin. All extinguishers (minimum 3 nos) should have the marking indicating

- next due date for pressure testing.
- xxiii. Pressure relief valves shall be tested every year by competent person and certificates/records maintained. The functioning of excess flow check valves should also be checked once a year.
 - xxiv. All pressure gauges, level gauges & temperature gauges should be calibrated once a year.
 - xxv. Tank/bullet mounted on the chassis shall be hydrostatically tested every 5 years through competent person and Certificates/records maintained. If the chassis is not suitable for taking the load the tank/bullet should be removed & tested separately.
 - xxvi. After maintenance / repair job the LPG tank trucks are to be purged by water displacement by LPG/inert gas.
 - xxvii. Driver of the vehicle should carry TREM card and route-map with detail locations and contact agencies in case of an emergency.
 - xxviii. Checklists for Bulk LPG tank trucks are given in Annexure - I.
 - xxix. Each tank shall be provided with a approved spark arrestor.

3.3.10 Painting

Vessel external surface shall be sand blasted and painted with two coats of red-oxide primer (as per IS: 2074 Part I) and two coats of enamel paint (as per IS: 2932 Part I), of the colour stipulated by statutory authorities.

3.4 SAFETY OF TANK TRUCKS IN TRANSIT

- i. Except for driving crew and oil companies officials during emergencies/leaks/accidents, no other person shall be carried on the tank truck.
- ii. Vehicle shall be constantly attended by the driver or his assistant.
- iii. The vehicle shall be halted at a safe place.
- iv. Vehicle shall be equipped with Anti-lock Braking System (ABS) as per Central MV Rules.
- v. The vehicle should be parked with the consent of the occupier in an open yard or enclosed premises subject to the Factories Act.
- vi. The driver should take all reasonable precaution to ensure that the vehicle is parked in safe environment.
- vii. The driver of a vehicle carrying petroleum product shall be trained in the properties of the material carried, the handling method applicable to the grades being carried, in the use of the fire extinguishing equipment carried on the vehicle and in the emergency procedure to be followed. The training to drivers should be in line with syllabus under rule 9 of The Central Motor Vehicle Rules 1989 and should be by any approved Govt. agencies for this purpose.
- viii. All necessary steps shall be taken by the owner/loader of the vehicle to ensure that the driver is fully aware of and understands all instructions
- ix. As a precaution against any accident or emergency that may occur during carriage, the driver shall be supplied with instructions in writing in the form of a safety instruction booklet.
- x. The nature of the danger presented by the dangerous substances carried and the safety ensures that must be taken to avert that danger.
- xi. The action to be taken and treatment to be given in the event of persons coming in contact with the dangerous substances being carried or with any substances which might escape there from.
- xii. The measures to be taken in case of fire and in particular the extinguishing methods and/or agents or groups of extinguishing methods and/or agents not to be used.
- xiii. The measures to be taken in case of breakage or deterioration of packaging or spillage of the dangerous substances, particularly on the road.
- xiv. These instructions should be in local language, Hindi and English.
- xv. The system of Transport Emergency Cards (TREM) meets the above requirements.

3.5 LABELLING OF CONTAINERS / VEHICLES CARRYING LPG

- i. To ensure that any package or truck carrying dangerous goods is recognized from a distance, the recommendations include a labelling system. The recommended labels are diamond shaped i.e. they are in the form of square (25 cm x 25 cm) set at an angle of 45 degrees. The upper half of the label is reserved for the pictorial symbol representing the nature of the risk, different symbols being provided for each of the Classes. The number of the class or division should be shown in block in the bottom corner of the label unless the substance in question presents more than one risk. Any other text inserted optionally in the lower half of the label should be printed in black and should be confined to particulars indicating the nature of the risk and precautions to be taken in handling.
- ii. Every goods carriage carrying any dangerous or hazardous goods shall display the class label both in front and in the rear in a conspicuous manner.
- iii. Every goods carriage used for transporting any dangerous or hazardous goods shall be legibly and conspicuously marked with an emergency information panels.
- iv. The display on vehicles of the descriptive names or prescribed "correct technical names" of the chemicals/petroleum products in letters not less than 50 mm high.
- v. The display on vehicle of special signs or plates denoting that dangerous goods are being conveyed or plates bearing special code numbers (HAZCHEM) which may identify the substances or reveal its hazardous property or indicate what action should be taken in emergencies.
- vi. The name and telephone numbers of the emergency services to be contacted in the event of any fire or any other accident in letters and numerals that are not less than 50 mm high and the name and telephone number of the consignor of the dangerous or hazardous goods or of some other person from whom expert information and advice can be obtained concerning the measures that should be taken in the event of an emergency involving such goods.
- vii. Every class label and emergency information panel shall be marked on the goods, carriage as stipulated in the Motor Vehicle Rules and shall be kept free and clean from instructions at all the times.
- viii. **Marking:**

Vessel Identification Plate:

Each vessel shall have a non-corrosive metal plate permanently affixed by brazing or welding on the rear dished end in a place readily accessible for inspection and maintained legibly. Neither the plate itself nor the means of attachment to the vessel may be subjected to impingement by the tank contents. The plate shall be plainly marked by stamping or embossing or by other means of forming letters to the metal of the plate with the following information in addition to that as required by local regulations:

1. Vessel Manufacturer
2. Vessel Manufacturer's Serial No.
3. Design code
4. Radiography
5. PWHT
6. Design Pressure
7. Design Temperature
8. Hydrostatic test pressure
9. First test date and subsequent test dates
10. Water capacity in liters
11. Licensed Product capacity in tonne and symbol or chemical name.
12. Name of the Inspection Agency with their stamp.

13. Certificate number of Inspecting Agency.
 - a) Shell thickness
 - b) Dish End Thickness
14. Next hydrotest date of the vessel shall be painted on the body of the vessel.

3.6 TRANSPORTATION BY RAIL

Railway Administration, acting as a carrier of Petroleum Products, is exempted from taking any licence for transporting it under Petroleum Rules 1976. Railway Administration have elaborate rules for the carriage of petroleum by rail as provided in Indian Railways Act and Red Tariff No.19 of Indian Railways Conference Association.

3.6.1 Design Criterion

All tank wagons used for the conveyance of petroleum products and LPG shall be of a design approved RDSO. Design parameters for tank wagons used for transportation by rail are issued by the Wagon directorate, Research, Design, and Standards Organisation of Indian Railways.

3.6.2 Safety Appurtenances and other Safety Features

- i. Tank wagons for petroleum class A : These wagons are marked as "TP" as per Railway Code, except Hexane which is loaded in TH tank wagon.
- ii. Each tank wagon is provided with an effective pressure valve as per approved design.
- iii. All openings of fill pipe and dip pipe are provided with air tight caps.
- iv. A master valve set at the bottom inside the body with control from the top of tank wagon.
- v. A block valve at bottom of the wagon to which unloading hose is connected.
- vi. The top fittings are protected by a dome cover.
- vii. Tank wagons designed by RDSO are provided with safety valve with Discharge Capacity : 10.3 cum/sec.
- viii. All other fittings such as liquid valves, vapour valves, magnetic gauging device, thermowell, sample valve and safety valves, pressure gauges are provided on top of the pressure vessel in a protective housing known as 'dome' with a cover.
- ix. After repair or maintenance tank wagons are required to be purged with LPG/inert gases.

Schedule-1C

4.0 SAFETY IN INSTALLATION AND MAINTENANCE OF LPG CYLINDERS MANIFOLD

4.1 Design of Installation

- i. In order to meet the larger requirement of commercial customers, it may be necessary to connect a number of cylinders to a manifold so that the required quantity of gas at requisite pressure can be obtained. The multi cylinder installations shall be designed as per IS:6044 (part I).
- ii. A suitable site for cylinder storage room shall be selected as per the layout considerations.

4.2 Requirement of Cylinder Bank/Burners

- i. While deciding at the size of the manifold it should preferably be designed for higher no. of cylinders to accommodate for increase in consumption in future.
- ii. Size of the cylinder storage room shall depend upon the number of installed cylinders designed for the layout of the manifold (parallel or linear) and the cylinder arrangement in the storage room (Standard or staggered). Enough room shall be provided for easy access to each and every cylinder.

4.3 Connections for LPG cylinder Manifold

- i. All The cylinders at the customers' premises shall always be connected to the manifold wherever the installed cylinders at the premises are more than four.
- ii. The cylinders should not be left unconnected or stored elsewhere.
- iii. Additional cylinders which are to be kept loose, can be stored as per stipulations in Gas Cylinders Rules, 1981. However such cylinders should not be stored in manifolded room.
- iv. Each arm of the manifold shall have a control valve. To each arm of the cylinder manifold, cylinders shall be connected through a pigtail.
- v. For 'SC' type valve cylinders, it is necessary to use an adaptor to connect the cylinder pigtail. The distance between the nipples on the manifold to which pigtails are attached, depends upon the type of cylinder arrangement required i.e., standard or staggered. The staggered arrangement is to be used when availability of space is limited.
- vi. The flexible hose/pigtail shall be in the same room and its length shall not exceed 2 M.
- vii. Flexible hose/ pigtail shall not pass through doors, windows, walls, ceiling (or) floors.
- viii. The pigtails shall be accessible for inspection.

4.4 Location for Manifold Installations

- i. Manifolded installations upto 40 kgs LPG can be installed on any floor. Minimum floor area required 5M².
- ii. Manifold installations not exceeding 40 kgs. of LPG may be installed in doors on any floor within the same workspace provided the minimum distance between two such installations is 3 M. The floor area for each installation should be at least 5M² and the aggregate quantity of LPG in all such installations does not exceed 200 kgs.
- iii. Manifolded installations not exceeding 80 kgs. of LPG may be installed indoors on any floor provided the floor area is not less than 12 M² for such installation.
- iv. Manifolded installation not exceeding 80 kgs. of LPG may be installed indoors on any floor area provided the minimum distance between the installations is 3 M, the proportion of such

installations to floor area is one installation per 12 M² and the aggregate quantity of LPG in all such installations does not exceed 200 kgs.

- v. Small manifold (i.e. Total capacity upto 320 kgs) can be accommodated within the building. For bigger manifold (i.e. capacity 321 to 1000 kgs), a separate shed away from the main building shall be provided keeping adequate safety distances as per IS:6044 (Part I).
- vi. For manifold capacity requirement of more than 1000 kgs, separate installations each not exceeding 1000 kgs. shall be provided.
- vii. The manifold (header) pipeline shall not have any joints to extend its length.

Schedule-1D

5.0 OPERATING PROCEDURES: BULK LOADING and UNLOADING

5.1 Loading of Tank Trucks

Check for following in a tank truck as per statutory regulations before accepting it for filling:

- i. Provision of two safety valves, level gauge, Internal Valve with Excess flow check and control valve on liquid and vapour lines, pressure gauge, temperature gauge on the vessel / bullet. Fire screen between cabin and vessel is provided. For this purpose, cabins with metallic back cover without any opening will be considered as fire screen. Provision of 2 nos. of 9 Kgs.DCP Fire Extinguishers.
- ii. Fitment of Spark arrestors of approved quality. No leakage in exhaust silencer pipe exists. Manufacturer's name plate with date of testing is fitted on the vessel. Valid Explosive License and RTO certificate is available. Approved drawings of vessel are available. Blind flanges/caps are provided on vessel. Availability of Earthing cable. Bonding between vessel and chassis and between flanges is satisfactory. Earthing / bonding point is available. Third party inspection/test certificates for vessel/fittings are available. Liquid / vapour line valves are in good condition.
- iii. Driver must be trained for hazardous goods transportation and their driving license/certificate must have RTO endorsement for hazardous goods transportation.
- iv. In order to prevent accidental movement, the handbrake and wheel chocks shall be firmly on and the engine shall be stopped.
- v. When discharge is in progress, the driver shall remain at his vehicle in such a position as to be able to stop the discharge immediately in an emergency.
- vi. A visual check shall be made of the surroundings, the tank and connections for unusual or dangerous situations.
- vii. Warning notices shall be displayed and suitable fire appliances shall be available for instant use.
- viii. Bonding leads shall be connected before making the hose connections and shall remain connected till the hoses have been removed. Perfect bonding contact should be ensured.
- ix. When operations are commenced, a further examination for leakage at connections shall be carried out.
- x. No person shall smoke while on or attending such a vehicle.
- xi. No article or substance capable of causing fire or explosion shall be carried on such a vehicle.
- xii. Move truck to the loading bay/weigh bridge and record the weight of the empty tank truck.
- xiii. Place the truck on loading bay and place choke blocks at front and rear wheels. Keep the truck in neutral mode with hand brakes "ON".
- xiv. Stop the engine and switch off all electrical equipment.
- xv. All persons should leave the driver's cabin.
- xvi. Make earthing connections of the vehicle at specified point to the fixed grounding system.
- xvii. Connect liquid 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.
- xviii. Start the loading pump.
- xix. The quantity loaded into the truck can be determined by –
 - a. Liquid level
 - b. Weighment
 - c. Positive displacement meter
 - d. Mass flow meter
 - e. The quantity of LPG filled shall not exceed the RLW of the tank truck.
- xx. Liquid level may be determined by roto-gauge or fixed liquid level gauge. Percentage volume to be filled shall not exceed 85 % at ambient temperature or the allowable filling limit as per PESO

whichever is lower.

- xxi. 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.
- xxii. When the filling operation is in progress, the pressure within the tank truck vessel shall 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.
- xxiii. The couplings may then be removed and plugs/caps replaced on the tank truck valves. Re-check tightness with soap solution.

5.1 Unloading of tank trucks

Additional precautions to be taken during unloading are as under :

- i. Liquid line and vapour line of the tank truck shall be connected to the respective hoses fixed to the unloading point.
- ii. Test the connections for leaks by slightly opening the valves for pressurizing. When satisfied, valves on the tank truck and the receiving vessel shall be opened.
- iii. Start the LPG 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.
- iv. 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.
- v. An authorized person of the company shall supervise the transfer operation and respond immediately in the event of an emergency.
- vi. After the liquid has been taken out, 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/cm²g. Checklist for bulk LPG tank Trucks at unloading locations is given at Annexure I.
- vii. Unloading by LPG Pump in the storage vessel can be undertaken after taking the safety precautions and SOPs.

5.2 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 for safe transportation and operations. The loading facilities are similar as for tank truck loading while 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 weighing on weigh bridge before and after emptying or, alternatively, mass flow meters can be used. .

5.2.1 Safety Precautions

- i. Do not allow the locomotive to come on the weigh bridge unless its capacity is designed to take the locomotive load.
- ii. Sufficient number of dummy wagons may be used to avoid electric loco coming closer to the gantry. Maintain the distance of 15 m from first fill point.
- iii. 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.
- iv. For connecting and disconnecting hoses, only non-sparking tools shall be used.

- v. After the wagons are placed on weigh bridge and before the loco is detached, the hand brakes on each and every wagon shall be applied.
- vi. Like-wise, before the wagons are moved from the weigh bridge, release brakes on all the wagons.
- vii. Do not use footwear with protruding nails.
- viii. Ensure that the lower portion of flapper bridge at wagon side is fitted with rubber or wooden padding.
- ix. Ensure that electrical continuity of the system is intact.
- x. Ensure that all fittings on the wagons are checked physically.
- xi. Hoses shall be tested as per statutory requirements and records maintained.
- xii. The loading/unloading operation shall be carried out under close supervision of authorized person.
- xiii. During unloading operation, after the liquid transfer is over, the wagon pressure shall not be reduced below 1.5 Kg/sq.cm.(g).

5.2.2 Filling Considerations

- i. Tank Wagons for Petroleum Class A Vapour space of not less than 4% of the capacity of tank wagon shall be kept. Since tank wagons are loaded in accordance with the load carrying capacity by weight in relation to axle design, the above vapour space is allowed. In addition the tank wagons are filled as per the calibration tables provided by railways and which specifies the maximum dip to be loaded for various products.
- ii. The maximum quantity of LPG filled in any tank wagon shall be limited to the filling density of the LPG and shall be such that the tank wagon shall not be liquidful due to expansion of the contents with rise of the temperature to 55 degree C. or limited to specified gross weight on the wagon whichever is less.

5.2.3 Operating Procedures

5.2.3.1 Loading Operations

- i. Place the wagon on weigh bridge taking care to see that all the four wheels are properly accommodated on the platform. Engage hand brakes.
- ii. Ask loco to move away and exhibit caution sign at suitable distance away from the wagons on both ends.
- iii. Switch off loco engine, if parked nearby.
- iv. Apply brakes on all wagons
- v. Ensure fire system, safety interlocks, communication system are OK
- vi. Take loading advice.
- vii. Connect earthing lugs to the wagons.
- viii. Lower the flapper bridge slowly on the wagon.
- ix. Open the lid of the wagon.
- x. Take the tare weight reading and set the pointer of the scale to zero. Compare this with the marked tare weight on the wagon. Alternatively, use mass flow meter to fill the wagons.
- xi. Connect the filling hose or loading arm and vapour return line hose or arm to the wagon. Ensure that the flare connection valves are closed.
- xii. Ensure that the header is charged with LPG and the bulk loading pump is running.
- xiii. Open the tanker filling line valve and vapour return line valve.
- xiv. Check the system for leaks.
- xv. 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. Ensure filling is up to safe filling level keeping in view temperature factors. Take mass flow meter readings if used.
- xvi. Once the filling is over, close the wagon filling and vapour return lines valves and also valves on

- filling and vapour return lines at the loading point.
- xvii. Open the valve on flare line connection to both feed line and vapour return line slowly to avoid ice formation. Thus, the hoses are depressurized. Then, close the flare line connection valves.
 - xviii. Disconnect the filling and vapour return line hose connections from the wagon. Replace and tighten the plugs on filling and vapour return lines.
 - xix. Close the top cover of the wagon and seal it properly. Remove earthing connections.
 - xx. Release the hand brake of the wagon.
 - xxi. Release all the wagons on the loading points in the lot.
 - xxii. Check the gross and net weight at the weigh bridge.
 - xxiii. Use loading arms for loading / unloading operations.

5.2.3.2 Unloading Operations

- i. Ascertain that the liquid discharge valve and the vapour valve within the tank wagon cover are in the closed position.
- ii. Open the port covers in the side of the dome shell, 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.
- iii. 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.
- iv. If the vapour discharge continues or if there is evidence of a liquid discharge, the valves should be re-tightened.
- v. 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.
- vi. 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.
- vii. 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.
- viii. After the vapour and liquid hoses have been connected and before any valve are opened, the valves on the tank wagon are crack opened in order to apply pressure to the hoses / loading arms as a test for leaks.
- ix. If any leak appears, the valve should be immediately closed and corrective measures applied.
- x. Recheck the lines and connections to make sure that they are connected correctly.
- xi. 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.
- xii. 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.
- xiii. 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.
- xiv. 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.
- xv. 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.
- xvi. 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.
- xvii. 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.
 - xviii. 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.
 - xix. 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.
 - xx. 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.
 - xxi. 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.
 - xxii. Remove bonding connections.
 - xxiii. Reverse or remove and replace the "Flammable" placard with "Dangerous - Empty" placard.
 - xxiv. Remove the "Stop – Tank Wagon Connected" sign and wheel blocks.
 - xxv. Any defect observed in the tank wagon should be noted on the appropriate forms and routed in accordance with acceptable procedure.
 - xxvi. Notify the railways in writing about release of wagon and ensure that it is removed from the siding promptly.
 - xxvii. Gauge the storage tanks, within the installation, which have received the LPG to determine that the liquid level is appropriate.
 - xxviii. In the event of LPG received on weight basis, the tank wagon may require weighing following the completion of the unloading operation.

5.2.4 Procedure for Degassing of LPG tank Wagons

The following sequence shall be followed:

- i. During degassing operation, all loading/unloading operations on that Spur shall be stopped. Earthing to be ensured even on the degassing bay before commencing the degassing.
- ii. Sampling valve should be opened and vapours allowed to escape fully.
- iii. The plugs of liquid and vapour reduction valves should be unscrewed and then valve be opened.
- iv. The method adopted to make the barrel free from LPG is to fill the barrel completely with water and allow to overflow for an hour. Pump out the water after 24 hours.
- v. Remove the manhole cover. In no case the heating of studs/bolts shall be adopted to open them. If required, rust remover solution shall be used.
- vi. Check thoroughly for presence of LPG vapours inside by explosivemeter. Repeat the procedure if explosivemeter shows presence of vapour inside.
- vii. Ensure that the barrel is completely dry in case water filling or steam purging method of degassing is adopted.
- viii. A safety instruction checklist should be exhibited at the degassing station containing all relevant points in the degassing procedure.
- ix. Degassing operation should be discontinued at the approach of thunder storm and all valves manhole covers and hoses disconnected to make the wagon ready for removal.
- x. Disposal of sludge from the LPG wagons should be transported away from the siding in wet condition and disposed of in safe manner.

ANNEXURE – I

CHECKLIST FOR UNLOADING OF BULK LPG TANK TRUCKS

Checks required to be carried out before allowing entry of tank trucks inside licensed area.

- i. TT has suitable spark arrestor of make and design approved by CCE, Nagpur, properly welded to exhaust.
- ii. Carries 2 nos. 9 Kg. DCP extinguishers in easily accessible and removable position with
- iii. Truck No. date of checking and charging painted on it.
- iv. Quick closing manifold valve with lever indicating close and open status.
- v. No visible dent on the bullet.
- vi. Whether tyres fitted is in roadworthy condition.
- vii. All junction boxes are properly sealed.
- viii. Any loose electrical wiring/terminal.
- ix. Electrical wiring is insulated and provided with suitable over current protection.
- x. Truck is self starting.
- xi. Readily accessible master switch for switching off the engine is provided inside the cabin.
- xii. Leakage from any fittings or joints.

Checks required to be carried out before issuing loading memo (During the course of unloading operations)

- i. Height barrier provided as per specifications.
- ii. Fuel tank is protected by means of stout guard and fuel tank cap is locked.
- iii. Paint of bullet is not peeling off.
- iv. First aid kit is available.

Checks required to be carried out on random basis minimum one day, once in a month:

- i. Internals of fire extinguishers in good condition.
- ii. Carries TREM CARD, instructions booklet detailing instructions on handling emergencies enroute.
- iii. Carries route map.
- iv. Carries TERM card.
- v. Has valid CCE licence and authenticated copy of drawing.
- vi. Carries RTO permits.
- vii. RLW-ULW Licensed capacity.
- viii. Hazchem sign, name of contractor with address and telephone No. displayed prominently.
- ix. Bullet has no sign of external corrosion.
- x. Excess flow check valves are functioning.
- xi. Liquid/vapour lines are adequately anchored and are well protected by means of stout steel guard.
- xii. Liquid/vapour pipe lines are in single piece from excess flow check valve to discharge valves
- xiii. Safety fitting viz. safety valve, roto-gauge, pressure gauge and temperature gauge are adequately protected.
- xiv. Operative fittings like roto gauge, pressure gauge and temperature gauge are operational.

General :

Following shall be available in Tank Truck :

- i. Tools for all fittings.

- ii. 4 Nos. caution sign board with luminous paint for stopping traffic in case of any emergency.
- iii. Based on the nature of defects either all the deficiencies should be got corrected at the unloading location itself or the tanker should be allowed to get the repairs done enroute and submit the details at loading location.
- iv.

