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DRAFT EAST AFRICAN STANDARD

Handling, storage and distribution of liquefied petroleum gas in domestic, commercial, and industrial installations — Code of practice — Part 3: Liquefied petroleum gas installations involving storage vessels of individual water capacity exceeding 9000 L

EAST AFRICAN COMMUNITY

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Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in the East African Community. It is envisaged that through harmonized standardization, trade barriers that are encountered when goods and services are exchanged within the Community will be removed.

The Community has established an East African Standards Committee (EASC) mandated to develop and issue East African Standards (EAS). The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the public and private sector organizations in the community.

East African Standards are developed through Technical Committees that are representative of key stakeholders including government, academia, consumer groups, private sector and other interested parties. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the Principles and procedures for development of East African Standards.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

The committee responsible for this document is Technical Committee EASC/TC 038*, Liquefied Petroleum and Natural Gas Equipment and Accessories.*

Attention is drawn to the possibility that some of the elements of this document may be subject of patent rights. EAC shall not be held responsible for identifying any or all such patent rights.

Handling, storage and distribution of liquefied petroleum gas in domestic, commercial, and industrial installations — Code of practice — Part 3: Liquefied petroleum gas installations involving storage vessels of individual water capacity exceeding 9000 L

1 Scope and field of application

1.1 This draft East African Standard covers recommendations for the layout, design and installation of liquefied petroleum gas equipment and of storage vessels of individual water capacity exceeding 9000 L.

1.2 This standard covers installation of aboveground, buried and mounded storage vessels

1.3 This standard does not cover refrigerated LPG storage. .

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EAS 924-2, *Handling, storage, and distribution of Liquefied Petroleum Gas (LPG) in domestic, commercial, and industrial installations — Code of practice — Part 2: LPG installations involving gas storage vessels of individual water capacity exceeding 150 L and combined water capacity not exceeding 9 000 L per installation*

EAS 924-1, Handling, storage, and distribution of Liquefied Petroleum Gas (LPG) in domestic, commercial, and industrial installations — Code of practice — Part 1: Storage and filling sites for refillable LPG containers of capacity not exceeding 150 l

BS 1600, *Specification for dimensions of steel pipe for the petroleum industry*

BS EN 3212, *Specification for flexible rubber tubing, rubber hose aid rubber hose assemblies for use in LPG vapour phase and LPG/air installations*

BS 4089, *Specification for metallic hose assemblies for liquid petroleum gases and liquefied natural gases*

BS EN 5292, *Specification for jointing materials and compounds for installations using water, low-pressure steam or 1st, 2nd and 3rd family gases*

ASME Section VIII, Divisions I and II : *Boilers and pressure vessel code- Rules for construction of pressure vessel*

EI 250/69, *Petroleum measurement tables — Metric units of measurement based on a reference temperature of 20 ^{0}C*

IEC 60079 parts 1-25 (All parts), *Explosive atmospheres*

ISO 3183, *Petroleum and natural gas industries — Steel pipe for pipelines — Technical delivery conditions*

EN 13445, *Unfired pressure vessels*

ASTM D1250/ IP200, *Petroleum measurement tables*

NFPA 58, *Liquefied petroleum gas code*

EEMUA publication No.190. *Guide for the design, construction and use of mounded horizontal cylindrical vessels for pressurised storage of LPG at ambient temperature*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
acceptable
that which meets the requirements of the approving authority

3.1
approved
that which has been authorised by the approving authority

3.2
approving authority
within the scope of the relevant competent authority(ies) in the Partner States

3.4
capacity
maximum water volume of the storage vessel

3.5
design pressure
pressure used for calculating the minimum shell thickness of the storage vessel

3.6
filling ratio
ratio of the mass of LPG introduced into a storage vessel to the mass of water (determined at, or corrected to, 20 °C) that would fill the storage vessel

NOTE The term filling ratio applies when the filling of a liquefied gas into a storage vessel is controlled by the mass of the gas introduced

3.7
fire protection
3.7.1
fire wall
wall or other barrier of height at least 1.8 m or top of the tank whichever is higher, and with a fire rating of at least 2 h constructed and placed with the objective of preventing the spread of fire as the result of the radiation of heat from one place to another

3.7.2
vapour barrier
wall or other barrier of height at least 0.5 m constructed and placed with the objective of preventing the passage of vapour from any one place to another

3.8
gas storage vessel
horizontal or vertical storage vessel of capacity exceeding 500 L and of the above-ground, buried, mounded (semi-buried) or semi-mounded type

3.9
hazard
threat of rupture or other failure of a storage vessel to surroundings within a radius of (nominally) 500 m of the storage vessel

NOTE Hazards will normally vary proportionately with the concentration of property or people within this radius as well as with the capacity of the storage vessel.

3.10
LPG (Liquefied Petroleum Gas)
pure propane, butane or a mixture of the propane and butane

3.11
point of gas release
location where liquid or vapour LPG can be released to atmosphere during the course of normal operations

3.12
point of transfer
location where connections and disconnections are made and where LPG is vented to the atmosphere in the course of transfer operations

3.13
regulations
vessels under pressure regulations as per Partner States legislation

3.14
risk
likelihood of a storage vessel being exposed to damage, gas escape, radiant heat and similar dangers

NOTE Risk is independent of the capacity of a storage vessel and represents an evaluation of the effect that external circumstances could have upon the storage vessel

3.15
safe working pressure
maximum gauge pressure, at the coincident metal temperature, that is permitted for a storage vessel when in operation

3.16
hazardous area
an area in which an explosive gas atmosphere is expected to be present in quantities that requires special precautions for constructions, installations and use of apparatus (see table 5)

3.17
Non-hazardous area
an area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for constructions, installations and use of apparatus

4 Construction and initial (production) testing of storage vessels

4.1 General

Consideration has to be given to the properties of the gas when the location of LPG vessels and the construction of installations for conveying the gas in domestic dwellings and commercial buildings are decided on.

All persons concerned with the installation of vessels and appliances should be registered with the approving authority and should be familiar with the following characteristics of the gas and the precautions to be observed:

a) the gases are stored as liquids under pressure;

b) leakage, especially of liquid, can release large volumes of highly flammable gases;

c) a gas-air mixture containing approximately 1.5 % to 10 % by volume of LPG is flammable. If a large enough volume of gas is dispersed in the atmosphere as to reach flammable proportions throughout, ignition of the mixture will result in a rate of combustion of near-explosive force;

d) LPS is denser than air and will flow along the ground and through drains, and can be ignited at a considerable distance from the source of leakage; low-level ventilation in buildings is, therefore, of utmost importance;

e) LPG is non-toxic but, as it can induce headaches and dizziness when inhaled, inhaling these gases should be avoided whenever possible;

f) LPG can, by its rapid vaporization and consequent lowering of the temperature, causes severe cold burns when in contact with the skin. Protective clothing, such as gloves, goggles, aprons, and gumboots should be worn when there is any possibility of such contact;

NOTE :The soles of gumboots should be made of leather or conductive rubber, and clothing should not be made of fabrics that contain artificial fibres because of the hazard of the generation of static electricity.

g) a storage vessel that has held LPG and is "empty" is dangerous. In this state the internal pressure is approximately atmospheric and, if the valve leaks or is left open, air can diffuse into the storage vessel and form a flammable or explosive mixture. An "empty" storage vessel that does not yield gas when the valve is opened might in fact not be quite empty. In cold weather the heavier fractions of the liquid might not vaporize and will remain in the storage vessel. All vessels that are (or appear to be) empty should be handled with the same care as used for a full storage vessel;

h) valves should be kept fully closed at all times when storage vessels are not in use;

i) due to the hazards involved with the filling of storage vessels, no one should fill a storage vessel with gas unless ;

   1) one is fully conversant with the relevant subsections of this part of Standard,

   2) one is satisfied that the storage vessel complies with the requirements of an approved manufacturing specification or the provisions of an approved manufacturing code (if necessary, this may be ascertained from the relevant storage vessel documents) ,

   3) one the employed staff are trained and experienced in the pre-filling inspection and actual filling of storage vessels with those gases been handled, and

   4) the storage vessel is not due for periodic inspection or testing.

j) permission to fill the storage vessel has been granted by the owner of the storage vessel.

