IS 6044-2 (2001): Code of Practice for Liquefied Petroleum Gas Storage Installations, Part 2: Commercial, Industrial and Domestic Bulk Storage Installations [PCD 3: Petroleum, Lubricants and their Related Products]

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भारतीय मानक

द्रवित पेट्रोलियम गैस भंडारण संयंत्रों की रीति संहिता

भाग 2 औद्योगिक, वाणिज्यिक तथा घरेलू के अधिक मात्रा में भंडारण के संयंत्र

(पहला पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR LIQUEFIED PETROLEUM GAS STORAGE INSTALLATIONS

PART 2 COMMERCIAL, INDUSTRIAL AND DOMESTIC BULK STORAGE INSTALLATIONS

(First Revision)

ICS 75.200

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 5

FOREWORD

This Indian Standard (Part 2) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Petroleum Products Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This code was prepared with a view to recommend basic safety requirements and practice for the design, construction and safe operation of storage and ancillary facilities for LPG. Wherever these recommendations conflicts with the statutory regulations framed by the Chief Controller of Explosives and Local Fire Brigade Authorities then the latter shall prevail.

This standard was first published in 1972. In this version (first revision) scope has been enlarged covering acrosol plant and auto LPG stations. Location of storage tanks and regulating equipment, fittings of storage tanks, filling capacity installation of underground tanks, pipe fittings, installation and testing, hoses pumps, compressors and meters used for LPG, transfer of LPG from railway tank wagons and water supply have been modified with the latest codes and orders.

In using this standard, IS 4576 which lists the various types of LPG generally marketed, shall be borne in mind.

In using this standard, the static pressure vessel code which is being framed by the Chief Controller of Expolosives shall be borne in mind.

In the preparation of this standard, considerable assistance has been derived from the following publications:

Safety Recommendations IGE/SR/6 Liquefied Petroleum Gases, July 1968. The Institution of Gas Engineers, 17 Grosvenor Crescent; London SW I.

Storage and Handling Liquefied Petroleum Gases, 1967 (N.F.P.A.) 58 The National Fire Protection Association International, 60 Batterymarch Street, Boston, Mass, USA.

Huges (JR), Storage and Handling of Petroleum Liquids, Practice and Law; 1967; Charles Griffin & Co Ltd; 42 Drury Lane; London W.E. 2.

Liquefied Petroleum Gas Safety Code, Part 9: 1967, The Institute of Petroleum, London.

Indian Standard

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PART 2 COMMERCIAL, INDUSTRIAL AND DOMESTIC BULK STORAGE INSTALLATIONS

(First Revision)

1 SCOPE

1.1 This standard (Part 2) lays down the code of practice for LPG bulk storage installations where storage tanks over 450 litres water capacity are used at commercial, industrial and domestic consumers premises.

1.1.1 This standard is not intended to cover LPG storage installations at:

a) Refineries and cylinder/container filling plants;
b) Storage at industrial or commercial premises involving tanks of individual capacity greater than 130 000 litres water capacity;
c) LPG-air distribution plants;
d) Aerosol plants; and
e) Auto LPG stations.

1.2 The maximum capacity of an individual tank and group of tanks at industrial, commercial and domestic premises shall be as follows:

Premises	*Maximum Water Capacity of an Individual Tank, Litres*	*Maximum Water Capacity of Group of Tanks, Litres*
Industrial	130000	260000
Commercial	40000	80000
Domestic	20000	80000

2 NORMATIVE REFERENCES

The following Indian Standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
407 : 1981	Brass tubes for general purposes (*third revision*)
1239	Mild steel tubes, tubulars and other wrought steel fittings :
(Part 1) : 1990	Mild steel tubes (*fifth revision*)
(Part 2) : 1992	Mild steel tubular and other wrought steel pipe fittings (*fourth revision*)
1367	Technical supply conditions for threaded steel fasteners:
(Part 1) : 1980	Introduction and general information (*second revision*)
(Part 2) : 1979	Product grades and tolerances (*second revision*)
(Part 3) : 1991	Mechanical properties and test methods for bolts, screws and studs with full loadability (*third revision*)
1913 (Part 1) : 1978	General and safety requirements for luminaires: Part 1 Tubular fluorescent lamps (*second revision*)
1978 : 1982	Line pipe (*second revision*)
1979 : 1985	High test line pipe (*second revision*)
2148 : 1981	Flameproof enclosures for electrical apparatus (*second revision*)
2309 : 1989	Practice for the protection of buildings and allied structures against lighting — Code of practice (*second revision*)
2501 : 1995	Solid drawn — Copper tubes for general engineering purposes (*third revision*)
2825 : 1969	Code for unfired pressure vessels
3043 : 1987	Code of practice for earthing
3710 : 1978	Filling ratios for low pressure liquefiable gas (*first revision*)
4576 : 1999	Liquefied petroleum gases (LPG) (*second revision*)
4712 : 1984	Forged steel, socket-welding fittings (*first revision*)
4864 : 1968	Shell flanges for vessels and equipment: General requirements