Schedule-1E

5.0 Bottling Operations

5.1 Receipt & Segregation of LPG Cylinders

- i. Cylinders shall be received in capped condition. Cylinder shall conform to IS:3196 Part I.
- ii. All cylinders received should be verified against valid documents and the actual receipt should be tallied with the details on the relevant documents and the shortages or any other shortcomings should be endorsed and certified on the body of the document.
- iii. All new cylinders received shall be supported by test certificates issued by BIS.
- iv. The defective returns from the distributors/end users shall be supported by a certificate providing description of the defects. Such cylinders shall be segregated for further corrective action.
- v. Purged cylinders shall be unloaded in upright condition and use of telescopic conveyors should be used for the purpose. Purged cylinders should not be rolled on the belly.

5.2 VISUAL INSPECTION/SEGREGATION

On line detailed visual inspection shall be carried out during receipt/unloading of cylinders at Plant in line with IS 15966.

5.2.1 Based on visual inspection, cylinders shall be segregated as under :

- i. Cylinders due for statutory testing.
- ii. Under-filled cylinders received from the distributors/end users, duly tagged and certified for further correction.
- iii. Leaky / defective cylinders received from the distributors/consumer duly tagged.
- iv. Spurious cylinders for investigation/scraping.
- v. Cylinders found unfit for filling (beyond repairs) on visual inspection (e.g. heavily rusted or heavily dented etc. (for degassing, de-shaping and disposal as scrap).
- vi. Cylinders found defective, but repairable such as
- vii. Cylinders having defective valves.
- viii. Cylinders having broken / bent foot rings / valve protection rings (to be segregated for cold / hot repairs depending upon the condition and those found unfit after close examination, are rejected as unserviceable).
- ix. Cylinders owned by Other Marketing Companies (OMC), wrongly mixed with receiving company's cylinders (to be segregated for further action as per receiving Company's Policies).
- x. Empty cylinders fit for filling.
- xi. Cylinders to be checked physically for presence of O ring. New O ring to be provided, if O ring is missing in cylinders.

5.2.2 Rejection criteria for physical and material defects on the cylinder shall be per IS 15966

5.2.3 Reasons for leaky/defective cylinders received from the distributors should be verified from the tag attached to the cylinder. These cylinders should be corrected.

5.2.4 New cylinders or cylinders received from statutory testing plants or hot repair plants or any cylinder which has undergone pneumatic test shall be purged as per Purging Procedure.

5.2.5 Cylinders due for statutory testing / hot repairs shall not be taken up for filling but sent to testing plant.

5.2.6 Cylinders without proper markings or without serial number shall not be taken up for filling and should be declared as spurious.

5.3 FILLING OF CYLINDERS

- i. The cylinders are passed through online washing and drying unit for external cleaning before filling.
- ii. Safety cap of the cylinder shall be removed only after the cylinder passes through a washing and drying unit as the entry of the water inside may damage the internals of the valve.
- iii. Cylinder shall be introduced to the filling machine only after removal of safety cap.
- iv. O' Ring (joint packing) shall be present and there is no apparent damage to valve. Same shall be checked before cylinder introduction into the filling machine
- v. It shall be ensured that all earthing and bonding connections of filling head, filling machine frame etc. are proper and there is no LPG leakage from filling machine or filling head.
- vi. It shall be ensured that vapour extraction system is switched on before start of filling operations. Where Cylinders are to be filled at carousel, vapour extraction blowers should be interlocked with the carousel rotation to ensure that carousel cannot be rotated without switching on of the vapour extraction blowers
- vii. bypassing of safety interlocks, fire water system, gas detection system, vapour extraction system and heat detection system shall not be permitted unless authorised by Location In-Charge in writing with proper justification and alternate mitigation measures are in place.

5.4 TARE WEIGHT MARKING

- i. Tare weight stenciling shall be legible and prominent on the cylinder.
- ii. Tare weight the new cylinders received at the plant shall be checked for their tare weights marked / stenciled on the cylinder. In case discrepancies are observed in a particular lot, the lot should be kept segregated for further corrective action.

5.5 FILLING OPERATION

Filling of cylinders are under taken either on Carousel or on Unit Filling Machine (UFM). All cylinders shall be filled on gross weight basis on filling machine

- i. Cylinder shall be introduced in the carousel or unit filling machine.
- ii. Filling head is fixed either manually or automatically on to the valve.
- iii. Tare weight of the cylinder shall be set/transferred to filling machine where the cylinder is to be filled.
- iv. After introduction of cylinder on filling machine LPG shall be filled into the cylinder through a filling head connected to LPG supply source.
- v. The filling pressure should not exceed maximum working pressure of cylinder i.e. 16.9 kg/cm² at 65 degree C.
- vi. When the gross weight (Tare weight + Net weight of LPG) reaches the targeted weight, the filling shall stop and filling head shall be disconnected from the cylinder.
- vii. After filling the cylinder shall be removed from the filling machine

5.6 CHECK WEIGHING-POST FILLING OPERATION / INSPECTION

- i. All filled cylinders coming out of the carousel shall be weighed for ensuring 100% check weighing.
- ii. Accuracy of the check scale shall be verified by using standard weights at the beginning of the shift and subsequently at suitable intervals
- iii. Maximum permissible errors on net quantity declared by weight shall be in accordance with the Legal Metrology(Packaged Commodities) Rules 2011 and its amendment/revision thereof.

- iv. On check weighing, the cylinders that do not meet the norms under Legal Metrology Rules as stated above shall be segregated for correction of the net weight quantity of LPG in the cylinder
- v. Cylinders meeting the net weight specifications of Legal Metrology Rules shall be proceed for further checks for valve defect
- vi. Daily record for underweight and overweight cylinders generated shall be maintained

5.7 LEAK TEST- VALVE , O-RING, BUNG & BODY DEFECTS

Checks shall be carried out for the following categories of leaks.

- i. Leak detecting equipment for valve / O ring shall be calibrated to detect leakage beyond 0.5 gm/hr.
- ii. Defective 'O'rings identified, shall be replaced with new "O" ring and again checked with O-Ring leak detector before despatch.
- iii. Valve Leak cylinders shall be sent for replacement of with new valves which shall be re-checked for valve leak before despatch
- iv. Cylinders having leaks through valve -bung threads shall be segregated and sent for valve replacement. If bung is damaged and leak re-surfaces after valve replacement, such cylinders shall be segregated, valves shall be retrieved after product evacuation and cylinder shall be degassed and scrapped
- v. Cylinders without valve or O-Ring leaks shall be proceed for futher checks for body and bung leak at water bath. Cylinder shall be capped prior to dipping in test bath water.
- vi. Leakage from the cylinder body, either from the parent metal or from the weld joints is identified at water bath and such cylinders are sent for evacuation, valve removal and deshaped for scapping
- vii. Daily record of leaky cylinders generated should be maintained at the plant
- viii. Suitable tags / markers should be used to identify different categories of leaky cylinders.
- ix. Valve defective cylinders shall be capped with safety caps until they are evacuated.
- x. Body leak and bung leak cylinders shall be evacuated on priority immediately.
- xi. Only those cylinders found passing all above weight and leak test checks shall be processed further for sealing

5.8 SEALING AND DESPATCH OF CYLINDERS

- i. Cylinders shall be sealed with PVC seal or Aluminium seal. Seal shall have identification mark of oil company, preferably name of plant and period of filling.
- ii. The sound filled cylinders that pass through all quality control checks, are then sealed at the sealing unit. All sealed cylinders ready for despatch shall meet the various marking norms as laid out in Legal Metrology (Packaged Commodity) Rules, 2011 with its amendments/revisions thereof.
- iii. The cylinders can be directly loaded to the stack trucks and dispatched or can be sent to filled cylinder storage shed for loading into stack trucks at a later stage.

5.9 AUXILLARY OPERATIONS

5.9.1 Purging

Cylinders received from manufactures or after statutory testing / hot repairs shall be purged before filling to purge air from the cylinders and introduce LPG in cylinders.

In purging, the air is sucked from the cylinder by means of a vacuum pump and the pressure inside the cylinder comes down below the atmospheric pressure $0.35 \text{ kg /cm}^2 \text{ absolute} = (-)0.65 \text{ kg/cm}^2(\text{g})$. The cylinder then immediately filled with LPG vapour to bring it back to at least

atmospheric pressure (i.e. a pressure of 1.035 kg / cm²) but not above working pressure of cylinder i.e. 16.9 kgf/cm² at 65 degree C. In this process, the entire cylinder space is occupied with LPG vapour.

5.9.2 Evacuation

- i. Before evacuation it must be ensured that bonding and earthing connections of the filling gun and equipment are proper to dissipate any static charge that may develop due to flow of LPG
- ii. Evacuation procedure will depend on the type of equipment provided. Therefore, the Manufacturer's manual should be referred for operating instructions.
- iii. Cylinders profusely leaking and over-filled cylinders shall be evacuated first. All cylinders with valve leak shall remain capped till evacuation and valve change.
- iv. After product evacuation, the cylinder shall be depressurized to pressure near atmospheric pressure by cold flaring the residual pressure through a flare line extending 1.5 m above eve of the shed.
- v. Provision for evacuation of all type of cylinders being handled shall be available at the Plant.
- vi. Provision shall also be made for evacuation of valve pin stuck/broken LPG Cylinders through use of suitable adapter.
- vii. All LPG has to be evacuated into the LPG vessel in closed loop and there shall not be any vented out of LPG at the Plant floor

5.9.3 Cold Repair of Cylinders

Cylinder having defective valve and with bung leak shall have to undergo valve removal and valve re-fixing operation.

The valve leak and bung leak cylinders are repaired as under :

- i. on-line valve changing machine shall be used to change the valve without evacuation as per the procedure laid out in the operating manual of the manufacturer. Alternatively, cylinder shall be evacuated of its product and thereafter depressurized to near atmospheric pressure through cold flare before opening the defective valve.
- ii. Before fixing the valve suitable jointing compound shall be used. Jointing compound shall be compatible with LPG, water and metallurgy of cylinders and valves
- iii. The valve shall be tightened to a torque of 20 Kgf-m +/- 2 Kgf-m by the valve screw / unscrew machine where the specified torque level is pre-set.
- iv. The torque limit (20 Kg-M. +/- 2Kg-M.) set on screw / unscrew machine shall be verified by using a torque wrench for the machine's correct setting
- v. The cylinders identified for the bung thread defects shall be segregated, recorded and further declared as scrap.
- vi. Cylinders marked for valve replacement and valve removal alone shall have suitable identification mark to prevent mixup and ensure proper segregation.

5.9.4 De-gassing of Cylinders

If the cylinders are identified as unserviceable during the operation, the same shall be degassed after evacuation. The unserviceable cylinders shall be evacuated and de-pressurized to atmospheric pressure and the valves are removed from the cylinders after de-depressurizing. The cylinder shall be filled fully with water and allowed to overflow and thereafter shall be emptied out by inverting.

5.9.5 Defective Cylinders

Cylinders with defects like, foot-ring (bent/broken), valve protection ring (bent / broken), body damage (dent / cut / pitting) etc., should be segregated for cold / hot repairs depending upon the condition.

5.9.6 De-shaping / Disposal of Cylinders

Any cylinder which fails to pass examination as per IS: 16054 or IS: 15966 or test or which loses in its tare weight by over 5 per cent or which for any other defect is found to be unsafe for use , shall not be filled with any compressed gas and shall be destroyed by flattening it as a whole or after being cut into pieces in such a manner that the pieces cannot again be joined together by welding or otherwise to form a cylinder. Plant must maintain record of cylinders which are scrapped for disposal with details line manufacturer's name, Serial No., Original test date, age profile etc.

5.10 Handling and Storage of Cylinders

- i. Handling and storage of LPG cylinders, whether empty or full, are covered under the Gas Cylinder Rules 2004 and its subsequent amendments. Therefore, all applicable rules and regulation shall be complied with.
- ii. The owner of a cylinder shall keep for the life of each cylinder, a record containing the following information regarding each cylinder, namely:-
 - a. Cylinder manufacturer's name and the rotation number;
 - b. The specification number to which the cylinder is manufactured;
 - c. The original hydrostatic test or hydrostatic stretch
 - d. Cylinder manufacturer's test and inspection certificates;
 - e. Number and date of letter of approval granted by the Chief Controller.
- iii. Purged cylinders shall be handled in the vertical position at all stages of operations and handling.
- iv. LPG cylinders shall not be dropped, rolled on body and shall not be subjected to any violent contact with any other cylinder or object cylinder shall be moved by rolling on its foot ring or on conveyors or hand trolleys.
- v. Belly rolling of purged cylinders either filled or empty is strictly prohibited.
- vi. No attempt shall be made to heat the cylinders for normal operation.
- vii. The safety cap shall not be removed from the cylinder valve until the cylinder is taken up for filling or any other operation. The same should be refitted as soon as the operation is over. Safety cap shall be fitted while the cylinders are passed through the washing unit and water bath.
- viii. Cylinders shall never be thrown from a height even though sufficient padding on the floor is available.
- ix. Any cylinder having body leak, bung leak, bulge, fire ravaged or spurious shall be evacuated immediately
- x. Cylinders requiring repairs other than valve leak shall be degassed for repairs.
- xi. All above cylinders shall be clearly identified, with markers, to their nature of defects and shall be kept capped during storage

5.10.1 Handling during Loading and Unloading Operations

- i. Cylinders shall be loaded/unloaded without dropping them or subjecting them to any excessive impact.
- ii. Telescopic conveyors shall be used for this purpose to extent possible,
- iii. Loading Operations – Filled cylinders or empty cylinders in use shall be stacked in vertical position in stake trucks upto a maximum height of 2m that the maximum height and overall gross weight of

the truck does not exceed the Registered Laden Weight (RLW) fixed by Regional Transport Officer (RTO) or any other local road restrictions en route.

- iv. Unloading operations of filled / empty cylinders : Cylinders should be handled in such a way, avoiding dropping or subjecting them to shocks or rolling inside the truck or on the ground.

5.10.2 Storage of Cylinders

- i. Valves of all cylinders stored in the plant shall be kept capped with safety caps.
- ii. LPG cylinders should be stored in a covered shed or a godown, duly licensed by PESO in earmarked cylinder stacks.
- iii. The storage area should be cool, dry, well ventilated, covered and away from any potential source of heat. The area should also be easily accessible
- iv. The quantity of empty serviceable cylinders and filled cylinders stored in the sheds at any point of time should not exceed the designed capacity of the area of the shed. Inventory of the filled cylinders shall not exceed the licensed capacity mentioned in the PESO license There should be different storage areas (stack marks) earmarked for different categories of cylinders to prevent mixup.
- v. All the filled cylinders shall be stacked vertically with the exception of body leak cylinders which may be temporarily laid horizontally. However, this should not be done in the case of cylinders having leakage through bungs or valves which shall be kept vertically. Such cylinders, however, shall be evacuated on priority.
- vi. For the cylinders segregated as scrap, the valves should be removed after de-pressurizing and then degassed
- vii. Cylinders either filled or empty should be stacked only two high.
- viii. In case removal of valve without immediate replacement, the bung hole must be covered with a suitable plug taking all precautions to ensure that the internal threads of the bung are not damaged, due to corrosion.
- ix. The cylinders shall be stored in such away that each cylinder is easily accessible at all times so that any leaky cylinder can be detected easily and speedily removed from the stack for corrective action.
 - a. To achieve this, the stack should comprise of small lots of 4 rows with 25 cylinders in each row in two high. Minimum access pathway of one metre wide must be maintained on both sides of the 4 rows and 2 meters after every 5 such lots.
 - b. After each length of 25 cylinders there must be a passage of 2 meters.
 - c. The stack areas must be properly marked/painted on the flooring. In addition two metres clear distance should be maintained from edges of the shed, edges of conveyer and from the equipment.
 - d. Each stack should be clearly marked with sign boards indicating the type of cylinders in the stack.
- x. All leaky cylinders shall be corrected or evacuated before the end of the working hours.
- xi. Minimum distance of 15 metres from cylinder loading area and minimum distance of 10 metres from filling point shall be observed for all filled cylinders stack.
- xii. Different type of cylinders shall not be mixed in single stack. Defective cylinders of different types shall be stacked separately.

5.10.3 Handling of Ethyl mercaptan

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.

The empty containers if ethyl mercaptan shall be disposed as per MSIHC Rules 1989.

Schedule-1F

6.0 OPERATION, MAINTENANCE AND INSPECTION

Each facility shall have a documented operating manual including operations, maintenance, training procedures, purging and record keeping based on experience and conditions under which the LPG facilities is operated, and a documented maintenance manual.

Each facility shall have written operating, maintenance, and training procedures based on experience, knowledge of similar facilities, and conditions under which they will be operated.

6.1 Basic Requirements

Each facility shall meet the following requirements:

- i. Have written procedures covering operation, maintenance, and training.
- ii. Keep up-to-date drawings of plant equipment, showing all revisions made after installation.
- iii. Revise the plans and procedures as operating conditions or facility equipment require.
- iv. Establish a written emergency plan.
- v. Establish liaison with appropriate local authorities such as police, fire department, or hospitals and inform them of the emergency plans and their role in emergency situations.
- vi. Analyze and document all safety-related malfunctions and incidents for the purpose of determining their causes and preventing the possibility of recurrence.
- vii. As per maintenance philosophy, the activities should be identified that would be contracted to third party contractors for maintenance and support.
- viii. The activity supervisors shall be identified according to the level of supervision required.
- ix. These supervisors are given Safe supervisor training by designated staff and then they are put on the job.
- x. The contractors staff shall be engaged in toolbox talk given on relevant topics are held with the Contract holders and owners.
- xi. OEM service engineers are involved in critical overhauls for better quality assurance and for first time activities.

6.2 The operating manual for LPG storage, handling and bottling facilities shall include standard operating procedures shall include procedures for the following:

- i. Bulk handling, bottling operations, maintenance, inspection, fire protection facilities
- ii. Determining the existence of any abnormal conditions, and the response to these conditions in the plant.
- iii. The safe transfer of LPG and hazardous fluids, including prevention of overfilling of vessels
- iv. for the proper startup and shutdown of all components
- v. to ensure that each control system is adjusted to operate within its design limits
- vi. For monitoring operations.
- vii. Emergency preparedness and handling

6.3 The operating procedures manual shall be accessible to all plant personnel and shall be kept readily available in the operating control room. The operating manual shall be updated when there are changes in equipment or procedures. All LPG plant components shall be operated in accordance with the standard operating procedures as per operating manual.

- 6.4 The periodic inspections and tests shall be carried out in accordance with generally accepted engineering practice / recommendations of Original Equipment Manufacturer to ensure that each component is in good operating condition.
- 6.5 Each facility operator shall ensure that when a component is served by a single safety device only and the safety device is taken out of service for maintenance or repair, the component is also taken out of service.
- 6.6 It shall ensure that where the operation of a component that is taken out of service could cause a hazardous condition, a tag bearing the words "Do Not Operate," or the equivalent thereto, is attached to the controls of the component. Wherever possible, the component shall be locked out.
- 6.7 Stop valves for isolating pressure shall be locked or sealed open. These shall not be operated except by an authorized person.

7.0 Maintenance Manual

- 7.1 Each facility operator shall prepare a written manual that sets out an inspection and maintenance program for each component that is used in its facility.
- 7.2 The maintenance manual for facility components shall include the following:
 - a. The manner of carrying out and the frequency of the inspections and tests as specified.
 - b. All procedures to be followed during repairs on a component that is operating while it is being repaired to ensure the safety of persons and property at the facility
 - c. Each entity shall conduct its maintenance program in accordance with its written manual for facility components.

In addition, the history card of all critical equipments, instruments and systems shall be maintained.

7.3 Maintenance Workflow

- i. The objective of the work flow is to provide an integrated proactive and reactive work plan so that repair work is minimized and reliability and availability are optimized. Maintenance execution begins with the receipt of a work request and concludes with the close out of the work order.
- ii. Correct prioritization of work and proactively preparing activities through high quality work preparation, combined with accurate scheduling, will lead to a more stable work environment. This will reduce deferrals and breakdowns, improve integrity and safety, and provide additional job satisfaction and ownership to technicians.
- iii. The management and control of day-to-day maintenance on all process units and utilities of a site is to provide:
 - a) Support for a maintenance strategy based on doing programmed maintenance on time
 - b) Safe, healthy and environmentally sound execution of maintenance work,
 - c) Availability of equipment
 - d) Business efficiency
- iv. The designated person for issue of work permit shall verify the execution of preparation activities before issue of the work permit.
- v. Maintenance work shall be undertaken in accordance with work permit requirements.
- vi. Inspection personnel should be notified on time at which moment witness or hold points set.
- vii. A verification of the HSE requirements should be carried as the maintenance execution includes HSE review and a toolbox talk as outlined in the work permit or work pack.
- viii. The maintenance supervisor should ensure that a toolbox talk is held before work commences.

- ix. Upon completion of the job, the job site should be left safe, clean and tidy. Any excess materials should be returned to the stores and tools should be cleaned and returned to the workshop or put away in the correct storage place.
- x. On a daily basis, the progress of work should be reported. If the work is not completed, it should continue the next working day after taking requisite permission and approval from work permit issuing personnel.
- xi. The work permit duly signed shall be returned to issuing authority on completion of job, removal of all material from site and handing over of facilities to user etc.

7.4 Maintenance Strategy

- i. The facilities should be designed for minimum maintenance intervention.
- ii. These maintenance requirements should be clearly defined and further optimized based on maintenance strategy reviews using tools such as reliability centred maintenance, Risk Based Inspection and Risk Assessment Matrix (RAM), after detailed equipment specifications are known.
- iii. The criticality of the equipment shall be taken into account during the maintenance strategy selection.
- iv. Appropriate diagnostic tools and staff competencies shall be provided to facilitate rapid fault finding and rectification and also to provide opportunistic maintenance during outages.
- v. Maintenance strategies shall maximize non-intrusive & on line data acquisition to support planning & analysis.
- vi. Special Critical Equipments shall have OEM defined performance standards which shall be periodically tested and verified.
- vii. Structural and pipeline survey and painting shall be done on a regular basis.

7.5 The entity shall prepare a written plan for preventive maintenance covering the scope, resources, periodicity etc. The corrective measures should include the preventive maintenance, scheduling, execution and closure.

7.6 Each facility should have well defined system for identification of spare part, rationalization and optimization to minimize any supply chain/logistics constraints & risks.

7.7 Well defined Roles & Responsibilities matrix should be available made for each machine as well as activity to be carried out in the workshop. The procedure for Audits and Review of the workshop shall be documented and adhered to.

8.0 INSPECTION

- i. Each facility shall have written inspection, testing and commissioning program in place. Inspection shall include before commissioning during installation as well as during regular operation of the LPG facilities.
- ii. All documents related to design, installation procedure of the respective vendors and the manufacturer's instruction for pre-commissioning and commissioning of the equipment, systems, instruments, control systems etc. shall be properly stored and followed.
- iii. Inspection shall cover the review of test protocols and acceptance criteria that these are in accordance with the protocols and acceptance criteria specified in line with OEM specific requirements
- iv. Inspection shall cover that the equipment is installed in accordance with design, and any deviations documented and approved.
- v. All safety systems are installed inspected and tested as per design /OEM requirement.
- vi. Inspection shall cover that all safety devices are installed and are in working condition as per the design/ OEM requirements.
- vii. Inspection shall cover the verification of various safety interlocks, ESD provided in the design.
- viii. Inspection shall cover the adequacy of sealing systems.