4.2 Construction and design

4.2.1 General

Storage vessels should be designed and constructed in accordance with an approved standard (e.g. EN 13445, and the ASME code for boilers and pressure storage vessels, Section VIII, Division 1, EEMUA).

4.2.2 Design temperature for aboveground, buried or mounded storage vessels

4.2.2.1 Maximum design temperature

The maximum design temperature for aboveground storage vessel shall be 55˚C The maximum design temperature for buried or mounded storage vessel should be the maximum product filling temperature or 38 ˚C whichever is the greater.

4.2.2.2 Minimum design temperature

The minimum design temperature for aboveground storage vessel shall be -20 ˚C. The minimum design temperature for a buried or mounded storage vessel should be the lowest expected temperature of the surrounding ground or -20 ˚C, whichever is the lowest.

4.3 Branches and manholes

4.3.1 Couplings, branches and manholes shall comply with the requirements of the standard in accordance with which the storage vessel is constructed.

4.3.2 Branches should be flanged but the couplings of any screwed connections should comply with an approved standard in respect of design and pressure rating.

4.4 Fittings

4.4.1 General

4.4.1.1 All fittings for LPG service should be suitable for use at the safe working pressure of the storage vessel concerned.

4.4.1.2 All equipment such as storage equipment, vaporizers, pumps and pipelines should be electrically bonded and earthed.

After completion of any LP gas installation (or any extension to it), all parts of the system should be tested for electrical continuity and resistance to earth which should not exceed 10 Ω. After an installation has been taken into service, regular tests should be carried out, at intervals not exceeding 24 months, to ensure that the resistance to earth remains within the above limit and such information should be recorded.

4.4.2 Connections for filling, withdrawal and equalizing

4.4.2.1 Manually operated primary shut-off valves should be fitted on all liquid and vapour connections with the following exceptions:

a) openings to which safety relief valves are fitted;

b) openings protected by a controlling orifice of diameter not exceeding 1.4 mm;

c) plugged openings;

d) openings fitted with approved gauging devices;

e) filling connections mounted directly on storage vessels of capacity not exceeding 9 000L provided that the opening is fitted with an approved non-return/excess-flow valve combination or one double non-return valve or two single non-return valves; and

f) openings fitted with approved quick-closing internal shut-off valves.

4.4.2.2 The shut-off valve should be fitted as close to the storage vessel as practicable except that where there is no mechanical joint between the shut-off valve and the storage vessel and the interconnecting piping is designed, constructed and tested in accordance with the design code used for the storage vessel, the valve can be located at the downstream end of that length of piping.

4.4.2.3 All liquid and vapour connections with the exception of those listed in 4.4.2.1 a) to 4.4.2.1 e) and drain openings should be fitted with an emergency shut-off valve (e.g. an excess-flow valve, an automatically operated valve, a remote-controlled valve or a non-return valve). Emergency shut-off valves and non-return valves are not considered necessary if the bore of the connection to the storage vessel does not exceed 3 mm in the case of liquid and 8 mm in the case of vapour.

4.4.2.4 If the emergency shut-off valve is of the excess-flow type, its closing flow rate should be below the flow rate that is likely to result from a complete fracture of the line it is protecting (calculated under the most adverse conditions likely to be experienced) but it should not exceed 1.5 times the design flow rate for the line.

Excess-flow valves should have a rated closing capacity sufficiently higher than the normal flow requirements as to prevent valve chatter.

4.4.2.4 A quick-closing internal shut-off valve can be used to give more positive protection in a storage vessel opening than is afforded by an excess-flow valve alone. Quick-closing internal valves should be arranged in such a way to give at least one point for thermal closure (by actuation of the heat-sensing device) and at least one point for manual closure from a safe remote position. Such valves should be kept closed when the line they serve is not in actual use.

4.4.2.5 If the filling connection is remote from the storage vessel, an approved non-return valve should be fitted in the liquid line at a distance not exceeding 500 mm from the filling connection, and an excess-flow valve (similarly located) should be fitted in the vapour return line, if relevant.

Remote storage vessel filling points and vapour connections should, in addition, have emergency shutoff valves, bleeder valves and terminal caps placed within 500 mm of the filling point.

4.4.2.6 Each drain connection should have a ball type, fire safe shut-off valve of nominal size limited to a maximum of 50 mm. This shut-off valve should be connected direct to a length of piping that terminates in a second shut-off valve /deadman (automatic close by spring-load) of nominal size not exceeding 25 mm.

The length of piping between the valves should be of length at least 1 m and such that the risk of simultaneous obstruction of both valves is minimized. On the downstream side, the second valve should be connected to piping that is long enough to ensure that discharge will not take place beneath the storage vessel. The end of the pipe should be closed by means of a screw plug. The second valve and all the piping should be so supported and secured as to prevent failure. The means of actuation of both drain valves should be such that they cannot be removed (or moved from the closed position) except by intentional operation.

4.4.3 Pressure relief valves

4.4.3.1 Each storage vessel should be equipped with at least two pressure relief valves, each in direct communication with the vapour space of the storage vessel. This can be accomplished by the use of a multi-port device.

If any valve is inoperative, the number and size of the remaining pressure relief valves should be sufficient to provide the full relief flow capacity required for the storage vessel. (see Annex A)

A number of pressure relief valves can be combined to constitute one multi-port device.

4.4.3.2 Each pressure relief valve should be of such design that it closes at a pressure not less than 90 % of the start to discharge pressure.

4.4.3.3 In storage vessels of capacity exceeding 9000 l, vent pipes should be fitted to the relief valve outlets. These pipes should project vertically upwards (terminating not less than 2 m above the storage vessel) and should discharge, without obstruction, to the open air. Each vent pipe should be equipped with a loosely-fitting rain cap that is held captive by a length of light chain or flexible wire. If liquid drain holes are required in vent pipes, such holes should be so positioned that jets of fluid cannot impinge on the shell or on any fitting to the storage vessel.

4.4.3.4 Pressure relief devices should be such that it is not possible to tamper with the relief valve settings.

4.4.3.5 Shut-off valves should not be installed between a storage vessel and any pressure relief device/valve.

4.4.3.6 Provision can be made to isolate any relief valve for testing or servicing provided that the remaining relief valves provide the full relief capacity required in terms of Annex A.

4.4.3.7 Each pressure relief valve should be plainly and permanently marked with the following:

a) the pressure at which the valve is designed to start to discharge;

b) the actual air discharge rate of the valve, in cubic metres of air per minute at normal temperatures and pressure, at 120 % of the start to discharge pressure;

c) a serial number; and

d) The standard used for design

4.4.3.8 Each pressure relief valve on a storage vessel should be recertified within a period of 5 years, and should be sealed and stamped with the date of testing and the identification mark of the testing authority.

4.4.4 Contents gauges

4.4.4.1 Each storage vessel should have a level measuring device and a device to indicate the maximum liquid level.

4.4.4.2 Each liquid level indicator should be suitable for operation at the maximum allowable operating pressure of the storage vessel that it serves.

4.4.4.3 Each gauging device (such as a rotary tube, a fixed tube or a slip tube) that relies on bleeding to the atmosphere should be designed such that;

a) unless it is protected by a suitable emergency shut-off valve, the maximum diameter of the bleed hole does not exceed 1.4 mm;

b) it cannot be completely withdrawn in normal gauging operations, and

c) the gland is capable of being repacked while the storage vessel is in service.