6044 (Part 1) : 2000	Code of practice for liquefied petroleum gas storage installations: Part 1 Commercial and industrial cylinder installations (*first revision*)

3 LOCATION OF STORAGE TANKS AND REGULATING EQUIPMENT

3.1 Location and Spacing

3.1.1 Storage tanks and first stage regulating equipment if used, shall be located outside of buildings.

3.1.2 Each individual tank shall be located with respect to the nearest important building or group of buildings or line of adjoining property which may be built on in accordance with Table 1. The distances given refer to the horizontal distance in plan between the nearest point of the storage tank and building/property line.

3.1.3 In heavily populated or congested areas the authority having jurisdiction may determine the need for other reasonable protective methods to be taken, such as, provision of fire walls, etc.

3.1.4 If fire walls are to be provided, the authority having jurisdiction may determine the extent to which the safety distances for above-ground tanks may be reduced.

3.1.5 Storage tanks shall not be installed one above the other.

3.1.6 No LPG tank (s) shall be located within the bunded enclosures of any other petroleum installation. The minimum distance of separation between LPG storage tanks and any petroleum installation shall be as prescribed under the *Petroleum Rules,* 1976 or as prescribed under SMPV Rules or as per distance specified above in Table 1, whichever is more.

3.1.7 The number of storage tanks in one storage installation shall not exceed six. In case there are more than one storage installations, the safety distance between two installations shall be the same as the distance between the tanks and the property line in accordance with Table 1.

3.2 Bunding

Since LPG is heavier than air, storage tank shall not be enclosed within bund walls. The accumulation of flammable liquid under LPG tanks shall be prevented by suitably slopping the ground.

3.3 Protection

3.3.1 To prevent trespassing or tampering, the area which includes tanks, direct fired vapourizers, pumping equipment and loading and unloading facilities shall be enclosed by an industrial type fence at least 2 m high along the perimeter of the safety zone. Any fence shall have atleast two means of exit. Gates shall open outwards and shall not be self-locking.

3.3.2 When damage to LPG systems from the LPG tank lorry is a possibility, precautions against such damage shall be taken.

3.3.3 Underground tanks shall be protected from above-ground loading by providing a suitable curb to prevent a possible accidental damage to the tank and its fittings by LPG tank lorry.

Table 1 Minimum Safety Distances
(*Clauses* 3.1.2, 3.1.6, 3.1.7 *and* 7.1.10)

Sl No.	LPG Storage Water Capacity of Individual Tank (in Litres)	Distance from Building/Property Line, *m*		Distance Between Tanks, *m*	
		Above-Ground	Under-Ground	Above-Ground	Under-Ground
(1)	(2)	(3)	(4)	(5)	(6)
i)	Up to 2 000	5	5	1	1.5
ii)	Above 2 000 and up to 10 000	10	7.5	1	1.5
iii)	Above 10 000 and up to 20 000	15	10	1.5	1.5
iv)	Above 20 000 and up to 40 000 adjacent	20	15	2	0.25 dia of vessel or 1.5 m (*Min*)
v)	Above 40 000 and above adjacent	30	15	2	0.25 dia of vessel or 1.5 m (*Min*)

NOTE – If the aggregate water capacity of a multi-tank installation is 40 000 litres or greater, the above minimum safety distances shall apply to the aggregate storage capacity rather than the capacity per individual storage tank.

4 STORAGE TANKS

4.1 Design Code

Storage tanks shall be designed, fabricated and tested in accordance with IS 2825 or such standards as laid down or approved by the Chief Controller of Explosives, Government of India.

4.2 Design Pressure

The design pressure of the tank shall be not less than the vapour pressure of the particular LPG to be stored at the highest temperature that the contents of the tank may reach in service. The maximum temperature as prescribed by the Chief Controller of Explosives, Government of India, is 55°C for tank.