- ix. Inspection shall cover the electrical systems, check its integrity, earthing resistance, bonding etc.
- x. Inspection shall cover the integrity of mechanical and rotating equipment.
- xi. The integrity and efficacy of gas detection, fire protection and fighting system, connected equipments shall be covered in the inspection.
- xii. Inspection shall cover the efficacy of corrosion system.
- xiii. Inspection shall cover and review the mechanical completion records that the PSVs are of the correct type and sizing as per the P&IDs/data sheets.
- xiv. Inspection shall cover location of inlet pipe-work to relieving devices in relation to potential restrictions (e.g. above liquid levels, vessel internals, etc.)
- xv. Inspection shall cover and review P&IDs to check the position of isolation valves for relieving devices, their capacities. Inspection to confirm by review of all vent locations (atmospheric vent from drums or equipment seals) that they vent to safe location and in the event of liquid carry over will not discharge to areas that may cause a hazard to personnel.
- xvi. Inspection shall review the area classification layouts and associated studies to confirm that all possible hazards have been appropriately considered (including possible migration), the hazardous area drawings correctly account for the actual location of the sources of release the hazardous areas have been appropriately defined.
- xvii. Inspection shall cover that all ESD devices move to their safe condition on loss of system output, hydraulic power or instrument air. All ESD Valves and actuators shall remain functional following an explosion or under fire conditions for a sufficient time period to perform their intended function.
- xviii. The maximum allowable back pressure and minimum design temperature of the relief system shall be checked for suitability for the highest identified flow rate.
- xix. Control System shall include all status monitoring and actions to and from the Control Rooms.
- xx. Inspection to cover the escape and evacuation passages.
- xxi. Inspection shall cover the emergency communication system for its effectiveness during emergency situations.

Schedule-1G

8.0 Safety Management System

8.1 The organization should establish a safety management system which shall be an integral part of the overall management system. Safety Management System (SMS) should be based on PDCA (Plan, Do, Check and Act) cycle which comprises of:

- i) Policy setting – includes policy, corporate acceptance of responsibility, objectives, requirements, strategies;
- ii) Organization – includes structure, accountability and safety culture, involvement of the workforce, systems for performing risk assessment;
- iii) Planning and execution – includes operational standards and procedures for controlling risks, permit to work, competence and training, selection & control over contractors, management of change, planning & control for emergencies and occupational health;
- iv) Measuring and evaluating – includes active monitoring, recording and investigation of incidents / accidents, auditing, handling of non-conformities;
- v) Continuous improvement – includes review and application of the lessons learnt. Safety management system should not degenerate into a paper exercise only, conducted solely to meet regulatory requirements.

8.2 Elements of Safety Management system

Safety management system should include at least the following basic elements:

- i) **Safety Organization-** Leadership and Management Commitment should be clearly visible in the SMS. Management should develop and endorse a written description of the company's safety and environmental policies and organizational structure that define responsibilities, authorities, and lines of communication required to implement the management program. Management should review the safety and environmental management program to determine if it continues to be suitable, adequate and effective at predetermined frequency. The management review should address the possible need for changes to policy, objectives, and other elements of the program in light of program audit results, changing circumstances and the commitment to continual improvement. Observations, conclusions and recommendations of management review should be documented.
- ii) **Safety Information-** Comprehensive safety and environmental information for the facility, which include documentation on process, mechanical and facility design, should be developed and maintained throughout the life of the facility.
- iii) **Process Hazard Analysis-**The purpose of Process Hazard Analysis (PHA) is to minimise the likelihood of the occurrence and the consequences of a dangerous substance release by identifying, evaluating and controlling the events that could lead to the release. Process hazards analysis should be performed for any facility to identify, evaluate, and reduce the likelihood and/or minimize the consequences of uncontrolled releases and other safety or environmental incidents. Human factors should also be considered in this analysis.

The process hazard analysis should be updated and revalidated by a team, having requisite back ground, at least every 5 years after the completion of initial process hazard analysis.

Recommendations resulting from the PHA should be completed before start-up for a new process or facility, or modification in existing facility.

- iv) **Operating Procedures-** Written down operating procedures shall be available describing tasks to be performed, data to be recorded, operating conditions to be maintained, samples to be collected and safety & health precautions to be taken for safe operation. Operating procedures should be based on process safety information so that all known hazards are taken care of. The human factors associated with format, content, and intended use should be considered to minimize the likelihood of procedural error.

The operating procedures shall provide plant specific instructions on what steps to be taken or followed while carrying out Startup, Normal operation, Temporary operation, Normal shut-down and Emergency operation and shut-down.

Manuals of operating procedures shall be made available to the employees. Training shall be imparted to the operators on operating procedures and should be certified as competent.

When changes are made in facilities, operating procedures should be reviewed as part of the management of change procedure. In addition, operating procedures should be reviewed periodically to verify that they reflect current and actual operating practices. Operating manuals should be certified as updated by authorized / competent person every year.

- v) **Safe Work Practices** - The entity shall maintain procedures that address safe work practices to ensure the safe conduct of operating, maintenance, and emergency response activities and the control of materials that impact safety. These safe work practices may apply to multiple locations and will normally be in written form (safety manual, safety standards, work rules, etc.) but site-specific work practices shall be prepared and followed. In cases where an employee believes that following a procedure will cause an unsafe condition, one shall have authority to stop work and get permission to deviate. Deviations should be documented for future analysis.
- vi) **Training-** The training program shall establish and implement programs so that all personnel are trained to work safely and are aware of environmental considerations, in accordance with their duties and responsibilities.

Training shall address the operating procedures, the safe work practices, and the emergency response and control measures. Any change in facilities that requires new or modification of existing operating procedures may require training for the safe implementation of those procedures. Training should be provided by qualified instructors and documented.

The training provided to contract personnel should include applicable site-specific safety and environmental procedures and rules pertaining to the facility and the applicable provisions of emergency action plans.

The entity should verify contractor training utilizing a variety of methods, which may include audits of the contractor's environmental, health and safety training programs; and operator observation of contractor work performance.

- vii) **Management of Change (MOC)** -There should be procedures to identify and control hazards associated with change and to maintain the accuracy of safety information. For each MOC, the operator shall identify the potential risks associated with the change and any required

approvals prior to the introduction of such changes. The types of changes that a MOC procedure addresses shall include:

- a) technical,
- b) physical,
- c) procedural, and
- d) organizational.

This procedure shall consider permanent or temporary changes. The process shall incorporate planning for the effects of the change for each of these situations. These procedures should cover the following:

- a) The process and mechanical design basis for the proposed change.
- b) An analysis of the safety, health, and environmental considerations involved in the proposed change, including, as appropriate, a hazards analysis.
- c) The necessary revisions of the operating procedures, safe work practices, and training program.
- d) Communication of the proposed change and the consequences of that change to appropriate personnel.
- e) The necessary revisions of the safety and environmental information.
- e) The duration of the change, if temporary.
- f) Required authorizations to effect the change.

- viii) **Contractors** -When selecting contractors, operators should obtain and evaluate information regarding a contractor's safety and environmental management policies and practices, and performance there under, and the contractor's procedures for selecting subcontractors. The entity shall communicate their safety and environmental management system expectations to contractors and identify any specific safety or environmental management requirements they have for contractors.

Interfacing of SMS of various entities (operator, contractor / service provider, subcontractor and third-party) should be ensured through a well written bridging document. Entity shall document the clear roles and responsibilities with its contractors.

- ix) **Assurance of quality and mechanical integrity of critical equipment**- Procedures should be in place and implemented so that critical equipment for any facility is designed, fabricated, installed, tested, inspected, monitored, and maintained in a manner consistent with appropriate service requirements, manufacturer's recommendations, or industry standards. Entity shall maintain inspection and testing procedures for safety-related equipment. Human factors should be considered, particularly regarding equipment accessibility for operation, maintenance and testing.
- x) **Pre-startup Safety Review**-Before a new or modified unit is started, a systematic check should be made to ensure that the construction and equipment are in accordance with specifications; operating procedures have been reviewed; hazards analysis recommendations have been considered, addressed and implemented; and personnel have been trained. It should be ensured that programs to address management of change are in place.
- xi) **Permit to Work (PTW) System**- PTW system is a formal written system used to control certain types of work which are identified as potentially hazardous. Essential features of permit-to-work systems are:
- clear identification of who may authorize particular jobs (and any limits to their authority) and who is responsible for specifying the necessary precautions;
 - training and instruction in the issue, use and closure of permits;

- monitoring and auditing to ensure that the system works as intended;
- clear identification of the types of work considered hazardous;
- clear and standardized identification of tasks, risk assessments, permitted task duration and supplemental or simultaneous activity and control measures.

xii) **Emergency Planning and Response-** A comprehensive Emergency Response and Disaster Management Plan (ERDMP) shall be developed in accordance to the Petroleum and Natural Gas Regulatory Board (Codes of Practices for Emergency Response and Disaster Management Plan (ERDMP)) Regulations, 2010. The copies of the ERDMP for the LNG facilities including jetty shall be maintained at each installation. The emergency response planning shall have clear written procedures for expected actions during anticipated emergencies. Emergency response plan shall include operational and procedural requirements for various emergency scenarios that are relevant for the installation.

The emergency procedures shall include, at a minimum, emergencies that are anticipated from an operating malfunction of any component of the LPG storage, handling and bottling facilities, personnel error, forces of nature, and activities carried on adjacent to the facilities.

- i. The emergency procedures shall include but not be limited to procedures for responding to controllable emergencies, including the following:
 - a. The notifying of personnel
 - b. The use of equipment that is appropriate for handling of the emergency
 - c. The shutdown or isolation of various portions of the equipment
 - d. Other steps to ensure that the escape of gas or liquid is promptly cut off or reduced as much as possible
- ii. The emergency procedures shall include procedures for recognizing an uncontrollable emergency and for taking action to achieve the following:
 - a. Minimize harm to the personnel at the LPG storage, handling and bottling facilities and to the public
 - b. Provide prompt notification of the emergency to the appropriate local officials, including the possible need to evacuate persons from the vicinity of the LPG storage, handling and bottling facilities
- iii. The emergency procedures shall include procedures for coordinating with local officials in the preparation of an emergency evacuation plan that sets forth the steps necessary to protect the public in the event of an emergency, including the following:
 - a. Quantity and location of fire equipment throughout the LPG storage, handling and bottling facilities.
 - b. Potential hazards at the LPG storage, handling and bottling facilities.
 - c. Communication and emergency-control capabilities at the LPG storage, handling and bottling facilities.

xiii) **Incident Investigation and Analysis-** Procedures for investigation of all incidents as per the Petroleum and Natural Gas Regulatory Board (Codes of Practices for Emergency Response and Disaster Management Plan (ERDMP)) Regulations, 2010 shall be developed. Incident investigations should be initiated as promptly as possible, considering the necessity of securing the incident scene and protecting people and the environment. The intent of the investigation should be to learn from the incident and help prevent similar incidents. A corrective action program should be established based on the findings of the investigation to prevent recurrence.

- xiv) **Compliance Audit-** Safety Audits are the periodic examination of the functioning of safety system. It gives an idea about how effectively the safety system is implemented and how they are being accomplished. It is the feed back mechanism that provides management with the status and measurement of effectiveness of the various safety system elements and activities and leads to the appropriate control over these efforts.

The audit program and procedures should cover:

- a) The activities and areas to be considered in audits
- b) The frequency of audits
- c) The audit team
- d) How audits will be conducted
- e) Audit Reporting

The findings and conclusions of the audit should be provided to the management. Management should establish a system to determine and document the appropriate response to the findings and to assure satisfactory resolution. The audit report should be retained at least until the completion of the next audit.

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Schedule-1H

9.0 FIRE PROTECTION FACILITIES

9.1 GENERAL

LPG Installations shall have well defined in-built fire prevention and protection system to mitigate any exigency. The requirements of fire prevention and protection system shall be as under :

9.2 DESIGN CRITERIA

- (i) The single largest fire risk shall be considered.
- (ii) All LPG storage Vessels, Cylinder Storage/ Filling/ Repair Sheds, LPG Pump / compressor Houses, remote operating valves /motor operating valves on LPG lines Bulk Lorry and Tank Wagon Gantries shall be fully covered by medium velocity water spray system.
- (iii) Fire Protection Facilities shall have fire fighting access, means of escape in case of fire and also segregation of facilities so that the adjacent facilities are not endangered during the fire.
- (iv) Heat Detectors for detection of fire for automatic actuation of medium velocity water sprinkler system shall be provided. The QB/EP detectors shall be placed directly overhead or inside the hazard. In areas without specific hazard, detectors shall be placed evenly across the ceiling or with maximum spacing of 3 meter inside the shed. Any other detectors if provided shall comply with the design requirements.

9.3 FLOW RATE DESIGN

The Fire Water pumping requirement for medium velocity spray system shall be calculated based on minimum spray density as 10.2 LPM/Sq.M of the exposed surface or area to be cooled, in case of LPG Pump/ compressor it shall be 20.4 LPM/Sq.M .

a. Storage Vessels

MV sprinkler system with automatic heat detection having remote/ local operated Deluge valve with spray density of Minimum 10.2 LPM/ Sq.M shall be provided on all above ground storage vessels.

For water flow calculations aggregate surface area of all vessels within distance of 30 Mts. from the periphery of the affected LPG vessel shall also be considered as single risk .

b) Sheds

MV sprinkler system with automatic heat detection having remote/ local operated Deluge valve with spray density of minimum 10.2 LPM/Sq.M shall be provided in the entire shed including the loading / unloading fingers.

For spray water calculations, the shed can be divided into suitable number of zones, each served by independent deluge system. The adjacent zones shall be operative around the zone under fire and the same shall be considered as a single risk. The width of a zone shall not be less than 10 meter except of the zone on either end of the shed. As there is no storage of cylinders in the loading / unloading fingers, spray system can be taken as separate zone with independent deluge valve to optimize the fire water requirement .

c) LPG Pump / Compressor House

MV sprinkler system with automatic heat detection having remote/ local operated Deluge valve with spray density of Minimum 20.4 LPM/Sq.M shall be provided.

The entire pump /compressor house shall either be considered as single risk area or can be divided into suitable number of zones with minimum 10 meter width.

d) Tank Lorry Gantry

In case of Tank Lorry Gantry, automatic detection of heat for automatic actuation of MV sprinkler system having remote/local operated deluge valve with spray density 10.2 LPM/Sq.M of surface area shall be provided. A maximum of 8 bays shall be considered as single risk area. In addition to the tank lorry surface, MV spray system shall effectively cover the tyres, manifold and dish ends of various size of tank lorries. There shall be atleast 3 tiers of MV sprinkler system and heat detectors uniformly cool the top , middle and the bottom of the tank lorry.

e) Tank Wagon Gantry

MV sprinkler system with automatic heat detection having remote/ local operated deluge valve with effective spray density of 10.2 LPM/Sq.M shall be provided. The gantry can be divided into suitable number of zones with minimum zone length of 30 meters and adjacent zones shall operate around zone under fire and same shall be considered as single risk. The spray system shall cover tank wagons surface on either side of tank wagon gantry atleast in two tiers as well as the associated LPG pipelines in the gantry.

The fire water system in the plant shall be designed to meet the highest fire water flow requirement of a single largest risk of any of the above cases at a time plus 288 Cu.M/Hr. for operating 2 Nos. Fire water Monitors/Supplementary Hose requirements.

9.4 FIRE WATER SYSTEM DESIGN

- (i) The Fire Water pressure system shall be designed for a minimum residual pressure of 7.0 kg/cm² g at the hydraulically remotest place of application in the plant.
- (ii) A fire water ring main shall be provided all around perimeter of the LPG Plant facilities with hydrants/ monitors spaced at intervals not exceeding 30 M when measured aerially. Fire hydrants and monitors shall not be installed within 15 Meters from the facilities/ equipment to be protected.
- (iii) Fire hydrant network shall be in closed loops to ensure multidirectional flow in the system. Isolation valves shall be provided to enable isolation of any section of the network without affecting the flow in the rest. The isolation valves shall be located normally near the loop junction. Additional isolation valves shall be provided in the segments where, the length of the segment exceeds 300 Mts.

9.5 FIRE WATER STORAGE

- (i) Water for the hydrant service shall be stored in any easily accessible surface or underground lined reservoir or above ground tanks of steel, concrete or masonry. The effective capacity of the reservoir above the level of suction point shall be minimum 4 hours aggregate working

capacity of pumps. Where make up water supply system is 50% or more this storage capacity may be reduced to 3 hours aggregate rated capacity of pumps.

- (ii) Large natural reservoirs having water capacity exceeding 10 times the aggregate water requirement of fire pumps may be left unlined.
- (iii) Storage tank/ reservoir shall be in two inter connected compartments to facilitate cleaning and repairs. In case of steel tanks there shall be a minimum of two tanks.

9.6 FIRE WATER PUMPS

- (i) Centrifugal type fire water pumps shall be installed to meet the designed fire water flow rate and head. These pumps shall have a flooded suction, alternatively suitable arrangement for auto priming shall be provided.
- (ii) The system pressure has to be maintained at 7 kg/cm²g at the hydraulically farthest end of the hydrant system with the help of Jockey Pump operating automatically.
- (iii) The Jockey Pump shall start-stop automatically actuated by pressure switches.
- (iv) A standby jockey pump shall be provided if the number of hydrant points is more than 100. One monitor shall be considered as equivalent to 4 hydrant points.
- (v) The fire water pump(s) including the stand by pump(s) shall be diesel engine driven. The pumps shall be capable of discharging 150% of its rated discharge at a minimum of 65% of the rated head. Each engine shall have an independent fuel tank of suitable size for 6 Hrs. continuous running.
- (vi) In refineries / gas processing plants/LPG Plants, where reliable source of electric power is available electrical driven centrifugal pumps can be used upto a maximum of 50 % of total pumping capacity. Power supply to the pump motors should be from two separate feeders.
- (vii) At least one standby fire water pump shall be provided upto 2 nos of main pumps For main pumps 3 and more, minimum two standby pumps of the same capacity as the main pumps shall be provided.
- (viii) Fire water pumps shall be used exclusively for Fire protection and prevention purpose only.
- (ix) Suction and discharge valves of fire water pump shall be kept open all the time.
- (x) The fire water pumps shall be provided with automatic starting facilities which shall function with specified logic even if initial pump does not start or having started , fails to build up the required pressure in the fire water ring main system within 20 seconds.

9.7 FIRE HYDRANT NETWORK

- i) Fire hydrant ring main shall be laid above ground ensuring that :
 - a) Pipe line shall be laid at a height of 300 mm to 400mm above finished ground level.
 - b) The mains shall be supported at regular intervals not exceeding 6 meters or as per design approved.
 - c) The system for above ground portion shall be analysed for flexibility against thermal expansion and necessary expansion loops where called for shall be provided.
- ii) However the ring main may be laid underground at the following places :
 - a) Road crossings.
 - b) Places where above ground piping is likely to cause obstruction to operation and vehicle

movement.

- c) Places where above ground piping is likely to get damaged mechanically, particularly in the LPG storage area where water supply lines are laid for feeding sprinkler deluge system.
 - d) Where Frost conditions warrant and ambient temperature is likely to fall below zero deg. centigrade underground piping at least 1 meter below the ground level should be provided. Alternatively, for above ground pipelines, water circulation to be carried out.
- iii) For Fire water ring main laid underground the following shall be ensured :
- a) The Ring main shall have at least one meter earth cushion in open ground, 1.2 meters cushion under the road crossings and in case of rail crossing, provisions stipulated by Indian Railways shall be complied.
 - b) The Ring main shall be suitably protected against soil corrosion.
 - c) In case of poor soil conditions it may be necessary to provide concrete/ masonry supports under the pipe line.
 - d) Ring main made of composite material can be used and shall be laid underground only.
- iv) Fire water ring main shall be sized for 120% of the design water flow rate. The velocity of water shall not exceed 5 meter per second in fire water ring main. Design flow rates shall be distributed at nodal points to give the most realistic way of water requirements in an emergency.
- In case of sea water service, the fire water main pipes shall be concrete mortar lined internally or other suitable coating material shall be used.
- v) Hydrants/ monitors shall be located considering various fire scenario at different sections of the premises to be protected and to give most effective service. At least one hydrant post shall be provided at a every 30 mtrs of external wall measurement or perimeter of battery limit in case of high hazard areas. For non-hazardous area, they shall be spaced at 45 mtrs. intervals. The horizontal range & coverage of hydrants with hose connections shall not be considered beyond 45 mtrs.
- vii) Hydrants shall be located at a minimum distance of 15 mtrs. from the periphery of storage tank or equipment under protection. In case of buildings this distance shall not be less than 2 mtrs. and not more than 15 mtrs. from the face of building. Provision of hydrants within the building shall be provided in accordance with IS : 3844. Hydrant/ Monitors shall be located along road side berms for easy accessibility.
- viii) Double headed hydrants with two separate landing valves on 3"/ 4" standpost shall be used. All hydrant outlets shall be 1.2 mtrs. above ground level.
- ix) Monitors shall be located to direct water on the object as well as to provide water shield to firemen approaching a fire.
- a. The requirement of monitors shall be established based on hazards involved and layout considerations.
 - b. The location of the monitors shall not exceed 45 mtrs from the hazard to be protected.
- x) Hydrants and monitors shall not be installed inside the dyked areas.

- xi) LPG tank wagon Loading/ unloading facility and Tank Truck gantry area should be provided hydrants having multipurpose combination nozzles for jet spray & fog arrangement and fire hydrants located at a spacing of 30 mtrs. on both sides of the gantry. The hydrants & monitors shall be located at a minimum distance of 15 mtrs. from the Tank Wagon/Tank Trucks measured from edge of the facilities.
- xii) Fire water monitors shall be provided with independent isolation valves.
- xii) Hose box with 2 nos. hoses and a nozzle shall be provided at each hydrant points.
- xiii) The deluge valves shall be located out side the kerb wall at a safe distance in case of LPG spheres/ bullets and 15 meters away from the limits of LPG cylinder sheds. A fire wall shall be provided for the protection of deluge valve and for operating personnel.
- xiv) The fire water deluge valves shall be kept outside the kerb wall at a safe distance in case of sphere/ bullet, and located 15 M away from limits of other sheds or shadows of spheres. A fire wall shall be provided for the protection of the deluge valve and for personal protection of the operator.

9.8 MATERIAL SPECIFICATIONS

All the materials used in fire water system using fresh water shall be of type as indicated below.

i) Pipes	:	Carbon Steel (CS) per IS:3589/IS:1239
ii) Isolation Valves	:	Carbon Steel
iii) Deluge valve	:	Carbon Steel
iv) Hydrant Standpost	:	CS Outlet valves Gunmetal/ Aluminium
v) Monitors	:	CS

Equivalent or superior materials meeting the design requirements can also be used

- vi) In case of underground mains the isolation valves shall be located in RCC/ brick masonry chamber.
- vii) The above ground fire water main and the fire hydrant standpost shall be painted with corrosion resistant "Fire Red" paint as per IS : 5.
- viii) Water monitor, hydrant point and hose box shall be painted "Luminous Yellow" IS : 5.

9.9 MEDIUM VELOCITY SPRINKLER SYSTEM

The medium velocity spray system shall be provided in all critical areas like LPG Storage Area, Sheds, LPG Pump/Compressor House, Tank truck/ wagon loading / unloading areas, valve manifolds etc.

- i) Spray nozzles shall be directed radially to the vessel at a distance not exceeding 0.6 m from the equipment surface. Only one type and size of spray nozzle shall be used in a particular facility. The horizontal extremities of water flow from spray nozzles shall at least meet.

Where projections (manhole flanges, pipe flanges, staircase, supports brackets) obstruct the water spray coverage, including rundown or slippages on vertical surface, additional nozzles shall be

installed around the projections to maintain the wetting pattern. First valve of the vessel shall be adequately covered with sprinklers.