4.4.4.4 Each maximum liquid level indicating device should be suitable for use with the LPG being stored and should indicate the maximum liquid level of the storage vessel, based on the appropriate filling ratio given in Table 1

Table 1 — Filling ratio by weight

Relative density of LP gas at 20 °C	Maximum permissible ratio of Storage vessels of capacity 4 500 L or more
0.495-0.499	0.45
0.500-0.504	0.46
0.505-0.509	0.46
0.510-0.514	0.47
0.515-0.519	0.47
0.520-0.524	0.48
0.525-0.529	0.49
0.530-0.534	0.49
0.535-0.539	0.50
0.540-0.544	0.50
0.545-0.549	0.51
0.550-0.554	0.52
0.555-0.559	0.52
0.560-0.564	0.53
0.565-0.569	0.53
0.570-0.574	0.54
0.575-0.579	0.55
0.580-0.584	0.55
0.585-0.589	0.56
0.590-0.594	0.56
0.595-0.599	0.57
0.600-0.604	0.58

4.4.5 Temperature measuring instruments

Storage vessels shall be fitted with a temperature measuring instrument of acceptable design and operation.

Bulbs or sensing heads of temperature measuring instruments should not be mounted in direct contact with the contents of a storage vessel. Thermo-well or a similar fitting shall be used for this purpose.

4.4.6 Pressure gauges

Storage vessels should be equipped with a suitable pressure gauge preferably ranging to 20 bar that has a face diameter not less than 50 mm and that is connected to the vapour phase of the storage vessel. Pressure gauge mounting connections shall be protected internally by means of a suitable excess-flow valve, or by a pressure tapping reduced internally to a bleed hole of diameter not exceeding 1.4 mm.

4.5 Mountings and supports

Mountings and supports should be designed such that they comply with the requirements of the standard in accordance with which the storage vessel is constructed.

4.6 Finish and marking

4.6.1 Finish

The outside of storage vessels shall have an approved corrosion protection finish which should be appropriate to the manner of installation.

4.6.2 Permanent marking of storage vessels

A plate, securely attached in a conspicuous place on the shell of the storage vessel, shall be permanently marked (by the manufacturer) with at least the following information:

a) manufacturer's name;

b) country of origin;

c) maker's serial number;

d) year of manufacture;

e) date of initial pressure testing;

f) maximum allowable working pressure, in bars;

g) design and test pressures;

h) minimum and maximum design temperature;

i) water capacity, in cubic metres (or litres); and

j) number and title of the standard in accordance with which the storage vessel was constructed.

4.7 Initial inspection, testing and certification

The inspection, testing and certification of storage vessels should be under the supervision of an approved inspecting authority who should furnish each storage vessel with a certificate giving, in addition to the information required in 4.6.2, the following information:

a) date of test;

b) pressure at which the storage vessel was tested;

c) any other data required by statutory regulations; and

d) stamp of the approving authority.

4.8 Periodic inspection, testing, risk assessments and certification

Periodic inspection, testing, risk assessments and certification shall be carried out in accordance with the requirements given in the statutory regulations of Partner States. In the case where statutory regulations do not exist, this shall be carried out at intervals of 5 years.

5 Filling ratios and volumes of storage vessels

5.1 Filling ratios

The safe filling ratio of a storage vessel is a function of ambient temperature and relative density. Table 1gives the appropriate values of the maximum permissible filling ratios for LPG at corresponding relative density.

NOTE The filling of any LPG vessel shall not be more than 85 % of its water capacity.

5.2 Filling by volume

Some means is required for calculating the maximum volume of liquid that may be placed in a storage vessel at any liquid temperature because the contents of a static storage vessel cannot normally be controlled by mass. When the temperature of the liquid (obtained by measuring the temperature of the LPG by means of a temperature measuring instrument placed in a pocket installed in the storage vessel and the filling ratios are known, the maximum volume of liquid that can be placed in the storage vessel can be determined from the following formula:

$$V_T = \frac{D \times 100}{G \times F}$$

where,

V_T is the maximum liquid volume (expressed as a percentage of the total storage vessel capacity) that can be placed in a storage vessel when the liquid temperature is T;

D is the filling ratio;

G is the relative density of the LPG at 20 ˚C;

F is the liquid volume correction factor (see Table ASTM D1250/ IP200);

T is the temperature of liquid LPG in the storage vessel, in ˚C.

The actual maximum quantity, in litre, of LPG that can be placed in a storage vessel is obtained by multiplying the water capacity of the storage vessel by $\frac{V_T}{100}$.

6 Storage vessel location

6.1 Risk assessment

, A risk assessment shall be carried out on each installation in accordance with appropriate local statutory regulations or appropriate international standards where the local statutory regulations do not exist.

NOTE Where other gases in excess of 9.0 m^3 are stored in conjunction with LPG, a full risk assessment for safety distances should be carried out in accordance with sound fire protection analysis.

6.2 Above-ground storage vessels

6.2.1 Storage vessels should not be placed beneath any building or in the basement of a building.

6.2.2 The surface area beneath a storage vessel (equal to the foot print of the vessel) should be made of a non-porous material (concrete or other material), and the surface beneath and around a storage vessel should slope away from the storage vessel, at a gradient of at least 1:50, to the edge of the appropriate safety distance limit (see Table 2) or a minimum of 5 m. A typical commercial LPG installation is shown in Figure 1.

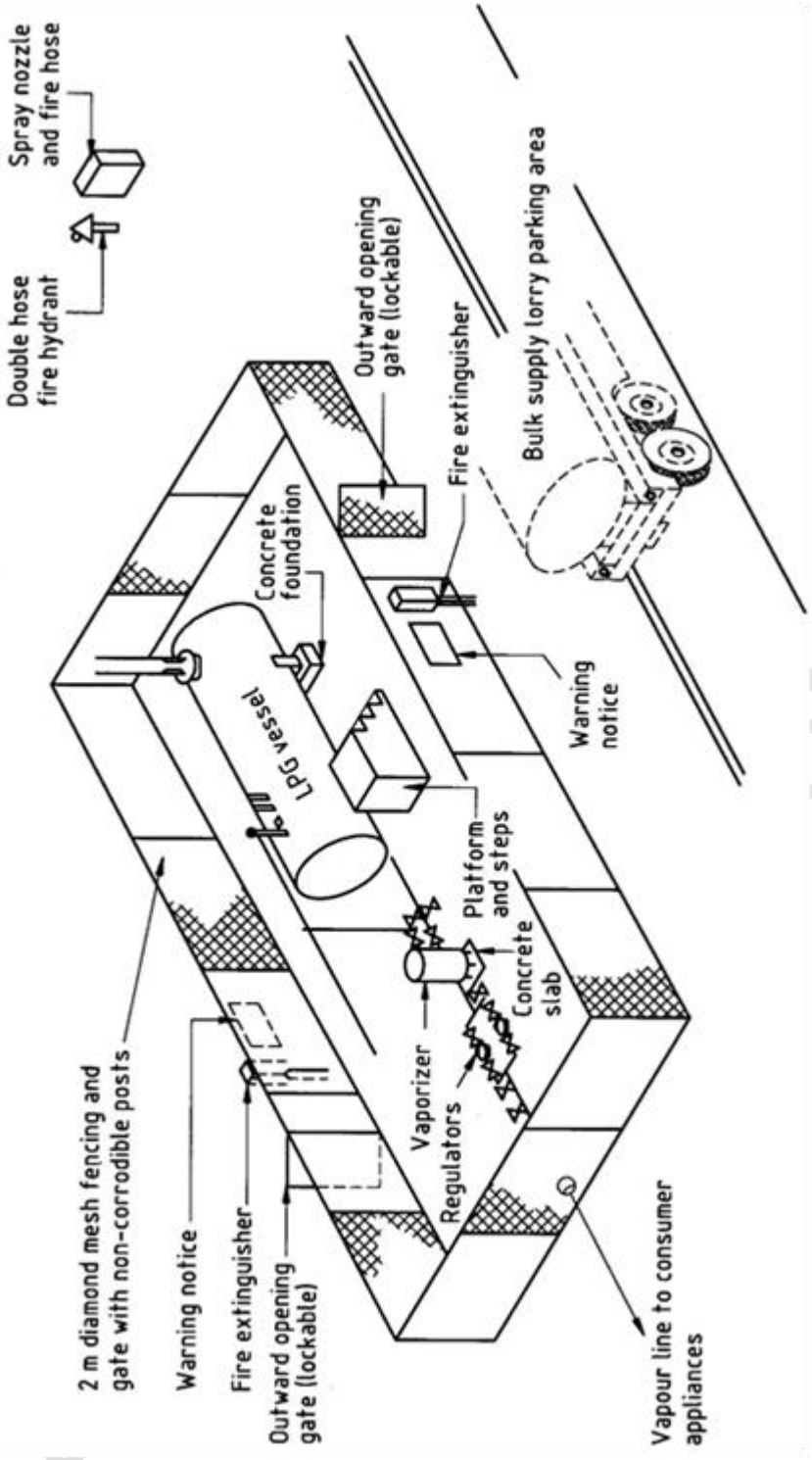


Figure 1 — Typical above-ground LPG bulk storage vessel and vaporizer

6.3 Buried and mounded storage vessels

The load imposed by any storage vessel should not affect other underground structures (e.g. foundations, pipelines, sewers). A storage vessel should not be subjected to loads from vehicular traffic or other surface loading, unless it has been designed and installed to withstand such conditions.