4.3 Fittings

4.3.1 *General*

a) Each tank shall be provided with the following fittings:

   i) Pressure relief valve connected to the vapour space — 2 No.

   ii) Independent liquid vessel indicators/gauge — 2 No.

   iii) Pressure gauge connected to the vapour space if the tank has over 2 500 litres water capacity.

Furthermore, each of these fittings shall be suitable for use with LPG at pressures not less than the design pressure of the tank to which they are fitted.

b) Pipe joints over 50 mm nominal size shall be welded or flanged; joints of 50 mm nominal size or smaller shall be welded, flanged.

c) A manhole, if fitted on an underground tank, shall be not less than 45 cm internal diameter and shall be in the form of an extended nozzle of sufficient length to bring the manhole cover above-ground level.

d) All tank fittings of underground tanks shall be on the manhole cover if the tank is equipped with manhole. If the tank is not so equipped, the fittings shall be on extended nozzles so as to be accessible at ground level subject to protection under **3.3.3**.

4.3.2 *Pressure Relief*

a) Relief valves shall be spring loaded and set to discharge at 100 percent and reach full flow conditions within 110 percent of design pressure as required under **4.1**. The design of the valves shall be such that they cannot be inadvertently overloaded and that it is not possible to temper with their pressure setting. Weight loaded relief valves are not permissible. Relief valves shall be constructed so that the breakage of any part will not obstruct the free discharge of vapour under pressure.

b) The full flow capacity of pressure relief valves for above-ground tanks shall be in accordance with Annex A. For underground tanks the full flow capacity of pressure relief valves may be reduced to not less than 30 percent of the prescribed value in Annex A.

c) Every relief valve shall incorporate the following permanent markings:

   i) Manufacturer's name and valve type number;

   ii) Nominal inlet and outlet sizes;

   iii) Start of discharge pressure; and

   iv) Certified discharge capacity of air at atmospheric pressure.

d) If provision is made to isolate any relief valve for testing/servicing, then the remaining relief valves connected to the tank shall provide the full discharge capacity as per Annex A.

e) For above-ground tanks of over 4 500 litres water capacity and for all underground tanks, relief valves shall be fitted with extended vent pipes adequately supported and having outlets at least 2 m above the top of the tank and at least 3.5 m above-ground level. The vent pipes shall be fitted with loose fitting rain caps.

4.3.3 *Shut-off and Emergency Shut-off Valves*

a) All liquid and vapour connections on tanks, with the exception of those for relief valves, plugged openings, and those where the connection is not greater than 1.4 mm diameter opening, shall have shut-off valves located at minimum 3 m from the shadow of the vessel.

b) All liquid and vapour connections on tanks with the exception of those for relief valves and drainage connections of small diameter, shall have an emergency shut-off valve, such as, an excess flow valve, an automatically operated valve or a remotely controlled valve. The emergency valve shall be in addition to the shut-off valve, mentioned in (a) above, unless the valve is a remotely controlled valve which can be operated from a safe area and it is of a fail safe type. Emergency shut-off valves are not considered necessary where the connection to tank is restricted to not greater than 3 mm diameter for liquid and 8 mm diameter for vapour.

c) Where the emergency shut-off valve is of the excess flow type, its closing rate of flow should be below that rate which is likely to result from a fracture of the line it is protecting.

d) Drain connections for larger tanks shall be provided with a shut-off valve which should be

limited to 5 cm nominal size. The shut-off valve should be provided with a length of piping terminating with a second shut-off valve limited to 2.5 cm nominal size. The length of piping between the valves should be such that the risk of simultaneous obstruction of both valves is minimized. A sufficient length of piping should be provided downstream of the second valve to ensure that discharge will not take place beneath the tank. For smaller tanks, the shut-off valve should be limited to 2.5 cm size and its outlet should be provided with a screwed plug or blank flange containing a drain hole of maximum 3 mm size.

4.4 Filling Capacity

The maximum quantity of LPG filled into any tank shall be as per the licenced quantity for the vessel as issued by the Chief Controller of Explosives or his representatives and shall be as per IS 3710.

4.4.1 The maximum filling densities and corresponding maximum liquid content at 15.5°C for LPG of various relative densities shall be as given in Annex B for both above-ground and underground tank installations.

4.5 Foundation for Above-Ground Tanks

4.5.1 Tanks shall be supported on concrete, masonary, or structural steel supports. In the case of structural steel supports, these supports, excluding tank saddles or supporting feet 45 cm or less in height, shall be encased in fire-resisting materials. The thickness of the fire-resisting material shall be in accordance with Table 2.