Horizontal dry piping down stream of the block valve and after deluge valve shall have adequate drain facilities at selected locations.

9.10 AUTOMATIC FIRE PROTECTION SYSTEM

9.10.1 Automatic fire protection (Fixed) system based on heat detection through thermal fuses/ quartz bulbs/ EP detectors shall be employed. Sensors shall be installed at all critical places wherever medium velocity spray system has been installed as described below :

a. In LPG storage area, such detectors shall be provided encircling each vessel, equi- spaced with a maximum spacing of 1 meter at an elevation of about 1.5 to 2.0 meter from bottom of vessel. Also minimum 2 nos. detectors shall be provided at the top of the vessel and atleast one near the liquid line ROV to take care of failure of flanges. In case of an automatic thermal fuse based fire protection system the instrument air supply pressure to thermal fuses shall be maintained through a pressure control valve and a restriction orifice.

b. Detectors shall be placed at critical locations in LPG sheds (filling, cylinder storage, testing, evacuation, etc.) loading/ unloading gantries, LPG compressor house, piping manifold, repair sheds etc. Upon actuation there shall be alarm in control panel, LPG pumps and compressors would trip, ROVs (wherever provided) on LPG supply and return lines would trip and the deluge valves on fire water sprinkler system will get actuated.

(i) In case, Quartzoid Bulbs are used for detection, the same shall be designed to blow at 79 deg. centigrade (max.) and Quartzoid Bulb network shall be maintained with plant air at a pressure not more than 3.5 kgs/sq.cm.g and shall be such that the discharge of air through one Quartzoid Bulb will depressurise the system to actuate the deluge valves.

(ii) In case of Electro pneumatic (E.P) heat detectors, it shall actuate the deluge valve in any of the following conditions :

a) Rate of rise - 10 °C/min of temp.

b) At 79 deg. C (max.)

The EP detectors shall be divided in groups and alternate detectors shall be connected in one circuit. Two detectors from two different groups shall function/ operate for actuation of sprinkler system.

(iii) Water spray nozzles and heat detection system shall be of approved type and duly certified for the performance.

(iv) The actuation of detectors shall initiate the following :

(i) Opening of deluge valve of the affected zone as well as adjacent zones.

(ii) Audio-visual alarm indicating the affected zone at the fire pump house and manned control panel. The control panel shall also have status indications for deluge valves with facility for actuation.

(iii) Fire siren of 1 km range

- (iv) Closure of all Remote Operated Valves in affected facility.
- (v) Tripping of main power supply barring the emergency power
- (vi) The water spray from all nozzles within 30 seconds.
- (vii) The fire water pump(s) shall start based on their set pressure to supplement/ to maintain the fire water pressure in the ring main.

9.10.2 Additionally suitable systems like push buttons etc. for initiating all the above actions shall be provided on remote operating panel. Further similar system like push buttons, air release valves etc shall also be provided in the field at safe location for enabling manual actuation by an operator. In case, the zoning concept is used for MV sprinkler system, the operations of sprinklers in various zones shall be clearly earmarked on the push buttons. In the field, manual bypass valves of fire water deluge valves shall also be provided.

9.10.3 The performance test certificates after installation in respect of spray density, flow rate, response time for each facility to be protected provided by manufacturer shall be maintained at the LPG Installations and verified once in 6 months and records maintained thereof. Further, all spray nozzles shall be inspected for proper positioning, corrosion and cleaned if necessary at intervals of not more than 12 months or earlier based on actual experience.

9.10.4 Care shall be taken in positioning nozzles so that water spray does not miss the targeted surface and reduce the efficiency or calculated discharge rate.

9.11 FIRST AID FIRE FIGHTING EQUIPMENT

9.11.1 PORTABLE FIRE EXTINGUISHERS

- i) Portable fire extinguishers shall be located at convenient locations and shall at all times be readily accessible and clearly visible.
- ii) The maximum running distance to locate an extinguisher in working areas shall not exceed 15 meters.
- iii) The top surface of the extinguisher shall not be more than 1.5 meter high.
- iv) The fire extinguishers shall be provided at various locations as under :
 - a. LPG Storage : Vessel(Each) 2 Nos. 9 kg DCP extinguisher.
 - b. LPG cylinder : 2 Nos. 9 kg DCP extinguisher per 200 Sq.M.Area of sheds.
 - c. LPG Pump houses : 2 Nos.9 kg. DCP extinguisher per 50 Sq.m. Area.
 - d. Tank Truck loading /unloading gantries : 1 No. 9 kg. DCP Extinguisher in each bay.
 - e. Tank Wagon loading/ /unloading gantries : 1 No. 9 kg unloading gantries DCP Extinguisher for every 15/20 meters of gantry.

- f. Other Pump Houses : 2 Nos. 9 kg DCP extinguisher
 - g. Office/Canteen/stores : 2 X 9 kg DCP extinguishers in each building
 - h. MCC/ DG Room / HT Room 2 x. 4.5 kg CO2 extinguisher in each room or for floor area of about 100 Sq.m.& 4 sand buckets & a stand shall be provided in MCC/ DG Room.
- v) 100% spare CO2 cartridges and 50% (Min) spare DCP bags (as per Fire Extinguisher Capacities) shall be stored in the LPG plant.

9.11.2 WHEELED MOBILE FIRE FIGHTING EQUIPMENT

- i) One No. Mobile 75 Kg DCP fire extinguisher shall be provided in filling shed, LPG storage vessels/ LPG Pump House area, Tank truck loading/ unloading gantry area & tank wagon loading/ unloading gantry area.
- ii) The Dry chemical powder used in the extinguishers shall be Potassium/ Urea based or Sodium Bicarbonate as per IS:4308. Nitrogen/ Carbon Dioxide shall be used as expelling gas.
- iii) A trolley containing first aid fire protective accessories shall be readily available in the LPG plant.

9.11.3 HOSES, NOZZLES AND ACCESSORIES

- i) Reinforced rubber lined hoses (63mm) conforming to IS : 636 (type A or B) shall be provided.
 - ii) The hoses shall be of 15 Meters standard length and shall be provided with Gun metal / Aluminium alloy male & female couplings of instantaneous pattern.
 - iii) Minimum of two or 25% spare Hoses shall be stored in the LPG plant.
 - iv) In addition to the nozzles provided in the hose boxes there shall be at least 2 Nos. spare nozzles in each category viz. Jet Nozzles with branch pipes, Fog Nozzles, universal Nozzles, water curtain Nozzles, Spray Nozzles and Triple purpose nozzles in the plant.
- v) The following accessories/ first aid items shall be provided in the plant :
- | | |
|----------------------------|---|
| 1. Fire hoses | Two nos. for each Hose Box |
| 2. Safety helmets | 1 no. for each person. (min. 10 nos.) |
| 3. Hose Box | At each hydrant point. |
| 4. Stretcher with | Min. 2 Nos. blankets. |
| 5. First aid Box | Min. 2 nos. |
| 6. Rubber hand gloves | Min. 2 pairs for electrical (BIS approved) purpose. |
| 7. Low temperature | 4 pairs rubber hand gloves for LPG emergency |
| 8. Low tem. Protective | Min. 2 sets clothing for LPG emergency. |
| 10. Fire proximity suit | Min. 1 No. |
| 11. Resuscitator | Min. 2 No. |
| 12. Red/Green Flags | As reqd |
| 13. Self contained | Min. 1 No..breathing apparatus with one spare cylinder. (Cap. 30 minutes) |
| 14. Water jel blankets | Min. 2 nos. |
| 15. Portable Gas detectors | min. 2./ Explosimeter |

The above are guidelines and minimum requirements of each item and can be increased depending upon the scale of operations, statutory/ mandatory requirement of local bodies/ State Governments or any other expert body.

9.12 EMERGENCY CONTROL / ALARM SYSTEM

9.12.1 FIRE ALARM SYSTEM

- i) Manual call points near to filling shed, storage area, tank truck/ wagon gantry, pump house, etc. shall be provided and clearly marked in the installation. Operation of these points shall raise audio visual alarm in control room.
- ii) Electricity operated Fire Siren shall be audible to the farthest distance in the plant (1 K.M. from the periphery of the plant).
- iii) Manually operated fire sirens shall be provided at strategic places.
- iv) For fire condition the siren shall be wailing sound for minimum `2 minutes and for all clear signal it shall be straight run siren for 2 minutes.
- v) For Disaster condition the wailing sound given shall be repeated thrice with a minimum 60 seconds gap.

9.12.2 COMMUNICATION SYSTEM

- i) Communication system like telephone/ PA or paging or walkie- talkie shall be provided.
- ii) In the hazardous areas, flame-proof / intrinsically safe telephones shall be provided.
- iii) Wherever possible Hot line connection between City Fire Brigade/ near by major Industries shall be provided.
- iv) Plant shall have a `Mutual Aid' arrangement with near by industries.

9.13 SPECIAL FIRE PROTECTION

9.13.1 The most hazardous situation in LPG vessel is the possibility of BLEEVE. This usually takes place when the vessel is subjected to external fire.

9.13.2 The unwetted (vapour space) portion of the shell gets overheated and fails even at the operating pressure. As such, it is important that metal temperature in the vapour space is protected from overheating by some measures. A passive measure like fire proofing/ insulation or fire retardant coating will provide protection in the initial period of fire which is very crucial. This will give some breathing time for activating other fire fighting measures like starting of pumps, organizing people, opening of valves etc. This will also take care of automation failure wherever it is provided.

9.13.3 The fireproofing of LPG storage vessel should be decided based on the risk analysis keeping in view local considerations, availability of water and societal risk.

9.13.4 The fireproofing of LPG storage vessel shall be decided based on the fire safety analysis keeping in view local considerations, population density, availability of water, societal risk and fire protection

measures provided.

9.13.5 Fire proofing provided on the vessel and supporting legs shall be adequate to protect the shell material from overheating and consequent failure. The minimum rating for fire proofing shall be as under :

9.13.6 LPG storage vessel & connected lines upto the fire safe ROVs : 1 hrs

Supporting legs of all above : 2 hr.

Fire proofing is not required for diagonal bracing, including tie rods, or redundant members that are not necessary for supporting the static loads.

9.13.7 Before fire-proofing application, protected metal surfaces shall be prepared through such means as sand- blasting and corrosion-protective primers. Particular attention shall be given to the top junction of the fire- proofing with the protected metal to prevent water ingress.

Fire water line to each sphere should be so routed that it is not exposed to direct fire. This is to protect it from failure in the initial period when water flow has not commenced. It is recommended that riser should be located away from bottom ROV. The horizontal run of the Fire Water line may be buried if fire engulfment cannot be avoided otherwise. Fire proofing shall include connected LPG lines and pipe supports within 15 M of a storage vessel or in the drainage paths.

9.14 INSPECTION AND TESTING

9.14.1 The fire protection equipment shall be kept in good operating condition all the time.

9.14.2 The fire fighting system shall be periodically tested for proper functioning and logged for record and corrective actions. In addition to routine daily checks/ maintenance the following periodic inspection/ testing shall be ensured.

9.14.3 FIRE WATER PUMPS

- i) Every Pump shall be in test run for atleast 30 minutes twice in a week at the rated conditions.
- ii) Once in a month each pump shall be checked and tested and the shut-off pressure observed and logged. Also the pump performance shall be ascertained.
- iii) The Jockey pump operation shall be checked periodically. Frequent start/ stop condition of Jockey pump indicates that there are water leaks in the system.

9.14.4 FIRE WATER RING MAIN

- i) The ring main shall be kept pressurised at 7 kg/sq.cm.g with the help of one or more jockey pumps.
- ii) The ring main shall be inspected for any visual leaks, detects, damage and corrosion at least once in week and records maintained thereof.
- iii) All valves on the ring main/ hydrant/ monitor valves shall be checked for leaks/ operation and lubricated once in a month.

9.14.5 FIRE WATER SPRINKLER SYSTEM

- i) All deluge valves and sprinkler system shall be operated and checked once in a quarter for correct remote operation performance of each nozzle and effectiveness of system in total.
- ii) Testing of sprinkler system in the sheds shall be carried out by closing the outlet of the deluge valve for correct remote operation once in a quarter.
- iii) The strainers provided in the Fire water sprinkler system shall be cleaned once in a quarter and records maintained.

9.14.6 FIRE WATER RESERVOIR

In case of a Reservoir the same shall be cleaned once in 6 months or earlier as and when needed so that there shall not be any foreign particles/ fungus/ vegetation in the reservoir.

9.15 MAKE UP WATER

Facilities to make up water during fire fighting shall be provided.

Schedule-1 I

10.0 GAS MONITORING SYSTEM

The gas monitoring system shall be designed considering small leaks (leaks which have secondary closures) such as mechanical seals failure etc. sampling point left open, gasket leaks, hose pinholes, valves gland leakage, drain point left partially open, TSV's relief discharge in manifold area, filling/ evacuation hoses leakage. The Gas Monitoring system shall provide early warning on build up of dispersed gas concentration below the LEL limits.

10.1 APPLICATION

- (i) The detectors for the gas monitoring system shall be strategically located in LPG Bottling Plant at all facilities close to the potential source of leakage.
- (ii) The detection control equipment should be provided in the control room for continuous monitoring even during power failure.

10.2 DETECTORS

The control equipment is not required to have automatic corrective action capabilities on sensing leakages as this is basically a warning device. However, in case of any specific recommendations made in the risk analysis / HAZOP studies, the same should be implemented.

10.3 ANNUNCIATION SYSTEMS

Appropriate annunciation system shall be available to ensure that all the alarms generated, both, audio and visual are reported to the plant personnel, who are authorized to take corrective action. Depending on the manning practice of the plant, the alarms both, audio and visual can be repeated at additional location to ensure corrective action is taken.

10.4 LOCATION OF DETECTORS

- (i) The behavior of the gas leakage governs the positioning of the gas detector. As LPG is heavier than air, the height of the detector should not be more than 0.3 M from the mounting level.
- (ii) The pre-dominant wind direction should be considered with respect to the potential source of leakage to ensure positioning of the detector on the downstream side of the wind direction.
- (iii) The detectors especially the catalytic type should not be positioned very close to the potential source of leakage to avoid poisoning of the detectors(temporary malfunctioning). The detectors should be located at least 0.3 meters away from the potential source of leakage.
- (iv) In case of infra-red detectors, the same shall be installed on the downwind side ensuring the path is free from obstructions. In case any additional expansion/ construction if undertaken, the detectors will have to be pre-positioned.
- (v) The minimum detectors facilities- wise are as given below:

Storage vessels (above ground) – 1 No. top and 1 No. near bottom ROV.
LPG pump house 1 No. in pump house and 1 No. in manifold.

Filled cylinder shed - 2 No. Valve change shed – 1 No.
Empty-cum-filling shed – 2 Nos. near carousel, 1 No. near evacuation unit tank, 1 No. weight correction unit, 1 No. at Valve changing machine without evacuation

TLD – one at each manifold and at ends.

Tank wagon gantry – 1 no. for every two bays or 30 m whichever is less at bottom. Additionally, some detectors at selected locations shall be provided at the top of platform.

The number and location of the detectors required over and above the minimum requirements specified above shall be as per the specific requirements identified in the risk analysis / HAZOP study report.

The location can be decided by assessing the behavior of gas drift and consequential safety risk.

(vi) Inspection and testing

The gas monitoring system shall be kept in good operating condition all the time.

The inspection of the system shall be done at an interval of 1 month in which the gas shall be released at all the detectors and the performance of the systems shall be established.

The calibration of the equipment shall coincide with the monthly inspection schedule every three months for calibration of the gas detectors the calibrated gas with known and certified level of concentration shall be used.

The drift in the sensitivity of the individual detectors shall be recorded in maintenance history log book during calibration and the detectors with abnormal or wide drift in sensitivity.

The plants should have at least 2 Nos. spare detectors for each system maintained at all times to facilitate immediate replacement of defective detectors.

Schedule -1 J

11.0 COMPETENCE ASSURANCE AND ASSESSMENT

- 11.1** Every operating company shall develop, implement, and maintain a written training plan to instruct all LPG plant personnel with respect to the following:
- a. Carrying out the emergency procedures that relate to their duties at the LPG plant as set out in the procedure manual and providing first aid
 - b. Permanent maintenance, operating, and supervisory personnel with respect to the following:
 - i. The basic operations carried out at the LPG plant
 - ii. The characteristics and potential hazards of LPG and other hazardous fluids involved in operating and maintaining the LPG plant, including the serious danger from frostbite that can result upon contact with LPG or cold refrigerants
 - iii. The methods of carrying out their duties of maintaining and operating the LPG plant as set out in the manual of operating, maintenance and transfer procedures
 - iv. Fire prevention, including familiarization with the fire control plan of the LPG plant; fire fighting; the potential causes of fire in an LPG plant; the types, sizes, and likely consequences of a fire at an LPG plant
 - v. Recognizing situations when it is necessary for the person to obtain assistance in order to maintain the security of the LPG plant
- 11.2** Each operating company shall develop, implement, and maintain a written plan to keep personnel of its LPG plant up-to-date on the function of the systems, fire prevention, and security at the LPG plant.
- 11.3** The Refresher programs for training of all personnel shall be conducted at an interval not exceeding 2 years to keep personnel current on the knowledge and skills.
- 11.4** Every operating company shall maintain a record for each employee of its LPG plant that sets out the training given to the employee under this section.
- 11.5** Each operating company shall ensure that LPG plant personnel receive applicable training and have experience related to their assigned duties. Any person who has not completed the training or received experience shall be under the control of trained personnel.
- 11.6** For the design and fabrication of components, each operator shall use personnel who have demonstrated competence by training or experience in the design of comparable components and for fabrication who have demonstrated competence by training or experience in the fabrication of comparable components.
- 11.7** Supervisors and other personnel utilized for construction, installation, inspection, or testing must have demonstrated their capability to perform satisfactorily the assigned function by appropriate training in the methods and equipment to be used or related experience and accomplishments. Further their capability shall be assessed periodically.
- 11.8** Each operator shall utilize for operation or maintenance of components only those personnel who have demonstrated their capability to perform their assigned functions by successful completion of the training as specified and possess experience related to the assigned operation or maintenance function.
- 11.9** Corrosion control procedures including those for the design, installation, operation, and maintenance of cathodic protection systems, must be carried out by, or under the direction of, a person qualified by experience and training in corrosion control technology.
- 11.10** Personnel having security duties must be qualified to perform their assigned duties by successful completion of the training as specified.
- 11.11** Each operator shall follow a written plan to verify that personnel assigned operating, maintenance, security, or fire protection duties at the LPG plant do not have any physical condition that would impair performance of their assigned duties.

- 11.12** i. Each entity shall provide and implement a written plan of initial training to instruct all permanent maintenance, operating, and supervisory personnel —
- a) About the characteristics and hazards of LPG and other flammable fluids used or handled at the facility, including, with regard to LPG, low temperatures, flammability of mixtures with air,;
 - b) About the potential hazards involved in operating and maintenance activities; and
 - c) To carry out aspects of the operating and maintenance procedures that relate to their assigned functions;
- ii. All personnel of an LPG installation shall be trained to carry out the emergency procedures that relate to their assigned functions;
- iii. All operating and appropriate supervisory personnel of an LPG installation shall be trained to understand detailed instructions on the facility operations, including controls, functions, and operating procedures; and to understand the LPG transfer procedures.
- 11.13** Personnel responsible for security at an LPG plant must be trained in accordance with a written plan of initial instruction to:
- i. Recognize breaches of security;
 - ii. Carry out the security procedures that relate to their assigned duties;
 - iii. Be familiar with basic plant operations and emergency procedures, as necessary to effectively perform their assigned duties; and
 - iv. Recognize conditions where security assistance is needed.
- 11.14** All personnel involved in maintenance and operations of an LPG plant, including their immediate supervisors, must be trained in accordance with a written plan of initial instruction, including plant fire drills, to:
- i. Know and follow the fire prevention procedures as specified
 - ii. Know the potential causes and areas of fire determined
 - iii. Know the types, sizes, and predictable consequences of fire determined and
 - iv. Know and be able to perform their assigned fire control duties according to the procedures and by proper use of equipment provided.
 - v. Marine
 - vi. TT Crew
- 11.15** Each entity shall maintain a system of records which —
- i. Provide evidence that the training programs required by this subpart have been implemented; and
 - ii. Provide evidence that personnel have undergone and satisfactorily completed the required training programs.
 - iii. Records must be maintained for one year after personnel are no longer assigned duties at the LPG plant.

Schedule -2

**SMALL LPG BOTTLING PLANTS
(DESIGN AND FIRE PROTECTION FACILITIES)**

SCHEDULE – 2 A

LAYOUT & DESIGN

SCHEDULE- 2 B

SAFETY AND FIRE PROTECTION

SCHEDULE -2

LAYOUT & DESIGN

1.0 SCOPE

Technical standards and specifications including safety standards (hereinafter referred to as standards) for capacity up-to 100 MT and maximum bottling of 20 MT per day on design, layout, storage, loading / unloading, operation LPG storage, handling and bottling are specified in this Schedule. Further, the section 4.0 of this schedule also specifies the additional minimum safety requirements on design, layout, storage, loading / unloading, operation at LPG installations having Bulk Storage (a) exceeding 100 MT but limited to 300 MT for aboveground storage and also for (b) 450 MT in mounded Or in combination of aboveground and mounded storage of LPG with total bottling quantity not exceeding 35 MT per shift. of 8 hrs. For LPG Storage, Handling and Bottling Facilities exceeding either of the above limits, Schedule – 1 shall be applicable.

1.1 SEPARATION DISTANCES

The various facilities within LPG storage, handling and bottling premises shall be located based on Table-I and Table-II. The separation distances as given are the distances in plane between the nearest point on a vessel other than the filling/discharge line and a specified feature, e.g. adjacent vessel, site boundary etc.

TABLE – I - INTERDISTANCES FOR LPG FACILITIES

(All distances are in metre)

	1	2	3	4	5
1. LPG STORAGE VESSEL	2	T-11	T-II	15	T-II
2. BOUNDARY/PROPERTY LINE/GROUP OF BLDGS. NOT ASSOCIATED WITH LPG PLANTS.	T-II	-	15	15	-
3. LPG SHED	T-II	15	15	15	30
4. TANK TRUCK GANTRY	15	15	15	NA	30
5. FIRE WATER PUMP HOUSE	T-II	*	30	30	-

-
- NOTES: 1. T-II : Refer Table II
2. * : Any Distance for operational convenience

TABLE – II

INTERDISTANCES BETWEEN LPG STORAGE VESSELS, FILLING SHED, STORAGE SHED AND BOUNDARY/PROPERTY LINE/GROUP OF BUILDINGS.

CAPACITY OF EACH VESSEL (CU. MTS. OF WATER)	DISTANCES (MTS.)
10 – 20	15
20 – 40	20
41 – 235 ^{Note}	30

Note : MAXIMUM PACKED STORAGE LIMITED TO 20000 KGS. Horizontal bullets with the total volumetric capacity upto 235 Cu. M. shall be used for storing LPG.

1.2 LOCATION

While assessing the suitability of any site for location of LPG storage facilities, the following aspects shall be considered:

- i. In addition to the requirements for safety the plant should be located in such a manner so as not to be contiguous to any industry having open flame. Property line of the plant shall be away from the central line of the road/railways as per statutory requirements and overhead high tension wire shall not traverse through the battery limit of the plant.
- ii. Adequate availability of water from a nearby reliable source should be ensured.
- iii. The topographical nature of the site with special reference to its effect on the disposal of LPG, in the even of its escape, if any, shall be considered.
- iv. The access for mobile fire fighting equipment to the storage vessels under all foreseen circumstances, preferably from two sides and upward prevailing wind direction js an important parameter.
- v. For any expansion beyond the specified limit, all provision under Schedule - 1 shall be applicable.
- vi. Predominant direction of wind and velocity shall be considered.
- vii. Longitudinal axis of horizontal vessels (Bullets) shall not point towards other vessels, vital process equipment and other facilities.
- viii. Storage vessels shall be located downward of processing units, important building and facilities.
- ix. Storage vessels shall be laid out in single row within a group.
- x. Storage vessels shall not be located one above the other.