6.4 Safety distances

6.4.1 General

One of the major requirements for an effective and hazard free fuel installation is that the various components comprising the total installation should be installed at specific and predetermined minimum distances in relation to each other. These distances are generally known as safety distances. The appropriate safety distances applicable to;

a) gas fuel installations are given in Figure 2, and

b) combined fuel gas facilities are given in Figure 3.

6.4.2 Installation involving above-ground storage vessels

6.4.2.1 The safety distances applicable to the installation of above-ground storage vessels, should be in accordance with the appropriate values given in Table 2.

6.4.2.2 Vapour barriers or firewalls as appropriate can be used to reduce the distances given in Table 2. The presence of vapour barriers and firewalls can create significant hazards, e.g. pocketing of escaping gas, interference with application of cooling water by the fire department, redirection of flames against storage vessels, and impeding ingress of personnel in emergency. Ensure that where two walls (in different directions) are joined to form an enclosing corner, the angle shall not be less than 90°. However, firewalls and vapour barriers can be used to reduce the safety distances by 50 % of the safety distances specified in Table 2 provided that the height of the firewall shall be at least equal to the topmost part of the tank shell and the plot sizes cannot be less than those shown in Figures A.1, A.2 and A.3.

6.4.2.3 The recommended minimum plot sizes shall be as shown in Figures A.1, A.2 and A.3 for the various ranges of LPG tank capacities.

6.4.2.4 The firewalls shall have a minimum rating of 2 h and their minimum height shall not be less than the top plane of the LPG tanks in the facility. These firewalls shall be built in accordance with the national building code. .

6.4.2.5 Safety distances should be measured horizontally and radially from storage vessels except that, if vapour barriers or firewalls are used, the distance should be measured in a horizontal line around such walls or barriers.

6.4.2.6 Storage vessels should not be installed one above the other or in series i.e. head to head.

6.4.2.7 The number of storage vessels in any one group should not exceed six. Unless a firewall is erected between the groups, each storage vessel in one group should be at least 7.5 m from the nearest storage vessel in another group. When firewalls are used to separate groups of storage vessels, the direct distance from each storage vessel in one group to the nearest storage vessel in another group should be at least 4 m.

6.4.2.8 The minimum horizontal separation between above-ground LPG storage vessels and above ground storage vessels containing liquids having flash points below 93.4 ˚C, should be 6 m, The minimum horizontal separation between an underground storage vessel and a second storage vessel, above or below ground, should be at least 1 m.

6.4.3 Installation involving buried and mounded storage vessels

6.4.3.1 The safety distances applicable to the installation of buried or mounded storage vessels should be in accordance with the appropriate values given in Table 2. Other parts of the storage vessel should be not closer than 1 m to a building, boundary or other equipment.

6.4.3.2 Buried or mounded storage vessels should be located outside of any buildings. Buildings should not be constructed over any buried or mounded storage vessels. Sides of adjacent storage vessels should be separated by not less than 1 m.

Table 2 — Safety distances

Water capacity of storage vessel L	**Minimum (safety) distances(m)**					
	From above-ground vessel to points of gas release[a)]	**From above-ground storage vessel to buildings and property boundaries**	**From buried and mounded storage vessel to buildings, property boundaries and points of gas release**	**From sealed surface equipment to building and property boundaries**	**From open flame equipment to building and property boundaries**	**Between above LPG storage vessels**
9 000 <V≤ 67 5 00	5.0	9.5	7.0	3.0	5.0	¼ of the diameters of adjacent storage vessels
67 500 <V≤ 135 000	9.5	15.0	15.0			
135 000<V≤ 265 000	15.0	22.5	15.0			
V> 265 000	15.0	30.0	15.0			
[a)] For points of transfer see Clause 12 and Figure 2.						

6.4.3.3 The distance between a storage vessel and the line of an adjoining property occupied by a school, church mosque, hospital, sports field or any other designated public gathering place shall be at least 75 m in all cases.

6.5 Enclosure of area

6.5.1 Storage vessels should not be installed within bunds. However, if the ground surface beneath and around storage vessels slopes towards a driveway or an unprotected work area, vapour barriers should be provided to prevent spillage from reaching those areas.

6.5.2 To minimize trespassing and tampering, any area that contains storage vessels, vaporizers, pumping equipment or facilities for loading, unloading and storage vessel filling should, unless otherwise adequately protected, be enclosed by a fence of height at least 1.8 m. At least two means of gaining access to the area in case of emergency should be provided.6.6 Warning notices

At least two notices shall be securely attached to the outer side of the fence surrounding the storage area. The warnings shall be of size at least 200 mm x 200 mm.

7 Installation

7.1 General

All materials used in the construction of an LPG installation (including non-metallic parts for valve seals, diaphragms, etc.) should be resistant to the action of LPG under the service conditions to which they are to be subjected.

No piping carrying gas should be installed in emergency routes required in accordance with building code.

Piping installed in normal escape routes shall comply with the approved fire plan of the installation.

7.2 Storage vessel installation

7.2.1 Buried storage vessels

Buried storage vessels shall be installed in accordance with NFPA 58.

7.2.2 Mounded storage vessels

Mounded storage vessels shall be installed in accordance with NFPA 58 and EEMUA publication 190.

7.2.3 Above-ground storage vessels (see Figure 1)

7.2.3.1 For storage vessels of capacity in excess of 9 000 L, it is recommended that a soil investigation be carried out before installation, to determine the expected overall and differential settlements.

7.2.3.2 Ensure that when the vessel is fully loaded with water for a period of not less than 24 h, by taking suitable measurements, the differential settlement between the two ends will not exceed 0.4 % of the length of the storage vessel. Place the storage vessel on a slope of 1.0 % with the water drain at the lower end to facilitate drainage.

7.2.4 Buried and mounded storage vessel connections

7.2.4.1 Ensure that connections for buried storage vessels are on top. Provide acceptable protection against accidental damage for fittings that are at or above ground level.

7.2.4.2 With the exception that the discharge, filling and drain lines may be bottom-connected (if the transfer equipment is such that this is possible) ensure that, where practical, the connections for mounded storage vessels are top mounted.

7.2.4.3 Make allowance for any possible future differential settlement between storage vessel and pipework.

7.2.5 Corrosion protection

7.2.5.1 General

Introduce and ensure acceptable corrosion protection of above-ground storage vessels and of all pipework, including coating materials and their application.

If cathodic protection is applied, take annual readings and record them in a pressure storage vessel logbook.

Ensure that these readings are reviewed by a competent person.

7.2.5.2 Buried and mounded storage vessels

Appropriate corrosion protection shall be applied. Protect buried and mounded storage vessels from loads due to vehicular traffic or other causes, either by erecting a barrier around the area in which the storage vessels are buried or by protecting the storage vessels with reinforced concrete slabs.

If the storage vessel area is not barricaded, protect the storage vessel manhole cover and the storage vessel fittings against tampering.