4.5.2 The design of tank supports and their attachment to the tank shall be in accordance with **4.1**.

4.5.3 Tank supports shall be designed to permit movement of tanks due to changes in temperature.

Table 2 Material for Protection of Structural Steel Supports

(*Clause* 4.5.1)

Sl No.	Protective Material	Minimum Thickness in cm
(1)	(2)	(3)
i)	Plaster:	
	(a) Vermiculite plaster	4.5
	(b) Perlite plaster	4.5
	(c) One layer gypsum wallboard, with 5 cm perlite over 1 cm gypsum board, 1.5 cm scratch coat, and 3.5 cm brown coat	6.5
ii)	Concrete (completely encased)	5
iii)	Brick	10
iv)	Hollow tile (semi-fireproof clay or shale) with wire mesh in horizontal joints, recentrant space filled with concrete	10

4.5.4 The design and construction of foundations shall be based on the load bearing capacity of the ground, its settlement characteristics, and the risk of flotation. The loadings shall take into account the static load of the tank and its contents (product or water if water tested) and wind loads.

4.6 Painting of Above-Ground Tanks

Tanks and their supports shall be adequately painted externally to prevent corrosion with a sun reflective paint such as white or as per colour approved by CCE. Aluminium paint shall not be used for this purpose.

4.7 Installation of Underground Tanks

4.7.1 Tank(s) shall be set on RCC concrete foundation, buried in a masonry pit and shall be surrounded with sweet sand. Where the water table may be high, tanks shall be securely anchored or weighted to prevent floating. The backfill material shall be free of rocks or other abrasive materials and shall be carefully consolidated. It is recommended that minimum 60 cm of cover should be provided on over the top of the tank, or any other recommendations as per CCE's approval condition.

4.7.2 It is recommended that specialist's advice should be obtained on corrosion protection of tanks, including coating materials and application, and whether cathodic protection is necessary or application of epoxy base paint as recommended in NFPA - 58 or any other as per suggestion CCE's licensed condition.

4.8 Marking of Tanks

Each tank shall be conspicuously and permanently marked to include the following:

a) The pressure vessel code to which it is made;
b) The manufacturer's name and serial number;
c) The water capacity in litres;
d) The maximum safe working pressure;
e) Test pressure; and
f) Test date.

5 PIPING VALVES AND FITTINGS

5.1 Materials

5.1.1 All materials including non-metallic parts for valves, seals, gaskets, and diaphragms shall be resistant to the action of LPG under the service conditions to which they are subjected.

5.1.2 Cast-iron piping materials shall not be used.

5.1.3 Seamless steel pipe is recommended. Electrical resistance welded steel pipe normalized throughout its length may be used.

5.1.4 Copper or brass pipe or tubing shall be seamless and shall only be used for sizes 12.5 mm and under.

5.1.5 Steel pipe shall conform to one of the following Indian Standard specifications:

IS 1239 (Part 1), IS 1978 and IS 1979.

5.1.6 Copper pipe shall conform to IS 2501.

5.1.7 Brass pipe shall conform to IS 407.

5.2 Pipe Thickness

To be decided as per design parameter of the system.

5.3 Pipe Joints

5.3.1 Pipe joints over 5 cm nominal size shall be welded or flanged. Joints of 5 cm nominal size or smaller may be welded, flanged, or screwed.

5.3.2 The fabrication of pipework by fusion welding shall be carried out.

5.4 Valves

Valves shall be of cast steel. Only ball valves shall be used. Cast iron valves shall not be used.

5.5 Flanges and Fittings

5.5.1 Steel flanges and flanged fittings shall conform either to section IV of IS 2825 or IS 4864.

5.5.2 Slip-on or welded neck flanges or screwed flanges may be used for sizes of 5 cm or smaller.

5.5.3 Steel butt welded fittings shall be at least of the same schedule thickness as the pipe.

5.5.4 Steel socket couplings and fittings shall be in accordance with IS 4712 and may be either welded or screwed type.

5.5.5 Steel unions shall be in accordance with IS 1239 (Part 2). They should have ground metal-to-metal seats; gasket type unions shall not be used.

5.5.6 Plugs shall be solid steel plugs or steel ball plugs. Cast iron or brass plugs shall not be used.

5.6 Bolting

Bolting shall be supplied according to IS 1367 (Parts 1 to 3).