1.3 LAYOUT

The following aspects shall be considered while establishing layout of LPG storage vessels :

1.3.1 LPG STORAGE FACILITIES :

i. GRADING :

Area below the storage vessels (Bullets) shall be free from vegetation, property graded with the slope of 1.100 (towards one side) away from the pipeline manifold.

ii. PIPING :

Piping manifold shall be away from the shadow of the vessel.

Spring loaded quick closing valve with fusible link or Rov to facilitate immediate closure in the event of emergency, if any, shall be provided in the LPG liquid line of each vessel between excess flow check valve (EFCV) and pipeline manifold.

iii. SURFACE DRAINAGE

In order to prevent the escape of spillage into the main drainage system, surface water from the storage area and from the manifold area shall be directed to the main drainage through a water seal designed to avoid the spread of hydrocarbon.

iv. GROUPING :

Vessels shall be arranged in a group and total volumetric capacity of the group shall be limited to 235 Cu. M. ^{Note 3}. Inter-distances as specified in Table-I and Table-II shall be maintained.

Top surfaces of all the vessels installed in a group shall be on the same plane so that the safety blowout from them do not affect each other.

1.4 LPG BULK HANDLING FACILITIES

1.4.1 LPG tank lorry loading/unloading gantry shall be located in a separate block and shall not be grouped with other petroleum products.

1.4.2 Space for turning with a minimum radius of 20 meters for tank lorries shall be provided commensurate with the capacities of the tank trucks.

1.4.3 LPG tank lorries upto the maximum of 2 Nos, at a time should only be taken for unloading.

1.4.4 Adequate permanent protection for TLD pipeline island shall be provided. The minimum width of such pipeline island shall be 1 metre.

1.5 LPG BOTTLING FACILITIES :

1.5.1 LPG Bottling facilities should be located a a safe distance from other facilities with minimum ingress of trucking traffic and downward wind direction with respect to bulk storage. There shall not be any deep ditches in the surrounding area to avoid settling of LPG.

1.5.2 Bottling section shed shall be of single story having asbestos roofing and open from all sides for adequate ventilation to ensure quick dessipation of LPG Vapour in the event of

leakage, if any, RCC roofing shall not be used. Anti-static mastic flooring conforming to IS-8374 shall be provided in the LPG filling shed/cylinder storage shed to avoid frictional sparks. Anti-static mastic coating up to 1.5 meters height from bottom of the supporting columns in the shed shall be provided.

- 1.5.3 Stacking area for empty and filled cylinders shall be marked specifically. Cylinders shall always be stacked vertically in two lines. Plant should have one shed each for filling and storing of filled./empty cylinders.
- 1.5.4 Valve changing operation should be carried out in a demarcated place within the filling shed itself.
- 1.5.5 Cylinder storage shall be kept on or above grade and never below grade in cellar or basement.
- 1.5.6 Filled cylinders shall not be stored in the vicinity of cylinders containing other gasses or hazardous substances.
- 1.5.7 Escape routes shall be specified in LPG sheds for evacuation of employees in emergency.
- 1.5.8 There shall not be any trapping of personnel in LPG sheds by conveyors, cylinders and other facilities. If such trapping cannot be eliminated, it should be kept to the minimum. In such places sufficient arrangements for escape routes to be provided.
- 1.5.9 Adequate lighting shall be provided in the cylinder filling area.
- 1.5.10 Water drains from cylinder filling areas to out side drainage system shall be provided with water seals (near the plant boundary).

1.6 PROTECTION OF FACILITIES :

- 1.6.1 There shall be road all around the various facilities within LPG storage, handling and bottling facilities for accessibility of fire fighting operations.
- 1.6.2 There shall be proper industry type boundary wall all around the Bottling Plant.

1.7 UTILITIES

Utilities consisting of Fire Water Pumps, Admin. Building, Motor Control Center, DG Room, Air Compressors, Dryers etc. shall be separated from other LPG facilities and to be located as per the area classification as specified in Table-I.

2.0 DESIGN CRITERIA

2.1 GENERAL

The design of storage vessels, facilities, safety features, process design shall be as per Schedule 1 of these Regulations except for requirements as specified below :

2.2 DESIGN BASIS

- 2.2.1 For safety reasons, the operation of facilities should be restricted to maximum two shifts operation. Facilities shall include the following :
 - i. Stationary Filling Machines : For filling Cylinders.
 - ii. Check Scale : To countercheck the quantity of LPG filled.
 - iii. Compact Valve Tester : To check valve/"O" Ring leakage.

- iv. Test Bath : To check the body./bung leak cylinders.
- v. Evacuation Rack : For evacuation of cylinders.
- vi. Purging Manifold : For purging of cylinders.

2.2.2 STORAGE CAPACITY

The maximum bulk storage (of all vessels) shall be restricted to 100 MT.

2.2.3 LPG LOADING/ UNLOADING FACILITIES

LPG loading/unloading facilities through tank truck should be provided.

2.2.4 CYLINDER FILLING FACILITIES

2.2.4 FILLING MACHINES :

- i. The filling machines should preferably be provided with auto cut-off system to ensure that LPG supply is cut-off after filling the desired quantity of product.. The filling pressure shall not exceed the design pressure of the cylinders.
- ii. Filling machines shall not have weight error more than +/-1% of the net LPG filled in the cylinder.
- iii. It is recommended that in-line check weigh scales with a minimum graduation of 50 gms be installed and all cylinders after filling should be counterchecked for correct weight.

2.2.5 CYLINDER STORAGE

Maximum cylinder storage of filled cylinders shall be restricted to a total of 20,000 Kgs.

2.3 LPG STORAGE VESSELS

2.3.1 FITTINGS:

- i. Bullets shall have a single nozzle at the bottom for inlet as well as outlet. The nozzle shall be fully welded, stress relieved along with the vessel and shall extend minimum 3 metres from the shadow of the bullet. Excess Flow Check Valve (EFCV) shall be provided on this bottom nozzle to ensure immediate stoppage of the flow of LPG in the event of downstream leakage rupture, if any. There shall not be any other manhole, instrument tapping on this nozzle upto the EFCV.
- ii. High level gauge should be provided to ensure safe filling of vessels and slip tube or Roto/Gauge/Rochester gauge should be provided for gauging of the vessels.
- iii. All the fittings shall be suitable for use at not less than the design pressure and temperature appropriate to the worst operating conditions of the vessel.

2.3.3 INSTRUMENTS

- i. The storage vessel shall have minimum 2 different type of level indicators as stated below:
 - a. High Level Gauge.

- b. Slip Tube Gauge/Roto Gauge/Rochester Gauge.
- ii. Each vessel shall have atleast two safety valves, each set at not more than 110% of design pressure of the vessel and having the relieving capacity adequate for limiting the pressure build-up in the vessel not more than 120% of design pressure. The relieving capacity shall be based on fire condition.

2.4 SAFETY/SECURITY SYSTEM

The features of safety/security system for the different areas in the LPG Bottling Plants shall be as follows:

- i. The hand operating/electrical siren should be provided to sound the alarm in case of fire/emergency, if any.
- ii. Manual push button should be provided at 2-3 strategic locations to bring to halt all the operational activities in the event of any emergency.

2.5 OTHER EQUIPMENT/ SYSTEM

2.5.1 BOTTLING PUMPS

Two pumps including one stand-by shall be provided with suction and discharge pressure gauge, a high point vent to safe height/flare, suction strainer and mechanical seal shall be provided. Pumps shall be designed to build a discharge pressure to ensure 5 Kg/CM² pressure above the vapour pressure at the operating temperature at the filling machines.

2.5.2 LPG COMPRESSOR

- i. Gear driven compressor shall preferably be used. However belt driven compressors can be used provided the belts used are anti static type and fire resistant.
- ii. There shall be minimum of two compressors including one as a standby.
- iii. The operating parameters shall be decided on a case to case basis. However, typical operating conditions may be as follows:
 - a. Suction Pressure : 10.0Kg/cm² abs (max). during unloading.
 - b. 2-11.8kg/cm² abs. During vapour recovery.
 - c. Discharge Pressure : 13.0 kg/cm² abs. During unloading 11.5 kg/cm² abs. During vapour recovery.
- iv. Compressor shall be provided with the following features:
 - a. Pressure gauges in suction and discharge.
 - b. Temperature gauge in discharge.
 - c. Discharge safety valve and a vent valve, their outlets leading to cold flare at a safe height outside the shed.
 - d. Suction and discharge block valves (lock open type).
 - e. Suction strainer.
 - f. Check valve in discharge.
 - g. A discharge to suction recycle valve for achieving capacity turndown during startup.

- v. Besides these, other indications/protections can also be provided along with those recommended by compressor vendor.

2.5.3 EVACUATION FACILITIES FOR DEFECTIVE CYLINDERS

- i. Proper cylinder evacuation facility with cold flaring arrangement shall be provided to evacuate the defective cylinder before undertaking cold repairing job.
- ii. Cylinders shall be evacuated and depressurised to near atmospheric pressure. The residual LPG in the cylinder shall be cold flared in the atmosphere at a vent outside the shed at 1.0 M height above the roof of the shed.

2.5.4 PURGING OF NEW CYLINDERS

Proper facility shall be provided to disperse the air from newly/ hydrotested cylinders before commissioning.

2.5.5 ELECTRICAL AREA CLASSIFICATION

For electrical area classification refer to IS-5571 and IS-5572 (Part-I).

3.0 FIRE PROTECTION FACILITIES

3.1 DESIGN CRITERIA

Following should be considered while designing the Fire Protection Facilities:

- i. City fire water supply/facilities not available for these LPG storage, handling and Bottling facilities.
- ii. One single largest fire risk situation shall be considered.
- iii. All LPG storage vessels, cylinder filling/storage shed, tank lorry loading gantry, LPG pump/compressor shall be covered by fixed water spray sprinkler system.
- iv. Fire protection facilities shall have fire fighting access, means of escape in the event of fire. Whole area should be segregated depending upon the risk involved and each segregated area should have independent system.
- v. Layout shall permit access from at least two directions.

2.4 FIRE WATER SYSTEM

Water to be used for fire extinguishment/ fire control/cooling of vessels/equipment and protection of equipment and personnel from heat radiation.

2.4.1 COMPONENTS OF FIRE WATER SYSTEM

The main components of the system are :

- (i) Fire water storage
- (ii) Fire water pumps
- (iii) Fire Hydrant/distribution piping network

(iv) Water Sprinkler.

3.4.2 FLOW RATE DESIGN

i. The fire water pumping requirement shall be calculated based on spray density as given below :

- a. LPG Storage Vessels 10 LPM/Sq M.
(R + 15)
- b. LPG Shed 10 LPM/Sq. M.
- c. LPG Unloading Gantry 10 LPM/Sq. M.

ii. LPG STORAGE VESSELS:

Fixed water system with manually operated isolation valve located at a safe distance of 15 meters shall be provided. For water flow calculations adjoining vessels within distance of R + 15 Mts. (Where R is the radius of the LPG Vessels) shall be considered.

iii. SHED

Fixed water spray system with isolation valve to be operated manually and placed at a safe distance of 15 meters from the shed shall be provided.

iv. TANK LORRY GANTRY:

For tank lorry unloading gantry, fixed spray system with manual operating valve located at 15 meters distance from the gantry shall be provided.

v. WATER REQUIREMENT :

The fire water system in the plant shall be designed to meet the highest fire water flow requirement of a single largest risk of any of the above cases at a time plus 72 Cu. M per hour for operating 2 hydrant points.

3.4.3 FIRE WATER SYSTEM DESIGN :

- i. Fire water ring main always charged with water (atmospheric pressure at a normal condition) shall be provided all around perimeter of the LPG plant facilities, with hydrants/monitors conveniently placed to combat the fire protection system.
- ii. Fire water ring main shall be designed for a minimum residual pressure of 7 Kg/cm² at the farthest point of application in the plant.
- iii. Fire hydrant network shall be in closed loops to ensure multidirectional flow in the system,. Isolation of any section on the network without affecting the flow in the rest. The isolation valves shall be conveniently located near the loop junction for ease of operation.

3.4.4 FIRE WATER STORAGE :

- i. Water for the hydrant service shall be stored preferably in above ground tanks for availing the advantage of flooded suction to enable easy start of fire water pump. The effective storage capacity shall be for two hours aggregate working capacity of fire water pumps.
- ii. Storage tank/reservoir shall be 2 in Nos. Interconnected with suitable valve to facilitate cleaning/repairs.

3.4.5 FIRE WATER PUMPS:

- i. Centrifugal type fire water pumps shall be installed to meet the designed fire water flow rate and head.
- ii. Atleast one fire water pump shall be of diesel engine driven type.
- iii. Pumps shall be capable of discharging 150% of its rated discharge at a minimum of 65% of the rated head.
- iv. Fire water pumps shall be exclusively used for fire fighting purposes only.

No. of fire water pumps of appropriate capacity shall be provided as per the following criteria :

- | | |
|----------------------|---------|
| (a) Normal operation | - 1 No. |
| (b) Stand –By | - 1 No. |

3.4.6 FIRE HYDRANT NETWORK ;

- i. Fire hydrant ring main should normally be laid above ground. Following precautions should be taken:
 - a. Pipe line should be laid at a height of 300 mm to 400 mm above finished ground level.
 - b. The mains shall be supported at regular intervals not exceeding 6 meters.
 - c. The system for above ground portion shall be analysed for flexibility against thermal expansion and necessary expansion loops where called for, shall be provided.
 - d. The portion of fire water hydrant above ground and within 15 M of the LPG storage vessels shall be fire proofed.
- ii. However, the ring main shall be laid underground at the following places:
 - a. Road crossings.
 - b. Place where above ground piping is likely to cause obstruction to operation and vehicle movement.
 - c. Place where above ground piping is likely to get damaged mechanically particularly in the LPG storage area where water supply lines are laid for feeding sprinkler deluge system.
- iii. Fire water ring main laid underground the following precautions shall be taken :
 - a. The ring main shall have at least one meter earth cushion in open ground and 1.2 meters cushion under the road crossings.

- b. The ring main shall be provided with protection against soil corrosion by suitable coatings/wrappings.
- c. In case of poor soil conditions it may be necessary to provide concrete/masonry supports under the pipeline.
- iv. Fire water ring main shall be sized for 120% of the design water rate. Design flow rates shall be distributed at nodal flow rates shall be distributed at nodal points to give the most realistic way of water requirements in an emergency.
- v. Hydrants/monitors shall be located bearing in mind the fire hazards at different sections of the premises to be protected and to give most effective service.
- vi. Connections for fire water monitors shall be provided with independent isolation valves.
- vii. Hose boxes with 2 Nos, hoses and a nozzle shall be provided by the side of the each hydrant points.
- viii. Considering radiation levels in the event of a fire, Hydrant/Monitors/Control valves shall be located at a safe distance from hazardous equipments/buildings.

3.4.7 FIXED WATER SPRAY/SPRINKLER SYSTEM:

Fixed water spray / sprinkler system shall be installed in LPG storage area. Tank lorry unloading area, LPG shed and in the pump/compressor shed, if any.

3.4.8 FIRE AID FIRE FIGHTING EQUIPMENTS

3.4.8.1 PORTABLE FIRE EXTINGUISHERS

- i. Portable fire extinguishers (only ISI approved) shall be located at convenient locations and shall at all times be readily accessible and clearly visible.
- ii. The maximum running distance to/ locate an extinguisher in working areas shall not exceed 15 meters.
- iii. The top surface of the extinguishers shall not be more than 1.5 meter high.
- iv. The fire extinguishers shall be provided at various as under :
 - a. LPG storage Vessels (each) 2 Nos. 9 Kg. DCP.
 - b. LPG Cylinder Filling/ storage shed 2 Nos. 9 Kg. DCP per 200 sq. M area
 - c. Tank Truck loading/ unloading gantries 1 No. 9 Kg. DCP Fire Extinguisher in each Bay and 1 No 50 Kg, Mobile DCP Unit per gantry.
 - d. Office/Canteen/Stores At least 2 Nos. 9 Kg, DCP Extinguishers in each Bldg
 - e. MCC/DG Room/HT Room/ Min 2 Nos, 4,5 kg. CO2 Extinguishers in each room /100 Sq. M area and 4 sand buckets with a stand.

- f. 100% spare CO2 cartridges and 50% spare Dry Chemical Powder i.e. DCP shall always be stored in the plant.

3.4.8.2 MOBILE FIRE FIGHTING EQUIPMENT :

The Dry Chemical powder used in the extinguishers shall be potassium/Urea based or Sodium Bicarbonate as per IS:4308. The expellent gas i.e. CO2 should be of food quality.

3.4.8.3 HOSES, NOZZLES AND ACCESSORIES :

- i. Reinforced rubber lined hoses conforming to IS:636 (Type A or B) shall be provided.
- ii. The hoses of 15 meters standard length shall be provided with gun metal/ Aluminium allow male & female couplings of instantaneous pattern.
- iii. 50% spare hoses shall be stored in the LPG Plant.
- iv. In addition to the nozzles provided in the hose boxes, 4 Nos. triple purpose nozzles shall be provided.
- v. Fire Hoses : 50% of no. of Hydrant points.
- vi. Sand drums with scoops : 20 Nos.
- vii. Hose boxes : 1 No. for each hydrant point
- viii. First aid box : 2 Nos. each
- ix. Explosimeter : 2 Nos.
- x. Siren: 1 No.
- xi. Red/Green Flag : 1 No. each
- xii. Hand gloves :
 - (a) Leather lined asbestos hand gloves for cold working : 2 pairs.
 - (b) Rubber hand gloves : 2 pairs for MCC room.

3.5 FIRE/ALARM /COMMUNICATION SYSTEM.

- i. Electricity operated Fire Siren shall be audible to the farthest distance in the plant.
- ii. Manually operated fire sirens shall also be provided at strategic places.

3.6 INSPECTION AND TESTING :

- i. The fire protection equipment shall be kept in good operating condition all the time.
- ii. The fire fighting system shall be periodically tested for proper functioning and logged for record and corrective actions. In addition to routine daily checks/maintenance periodic inspection /testing shall be ensured.

3.7 FIRE WATER PUMPS :

- i. Every pump shall be subjected to test run for atleast 10 minutes minimum twice a week.
- ii. Once in a month each pump shall be checked and tested and the shut-off pressure observed should be logged. Also the pump performance shall be ascertained.

3.8 FIRE WATER RING MAIN :

- i. The ring main shall be inspected for any visual leaks, defects, damages and corrosion.
- ii. All valves on the ring main/hydrant/monitor valves shall be checked for leaks/operation and lubricated once in a month.

3.9 FIRE WATER SPRINKLER SYSTEM

- i. The sprinkler system in the sheds shall be tested once in a month.
- ii. The strainer provided in the fire water sprinkler records maintained. System shall be cleaned once in a quarter and record maintained.

3.10 FIRE WATER RESERVOIR :

In case of a reservoir the same shall be cleaned once in 6 months or whenever needed so that there shall not be any Foreign particles/fungus/vegetation in the reservoir.

3.11 Make up water :

Facilities to receive make up water during fire fighting shall be provided.

4.0 Additional minimum safety requirements on design, layout, storage, loading / unloading, operation at LPG storage, handling and bottling facilities

- i. For all Aboveground Horizontal bullets with the total volumetric capacity upto 705 Cu. M. shall be used for storing LPG and in case of mounded storage (all vessels) the total capacity shall increased up to 1058 cu M.
- ii. For combination of mounded and aboveground vessels, the total capacity of 450 MT shall be permitted with maximum aboveground storage capacity 100 MT.
- iii. The maximum filling in single shift shall not exceed 35 MT.

4.1 GENERAL

The requirements under this section are minimum additional safety requirements for the LPG storage, handling and bottling facilities meeting the requirements as per 4.0. The all other provisions of Schedule 1.0 & 2.0 shall be applicable.

- i. There shall be minimum 3 nos of vessels in each case.
- ii. Confinement / Grading shall be as per Schedule 1 of these Regulations.
- iii. the operation of facilities should be restricted to maximum two shifts operation.
- iv. Filing Facility shall meet the following requirements :
 - a. Filling Machines (Stationary or Carousel) :With not more than 10 filling units.
 - b. Check Scale :To countercheck the quantity of LPG filled.
 - c. Correction scale with Auto cut off facility.
 - d. Compact Valve Tester or any other proven device :To check valve/"O" Ring leakage.
 - e. Test Bath :To check the body./bung leak cylinders.

- f. Evacuation Rack : For evacuation of cylinders.
- g. Purging Manifold : For purging of cylinders.

4.2 Filling Machine

The filling machines shall be provided with auto cut-off system to ensure that LPG supply is cut-off after filling the desired quantity of product.. The filling pressure shall not exceed the design pressure of the cylinders.

4.3 Instrumentation

The storage vessel shall have minimum 2 different type of level indicators. One of them shall be High Level switch With alarm interlocked to close ROV of liquid line and the other may be - Slip Tube Gauge/Roto Gauge/Rochester Gauge/Servo Gauge/Radar Gauge/ or any other proven gauge developed through advancement in technology.

4.4 Safety and Fire Protection

All LPG storage vessels shall be provided heat detection based auto operated sprinkler System with deluge valve.

4.5 Hydrant Main

Fire water ring main always charged with water maintain residual pressure of 7 Kg /sq cm at farthest point with the help of Jockey Pump.

Schedule – 3

Design, Layout, Operation & Maintenance of Refrigerated LPG Storage

Schedule-3A Introduction

Schedule-3B Scope

Schedule-3C Definitions

Schedule-3D Refrigerated LPG Storage and Handling Facilities - Process

Schedule-3E Terminal Layout

Schedule-3F Design Considerations Refrigerated Storage Tanks

Schedule-3G Fire Protection, Safety and Emergency Systems

Schedule-3H Operations of Refrigerated LPG Storage Installation

Schedule-3I Inspection & Maintenance of Refrigerated LPG Storage Installation

Schedule-3J Commissioning and Decommissioning :

Schedule-3K References

Design, Layout, Operation & Maintenance of Refrigerated LPG Storage

1.0 INTRODUCTION

Safety in Refrigerated LPG Storage facilities need specific attention considering the fact that large volumes of LPG are stored at near atmospheric pressure well below the ambient atmospheric temperatures. Any change in the ambient conditions of the product would result in boiling of large volume of liquid at a very high rate which may lead to rise in tank pressure and failure of storage tanks. These tanks are prone to collapse under vacuum in case of high rate of evacuation of product. The product stored in the tanks is without any odour. At present, there is no specific standard in the country for standardizing the design, Layout, Operation and Maintenance of the refrigerated LPG Storage Facilities. This standard is intended to serve as a guide to the Design, Layout, Operation & Maintenance of Refrigerated LPG Storage facilities.

The primary objective of preparing this standard is to ensure safety in Refrigerated LPG Storage facilities by following the basic safety requirements and practices in the design, construction and Operation of Refrigerated Storage Facilities .