Provide permanent markers to indicate the perimeter of the area under which the storage vessels are buried and erect a suitable permanent warning sign.

7.2.6 Storage vessel compounds and bunding

LPG storage vessels shall not be located in the same bund area as other petroleum products. No bunding is required for pressure-type storage, but a diversion wall can be provided to control a spill. If the storage vessels are fenced or otherwise protected to prevent unauthorized access, ensure acceptable ventilation.

7.3 Pipe-work

7.3.1 Pipes for conveying liquid or vapour shall made be of steel or any other approved material.. Steel pipe lines shall have adequate corrosion protection.

7.3.2 Steel piping shall be seamless and as follows:

a) Where screwed joints are used, these shall be limited to pipes of nominal bore not exceeding 32 mm. Such pipes shall comply with the requirements of BS 1600 for Schedule 80 piping (or equivalent); pipe fittings shall be of wrought steel and of a grade at least equal to that of the mating pipes;

b) Pipes of nominal bore larger than 32 mm shall have welded or flanged joints and shall comply with the requirements of ISO 3183; and

7.3.3 All pipe lines shall be designed to have enough flexibility to accommodate any settlement of storage vessels and other equipment, thermal expansion and contraction, and any other stresses that can occur in a pipe system.

7.3.4 Where it is possible for LPG in the liquid phase to be trapped between two valves, a hydrostatic thermal relief valve should be fitted to relieve the pressure that might build up through thermal expansion of the liquid gas. This applies in all circumstances even though the space between the valves might be occupied by a piece of equipment such as a pump casing or a meter. Discharge from the relief valves shall not be allowed to vent to the atmosphere inside a building or to impinge on other parts, e.g. storage vessels.

7.4 Valves and other fittings

7.4.1 Valves and other fittings shall be made of steel with steel trim. Cast iron and nodular iron fittings and valves shall not be used.

7.4.2 In the case of commercial butane (liquid or vapour), and propane vapour, flanges and flanged fittings should comply with the relevant requirements of minimum class 300, and in the cases of liquid commercial propane and liquid LPG mixtures (at storage vessel pressure) they should comply with the relevant requirements given in API and ISO standards.

7.4.3 The regulating device for the first pressure reduction stage in the vapour discharge line (from the vaporizer) should be set in such a manner to reduce the supply pressure to a predetermined lock-up value appropriate to the plant.

WARNING Precautions should be taken to ensure that the pressure does not increase to a stage where the vapour could liquefy.

7.5 Testing for leaks

After assembly, all pipe line systems shall be tested for leaks at the appropriate of the following pressures for at least 30 minutes:

a) in the case of pneumatic testing – 1.1 times the maximum operating pressure; and

b) in the case of hydraulic testing – 1.25 times the maximum operating pressure.

After testing, all pipe line systems shall be purge-filled thus ensuring that a flammable mixture does not exist in the system.

7.6 Fire hazard control

7.6.1 Fire safety

7.6.1.1 Loose or piled combustible material, weeds and long dry grass shall not be permitted within 3.0 m of any storage vessel.

7.6.1.2 The fire department authority, in whose area LPG storage vessels will be erected, has final jurisdiction regarding the fire hazard involved with such an installation. The relevant Fire Department shall be consulted at an early stage regarding the placing of storage vessels and any other guidance in respect to fire-fighting and fire protection facilities.

7.6.1.3 Such coordination will include the planning for effective measures for control of inadvertent LPG release or fire and the safety of emergency personnel. The provision of suitable roadways or other means of access for emergency equipment (e.g. fire departments) and the effective location and marking of emergency controls, should be considered.

7.6.1.4 Each LPG storage facility shall be equipped with an appropriately designed and installed fire alarm and an electrical, hydraulic or pneumatic emergency shutdown system (ESD).

7.6.2 Passive protection

7.6.2.1 Where fixed sprays or portable monitors or fixed sprays in conjunction with portable monitors are required for protection, a system of passive fire protection such as thermal insulation of the vessels can be applied as an alternative.

7.6.2.2 Passive protection should be of such quality that when it is subjected to an acceptable flame impingement for a minimum of 1 h, the shell temperature will not exceed 430 ˚C.

The above requirement shall be verified by means of an approved test method.

7.6.3 Fire protection

7.6.3.1 Water supply

7.6.3.1.1 At all installations there shall be an adequate supply of water for fire protection for use in an emergency. To provide adequate protection for a storage vessel threatened by fire, an application rate of 10.5 $L/m^2/min$ over the whole surface of the storage vessel for at least 2 h is required. The capacity of the supply may need to be increased where there are no additional water supplies available near the premises. If water is supplied by means of a recirculating system, the storage reservoir should hold a 1 h water supply. The primary fire water pump shall be diesel engine driven.

7.6.3.1.2 On-site hydrants and fixed drench systems should be designed such that the water flow can be controlled from a safe position beyond the separation distances set out in Table 2. Connections for fire brigade use shall be provided on the water supply to fixed drench systems. The connections shall be located in a safe place agreed with the fire brigade.

7.6.3.1.3 There should be acceptable drainage to deal with water used for fire protection and fire-fighting purposes. Water-sealed interceptors (gas traps) should be fitted to prevent LPG entering the storm water drains and sewers. The surface below the LPG storage vessels shall be slopped away from the tanks and the piping to ensure that liquid gas that may escape from the tank or pipe work does not accumulate under the tanks or pipes. Minimum slope of 2 % is recommended.

7.6.3.1.4 A summary of the fire protection details are given in Table 3. The final system of protection should be acceptable to the fire department.

Table 3 — Summary of fire protection details

1	2
Installation capacity (L)	**Fire precautions**
9 001 – 45 000	Means of applying cooling water to the storage vessels should be provided. 20 mm hose reel and 2 x 9 kg dry powder extinguishers
45 001 – 67 500	Fixed or portable monitors or fixed sprays (or a combination) 20 mm hose reel 2 x 9 kg dry powder extinguishers
>67 500	Automatic or manual fixed sprays and hydrant and hose 20 mm hose reel 2 x 9 kg dry powder extinguisher
Road tanker filling or deliveries	Protection appropriate to the site risk, 20 mm hose reel, 2 x 9 kg dry powder extinguishers , wheeled fire extinguisher, means of applying cooling water to the road tanker

7.6.3.2 Fire protection details

The provision for fire protection at fixed installations depends on a number of considerations. These include the maximum storage capacity of the installation,

a) individual storage vessel sizes,

b) the number of tanker deliveries and

c) whether there is an increased risk of fire on site which might affect the storage vessels, e.g. at LPG cylinder filling areas (see Table 3).

Higher standards of fire protection might be required by the approving authority where other factors such as increased off-site risks and hazards, location of the nearest water supply and the time for the fire brigade to reach the site prevail.

At large installations where continuous supervision is available, manually operated water sprays may be sufficient. At these installations it might not be necessary to simultaneously drench all storage vessels and means can be provided to allow drenching of individual storage vessels or groups of storage vessels. A remote manual operating point should be provided in a safe place.

7.6.3.3 Precautionary measures

Fire protection needs to be considered under the following circumstances:

a) an acceptable level of protection is necessary at some aerosol filling plants where the storage vessels could be threatened by a fire involving the filling installation or the aerosol store;

b) at installations with a total inventory in storage vessels of 45 000 L or greater, the road tanker bay should be provided with the same level of fire protection as the fixed storage vessels;

c) rail loading and unloading gantries should be provided with fixed water sprays or an equivalent form of fire protection.

7.6.3.4 Protection by monitors

If monitor nozzles are used, they should be so located and arranged such that all storage vessel surfaces likely to be exposed to fire will be wetted.

7.6.3.5 Portable fire-fighting equipment

7.6.3.5.1 There should be sufficient, acceptable, portable fire-fighting equipment on the premises. This equipment should be selected and located to enable fires adjacent to the storage vessels to be extinguished

and to prevent fire spreading to, or jeopardizing, the LPG installation. Fire extinguishers or hose reels or an equivalent combination of the two types of equipment may be provided.