5.7 Installation and Testing

5.7.1 Liquid and vapour pipelines shall be installed so as to have adequate flexibility to accommodate any settlement of tanks or other equipment, thermal expansion, or contraction or any other stresses which may occur in the pipework system.

5.7.2 Any equipment or section of pipeline in which liquid may be trapped, for example, between shut-off valves, shall be protected against excessive pressure caused by thermal expansion of the contents. The minimum setting of relief valves provided for this purpose shall be not less than the maximum pressure, under normal operating conditions, of the section of pipeline which they are protecting. If pressure relieving devices discharge to atmosphere, the discharge should be arranged in a safe manner.

5.7.3 All pipeline system after installation shall be proved free from leaks at the following pressure or at the maximum operating pressure whichever is higher (*see also* **5.8**).

a) Vapour pipelines (up stream and down stream at 1.5 times working pressure)

b) Liquid pipelines (down stream) at 1.5 times working pressure.

5.7.4 Piping both underground and above-ground shall be protected against physical damage and corrosion.

5.8 LPG Inside Premises

LPG in either the liquid or vapour phase shall not be piped inside premises at pressures in excess of 1.5 kg/cm^2 gauge.

NOTE — Piping, fittings and valves installed inside premises shall be in accordance with relevant clauses of IS 6044 (Part 1).

6 HOSES, PUMPS, COMPRESSORS, AND METERS USED FOR TRANSFER OF LPG

6.1 Hoses

6.1.1 The design, materials, and construction of hoses shall be suitable for the grade of LPG which they are to handle. They shall be tested at 30 kg/cm^2 during initial manufacturer and designed to withstand a minimum bursting pressure of four times the maximum pressure they will carry in service.

6.1.2 Hoses shall periodically be tested for electrical continuity, the frequency of the test depending on the amount of use.

6.1.3 Excess-flow valves, automatically operated valves, or remotely controlled valves or of quick shut-off couplings to be installed in pipelines to which hoses are connected to prevent discharge of LPG in the event of failure of the hose.

6.2 Pumps, Compressors and Meters

6.2.1 The design, materials, and construction of pumps, compressors and meters shall be suitable for the type of LPG which is to be handled, and they shall be designed for the maximum outlet pressure to which they will be subjected in operation.

6.2.2 Seals used shall be of the mechanical type.

6.2.3 Positive displacement pumps and compressors shall have a by-pass or other suitable pressure relieving device against over pressure.

7 VAPOURIZERS

7.1 General

7.1.1 Vapourizers may be low pressure steam heated, hot water heated, electrically heated, or direct gas fired type.

7.1.2 Vapourizers shall be of sufficient capacity to supply the latent heat of vapourization necessary to convert the liquid into vapour at the maximum off-take required from the installation.

7.1.3 Where necessary, precautions against the accumulation of condensate in the vapour discharge line shall be taken. This may require insulation of the vapour discharge line or, in cold areas, the provision of condensate pockets capable of containing the quantity likely to be condensed during a plant shut-down.

7.1.4 With steam and hot water heated vapourizers, care shall be taken to avoid freezing of the steam condensate of water. Ice may be formed when exceptionally high vapour withdrawal rates cause excessive cooling of the liquid LPG in the bottom of the vapourizer.

7.1.5 If a vapourizer system is provided with a drain, the discharge should be arranged at a safe place.

7.1.6 Vapourizers shall not be fitted with fusible plugs.

7.1.7 Heating coils shall not be installed inside a storage tank to act as a vapourizer.

7.1.8 Valves shall be installed to shut-off the liquid and/or the vapour connection between the storage tank and the vapourizer.

7.1.9 Vapourizers shall not be installed in a building except where the building is used exclusively for gas manufacture or distribution. Such buildings should be of non-combustible construction and well ventilated near the floor line and roof.

7.1.10 Vapourizers, other than direct fired type, shall be installed at a minimum distance of 2 m from the nearest storage tank. Direct fired vapourizers shall be installed at minimum safety distances, in accordance with Table 3. When the safety distances for direct fired vapourizers exceeds the safety distances for the tank as specified in Table 1, then an industrial fence at least 2 m high shall be provided around the vapourizer at a minimum distance of 2 m from the vapourizer. No combustible material shall be stored within the safety zone.