2.0 SCOPE

This standard lays down the minimum safety requirements for Design, Layout, Operation & Maintenance of Refrigerated LPG Storage facilities. The facilities at port and the associated cross country pipelines are not part of the scope of the present standard. This standard does not cover the buried / semi buried refrigerated LPG storage facilities.

The requirements of Schedule 1 shall be applicable after the point LPG is no longer in Refrigerated State.

3.0 DEFINITIONS

- a. "Aboveground Tank or Aboveground Vessel" means a tank or vessel all or part of which is exposed above grade.
- b. "Auto-refrigeration" means the chilling effect of vaporization of LPG when it is released or vented to a lower pressure.
- c. "Annular Space" means the space between the primary cylindrical liquid container and the primary cylindrical product vapor container or cylindrical purge gas container of a double wall tank.
- d. "Base Heating System" means a heating system provided in the base slab or soil below the tank system to prevent freezing of the soil and frost heave.
- e. "Base Slab" means a continuous concrete base supporting the tank system. This base may be either at grade or elevated and may be either supported by soil or piles.
- f. "Deriming synonymous with defrosting or de-icing" means the removal, by heating and evaporation, sublimation, or solution, of accumulated constituents that form solids, such as water, carbon dioxide, etc. from the low-temperature process equipment.
- g. "Dyke" means a structure remote from the tank system used to establish an impounding area for the purpose of containing any accidental spill of stored liquid. Sometimes this structure is referred to as a bund wall.
- h. "Elevated Foundation" means a foundation with base slab, supported by either piles or piers located at an elevation above grade, leaving an air gap between the grade and the bottom of the base slab.
- i. "Flameproof Enclosure" means type of protection in which the parts which can ignite an explosive atmosphere are placed in an enclosure which can withstand the pressure developed during an internal explosion of an explosive mixture and which prevents the

- transmission of the explosion to the explosive atmosphere surrounding the enclosure.
- j. "Hazardous Atmosphere" means an atmosphere containing any flammable gas or vapour in a concentration capable of ignition.
 - k. "Design Liquid Level" means maximum liquid level that will be experienced during operation of the tank. This is used for the static shell thickness determination.
 - l. "Maximum Liquid Capacity" means the total volume between the design liquid level and the tank bottom. (This is also referred to as total liquid capacity in API 620.)
 - m. "Maximum Normal Operating Level" means maximum liquid level that will be experienced during normal operation of the tank.
 - n. "Minimum Normal Operating Level" means minimum liquid level that will be maintained during normal operation of the tank. The unusable volume of liquid below the minimum normal operating level is known as Heel.
 - o. "Net Working Capacity" means the volume between the maximum normal operating level and minimum normal operating level.
 - p. "Overfill Protection Margin" means capacity (tank height or volume) between the maximum normal operating level and the design liquid level.
 - q. "Seismic Freeboard" means the design height above the maximum normal operating level to minimize or prevent overflow or damage to the roof due to sloshing of the liquid contents during a seismic event.
 - r. "Load Bearing Insulation" means insulation with special compressive strength properties used for thermal insulation and for transferring the load to the load bearing structure.
 - s. "Primary Liquid Container" means parts of a tank system that contain the liquid during normal operation.
 - t. "Primary Vapour Container" means parts of a tank system that contain the product vapour during normal operation.
 - u. "Pump Column" means a pipe column to house a combined vertical pump and close coupled electric motor. The column itself protrudes through the outer tank roof.
 - v. "Refrigerated Tank System" means storage in a vessel or tank artificially maintained at a temperature below the nominal ambient temperature. This includes the combination of a primary liquid container, together with secondary liquid container (if any), insulation, vapor container, appurtenances, instrumentation and all other associated elements. The product is stored at their respective boiling point depending upon the constitution at near atmospheric pressure.
 - w. "Secondary Liquid Container" means parts of a tank system that contain the liquid in the event of leakage from the primary liquid container.
 - x. "Stratification" means when liquids of different densities are received in the same tank, there is a possibility that layers are created with a less dense liquid overlaying a heavier one. This is called stratification. Unstable stratification may also occur when the liquid in the lower layer becomes less dense due to heat input, while the liquid in the upper layer becomes heavier due to the evaporation at the surface. This unstable situation can relieve itself with a sudden /spontaneous rapid mixing process (Roll over) which occurs in tanks as a result of a density inversion
- y. Process
- i. "Boil-Off" means the process of vaporization of refrigerated product by heat conducted through the insulation surrounding the tank.
 - ii. "Design Pressure" means the maximum gauge pressure permissible in the vapour space above the product of a tank system in its design condition.
 - iii. "Rollover" means the spontaneous and sudden uncontrolled movement of a large mass of liquid from the bottom to the top surface of a refrigerated storage vessel due to an instability caused by an adverse density gradient due to presence of stratified liquids of different densities. Rollover can cause a sudden pressure increase and can affect vessel integrity.
 - iv. "Set Pressure" means the gauge pressure at which the pressure relief device first opens.
 - v. "Set Vacuum" means the gauge pressure at which the vacuum relief device first opens.
 - vi. "Sweetening" means the introduction of LPG vapour into the tank

- vii. "Purging" means the replacement of one gas/vapour by another in an enclosed tank system by displacement, by dilution, by diffusion or by combinations of these actions.

4.0 REFRIGERATED LPG STORAGE AND HANDLING FACILITIES - PROCESS

4.1 Refrigerated LPG:

The product stored either in pure propane & pure butane form or in premixed LPG (i.e. mix of propane & butane conforming to IS: 4576) at their respective boiling point at near atmospheric pressure.

4.2 Receipt of refrigerated LPG, butane or propane.

The refrigerated propane, butane or LPG is discharged by the pumps of the ocean tanker through the unloading arms at the port to the cross country pipelines and is transferred to the designated storage vessels at the terminal through insulated pipelines.

4.3 Storage of Refrigerated LPG:

The primary function of storage vessel is to receive, hold and stock refrigerated product. Above ground dome roof tanks are used to store the liquefied gas at or below its boiling point. The tank is designed to ensure the following functions:

4.3.1 Liquid Retention

The storage tank shall be capable of withstanding the hydrostatic load of the liquid and low temperature of the propane, Butane and /or LPG.

4.3.2 Gas Tightness

Tanks should be tight enough to prevent any evaporation losses and also to avoid ingress of air and moisture.

4.3.3 Thermal Insulation

Thermal insulation shall be provided to limit boil-off rates and to avoid cold spots on the outer shell.

4.3.4 Thermal Stresses

Under normal operating conditions, the tank is subjected to variation in the temperatures. Also during start up, tank temperature is required to be brought down from ambient to refrigerated temperatures. Sometimes the tank may require deriming for various reasons like repair of internals, modifications etc. Hence, the tanks shall be capable of withstanding the heat variation.

The detailed requirements of Refrigerated Storage Tanks has been detailed in section 6.

4.4 REFRIGERATION SYSTEM: BOIL OFF COMPRESSORS, FLASH COMPRESSORS, CHILLERS/ CONDENSERS:

- i. An auto-refrigeration system comprising of positive displacement compressors, LPG condenser and liquid receiver is provided to maintain refrigerated LPG tank pressure. The auto-refrigeration system compensates for heat gain in the tank, headers and in-tank pump heat.

- ii. Large capacity refrigeration compressors called Flash Compressors are operated to handle large-scale refrigeration requirement during ocean tanker receipts and smaller capacity refrigeration compressors called Boil-Off Compressors are used during normal course of operations to maintain tank temperatures at required levels.
- iii. The vapor thus extracted is compressed and then re-liquefied by condensing in condensers / chillers. The condensate, intermediately stored in condensate receivers, is then pumped to separate buffer storage tanks thereby completing an open-cycle auto-refrigeration process. The liquid returned to the either refrigerated storage tank or above ground tank as per the designed process flow.
- iv. Refrigerated storage tanks and refrigeration systems are designed to maintain normal process operations during routine maintenance of equipment, and to assure plant safety under emergency conditions. Sufficient sparing of equipment is provided so that any single piece of equipment can be removed from service while maintaining normal operations.

4.5 Flare System

- i. The terminal shall be provided with flare system to enhance the plant safety. The flaring is done only as a final solution when the normal Boil / Flash compressor are not available able to meet the requirement. Flare is connected to the tank pressure vent valve to provide sufficient time for operator intervention in case of pressure rise. Hot flare shall be provided in view of LPG vapour being heavier than air and no mercaptan is added in the refrigerated product.
- ii. Flare System is very important considering the following:
 - a. Automatic release in the event pressure develops beyond the design pressure.
 - b. Manual venting through ROV & Control Valve during vapour purging operation while commissioning the terminal.
 - c. Moreover, since there would be two types of release, one low temperature and other higher temperature the flare system shall have properly designed knock-out drum.

4.5 Product withdrawal

The product stored in the tanks is pumped out using In tank Pumps (duty and standby) installed inside each tank.

4.7 Heating / Blending

- i. The refrigerated product (LPG/propane/ butane) is brought to ambient condition from its sub-zero temperature by various method of heating the product by either through steam / heat exchangers / air preheaters etc. It is very important to ensure that the product LPG / propane / butane at downstream of heating arrangement shall be at temperature above 15°C. The failure of the heating arrangement to increase the temperature of the product upto 15°C should immediately trip the intank pump and prevent flow of refrigerated product from heating arrangement.
- ii. The product (propane & butane) above 15°C is blended in a blending unit in the correct ratio to make commercial LPG. The final product is dozed with dozing facilities for odorizing ethyl mercaptan from the LPG in the correct proportion.
- iii. The product piping / equipment at the downstream of the heating arrangement up to the blending section shall be of LTCS material only. Other process / utility pipelines shall be as per design

requirements as Per ASME B 31.3.

5.0 Terminal Layout:

5.1 Philosophy:

- i. Terminal lay out philosophy shall consider location of the facilities at a site of suitable size, topography and configuration with a view to minimise the hazards to persons and property due to leaks and spills of LPG. Before selecting a site, all site related characteristics which could affect the integrity and security of the facility shall be determined. A site shall provide ease of access so that personnel, equipment, materials from offsite locations can reach the site for fire fighting or controlling spill associated hazards or for the evacuation of the personnel.
- ii. The safety distances among various facilities shall be maintained as given in Schedule – 1. The minimum distance of 60 m shall be maintained between LPG Storage Tank and Substation. Specific points related to Refrigerated LPG are brought out here.

5.2 Basic Information

Information on following items should be collected before proceeding with the development of overall plot plan.

A:

- Site location map
- Site Geotechnical and Seismic data.
- Soil characteristics
- Prevailing wind speed and direction over a period
- Meteorological data including corrosive characteristics of the air and frequency of lightening
- Area topography contour map
- High flood level in the area and worst flood occurrence.
- Storm water disposal point and effluent disposal point
- Source of water supply and likely entry / exit point
- Electric supply source and direction of entry point
- LPG entry point/ Gas exit point
- Approach roads to main Terminal areas
- Surrounding risks
- Air routes and the proximity of the Airports.
- Fire station
- The Proximity to the unloading jetty.

B:

- Terminal capacity-
- Process flow diagram indicating flow sequence
- Process units and capacities
- Refrigerated LPG storage tanks, sizes and type of storage tanks
- Other LPG storage tanks
- LPG transfer
- No. of flares
- Provision for spill containment and leak control
- Minimum inter distances between facilities as well as between facilities & boundaries
- Operating and maintenance philosophy for grouping of utilities
- Plant and non-plant buildings
- Space for future Expansion

- Chemical storage
- Ware house and open storage areas.

5.3 Grouping:

The Refrigerated LPG Terminal may consist of the following basic facilities.

- Refrigerated LPG receipt line to shore terminal.
- Refrigerated LPG Storage
- Pressurized LPG storage facilities.
- Boil Off / Flash Compressor, condensers, chillers,
- Process Area
- Heating / Blending / dozing facilities.
- Flare system
- Utility Block (Air Compressors, De-mineralization plant, Boiler Room etc.)
- Fire water Storage and fire water Pump House.
- LPG loading/ transfer facilities Road / Rail / Pipeline
- Control Room
- Administrative Block
- Workshop
- Warehouse
- Electrical Substation.
- Laboratory

5.4 General Considerations

- i. Future expansion requirement shall be assessed and provision of space for the same should be made.
- ii. The Erection and Maintenance requirements shall be considered.
- iii. The layout of the facilities including the arrangement and location of plant roads, walkways, doors and operating equipment shall be designed to permit personnel and equipment to reach any area effected by fire rapidly and effectively.
- iv. The layout shall permit access from at least two directions.
- v. Each group shall be separated by roads on all four sides for easy access and emergency handling.
- vi. Classification of areas for Electrical Installations in LPG Terminal shall be as per IS 5571 as applicable.

5.5 Processing Equipment Spacing:

It shall meet the requirements as specified in design standards / licensors guidelines.

5.6 Aboveground Refrigerated LP-Gas Containers

- i. The minimum horizontal distance between the shell of a refrigerated LPG tank and the line of adjoining property that may be developed shall be 60 m. Where residences, public buildings, places of assembly, or industrial sites are located on adjacent property, greater distances or other supplemental protection shall be evaluated.
- ii. Non refrigerated LP-Gas containers or flammable liquid tanks shall not be located within dykes or impoundments enclosing refrigerated LP-Gas containers.
- iii. Refrigerated LP-Gas containers shall not be installed one above the other.
- iv. The minimum distance between aboveground refrigerated LP-Gas containers shall be one-half the diameter of the larger container.
- v. The minimum horizontal distance between the shell of a refrigerated LPG tank and the shell of another non-refrigerated hydrocarbon storage facility shall be the largest of the following

distances subject to a maximum requirement of 60 m.

- a. If the other storage is pressurized, three quarters of the larger tank diameter. or 30 m whichever is more.
 - b. If the other storage is in atmospheric tanks and is designed to contain material with a flash point of 55 or less, one diameter of the larger tank or 30 m whichever is more
 - c. If the other storage is in atmospheric tanks and is designed to contain material with a flash-point greater than 55 C, half the diameter of the larger tank or 30 m whichever is more.
- vi. Refrigerated LPG tanks shall not be located within buildings, within the spill containment areas of other flammable or combustible liquid storage tanks or within the spill containment areas of pressurized storage tanks.
 - vii. The inter-distance requirements among various process facilities such as flash / boil off compressor area heat exchanger / condensers / blending / dosing facilities shall be governed by process / design / hazop considerations.
 - viii. There shall not be any process facility such as condenser / compressor house / dosing / blenders within 30 m of tank shell.
 - ix. The inter-distance for the facilities handling non refrigerated LPG shall be as per Schedule – 1 for respective facilities.

5.7 Spill Containment

- i. Single containment Refrigerated LPG tanks shall be provided with spill containment facilities. Spill containment shall be provided by the dyking of the area surrounding the vessel.
- ii. For double and full containment tanks, only kerb wall of at least 0.6 m height shall be provided. The distance of kerb wall from tank shell shall not be less 15 m. In this case, double wall tanks shall be designed to hold the entire quantity in the outer shell as well as suitable to handle hydrostatic pressure and low temperature requirements.
- iii. To prevent the accumulation of flammable material under or near a refrigerated LPG tank, the ground under and surrounding the tank shall be graded to drain any spills to a safe area away from the tank.
- iv. Dyking (Dyke wall):
 - a. If Dyking around the vessel is to be used for spill containment, the dyked area shall be designed to meet the capacity of single largest tank in the dyke. Effective containment capacity shall be after considering 0.2 m of free board.
 - b. The grading of the area under and surrounding the vessel shall direct any leaks or spills to the edge of the dyked area. The grading shall be a minimum of 1% slope. Within the dyked area, the grading shall cause spills to accumulate away from the vessel and any piping located within the dyked area.
 - c. Each refrigerated LPG tank shall be provided with its own dyked area. The holdup of the dyked area shall be at least 100% of the volume of the tank.
 - d. More than one tank may be enclosed within the same dyked area provided provisions are made to prevent low temperature exposure resulting from leakage from any one tank from causing subsequent leakage from any other tank. When dykes are used as part of the spill containment system, the minimum height shall be 0.5 m, measured from the inside of the dyked area. Where dykes are higher than 1.8 m, provisions shall be made for normal and emergency access into and out of the dyked enclosure. The height of dyke shall not exceed 2.0 m excluding free board of 0.2 m.
- v. The edge of a dyke/ kerb wall , impoundment, or drainage system that is intended for a refrigerated LP-Gas container shall be 30 m or more from a property line that can be built upon, a public way, or a navigable waterway.
- vi. The ground within 7.5 m of any aboveground refrigerated LP-Gas container and all ground within a dyke, impoundment, or drainage area shall be kept clear of readily ignitable materials such as weeds and long, dry grass.

5.8 Marking of Tanks

Each refrigerated storage system shall be identified by the attachment of name plates readily visible and accessible which shall give the following details:

- Manufacturers name and serial number
- Design standard
- Maximum LPG filling level
- Liquid volume of the tank when filled with LPG to the maximum safe level
- Maximum and minimum design pressure
- Maximum and minimum design temperature
- Density of the LPG for which the tank is designed
- Year of construction and test

5.9 Piping, Valves and Equipment:

- i. Piping, valves and equipment for handling refrigerated LPG shall conform to the low temperature requirements and to be suitable for use at the temperature of the application and shall be designed for not less than the maximum pressure and for minimum temperature to which they may be subjected.
- ii. Cast iron shall not be used for piping systems handling refrigerated LPG
- iii. Screwed joints and compression fittings shall not be used in piping for low temperature Propane, Butane or LPG service , except for the instrument lines downstream of an isolation valve.
- iv. All the welds of Propane, Butane or LPG service line shall be tested as per ASME B31.3 Chapter VI and records maintained for future references.
- v. Piping systems and their supports shall be suitably insulated / protected for fire exposure conditions.

6.0 DESIGN CONSIDERATIONS REFRIGERATED STORAGE TANKS

6.1 Design Information: Following information shall be collected at the design stage:

- Natural environmental loads (such as earthquake, wind),
- Spillage handling requirements,
- Corrosion allowances,
- Hazard Protection System requirements (such as water spray, gas detection, if any);
- Accidental loads determined by assessment of risk (such as fire, pressure wave, projectile impact, if any);
- Settlement prediction and inspection method;
- Ambient temperature
- Properties of the stored product, including density at the design temperature,
- Minimum design temperature of primary containment,
- Tank maximum liquid capacity;
- Design liquid level;
- Internal diameter and height of inner tank
- Normal maximum/minimum operating liquid level;
- Design pressure/vacuum, maximum/minimum operating pressure,
- Pressure relief and vacuum set points.(High/low pressure alarm set point,)
- High/low level alarm.
- Minimum normal operating level basis,
- Overfill protection margin,
- Capacity to receive the interface turbulence of two products at different temperature and density.
- Product filling/emptying rates,
- Rollover applicability and rollover prevention provisions,
- Design boil-off rate,
- Condensation of vapours in annular space.
- Risk assessment,

- Applicable codes and standards;
- Materials of tank construction;
- Emergency relief valve discharge flow rate
- Piping and instrumentation requirements,
- NDE applied to non-hydrostatically tested components;
- Tank type,
- Networking capacity,
- Tank location on plot plan,
- Process flow diagrams, piping & instrumentation diagrams (P&IDS)
- Pre-commissioning and commissioning procedures, including purging, drying, and cool down;

6.2 DESIGN REQUIREMENTS

6.2.1 Tank Systems for Refrigerated Storage

This section covers low pressure, aboveground, vertical, and cylindrical tank systems storing liquefied gases requiring refrigeration. These are general requirements on selection of storage concept, performance criteria, accessories/appurtenances, quality assurance, insulation, and commissioning of tank systems. The Refrigerated storage tank system consist of a primary liquid and vapor containment constructed of metal, concrete, or a metal/concrete combination and, when required, a secondary liquid containment.

6.2.2 Metallic Containers

Metallic container materials, design, fabrication, inspection, examination, and testing shall be in accordance with API 620 including Appendix R.

6.2.3 Concrete Containers

Concrete container materials, design, construction, inspection, examination, and testing shall be in accordance with ACI 376.

6.2.4 General Requirements:

For all containment systems, liquid-tightness of the primary liquid container is required. Liquid is not permitted to accumulate outside the primary liquid container during normal operation. Tank systems where this is not assured would require consideration of issues such as liquid collection and disposal, potential cold spots, effect on tank venting, etc.

6.2.5 Type:

Three main different storage concepts are Single containment, Double Containment Tank System and Full Containment Tank System.

6.2.6 Single containment

A single containment system is one having either a single tank or a tank comprising an inner tank and an outer container designed and constructed so that only the inner tank is required to meet the low temperature ductility requirements for storage of that product. The outer container of a single containment storage tank would primarily be for retention and protection of insulating material and to contain the vapour gas pressure, and would not be designed to contain liquid in the event of leakage from the inner tank.

6.2.7 Double Containment (double integrity) Tank System

A double containment system is one having a double tank designed so that both the inner tank and the outer tank are capable of independently containing the refrigerated liquid stored. The inner tank contains the refrigerated liquid under normal operating conditions. The outer tank is intended to contain the refrigerated liquid product leakage from the inner tank. The outer tank is not designed to contain product vapour in the event of liquid leakage from the inner tank.

6.2.8 Full Containment Tank System

- i. A full containment storage tank is one meeting all the requirements of double containment storage plus the additional requirement of that it shall avoid the uncontrolled release of product vapour in the event of liquid leakage from the inner tank.
- ii. The full containment concept evolved from double containment and has the following advantages:
 - a. Controls or prevents the release of product vapors following primary liquid container leakage or failure;
 - b. Greater ability to resist external threats such as blast, fire and impact compared to single and double containment tanks.

6.2.9 Guidance on selection of storage concept:

The selection is to be based on a risk assessment. The risk is a function of not only the storage concept itself but also the way the tank system relates to many other aspects of the overall facility. Therefore other aspects of the facility and its surroundings shall be considered.

Plans for the proposed facility should specifically address the impact of vapour clouds and radiant heat flux on plant facilities and adjacent properties. Intrinsic within this approach is the selection of storage concept; separation distances and proximity to property lines; site topography; soil conditions; and ground water conditions. A review of the site may identify constraints or provide opportunities to utilize specific features of site to the benefit of the facility.

The rate of heat generation from a large pool of burning liquefied gas is significantly higher than that of a similar pool of another oil product. In order to limit the radiant heat flux on the surroundings to acceptable levels it may be necessary to reduce as much as possible the area of the pool of spilled liquefied gas through the selection of containment concept.

6.3 External hazards include the following:

- Environmental hazards including earthquake, lightning, wind loading including hurricane/typhoons, flooding,
- Snow and ice loading, tsunamis;
- Ground conditions, weak strata, liquefiable layers, lateral spreading, and presence of caverns, voids and defects;
- Flying objects, and equipment following a process incident;
- Pressure waves due to vapor cloud ignitions from the process plant, adjacent plant, process equipment, and Carriers including facilities located outside the boundary limits;
- Operational and upset conditions including spillage and leakage of product;
- Maintenance hazards;
- Fire hazards from adjacent tanks, dykes, relief valves, sumps, jet fires, and plant areas;
- Proximity of tanks to external uncontrolled sources of ignition such as ground flares, flares.

6.4 Internal hazards include the following:

- Leakage of product from the inner tank;
- Overfilling of the tank;
- Over/under pressurization of the tank due to process upset;
- Rollover leading to over pressurization of the tank;

- Major leak (i.e. The complete failure of the inner tank);
- Minor leak (i.e. Partial leakage from the inner tank due to a postulated defect);
- Fatigue and cyclic loading of key components (e.g., annular plates);

- Corrosion;
- Failure of pipe work attached to the tank bottom/sides;
- Instrumentation failures.