7.6.3.5.2 Access to and around the installation shall be provided for fire-fighting and shall be kept free at all times.

7.6.3.6 Fire instruction and training

People on premises where LPG is stored shall receive adequate instructions with training as appropriate to enable them to understand the fire precautions and action to be taken in the event of fire or of leakage of LPG. They shall receive instruction and training appropriate to their responsibilities in the event of an emergency. Those trained to fight LPG fires shall be aware that these fires should not normally be extinguished unless the source of LPG can be isolated. At commercial and industrial sites, notices setting out the emergency procedures shall be prominently displayed near the LPG storage area.

7.6.4 Rational design

In terms of the building regulations, all building structures within a gas installation are defined as a building. As such, the fire protection can be in terms of a rational design as described by national building code.

7.7 Protection against static electricity (inductive sparking)

7.7.1 Unless other precautions are taken,

a) an effective earthing connection shall be provided at the discharge point for discharging static electricity from bulk storage vessels; and

b) provision should be made for effectively bonding each storage vessel and the delivery storage vessel before and during each delivery operation.

7.7.2 The storage vessels shall be electrically earthed in such a manner to provide complete protection against lightning and the accumulation of static electricity.

NOTE A resistance not exceeding 10 Ω is recommended and the checks should be done annually.

7.7.3 Pipelines shall be installed in such a way to ensure electrical continuity, and should be effectively connected to earth. Bonding across flanged joints is not required if the measured resistance does not exceed 10 Ω.

7.8 Decommissioning of storage vessels

The following procedure shall be applied before a storage vessel is decommissioned.

a) remove as much LPG liquid as possible through the storage vessel liquid withdrawal connection;

b) remove as much of the remaining LPG vapour through the venting connection. (The vapour should be burnt-off or vented to the open air at a safe location in an approved manner.); and

c) purge the storage vessel in accordance with requirements given in EAS 924-1.

8 Vaporizers

8.1 General

8.1.1 Vaporizers include the following types:

a) Ambient;

b) low-pressure-steam heated;

c) hot-water heated;

d) electrically heated.

The capacity of the vaporizers installed should be large enough to supply the latent heat of vaporization necessary to convert the liquid into vapour at the maximum off-take required from the installation.

NOTE Direct gas fired vaporizers are not allowed. Where necessary, accumulation of condensate in the vapour discharge line should be prevented by lagging of the vapour discharge line or, in cold areas, by the provision of condensate pockets capable of containing the quantity likely to be condensed during a plant shut-down. With steam heated and hot water heated vaporizers, care should be taken to avoid freezing of condensed steam or of water.

8.1.2 Vaporizers should not be fitted with fusible plugs.

8.1.3 Heating or cooling coils should not be installed inside a storage vessel to act as a vaporizer

8.1.4 Manually operated valves should be installed to shut off the liquid or the vapour connections (or both) between the storage vessels and the vaporizer(s).

8.2 Safety distances

8.2.1 Direct-fired vaporizers are not recommended, however where used of any capacity should be located not closer to the nearest storage vessel, storage vessel shut-off valves, point of transfer, building(s) or property boundary than the relevant distance given in Table 4.

Table 4 — Safety distances for direct-fired vaporizers

1	2	3
Minimum safety distance (m)		
To storage vessel (Distance B[a)])	To point of transfer	To building(s)[b)] (Distance C[a)]) and property boundary (Distance D[a)])
5	6	7.5
a) See Figure 2. b) Other than a building in which a vaporizer is installed.		

8.2.2 Pressure regulating and reducing equipment, should be protected against radiant heat.

8.2.2.1 Vaporizers can be installed in buildings used exclusively for gas manufacturing and distributing operations or, in the case of vaporizers of capacity not exceeding 70 L/h in buildings other than those referred to above if the room containing the vaporizer is separated from the remainder of the building by a wall that is designed to withstand a static pressure of at least $5x10^{-2}$ bar, and that has no opening or pipe or conduit passing through it.

8.2.2.2 Buildings used to house vaporizers should be of non-combustible materials and should be well ventilated at both floor and roof levels.

8.2.3 Steam or hot-water heated vaporizers should be separated from the device that produces the steam or hot water by a wall that is designed to withstand a static pressure of at least $5x10^{-2}$ bar, and that has no opening or pipe or conduit passing through it.

8.2.4 The electrical components of electrically heated vaporizers should be manufactured and installed in accordance with the provisions of Clause 10.

8.3 Design and construction

8.3.1 Vaporizers shall be designed, constructed and tested in accordance with an approved standard. All parts of the vaporizers in contact with the liquid LPG shall be of steel or other approved material. The vaporizer storage vessels shall be painted with a suitable corrosion resistant and light-reflecting paint.

8.3.2 A plate, securely attached in a conspicuous place to the shell of the vaporizer storage vessel, shallbe marked by the manufacturer with the following information and any other information required by the relevant statutory regulations:

a) manufacturer's name;

b) t country of origin;

c) manufacturer’s serial number;

d) year of construction;

e) date of initial pressure testing (see 4.7)

f) design and test pressure in bars

f) minimum and maximum design temperature;

g) outside surface area, in square metres (when relevant);

h) inside heat exchange surface area, in square metres (when relevant);

i) the vaporizing capacity, in litre per hour or kilogram per hour;

j) the number and title of the standard in accordance with which the vaporizer was constructed; and

k) the electrical details (when relevant).

8.4 Fittings

8.4.1 Pressure relief devices

Vaporizer systems should have, at or near the point of vapour discharge, at least one pressure relief device. The maximum start-to-discharge pressure of the devices should be not higher than 110 % of the design pressure of the vaporizer storage vessel.

The pressure relief devices should discharge at a rate of not less than the appropriate rate shown in Annex A, Table A.1, before the vaporizer pressure exceeds 120 % of the start-to-discharge pressure.

In the case of a direct-fired vaporizer, the discharge from the safety relief device on the vaporizer should be piped to a safe location. However direct fired vaporizers are not allowed.

NOTE In the case of relief devices for vaporizers, the total surface area is the sum of the wetted area of the vaporizer shell and the surface area of the heat exchanger. (See Column 1, 3 and 5 of Table A.1).

For vaporizers smaller than those given in Table A.1, an approved standard shall be used (e.g. NFPA or API).

8.4.2 Control of liquid carry-over

Vaporizers should have acceptable controls to prevent liquid carry-over.

8.4.3 Heat input control

The heat input should be controlled in such a way to prevent the pressure in the vaporizer storage vessel from reaching the start-to-discharge pressure of the pressure relief devices in the vaporizer system. The heat input control should be suitable for the connection system.

8.5 Connections between vaporizers and storage vessels

The vaporizer should be connected direct to the liquid phase and may also, when necessary, be connected to the vapour phase of the storage vessel(s).

9 Periodic inspection and retesting

All storage vessels and vaporizers shall be tested and inspected in accordance with the relevant regulations framed under the competent authorities of the Partner States.

NOTE Any leakage from plant or pipelines should receive immediate attention.

10 Electrical equipment and other sources of ignition

10.1 The sites of the equipment and operations listed in Column 1 of Table 5 are classified, in terms of IEC 60079 parts 1-25, as hazardous locations of the appropriate zone given in Column 3, and the extent of each classified area is defined in Column 2. Electrical equipment and wiring sited in these areas should be limited to the types permissible approved for use in such areas, and they should be installed in accordance with approved standards.

10.2 Except as allowed in Clause 8 in respect of open flames, cutting and welding operations, portable electric tools, extension lights or any other equipment capable of igniting LPG shall not be permitted within the classified areas defined in Column 2 of Table 5 unless the LPG facilities have been freed of all liquid and vapour, or special precautions have been taken under carefully controlled conditions.