Table 3 Safety Distances for Direct Fired Vapourizers

Liquid Vapourizing Capacity of Vapourizer, kg/h	Distance of Vapourizer from Storage Tank, Building, or Property Line, m
Up to 80	4.5
Over 80 and up to 220	7.5
Over 220	15

7.2 Construction

7.2.1 Vapourizers shall be designed, fabricated, and tested in accordance with a recognized and appropriate pressure vessel code, for example, for vapourizers other than the direct fired type (*see* IS 2825) and the direct fired type vapourizers shall conform to those codes as applicable to the conditions for which the unit is designed.

7.2.1.1 Vapourizers shall be designed to facilitate testing, inspection, and servicing of both LPG and heating units without undue disturbance of the whole vapourizer.

7.2.2 Each vapourizer shall be marked to include the following:

a) The pressure vessel code to which it is made;
b) The manufacturer's name and serial number;
c) The maximum working pressure and temperature;
d) The vapourizing capacity in kg/h;
e) The year in which it is made; and
f) Dates of tests.

7.3 Pressure Relief Devices

7.3.1 Vapourizer systems shall have, at/or near the vapour discharge, a pressure relief valve or valves which are set to discharge and which will reach full flow conditions as required by the code to which the vapourizer is designed and constructed.

7.3.2 The pressure relief valve or valves shall provide an effective rate of discharge in accordance with 7.3.3.

7.3.3 The minimum required rate of discharge shall be obtained as follows:

a) Obtain the total surface areas by adding the surface area of the vapourizer and heat exchanger directly in contact with the liquid LPG.
b) From Annex A, obtain the minimum required rate of discharge in cubic metre of air per minute at 15.5°C and one atmosphere pressure.

7.4 Liquid Control

7.4.1 The liquid level control may be integral with the vapourizer vessel or fitted separately adjacent to the vapour discharge from the vapourizer vessel.

7.4.2 Vapourizers shall be provided with suitable automatic means to prevent liquid LPG passing through the vapourizer to the gas discharge piping.

7.5 Heat Input Control

7.5.1 The heat input shall be suitably controlled to prevent the pressure in the vapourizer vessel reaching the start-to-discharge pressure of the pressure relief valve or valves in the vapourizer system.

7.5.2 The heating medium lines leading into and leaving the vapourizer shall be provided with a suitable means

for preventing the flow of LPG into the heating system in the event of tube rupture in the vapourizer.

7.6 Connections Between Vapourizer and Storage Tank

The vapourizer may be connected to a vapour phase position on the storage tank in addition to the connection to the liquid phase position. The necessary liquid controls under 7.4, and heat input control under 7.5 shall be designed to suit the arrangement employed.

8 GENERAL SAFETY REQUIREMENTS

8.1 Static Electricity and Lightning Protection

Earthing and bonding, telecommunications and instrumentation shall be in accordance with IS 1913 (Part 1), IS 2309 and IS 3043.

8.2 Hand torches if used shall be of approved flame-proof type.

8.3 All electrical installations within the safety zone shall be of flame-proof type conforming to IS 2148.

8.4 Grass and Weed Removal

Readily ignitable material, such as, weeds, long grass or any combustible material shall be removed from an area within 3 m from the shell of any LPG tank of up to 2 000 litres water capacity, and within 6 m from the shell of larger tanks. If weed killers are used, chemicals which are a potential source of fire hazard shall not be selected for this purpose.

8.5 Warning Signs

No smoking or naked flames shall be permitted within the safety zone of the installation. Prominent, notices to this effect shall be posted at access points.

9 TRANSFER OF LPG

9.1 From Road Tank-Lorries

9.1.1 A minimum safety distance of 9 m shall be maintained between:

a) Centre line of tank-lorry hard standing/discharge point and the adjoining property,

b) Centre line of the tank-lorry hard standing and the storage tank shell.

9.1.2 The tank-lorry hard standing shall be within the fence area of the storage installation.

9.2 Instructions given in Annex C shall be strictly observed during the transfer of LPG from road tanker to the installed tanks.

10 FIRE PROTECTION

10.1 General

The possibility of a major fire outbreak, leading to direct flame impingement of the storage tank, shall be minimized by sound engineering in plant design and layout, good operating practice, and proper education and training of personnel on both routine operations and on action to be taken in an emergency.

10.2 Water Supply

Provision shall be made for an adequate supply of water and fire protection in the storage area according to the local fire services regulations, or minimum arrangements shall be made for spraying of water at the rate of 10 lpm on each vessel in the bund. Spraying of water to be arranged in the LPG pump/compressor house also. The fixed water spray system shall be automatic. The additional application of water may be by hydrants fixed monitors and through mobile equipment. Control of water flow should be possible from outside any danger area.