6.5 Safety Improvement

If the assessment of risk identifies risks that exceed acceptable limits, then positive measures (action) should be taken to reduce the level of risk to an acceptable level. Typical mitigation measures may be as follows:

- Selection of alternative containment concepts (i.e. Migration from single containment to double or full containment);
- Improvements to process equipment selection;
- Substitution of a metal roof on a full containment tank with a concrete roof;
- Increase in safety distances (separation distances) to limit impact in respect of vapor dispersion and radiant heat flux;
- Elimination of ignition sources;
- Selection of alternate layouts and site locations;
- Inclusion of protection systems to shield/protect critical equipment from hazard.

6.6 General Design Considerations:

- i. All pipe connections shall be through the top of the tank to avoid siphoning effect. All isolation valves shall be pneumatically operated and interlocked to prevent accidental movement of tank contents from one tank to another.
- ii. Each tank shall be provided with at least two independent means of determining the liquid level. The same shall be provided with isolation arrangement so that they can be replaced/ repaired without taking the tank out of service
- iii. Additionally each tank shall be provided with high level alarm and a high level trip system which shall be designed to stop all liquid flows into the tank to prevent over-filling.
- iv. The high level trip system shall be independent of both high level alarm and of liquid level gauges.
- v. Double and full containment system shall be provided with means for detecting and removing the liquid leakage / buildup of condensation in the annular space. The provision made for injecting nitrogen for purging is considered meeting the requirement. Vapor at higher temperatures may be pushed for vaporizing the condensate thru this provision.
- vi. All the primary containers shall be tested to the maximum filling level with water.
- vii. Outer tanks of double and full containment system shall be tested as above. To prevent damage to the inner shell the level in the inner tank shall be maintained above the level in the outer shell during the hydrostatic test.
- viii. The tank has a spray-ring for cool-down with product and skin mounted temperature elements at Tank Shell to monitor the cool-down during commissioning. Temperature element is also required to be provided at Tank bottom at different radii in uniformly distributed manner to avoid temperature stratification during commissioning.
- ix. If the tank is resting for a longer period, a potential for temperature stratification could exist. Warmer liquid from the tank bottom is moved upwards during restarting which could lead to excessive evaporation and higher tank pressure. Mean, such as the recirculation should be provided to break the stratification.
- x. Tank shall be provided with pressure/vacuum relief valves as per API standard 2000 independent of the pressure/vacuum control and trip systems.
- xi. Sections of LPG pipe-work that could be blocked are provided with thermal relief valves.
- xii. 100% capacity In-tank pumps (duty and standby) shall be provided for delivery of product from the refrigerated storage tank. An additional separate pump well and foot valve shall be provided

- in each refrigerated tank.
- xiii. Roof manholes shall be provided as per requirement.
 - xiv. Walkways or platforms shall be provided to access all roof appurtenances requiring periodic maintenance such as vents and level gauges and for access to the roof manholes.

6.7 Design Pressure

- i. The design pressure of a refrigerated LPG tank is determined by the product's vapor pressure at the - storage temperature. The set pressure / sizing of the pressure-relieving devices shall be such so as not to allow pressure buildup of more than 105% of the design pressure in the container.
- ii. The tank section above the maximum liquid level shall be designed for a pressure of at least that at which the pressure relief valves are to be set and for the maximum partial vacuum that can be developed. All portions of the tank below the maximum liquid level shall be designed for at least the most severe combination of gas pressure (or partial vacuum) and static liquid head affecting each element of the tank.

6.8 Design Temperature

The design temperature for a refrigerated-LPG tank shall be the lowest of the following:

- i. The lowest temperature to which the tank contents will be refrigerated.
- ii. The lowest shell temperature resulting from cold ambient conditions, if that temperature is below the refrigerated product temperature.
- iii. The auto refrigeration temperature of the contents.

6.9 Pressure / Vacuum Control and Relief Systems:

- i. The purpose of the pressure relief system is to prevent the Tanks from excess pressure beyond design by way of controlled release of hydrocarbon vapour to the atmosphere.
- ii. The purpose of the vacuum control system is to prevent the Tanks from implosion under vacuum beyond design by way of controlled breathing of air from atmosphere into the tank.
- iii. All the tanks shall be provided with a pressure / vacuum control and relief system to maintain the Tank pressure within the design pressure range in all conditions.
- iv. The pressure relief system shall be sized to relieve the flow capacity determined for the combination of the following scenarios responsible for Vapour generation:
 - a. Liquid entering the tank.
 - b. System heat in-leak
 - c. Energy input from Intank Pumps.
 - d. Decrease in atmospheric pressure.
 - e. Mixing of Product of different constituents.
 - f. Fire Exposure
 - g. Operational Upset, such as failure of a control device.
- v. In normal operation such vapours shall be collected by the Boil Off / Flash compressors and the same is re-liquefied thus preventing their loss to the atmosphere.
- vi. The terminal shall be provided with flare system to relieve the excess pressure, when the normal Boil / Flash compressor are not available / able to meet the requirement. Flare is connected to the tank pressure vent valve to provide sufficient time for operator intervention in case of pressure rise.
- vii. The venting rate to be calculated for arriving at the following:
 - a. Size of Control Valve

- b. Size of Flare Header
 - c. Capacity of Flare Stack.
- viii. Low pressures shall be limited by the use of following systems:
- a. Tripping of Boil off / Flash compressors and product transfer pumps.
 - b. The supply of hot gas or liquid or inert gas into the tank.
 - c. The relief system shall be such that it is able to function even at time when the control system is failed.
- ix. The mixing of air with flammable LPG vapours is undesirable and only acceptable when an alternate (implosion leading to potential tank failure) would constitute a greater hazard.

6.10 Pressure / Vacuum-Relieving Devices

- i. Relief Valves shall be provided for tanks designed to conform to API Std 620 R in accordance with API Std 2000.
- ii. The pressure relief valves should be adequate to relieve the worst case emergency flow, assuming all other outlets from the tanks including that of flare are closed.
- iii. When a closed inner-tank design is used with an outer vapor-tight shell, the outer shell shall be equipped with one or more pressure/vacuum-relieving devices.
- iv. Each refrigerated LPG tank shall be provided with a sufficient no of pressure-relieving device set to discharge at no more than the maximum allowable design pressure of the tank.
- v. Tanks that may be damaged by internal vacuum shall be provided with a sufficient no of vacuum-relieving device set to open at not less than the vacuum design pressure.
- vi. A sufficient number of pressure and vacuum relief valves shall be installed on the LP-Gas container to allow each relief valve to be isolated individually while maintaining the full relieving capacities required.
- vii. Factors for consideration for sizing of pressure relief valves:
 - a. Liquid entering the tank at maximum rate.
 - b. Maximum possible boil off assuming failure of boil off compressor.
 - c. Effect of radiation from an adjacent fire (tank)
 - d. Effect of possible hot product intake in the tank.
 - e. Flow of hot liquid / vapour in the tank assuming failure of vacuum protection system.
 - f. Effect of possible mixing of products
 - g. Operational Upset, such as failure of a control device.
- viii. As a minimum, the pressure relief valves shall be sized to discharge vapor in case of refrigeration system failure to maintain the refrigerated storage tank pressure within the design limits for at least 24 hrs.

6.10.1 Product Mixing

- i. Loading LPG into a partially full refrigerated LPG tank where LPG being loaded has a different composition than the existing tank content can cause generation of huge quantities of vapor. If this condition can exist, the vaporization rate can be calculated and included in the sizing of the tank pressure relief valves.
- ii. The vacuum relief devices shall be sized to relieve the flow capacity determined from the combinations of the following factors :
 - a. Maximum possible liquid withdrawal rate.
 - b. Maximum possible vapour withdrawal rate (assuming the compressors fail to trip)
 - c. Rise in barometric pressure.
 - d. Reduction in vapor pressure as a result of filling with sub-cooled liquid

- iii. No vacuum relief capacity credit shall be allowed for gas-repressuring or vapour make-up systems.
- iv. Reduction in the vacuum relief capacity to allow for the rate of vaporization resulting from minimum normal heat gain to the contents of the container shall be allowed.
- v. The pressure and vacuum relief valves must be provided with stop valves with spare positions and interlocks so that inspection / maintenance can be done without opening the tank to atmosphere and without reducing the relief capacity below the design requirements.
- vi. Inlet and outlet piping connections to relief devices shall be included in the selection and sizing of relief devices
- vii. A manually operated full opening stop valve shall be installed between each pressure and vacuum safety relief valve and the LP-Gas container.
- viii. All stop valves installed between a relief valve and a container shall be lockable or sealable in the fully open position.
- ix. Emergency Pressure relief valves shall discharge directly to the atmosphere.
- x. Precautions must be taken to prevent icing on relief valves. Care must be taken to ensure prevention of possibility of freezing up of vent / flare system.
- xi. Care must be taken to ensure prevention of possibility of blockage due to liquid in lines of vent / flare system. Therefore such lines should be free of pockets and slope towards a knock out drum.

6.11 THERMAL CONSIDERATIONS

The tank foundation shall be designed to prevent 0°C (32°F) or lower temperatures from penetrating the pad and soil. This limitation shall be accomplished by ventilation, insulation, heating systems, or a combination of these. Heating elements, controls, and temperature sensors shall be designed for easy access and replacement while the tank is in service. Foundation heating systems shall be provided with temperature monitoring and controls. The design of the supporting structure shall consider loads resulting from (a) the thermal gradient across the supporting structure, foundation, and piling due to the temperature of the contents of the vessel and (b) the thermal shock from accidental spills.

6.11.1 Insulation

- i. The tanks external insulation and cladding shall:
- ii. Be weatherproof and capable of withstanding direct impingement of the cooling water from any fixed deluge system.
- iii. Be impervious to the ingress of moisture. The insulation shall comprise or contain a vapor barrier shall be weatherproofed.
- iv. Insulation and weatherproofing to be fire retardant. Steel surfaces covered by insulation to be properly coated to prevent corrosion.

6.12 TANK ACCESSORIES

6.12.1 Temperature Indicators/ Level Indicators / Pressure Indicators

- i. Each tank shall be fitted with thermocouples or equivalent temperature indicating devices for use during cooldown and operations. Temperature Element shall be provided in skin at uniform interval of the tank shell at different heights for correct representation of temperature of product inside.
- ii. Temperature element is also required to be provided at Tank bottom at different radii in uniformly distributed manner to avoid temperature stratification during commissioning.

6.12.2 Level Indicators

- i. Each tank shall be provided with at least two independent means of determining the liquid level. The same shall be provided with isolation arrangement so that they can be replaced/ repaired without taking the tank out of service
- ii. Additionally each tank shall be provided with high level alarm and a high level trip system which shall be designed to stop all liquid flows into the tank to prevent over-filling. The high level trip system shall be independent of both high level alarm and of liquid level gauges.
- iii. Double containment and full containment system shall be provided with means for detecting and removing the liquid leakage in the annular space

6.12.3 Pressure Indicators

Each tank shall be provided with at least two Pressure Gauges/Transmitters. The same shall be provided with isolation arrangement so that they can be replaced/ repaired without taking the tank out of service. Pressure indicators shall also be provided with local display.

6.12.4 Sampling Connections

If sampling connections are required, they shall be installed on the tank piping rather than on the tank.

6.12.5 Tank Accessory Materials

- i. All materials including non-metallic parts of valves, seals, gaskets, etc shall be resistant to LPG under the service conditions of pressure and temperature to which they will be subjected.
- ii. Low-ductility materials such as cast iron shall not be used.
- iii. Except for instrument lines downstream of an isolation valve, screwed joints and compression fittings shall not be used in piping for low temperature service.

6.13 PIPING REQUIREMENTS

- i. Piping for refrigerated product shall conform to the low temperature requirements of ASME B31.3 or equivalent.
- ii. All the piping welds shall be 100 % radiographed. The same shall be preserved for future reference.
- iii. Location: When cold piping is routed below grade, trenches, casing, other means shall be used to permit expansion and contract of the piping.
- iv. Multiple Product Types: When a storage facility handles more than one type of product, dedicated loading and unloading lines between tanks and racks shall be considered for each type of product.

6.14 Thermal pressure relief:

- i. Any sections of pipelines in which product may get trapped e.g. between shut off valves, shall be protected against excessive pressure caused by thermal expansion of the liquid contents by thermal pressure relief valves.
- ii. The settings shall of thermal pressure relief valves shall not be less than the maximum working pressure of the line and shall not be more than the design pressure of the pipe line.
- iii. If the relief valves discharge to atmosphere the discharge must be arranged in a safe manner.

6.15 Valves

Shutoff valves and accessory equipment shall be of material suitable for the operating pressure and temperature extremes to which they may be subjected.

6.16 REFRIGERATION SYSTEM

6.16.1 LPG Temperature

The refrigeration system shall maintain the product (Commercial Propane, butane and /or LPG) at a temperature at which the LPG's vapor pressure does not exceed the tank's design pressure.

6.16.2 Sizing

- i. The sizing of the refrigeration system shall consider the following factors:
- ii. Heat flow from the following sources:
 - a. The difference between the design ambient temperature and the design storage temperature.
 - b. Maximum solar radiation.
 - c. Receipt of product that is warmer than the design temperature, if such an operation is expected.
 - d. Foundation heaters, connected piping.
 - e. Vapor displacement during filling and vapor return during product transfer.

6.16.3 Pressure-Relieving Devices

- i. The system shall be in line with the design code of the refrigerated storage.
- ii. Refer to API 2000 & API RP 520, Parts I and II, for the proper design of pressure-relieving devices and systems for process equipment used in liquefaction and vaporization facilities.

7.0 FIRE PROTECTION, SAFETY AND EMERGENCY SYSTEMS

7.1 GENERAL

- i. The concept of loss control shall be based on the philosophy that an incident of loss of containment of LPG should not escalate to the extent that facilities are endangered and the public at large is subjected to an unacceptable risk. Reasonable and reliable safeguards for the protection of properties, personnel and surroundings from damages resulting from fires, explosions and other unsafe conditions in a Refrigerated LPG Storage Facility shall be provided so as to accomplish the following objectives considering both normal and abnormal conditions:
 - a. Limit or prevent escalation of a fire by providing spacing that adequately separates the Storage, transfer, loading and unloading equipment, buildings, utility etc.
 - b. Minimize or avoid serious injury to personnel by providing adequate means of escape to evacuate safely, access for emergency responders and safe access for personnel to isolate plant and equipment.
 - c. Contain and prevent the spread of fire by having early detection and warning devices that enable emergency isolation, shutdown and depressurization of vessels/equipment remotely to limit the volume of flammable material released in the event of a fire.
- ii. Refrigerated tanks and their associated dykes and impounding basin should be such that in the event of either a tank fire or a spill fire, thermal radiation levels do not exceed the maximum limits in the table below (IP 1987): In any case, minimum Inter-distances as per design standard / licensors requirements shall be maintained.

Sl Nos	Site							Maximum Thermal Flux (kW/m ²)
1	Outer surfaces of adjacent refrigerated tanks							
			-	Thermally protected(1)				32

				- Unprotected(2)				8
2	Outer surfaces of adjacent tanks having flammable products							
				-Thermally protected(1)				32
				-Unprotected(2)				8
3	Outer surfaces	of adjacent LPG pressure vessels/ process						8
				equipment(3)				
4		Personnel inside boundary						
				-Process Area (4)				8
				-Protected work area(5)				8
				-Work area (6)				5
5		Plant Boundary						
				-Critical area(7)				1.5
				-Urban Area(8)				5
				-Remote area (9)				13
Notes	(1) Protection by water sprays, insulation , radiation screens							
	(2) Protection by spacing alone							
	(3) Allowable radiation flux restricted due to longer duration of exposure resulting from a refrigerated tank /bund fire.							
	(4) Trained plant personnel familiar with escape routes and temporary shelter locations in plant							
	(5) Permanent building where personnel are shielded							
	(6) Temporary building without shielded means of escape							
	(7) Unshielded area with people present during emergencies							
	(8) Neither a remote or critical area							
	(9) Infrequently occupied by people							

- iii. The extent of Fire Protection shall be determined by an evaluation based upon sound fire protection engineering principles, analysis of local conditions, hazards within the facility and exposure to or from other property and include, as a minimum:
 - a. The type, quantity and location of equipment necessary for the detection and control of fires, leaks and spills of LPG, flammable refrigerants or flammable gases all potential fires non process and electrical fires.
 - b. The methods necessary for protection of the equipment and structures from the effects of the fire exposure.
 - c. Fire protection water system
 - d. Fire extinguishing and other fire control equipment's
 - e. The equipment's and process systems to be operated with the emergency shutdown (ESD) system.
 - f. The type and location of sensors necessary for automatic operation of the emergency shutdown (ESD) systems or its subsystems
 - g. Hazard area identification and communication system (Walkie Talkie/ Paging Units).
 - h. The availability and duties of individual plant personnel and the availability of external response personnel operating an emergency.
 - i. The protective equipment and special training necessary by the individual plant personnel for their respective emergency duties.
- iv. Procedures developed for handling emergencies shall include:
 - a. Shutdown or isolation of various equipment in full or partial and other applicable steps to ensure that the escape of gas or liquid is promptly cut off or reduced as much as possible.
 - b. Use of fire protection facilities.
 - c. Notification of public authorities.
 - d. First aid
 - e. Duties of personnel.
 - f. Communication procedure in case of emergency

- vi. Pre incident planning which forms part of site emergency plans should be prepared addressing likely and realistic scenarios to define personnel responsible for addressing an emergency, communication, determine operational actions required for isolating plant and equipment ,quantify the fire or vapour cloud dispersion, set priorities for fire fighting and quantify extent of fire fighting capacity required (equipment and resources) to control the incident effectively. The updated emergency response plan shall be available in the operating control room.
- v. All personnel shall be trained in handling flammable products, use of portable, mobile and fixed fire protection equipment, first aid and breathing apparatus. Training should expand to cover Emergency response the use of fire protection equipment. Refresher training of personnel shall be conducted periodically.
- vi. The planning of effective fire control measures shall be co-ordinated with the authority having jurisdiction and emergency handling agencies such as Fire and Mutual Aid arrangements that are expected to respond to such emergencies.

7.2 IGNITION SOURCE CONTROL

- i. Sources of ignition should be effectively controlled in all hazardous areas by a combination of design measures, and systems of work:
 - a. Using electrical equipment and instrumentation classified for the zone in which it is located.
 - b. Continuity of Earthing /Bonding of all plant/ equipment to avoid static electrical charges build up.
 - c. Elimination of surfaces above auto-ignition temperatures of flammable materials being handled/stored.
 - d. Provision of lightning protection involves installation of a surge protection device between each non-earth bonded core of the cable and the local structure.
 - e. Control and restricted entry of vehicles/ in the zoned areas. Site rules should be clear where normal road vehicles may be taken and areas where they must be excluded.
 - f. Prohibition of smoking/use of matches/lighters.
 - g. Controls will be needed to prevent or minimize the release of gas or vapor during the transfer operation.
 - h. Control of maintenance activities that may cause sparks/hot surfaces/naked flames through a Permit to Work System.
 - i. Furnaces /Heaters with open flames shall be located upwind of the LPG storage or sources of potential leaks.
 - j. Precautions to control the risk from pyrophoric scale, in process equipment.
 - k. Flare shall be located in predominant upwind area at a safe distance arrived as per consequences modeling. Cold flaring/venting should be avoided.
- ii. Road and Rail rakes permitted to enter hazardous areas shall have their engines switched off and locomotives removed prior to commencement of loading /unloading operations. No vehicles shall be permitted within impounding areas or within 15 m of containers or equipment containing LPG, flammable liquids or flammable refrigerants except when specifically authorised and under constant supervision.

7.3 EMERGENCY SHUTDOWN SYSTEMS

- i. The emergency shutdown system shall consider process safety as well as leakage of gas, fire, smoke detection. Depending on seriousness, the level of shut down is required to be graded and considered. This could be by way of section isolation or total complex shut down.
- ii. The emergency shutdown system (ESD) or systems shall be of failsafe design. It should be installed, located or protected so as it is easily operate in the event of an emergency or failure of the normal control system.
- iii. Emergency shutdown systems shall have all components that are located within 15 m of the equipment to be controlled either:

- a. Installed or located where they will not be exposed to a fire or
- b. Be protected against failure due to fire exposure of at least 15 minutes duration.
- iv. Emergency shutdown (ESD) system that when operated:
 - a. Isolates or shutoff a source of LPG, flammable refrigerant or flammable gases.
 - b. Shuts down equipment which on continued operation may add to an emergency.
 - c. Audio-visual alarm at control room with identification of the hazard or emergency area.
- v. When equipment shutdown result in an additional hazard or substantial mechanical damage to the equipment , the shutdown of such equipment or its auxiliaries shall be omitted from the ESD system , provided that continuous release of flammable or combustible fluid are controlled.
- vi. Vessel containing liquids that are subjected to metal overheating and catastrophic failure from fire exposure and not otherwise protected shall be depressurized by the ESD system.
- vii. Initiation of ESD system shall be either manual, automatic, or both manual and automatic, depending upon result of evaluation performed in accordance with fire protection facilities. Manual actuator shall be located in an area accessible in an emergency and shall be located at least 15 meters away from the equipment and marked distinctly and conspicuously with their design function.
- viii. Communication shall be provided between ship and terminal control room. Interlock shall be provided between the ship and the Jetty control Room. Provision shall be given in the jetty for the above facility. During unloading operation, the terminal operator shall take control of the unloading. In addition to automatic shutdown system (ESD) the terminal operator shall be in a position to initiate shut down of unloading.

7.4 FIRE AND HYDROCARBON LEAK DETECTION SYSTEM

- i. Hydrocarbon detectors shall be installed near all potential leak source of LPG vapors e.g. On the top of the vessel, tank dykes, manifolds, pump house manifold etc. Hydrocarbon detector of proper type shall be selected and also shall be proof tested and shall be maintained in good condition. The Hydro Carbon Detection System shall provide early warning on build up of Vapour concentration below the LEL limits. These detectors shall be placed in a way that entire possible source of leaks and collection of products is continuously detected and alarm is set at 20% of lower explosive limit.
- ii. Those areas including enclosed buildings that have a potential for flammable gas concentrations of LPG or spill of flammable refrigerant and fire shall be monitored.
- iii. Continuously monitored low temperature sensors or flammable gas detection systems shall sound an alarm at the plant site and at a constantly attended location. Flammable gas detection systems shall initiate this alarm at 20 % LEL of the gas or vapour being monitored.
- iv. The Fire detectors shall initiate an audio and visual alarm at the plant site and at a constantly attended location.

7.4.1 Power Supply: The supply to the system (control system such as DCS , PLC , control valves , Txs) shall be through a reliable on line uninterrupted power supply. (online UPS).

7.4.2 Architecture Components

- i. The main components shall be:
 - a. Hydro Carbon Detectors
 - b. Field Transmission units / Signal scanners.
 - c. Control system / PC with printing option for alarms
 - d. Display
 - e. Annunciation System etc
 - f. Cables, hooters, repeater, Power Supplies etc.
- ii. All the components installed in the hazardous area shall confirm to the Hazard Area Classification

applicable and shall be certified by PESO / Authorized lab by the country of the origin.

7.4.3 Annunciation System

Appropriate annunciation system shall be available to ensure that all the alarms generated, both, audio and visual are reported to the installation personnel at local and remote control panel. The alarms both, audio and visual can be repeated at additional location to ensure corrective action is taken.