Table 5 — Extent of hazard zones for certain specified sources of release for heavier-than-air gases or vapours

1	2	3
Installation	**Extent of classified location (excluding areas beyond an unpierced wall, a roof or a solid vapour-tight partition)**	**Zone[a)]**
Storage vessels	Within 5 m (in all directions) of connections other than those covered elsewhere in this table	2
Tank vehicle and tank car loading and unloading	Within 2 m (in all directions) of connections regularly made or broken for product transfer	1
	Beyond 2 m from but within 5 m (in all directions) of a point where connections are regularly made or broken and within the cylindrical volume between the horizontal equator of the sphere and ground level as shown in Figure 5.	2
	NOTE When the extent of a hazardous location is classified, consideration should be given to possible variations in the siting of tank cars and tank vehicles at unloading points and the effect that these variations of actual siting point could on the point of connection.	2

Gauge vent openings	Within 2 m (in all directions) of the point of discharge	1
	Beyond 2 m from but within 5 m (in all directions) of the point of discharge	2
	Beyond 2 m from but within 5 m (in all directions) of the point of discharge except within the direct path of discharge	2
Pumps, compressors, gas-air mixers, and vaporizers (excluding direct fired vaporizers) a) Indoors without ventilation	Entire room and any adjacent room not separated by a gas-tight partition	1
	Within 5 m of the exterior side of any exterior wall or roof that is not vapour-tight, or within 5 m or any exterior opening	2
b) Indoors with adequate ventilation NOTE Ventilation, either natural or mechanical, is considered adequate when the concentration of the gas in a gas-air mixture does not exceed 25 % of the lower limit of flammability under normal operating conditions.	Entire room and any adjacent room not separated by a gas-tight partition	2
c) outdoors in open air at or above ground level	Within 5 m (in all directions) of the equipment and within the cylindrical volume between the horizontal equator of the sphere and ground level as shown in figure 4	2
Pits or trenches that contain or are located beneath gas valves, pumps, compressors, regulators, and similar equipment a) without adequate mechanical ventilation	Entire pit or trench	1
	Entire room and any adjacent room not separated by a gas-tight partition	2
	Within 5 m (in all directions) of a pit or a trench when located outdoors	2
b) with adequate mechanical ventilation	Entire pit or trench	2
	Entire room and any adjacent room not separated by a gas-tight partition	2
	Within 5 m (in all directions) of a pit or a trench when located outdoors	2
Special buildings or rooms for storage of portable containers	Entire area	2
Pipelines and connections that have operational bleeds, drips, vents or drains	Within 2 m (in all directions) of the point of discharge	1
	Beyond 2 m from the point of discharge, the delimitations given under a) Pumps, compressors, gas-air mixers, and vaporizers (excluding direct fired vaporizers)" should be applied	See above
Containers filling apparatus	Within 2 m (in all directions) of the filling point	1
	Beyond 2 m from but within 5 m (in all directions) of the filling apparatus	2

[a] Zone is classifying the probability that a location is made hazardous by presence or potential presence of flammable concentration of gases or vapour. Zoning is classified as follows:

- Zone 0 is an area in which an explosive atmosphere consists of a gas air mixture is continuously present for a long period or frequently.
- Zone 1 is an area in which an explosive atmosphere consists of a gas air mixture is likely to occur in normal operation occasionally
- Zone 2 an area in which an explosive atmosphere consists of a gas air mixture is not likely to occur in normal operation occasionally

11 Filling point for bulk storage vessel

11.1 The remote filling connection by which a storage vessel is filled, or through which it fills other tanks shall be at least;

a) 5 m away from the cylinder filling area (when applicable),

b) 3 m away from the cylinder storage area (when applicable),

c) 7.5 m away from the boundary of premises, offices and sales rooms,

d) 75 m away from open fires and from schools, churches, hospitals and similar institutions,

e) the following distance from the storage vessel itself:

   1) 3 m for storage vessels of size up to and including 67 000 L

   2) 6 m for storage vessels of size 67 500 L to 135 000 L and

   3) 9 m for storage vessels of size in excess of 135 000 L

11.2 **"**No smoking" signs shall be conspicuously displayed at the operations place..

12 Filling of portable containers (up to 150 L water capacity)

12.1 The filling procedure for portable containers shall, in general, be carried out in accordance with EAS 900-1

12.2 The area of the filling site shall embrace the area within a distance of 2 m of the perimeter of the filling equipment and shall allow for the intermediate storage of 2 000 L of LPG.

12.3 The boundary of the filling site shall be at least 5.0 m inside the boundary of the premises on which it is located,

b) 5.0 m away from driveways within the premises,

c) 3.0 m away from any container storage area,

d) 75.0 m away from outdoor places of public assembly (including school yards, athletic fields and playgrounds, busy thoroughfares and sidewalks),

e) 15 m away from any permanent open fire, e.g. a boiler room, and

f) a distance as given in Columns 2 and 3 of Table 2 away from the storage vessel.

13 Container storage areas

13.1 The distances between an outside (open-air) storage area for containers (awaiting filling or despatch after filling) and the nearest building, the boundary of the premises, a public thoroughfare or sidewalk, and the line of an adjoining property occupied by a school, church, hospital, athletic field or other point of public gathering shall be not less than the appropriate minimum distances given in Table 6.

Table 6 — Minimum safety distances

1	2	3
Total quantity of LPG stored (kg)	**From buildings and boundary of the premises (m)**	**From line of adjoining property of school, church, entertainment places, etc. (m)**
≤ 1 000	3.0	3.0
1 000 < ≤ 3 000	5.0	5.0
3 000 < ≤ 5 000	7.5	7.5
5 000 < ≤ 20 000	10 0	10 0
Greater than 20 000	15.0	15.0

13.2 All containers that are empty (or appear to be empty) should be handled with the same care as a full container, and the distributing plant operator should ensure that the valves of all empty containers received for filling are closed properly.

13.3 Containers should not be stored within 1.5 m of the edge of a platform at which customers or container-distribution vehicles are served.

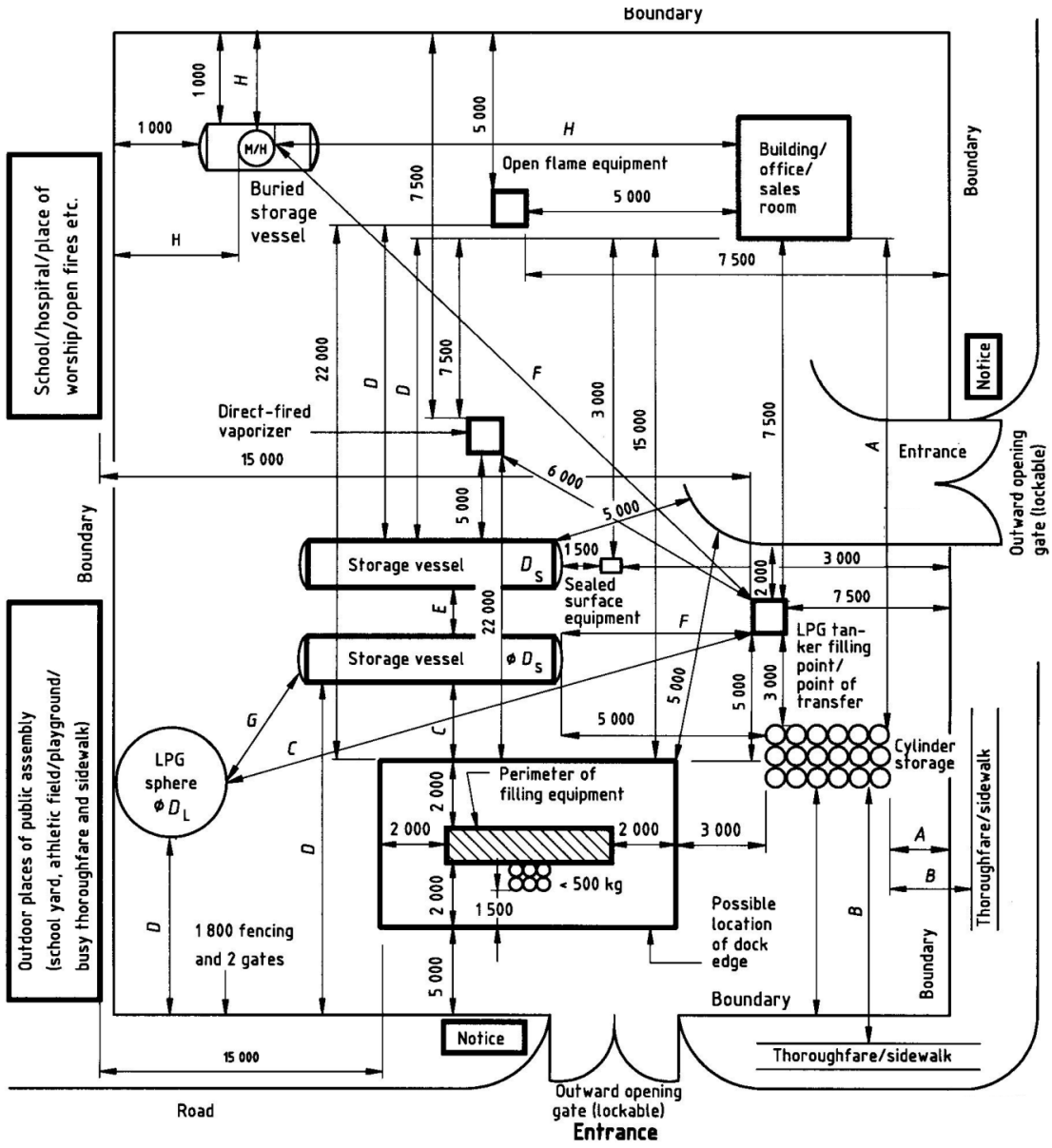
14 Filling sheds for portable containers