10.2.1 Hydrants, where provided, shall be readily accessible at all time and so spaced as to provide for the protection of all tanks.

10.2.2 Sufficient lengths of fire hose shall be provided and be readily available. It is desirable to equip the outlet of each hose line with a combination jet and fog nozzle. These should be in good condition and periodically inspected.

10.2.3 Mobile equipment, field monitors, or fixed spray systems shall be designed to discharge water at a rate sufficient to maintain an adequate film of water over the surface of tank and support under fire conditions.

10.2.4 Consideration shall be given to the provision of mobile or fixed water-spray systems giving suitable and effective protection for road tanker and rail tank car loading and unloading areas.

10.3 Fire Extinguishers

At least two numbers of 10 kg capacity dry chemical powder type and one number of 50 kg capacity dry chemical powder type wheel mounted fire extinguishers shall be positioned near the storage area. In addition minimum two numbers of 10 kg DCP (dry chemical powder type) fire extinguishers shall be positioned at the product transfer area, that is, tank truck unloading area.

ANNEX A

[(*Clause* 4.3.2 (b)]

CAPACITY OF SAFETY VALVES (IN CUBIC METRES PER MINUTE OF AIR WITH RESPECT TO SURFACE AREA OF THE PRESSURE VESSELS)

Surface Area in m^2	*Flow Rate in* m^3*/Min of Air*	*Surface Area in* m^2	*Flow Rate in* m^3*/Min of Air*	*Surface Area in* m^2	*Flow Rate in* m^3*/Min of Air*
(1)	(2)	(1)	(2)	(1)	(2)
2.0	19	15.5	102	56	292
2.5	23	16.0	106	61	315
3.0	27	16.5	108	66	335
3.5	31	17.0	111	71	356
4.0	34	17.5	114	76	377
4.5	37	18	116	81	398
5.0	42	19	121	86	418
5.5	44	20	126	91	437
6.0	46	21	132	96	459
6.5	50	22	137	101	476
7.0	54	23	142	106	495
7.5	56	24	147	111	513
8.0	58	25	152	116	533
8.5	62	26	158	121	550
9.0	65	27	162	126	570
9.5	68	28	166	131	589
10.0	71	29	174	136	607
10.5	75	30	178	141	625
11.0	77	31	183	146	644
11.5	81	32	187	151	662
12.0	83	33	192	156	680
12.5	86	34	195	161	698
13.0	88	35	200	166	715
13.5	91	36	204	171	733
14.0	94	41	227	176	751
14.5	97	46	250	180	765
15.0	99	51	272		

ANNEX B

(*Clause* 4.4.1)

MAXIMUM FILLING DENSITIES AND CORRESPONDING MAXIMUM LIQUID CONTENT AT 15.5°C FOR LIQUEFIED PETROLEUM GASES OF VARIOUS RELATIVE DENSITIES

LPG Relative Density at 15.5°C	*Above-Ground Containers*		*Under ground Containers*	
	Filling Density	Maximum LPG Content at 15.5°C Volume	Filling Density	Maximum LPG Content at 15.5°C Volume
	Percent	Percent	Percent	Percent
(1)	(2)	(3)	(4)	(5)
0.496-0.503	41	82.6-81.5	45	90.7-89.4
0.504-0.510	42	83.3-82.3	46	91.2-90.2
0.511-0.519	43	84.1-82.8	47	91.9-90.5
0.520-0.527	44	84.6-83.5	48	92.3-91.1
0.528-0.536	45	85.2-83.9	49	92.8-91.4
0.537-0.544	46	85.6-84.5	50	93.1-91.9
0.545-0.552	47	86.2-85.1	51	93.5-92.3
0.553-0.560	48	86.8-85.7	52	94.0-92.9
0.561-0.568	49	87.3-86.3	53	94.4-93.4
0.569-0.576	50	87.9-86.7	54	94.9-93.7
0.577-0.584	51	88.4-87.4	55	95.3-94.2
0.585-0.592	52	89.9-87.8	56	95.8-94.5
0.593-0.600	53	89.4-88.3	57	96.1-95.0

ANNEX C

(*Clause* 9.2)

INSTRUCTIONS FOR TRANSFER OF LPG

C-1 OPERATIONS

C-1.1 Training

The following recommendations apply to industrial and commercial installations.