7.4.4 Hydro Carbon Detectors:

- i. The detectors shall be able to detect the presence of Hydro Carbon Vapours well below the LEL level. Any one or more in combination from the following types can be provided.
 - a. Catalytic detectors
 - b. Infra-red detectors
 - c. Line / Path detectors.
- ii. The system shall be available at all times. The control equipment should have data logging facilities to provide print outs of the history of the events with date and time of leakages. The control equipment should be able to generate at least two alarms at different levels of LEL concentration of Hydro Carbons.

7.4.5 Inspection and Testing:

- i. The system health status shall be checked by the safety officer on a daily basis.
- ii. The system shall be thoroughly inspected once in each quarter by releasing Hydro Carbon Mixture at each detector.
- iii. Calibration of the detectors shall be done every three months by releasing known concentration of Hydro Carbon mixture and the records maintained. The drift in the sensitivity of the individual detectors shall be recorded in maintenance history log book during calibration and the detectors with abnormal or wide drift in sensitivity shall be rectified / replaced.

7.5 FIRE PROTECTION SYSTEM FOR LPG TERMINAL

The primary source of fire and explosion hazard is from a leak or spill from the LPG storage or transfer systems.

7.5.1 FIRE WATER SYSTEM

The main components of the fire water system are:

- a. Fire Water Storage
 - b. Fire Water Pumps
 - c. Fire Hydrant/ Monitor distribution piping network.
 - d. Water Sprinkler/ Deluge system.
- i. The fire protection scheme shall be designed on the assumption that only one major fire shall occur at a time in the terminal.
 - ii. For the storage tanks, water sprays shall be provided on the tank shell including the roof and the appurtenances on the tank.
 - a. Water application rate for the tank roof and walls shall be minimum 3 lpm/m²
 - b. The water application rate on the appurtenances shall be 10.2 lpm / m² as per this code.

- c. Water spray is not applicable for the concrete outer tank.
- d. The water densities applicable to other equipment shall be as follows:
 - i. Vessels, structural members Piping & valves manifolds 10.2 lpm / m²
 - ii. Pumps and Compressors: 20.4 lpm/ m²
- iii. The roof section shall be provided with duplicate 100% risers.
- iv. The deluge valves on the water spray systems on the tanks as well as the pumps, compressors, vessels etc. shall be actuated automatically through a fire detection system installed around the facilities with provisions of manual actuation from Control Room or locally at site.
- v. For single containment tanks having metallic outer tank which are having a dyke, high expansion foam systems shall be provided as per NFPA 11. High expansion foam generators shall be located on the impounding area around the storage tanks. Foam units comprising storage facilities and pumps shall be provided in a safe area removed from the protected risk and shall be accessible in an emergency.
- vi. Portable high expansion foam generators may also be provided, suitable for coupling to hydrant hose lines for isolated LPG spills.
- vii. Fire hydrants shall be provided along the main fire header at suitable intervals in the process and storage areas. Fixed foam/water monitors may be provided around the process areas based on requirement.
- viii. Water Spray System shall be provided for process area housing condensers heat exchangers, evaporators, blender with spray density @ 10.2 lpm / Sq. M.

Refer Annexure A1 for typical water Calculations in Refrigerated LPG terminal.

7.6 FIRE EXTINGUISHING AND OTHER FIRE CONTROL EQUIPMENT

- i. Portable wheeled fire extinguishers suitable for gas fires, preferably of the dry chemical type shall be made available at strategic locations.
- ii. Fixed fire extinguishing and other fire control systems that may be appropriate for the protection of specific hazards, are to be provided.
- iii. Vessels, equipment, structures, cables, safety critical instruments etc., that are likely to be exposed to LPG fire radiation shall be provided with a passive fire protection in the form of fire proofing insulation or/and water deluge for the duration of the hazard . Fire proofing shall be executed as per appropriate standards. The extent & duration of passive Fire protection shall be based on the HAZOP study.
- iv. Embrittlement Protection. Equipment and structures shall be protected by insulation or appropriate metallurgy selection against cold shock and failure due to a spill of LPG.
- v. CCTV cameras shall be provided at the critical points for continuous monitoring such as Flash & Boil off Compressor house, heaters, condenser, refrigerated tank dyke, Top of refrigerated tanks, LPG storage Vessels, LPG pump house and blender area, Flare, process area, cross country pipeline transfer area etc.

7.7 PERSONNEL SAFETY

- i. Personnel shall be advised of the serious danger from frostbite that can result upon contact with LPG or cold refrigerant. Suitable protective clothing and equipment shall be made available. Low temperature suits / hand gloves shall be worn when carrying out emergency repairs / maintenance. This is also suitable in case of exposure to flash fires as well.
- ii. Those employees who will be involved in emergency activities shall be equipped with the necessary clothing and equipment.
- iii. Self-contained breathing apparatus shall be provided for those employees who may be required to enter an atmosphere that could be injurious to health during an emergency.
- iv. A portable flammable gas indicator shall be readily available because LPG and hydrocarbon refrigerants within the process equipment are usually not odorized and the sense of smell cannot be relied upon to detect their presence.

8.0 OPERATIONS OF REFRIGERATED LPG STORAGE INSTALLATION:

In refrigerated LPG installation the product is stored either in pure propane & pure butane form or in premixed LPG (i.e. mix of propane & butane conforming to IS: 4576) at their respective boiling point (i.e. - 42 deg C for Pure Propane, - 5 deg C for Pure Butane and – 25 to – 28 deg C for LPG depending upon the constitution) at ambient pressure. The area wise operations are as followings:

8.1 Storage Tank Operation:

8.1.1 Receipt & Storage:

- i. Before receipt of any parcel in the refrigerated storage tanks, it is required to be ensured that the receipt lines to be maintained at the temperature of the receiving product. This is normally done by re-circulating the product of the same specification already available in the storage tank.
- ii. Receipt operation should be carried out in a way so that storage tank pressure & temperature can be maintained within the limit. The same may be accomplished by operating the refrigeration compressors. The storage tank pressure & temperature are the key parameters for this kind of installation, which should be religiously monitored by operational personnel to avert product loss due to auto-flaring or pop-up of SRVs on excess pressure.
- iii. After completion of receipt the receipt lines need to be evacuated by pushing compressed vapor from the refrigeration compressor discharge.

8.1.2 Dispatch:

- i. Specially designed submersible In-tank pumps are used for dispatching of product because of very low NPSH availability. The levels of product to be monitored while starting & during the dispatch operation. The Tank pressure & temperature to be continuously monitored during the dispatch operation as there may be pressure rise due to re-circulation of product or pressure decrease due to faster evacuation of product.
- ii. Before start-up of pumps, it is to be ensured that all the discharge valves are in closed condition. The recirculation valve to be put mandatorily on auto mode.

8.2 Compressor House Operation:

- i. The refrigeration compressors plays very important role in keeping the pressure & temperature in the refrigerated storage tanks under control. The compressors to be run on need basis as per the requirement during receipt, dispatch and even when there is no operation to maintain the pressure.
- ii. These compressors are very big compressors normally run by HT motors with lot of safety interlocks. Normally the capacity of the compressors may also be varied seamlessly as per the requirement.
- iii. These compressors are positive displacement types hence the discharge valves should mandatorily be in open condition while starting the compressors. The cooling water supply & control air supply as per the specification must be ensured. The lubricant supply should be ensured before starting.

8.3 Process Unit Operation:

The process unit consists of following operations:

- a. Condensation of the Refrigeration Compressor Discharge
- b. LPG Condensate Transfer unit
- c. Heating Section for heating the refrigerated product to ambient temperature
- d. Steam Condensate Transfer Unit

- e. Blending of Pure Propane & Pure Butane for manufacturing LPG
- f. Odourisation
- g. Vapour Pressure Analyser

8.4 Condensation of the refrigeration compressor discharge:

- i. Compressed gas from the discharge of the refrigeration compressor is being fed to the condensation unit where the liquefaction process is taking place through heat exchangers using Cooling Water as the cooling medium and the condensate is received in transit tanks (known as product condensate receiver). Subsequently the condensate is pumped to buffer storage bullets where the product is stored under pressurized conditions.
- ii. The whole system of condensation and condensate pumping is being associated with safety interlocks and alarms for safe operation.

8.5 Heating Section for heating the refrigerated product to ambient temperature:

- i. The refrigerated product pumped from the storage tanks is heated through Heat exchangers using LP Steam as the heating medium or by any suitable alternate heating mechanism such as hot air, ambient air, water etc. The steam / air / water heating process is normally a multistage process where product is passed thru more than one heat exchanger. The hot product is routed to blending section for further processing and the steam condensate in case of steam heating arrangement (i.e. LP Steam converts into water by releasing latent heat to the refrigerated product) is collected in a Steam Condensate receiver. The Steam condensate is subsequently pumped from the receiver to the Demineralised Water plant polishing unit for further processing.
- ii. The whole system of heating of product is associated with safety interlocks and alarms to ensure desired temperature of product at the heating section outlet for safe operation.

8.6 Air Preheater System:

Tube bundle is provided for increasing the surface area of the product during travel. All tubes are covered with fins and subjected to forced draft air from the fans operating at fixed / variable RPM to maintain the required temperature at the outlet.

8.7 Steam Condensate Transfer Unit

The unit consists of a Steam Condensate receiver & Condensate transfer pumps. The steam condensate is transferred by the pumps at regular interval preferably in auto mode interlocked with the level of receiver to DM plant condensate receiver tank for further processing.

8.8 Blending of Pure Propane & Pure Butane for manufacturing LPG

The heated product (i.e. Pure Propane & Pure Butane) is blended at specified ratio in blender with the help of automatic flow control valves for making LPG conforming to IS:4576. The property of the blended product is checked thru online analyzer for meeting IS:4576 and subsequent feedback control mechanism. Blending conforming to IS: 4576 is compulsory & hence necessary measure should be always in place to check the composition meeting IS: 4576.

8.9 Odourisation Unit

The LPG is extremely inflammable and it has no odour, so that detection of any leakage of LPG is very difficult. Hence the LPG is subsequently passed thru odourisation section where Ethyl Mercaptan is dosed @ 15 to 20 PPM immediately after blending for identification of any leakage at the downstream in line with IS: 4576. Proper deodorizing agent i.e. Sodium hypo chloride / sand / mask/ etc to be provided at Dozing unit.

8.10 Buffer Storage Operation:

The product transferred from Product condensate receiver is stored at buffer storage in pressurized condition at ambient temperature. Subsequently the product is evacuated by pumps and sent to blending area for further processing.

8.11 Flaring Operation:

Normally these types of installations are equipped with hot flaring facility. Flaring is usually avoided as it leads to loss of product however whenever required flaring resorted to control the pressure inside the refrigerated tanks. Flaring can be done thru flow control valves by operator or it may be done in auto-mode as per the system presets. The flaring is of extreme importance as this is the last resort to maintain the pressure inside the tank & avoid any untoward even due to pressure rise.

8.12 Control Room Operation:

There is lot of operations to be handled simultaneously for running these types of installations. Hence a central control room is provided to facilitate all the operation from remote from a single location. Control Room houses DCS based or equivalent automation system where from all the commands can be initiated, controlled & all the parameters can be monitored thru single window system. The system is backed-up with UPS of suitable capacity.

8.13 Utility Section

The utility section mainly consists of following facilities:

- a) Boiler
- b) Instrument Air
- c) Cooling Tower
- d) Electrical Sub-station

8.13.1 Boiler

If Low Pressure Steam heating is envisaged, Boiler of suitable capacity is used to produce LP Steam for using in heating of refrigerated product. Boiler system houses DM Water Generation Plant, Effluent Treatment Plant & Boilers.

8.13.2 Instrument Air

Instrument Air is used for operating ROVs and other control systems of the entire plant.

8.13.3 Cooling Tower

Cooling Tower is used for supplying Cooling Water for mainly using in condensation of refrigeration compressor discharge, for cooling of refrigeration compressors and other cooling requirements. Maintaining schedule for chemical treatment of cooling water / cooling tower

8.13.4 Electrical Sub-station

- i. For catering the electrical requirement of all HT & LT Motors and other electrical loads.
- ii. DG sets for HT supply and LT supply

8.13.5 Raw Water Tank

Raw Water Tank and associated pumping system on auto mode to top up cooling water reservoir shall be considered.

9.0 INSPECTION & MAINTENANCE OF REFRIGERATED LPG STORAGE INSTALLATION

9.1 INSPECTION –TANK

Routine internal inspection of Refrigerated LPG tanks are not required to be carried out since Refrigerated LPG tanks are not subjected to corrosion under service condition because of the low temperature involved. However, Refrigerated LPG tanks can be taken up for internal inspection when the tanks are taken out of service for other operational / repair reasons.

- i. Inspections to be carried out under the supervision of technically qualified experienced person.
- ii. Tank Settlement – Tanks levels and settlements shall be checked at intervals and records shall be maintained at a frequency of at least once in a year.
- iii. Roof – Outer roofs shall be checked visually for external corrosion at intervals of every Quarter.
- iv. Regular monitoring of LPG leakage in between area of tank & dyke wall using GMS sensors
- v. Check for leakage of liquid LPG from inner tank to outer tank in case of double containment & full containment tanks on continuous basis.
- vi. Visual check to ascertain the condition of external insulation cladding, insulating material & load bearing insulation every year.
- vii. Check foundation bolts and anchor straps for deterioration & tightness every year
- viii. Check filling and off take pipes, supports for movements yearly
- ix. Pressure & Vacuum Relief Valves – Shall be inspected for corrosion, blockage etc and tested annually and records maintained. In-situ tests shall be permissible.
- x. Refrigerated LPG lines inside the terminal – NDT shall be carried out once in three years at selected windows and records maintained. Hydro test of the concerned section shall be done after any hot work.
- xi. Process Unit – Equipment / fittings shall be inspected & tested as per the OEM Stds.

9.1 Storage Tank:

This atmospheric above ground refrigerated tanks are designed for life time without any appreciable maintenance. However regular maintenance is required regarding external painting, insulation, external cladding, calibration of valves, transmitters, gauges etc.. For any other maintenance in this type of tank requires complete de-commissioning of the tank.

9.3 Compressor House:

The regular maintenance requirement of the compressors is as following:

- Checking of lubricant level in the gear box
- Checking of lubricant level in the oil separator drum
- Checking & cleaning of the vapour suction filter
- Checking & cleaning of the Oil Filters
- Cleaning of Intercooler, After-cooler heat exchangers
- Calibration of Safety Valves
- Insulation Resistance Checking of Motors
- Greasing of Motor Bearings
- Checking of Alignment between Motor, Gear Box, Compressor as applicable
- Checking functioning of solenoid valves & control valves
- Maintenance Painting of the equipment

- Major overhauling of the compressor as per the period specified by OEM

9.4 Process Unit:

- Periodical cleaning of Condensers
- Periodical cleaning of Pump Filters
- Periodical cleaning of Heat Exchangers & Vaporisers
- Periodical testing & calibration of safety valves
- Periodical maintenance / overhauling of mechanical valves
- Periodical calibration of gauges, transmitters
- Statutory testing of Heat Exchangers, Condensate Receiver Vessels
- Periodical Calibration of Vapor Analysers
- Maintenance Painting of Structures & equipments
- Periodical calibration of metering pump of odourisation unit.
- Periodic testing of redundancy of the Digital Control System (DCS) and Programmable Logic Controller (PLC) system.
- Periodic checking of various parameters of software programs.
- Periodic checking of all interlocks and logic for effective functionality.

9.5 Buffer Storage

- Periodic Testing of Buffer Vessels
- Periodic cleaning of Pump Filters
- Periodic maintenance / overhauling of pumps
- Periodical testing & calibration of safety valves Periodical maintenance / overhauling of mechanical valves
- Periodical calibration of gauges, transmitters
- Daily monitoring of CP system & rectification if required
- Statutory testing

9.6 Utility Section

- Periodical testing of DM water quality
- Health Checking of the Refractory of Boiler
- Statutory inspection by IBR
- Periodical testing & calibration of safety valves
- Periodical maintenance / overhauling of mechanical valves
- Periodical calibration of gauges, transmitters
- Maintenance Painting of Structures & equipments
- Periodical maintenance of IA Compressor
- Periodical cleaning of Cooling Tower
- Periodic chemical treatment of cooling water.
- Periodical testing of CW Water quality
- Periodical checking & filling of lubricant in CW Fan Gear Box
- Periodical health checking of CW Fan Motors

9.7 Electrical Sub-station:

Carrying out all electrical maintenance periodically as per requirements.

9.8 Inspection of Refrigerated LPG Storage Installation

- Besides routine and statutory inspections like other plants following specific inspection may be undertaken.
- Checking the condition of Insulation of the storage tanks
- Checking the condition of Insulation of receipt lines
- Checking the health of Refractory Lining of Boilers

- SQC of DM Water
- SQC of Cooling Water
- Periodical Checking the quality of all lubricants

9.9 Ethyl Mercaptan Dosing unit

- Periodic testing of ethyl mercaptan storage tank,
- Periodic testing of ethyl mercaptan pumps
- Periodic testing of SRV on mercaptan tank.

9.10 EQUIPMENTS MAINT & INSPECTION

Relevant OEM recommendations shall be followed.

10.0 COMMISSIONING AND DECOMMISSIONING :

10.1 COMMISSIONING

- i. After hydro testing Tanks to be dried to desired level considering storage of the refrigerated product.
- ii. Purging of the Tank to be done by inert gas to drive away ambient air & moistures
- iii. Cool down shall be performed after the tank purge has been completed. A cool down procedure shall be developed to provide a controlled process. During the initial introduction of liquid product, it is important to ensure that the storage tank cools as uniformly as possible. Sharp thermal gradients can cause permanent local distortions and potential crack growth. The cool down rate for a steel primary liquid container shall be as per the design in line with the standard used for design.
- iv. Sweetening of Tanks to be done very slowly by taking refrigerated product vapor thru bottom ring so that temperature stratification at the tank bottom & tank wall can be avoided. The temperature gradient to be closely monitored. The pressure inside the tank is also to be closely monitored so that it lies within the designed pressure range of the Tank. For controlling pressure inside the tank controlled flaring to be resorted till the Tank is completely filled up with the refrigerated product vapour.
- v. For sweetening of tank & maintaining uniform temperature gradient the bottom sprayer rings installed inside the tanks to be used.
- vi. On achieving the final temperature inside tank using refrigerated product vapour, refrigerated liquid product to be introduced very slowly thru bottom sprayer rings for avoiding any cold spot & to be filled up to minimum 6 inches, thereafter the rate may be slowly increased up to designed level.
- vii. The Compressors, Process Unit Equipment, product pipings & Buffer Storage to be purged & sweetened before commissioning of Tank. After sweetening of the Tanks is completed, immediately compressor to be used for maintaining pressure & temperature inside tanks for avoiding flaring loss.

10.2 DECOMMISSIONING:

- i. Refrigerated LPG tanks are constructed for life time and not envisaged for decommissioning. Maintenance of the tank internals should not be attempted on routine basis. However if any operational reasons or any tank internal failure is envisaged decommissioning may be planned.
- ii. Following minimum procedures to be adopted :
 - a. Removal of pumpable liquid using In-tank pumps
 - b. Removal of liquid dead-stock using Compressors by means of vaporization as advised by the licenser. Close monitoring to be done to maintain the Tank Pressure within design pressure range & maintaining a slow temperature gradient suitable as per design.
 - c. Degassing the Tanks using dry inert-gas introducing from the top & evacuating the hydrocarbon

from bottom dip-pipe. The procedure to be continued till the entire tanks become gas free which may be ascertained by sampling.

11.0 REFERENCES

The following codes, standards and publications have either been referred to or used in the preparation of this document and the same shall be read in conjunction with this document:

S.No.	Ref Code No	Title
1	EEMUA: Pub 147	Recommendations for the Design and Construction of Refrigerated Liquefied Gas Storage Tanks
2	IP 9	Institute of Petroleum Liquefied Petroleum Gas Volume 1 Large Bulk Pressure Storage and Refrigerated LPG
3	API 2510	Design and Construction of LPG Installations
4	API 620	Design and Construction of Large, Welded, Low-pressure Storage Tanks
5	API 2350	Overfill Protection for Storage Tanks in Petroleum Facilities, Third Edition
6	API 2000	Venting Atmospheric and Low-pressure Storage Tanks
7	NFPA 58	Liquefied Petroleum gas Code
8	NFPA 59	Utility LP-Gas Plant Code
9	NFPA 59A,	Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)
10	API 625	Tank Systems for Refrigerated Liquefied Gas Storage
11	ACI 376	Code Requirements for Design and Construction of Concrete Structures for the Containment of Refrigerated Liquefied Gases and Commentary
12	AGA XK 0101	Purging Principles and Practice
13	EN 14620:1-4	Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gasses with operating temperatures between 0 °C and –165 °C Part 1 to Part 4.
14	ASTM C165	Standard Test Method for Measuring Compressive Properties of Thermal Insulations
15	ASTM C177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
16	ASTM C240	Standard Test Methods of Testing Cellular Glass Insulation Block
17	ASTM C552	Standard Specification for Cellular Glass Insulation
18	ASTM C549	Standard Specification for Perlite Loose Fill Insulation
19	ASTM C764	Standard Specification for Mineral Fiber Loose-Fill Thermal Insulation
20	ASME B31.3	Process Piping
21	IS 15652	Insulating mats for Electrical purposes
22	IS:875	Code of Practice for Design loads (Other than Earthquakes) for buildings and other structures.
23	IS:1893 (Part 1)-2002	IS 1893 (Part 1) (2002, Reaffirmed 2007): Criteria for Earthquake Resistant Design of Structures
24	IS 3043	Code of Practice for Earthing.
25	IS 5571	Guide for selection of electrical equipment for hazardous areas.
26	IS 5572	Classification of Hazardous area having flammable gases and vapours for electrical installation.

Annexure A1

Fire Water / Pump Requirement Calculation

A. Medium Velocity Water Spray System (MVWSS):							
Sl. No.	Location	Area / size	Area / size	Area of Single largest zone	Area of adjacent zones	Spray Density (LPM)	Hour Cu Mtr per hr
1	Tank Truck Loading / Unloading Facility	30	15	450	0	10.2	275
2	a. Refrigerated Tank Surafce area	35	20	2198	2198	3	791
	b. Refrigerated Tank Roof area	35		961.6	961.63	3	346
	c. Refrigerated Tank Total area						1137
3	LPG Pump House	20	10	200	0	20.4	245
4	Compressor House	30	20	600	0	20.4	734
5	Rail Loadinf Facility	30	15	450	900	10.2	826
6	Process Area	20	15	300	0	10.2	184
7	Horton Sphere	18		1017.4	2034.7	10.2	1868
8	Shed	40	12	480	960	10.2	881

- i. Single largest area covered by Medium velocity Water Sprinkler System is Horton Sphere: 1868
 - ii. Water Requirement for operating 2 nos. Monitors @ 144 Cum/Hr : 288
 - iii. Total Water requirement (i & ii) : 2156 Cum/Hr
 - iv. No. of Fire Water Pumps Required (410 Cum/Hr capacity): $2156/410=5.3$ Say 6
 - v. No. of standby pumps required : 2
- Note:** At least one standby fire water pump shall be provided upto 2 nos of main pumps. For main pumps 3 and more, minimum two standby pumps of the same capacity as the main pumps shall be provided.
- vi. Total number of Fire Water Pumps Required (6 + 2)= 8
 - vii. Total No. of main Fire Water Pumps Available : 6
 - viii. Fire water storage tanks capacity required for 4 Hrs fire fighting (6 x 4 x 410): 9840 Kl
 - ix. Minimum two nos of tanks shall be provided.