C-1.1.1 Those responsible for the operation of equipment and the handling of LPG should understand the physical characteristics of the product and be familiar with the relevant sections of this code relating to their spheres of responsibility.

C-1.1.2 Responsible personnel should be trained in the fundamentals of fire-fighting and fire-control with particular reference to fires involving LPG. They should also be trained in the correct handling of any fire fighting and fire-control equipment provided and should be exercised in this respect at frequent intervals. The location of all gas and liquid piping and valves should be known and their use understood.

C-1.2 Product Transfers

C-1.2.1 Before LPG is transferred from a container to any other container whether it is a storage tank, road tanker, rail tank car, or portable container, the following procedure should be followed:

a) The receiving container should be checked to ensure that it is in safe working condition and that it is not to be filled with a grade of LPG for which it is not designed.

b) The receiving container should be checked to ensure that it has sufficient ullage to receive the parcel being transferred to it.

c) The inter-connecting system, that is, pipework, fittings, valves, hoses, etc, should be checked to ensure that it is in safe working condition and that only valves, etc, required for the transfer operation, or any other operation proceeding simultaneously, are open.

d) The inner-connecting systems should be checked to ensure that product cannot be charged into lines, equipment, or containers not designed to handle it and that unacceptable product contamination will not occur.

C-1.2.2 During LPG transfers from container to container and on completion of the operation, the receiving container should be checked to ensure that it is not being overfilled and on completion is not filled above its safe working level.

C-1.2.3 In this case of road tankers and rail tank cars, in addition to the requirements of **C-1.2.1** and **C-1.2.2**, the following procedure should also be followed:

a) The vehicle should be prevented from accidental movement during the transfer operation. The parking brake of a road tanker or the hand brake of a rail tank car should be on and, where necessary, wheel chock blocks should be used.

b) Any driving units or electrical equipment not required and not specifically designed for the transfer operation should be stopped and/or isolated.

c) The tank of a road tanker should be electrically connected to the fixed installation before any product transfer operation is carried out.

d) Before the vehicle is moved, the electrical and the liquid and vapour connections should be disconnected, care being exercised to avoid spillage. Where wheel chock blocks have been used they should be removed. The vehicle should be checked to ensure that any LPG that has leaked or has been vented has safely dispersed.

C-1.3 Draining of Tanks

Particular care should be exercised when draining water from tanks in order to prevent escape of LPG. On larger tanks there should be two drain valves. The valve nearer the tank should be opened first and draining controlled by gradually opening the valve further from the tank. On completion of the draining operation, the valve further from the tank should be closed first, then the valve nearer to the tank.

C-1.4 Attendance During Operations

C-1.4.1 A competent person remain in attendance during all transfer operations and should ensure that when transfers take place outside a petroleum or other protected area, the necessary warning notices against smoking and the use of naked lights are displayed and that the requirements of **C-1.2** are complied with.

C-1.4.2 No drain valve, bleed valve, pipeline, etc, in the LPG system which communicates directly to the outside air should be left open without an operator in attendance unless positive measures have been taken to prevent escape of product.

C-1.4.3 If it is necessary to discontinue temporarily a vehicle loading operation, and return later to complete it, the loading hose should be disconnected from the vehicle for the period of absence.

C-1.4.4 The person in-charge of operations should ensure that transfer operations are stopped and all valves closed in the event of the following occurrences:

a) Uncontrolled leakage,

b) A fire in the vicinity, and

c) A severe electrical storm in the vicinity in the case of an operation which involves venting of LPG.

C-1.5 Lighting Storage and Operating Areas

Operations should not be carried out during the darkness unless adequate flameproof lighting is available.

C-1.6 Purging and Filling Tanks and Systems

C-1.6.1 When new tanks and systems are to be taken into commission or tanks and systems which have been gas-free are to be filled they should first be cleared of air.

C-1.6.2 Air should be replaced by an inert gas, water, or LPG dependent on circumstances. If water is used to replace the air, provision should be made for its complete removal. If LPG vapour is used to replace the air, then the tank and the system will contain, for a period of time, a flammable mixture, and a flammable mixture will be vented from the tank and the system; adequate precautions to prevent its ignition are, therefore, essential.

C-1.6.3 In the case of air removal by means of an inert gas or LPG vapour, sampling and testing of the tank contents and the mixture determine the completeness of the air removal and the flammability of the issuing gas.

C-1.6.4 On filling the tank and the system, care should be taken to prevent excessive chilling by the too rapid evaporation of the LPG pumped into it.

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