14.1 Buildings used for the filling of portable containers with LPG shall be reserved exclusively for this purpose. Ensure that floors in the filling area have a non-sparking surface and that they are not below ground level. When a raised platform is used, either fill in completely the space under the platform or leave it open on all sides (to afford free ventilation). In the latter case, do not permit the use of the space under the platform for any purpose, and keep it free from rubbish. Provide surface water drains (equipped with a gas-liquid separator) situated outside the building.

14.2 , The formation of pits and similar depressions in the floor should be avoided because of the danger of gas accumulations. If pits or channels are required for conveyors or other equipment, adequately ventilate such pits or channels by drains that lead to the outside of the building. such drains shall be graded such that to permit the flow of vapour under gravity, or connect them to forced-ventilation systems.

14.3 Sheds should preferably be open-sided, but where it is necessary, because of climatic conditions, to give protection to the workers, provide adequate ventilation at both ground and roof levels. Filling of storage containers in a cellar or in the upper storey of a building shall not be carried out.

14.4 Provide on the delivery pipeline (on the inside of the filling shed, at the point where the delivery pipeline enters the filling shed) an automatic or remotely operated shut-off valve for use in emergency situations (e.g. gas leakage fires).



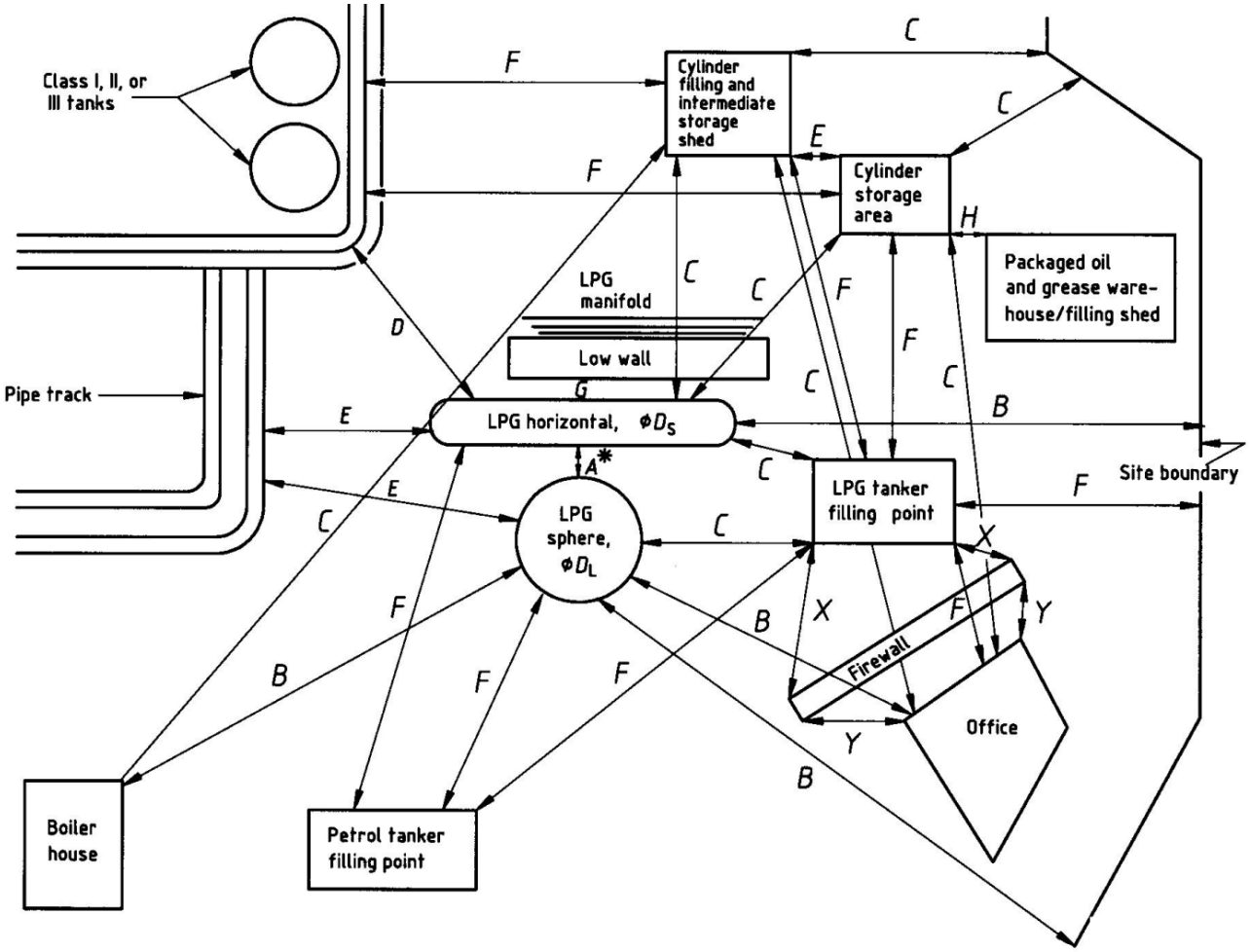
D_L = diameter (large)
D_S = diameter (small)
M/H = manhole

Figure 2a — Recommended safety distances for gas fuel installations

Dimensions in millimetres

1	2	3	4	5	6	7	8	9	10	11	12
Total quantity of stored LPG kg	***A***	***B***		**Size of vessel** litre water capacity	***C***	***D***	***E***	***F***	***G***	***H***	
500 – 3 000	3 000	3 000	Above-ground vessels	500 – 2 250	5 000	5 000	¼ of sum of diameters of adjacent storage ½ of sum of diameters for vertical vessels	0	$\varphi \frac{D_L + \varphi}{4}$	Buried vessels	3 000
3 001 – 5 000	7 500	7 500		2 251 – 9 000	7 500	7 500		0			5 000
5 001 – 20 000	10 000	10 000		9 001 – 67 500	9 500	9 500		3 000			7 000
> 20 000	15 000	15 000		67 501 – 135 000	15 000	15 000		6 000			15 000
				135 001 – 265 000	15 000	22 500		9 000			15 000
				> 265 000	15 000	30 000		9 000	D_L		15 000

Figure 2 b — Recommended safety distances for gas fuel installations (concluded)



Dimensions in metres

1	2	3	4	5	6	7	8	9	10
Vessel size or description	**Safety distances**								
	***A*[a]**	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***X* + *Y*[b]**
a) Vessel capacity, L									
67 500 – 135 000	–	15	15	15	–	15	5	–	≥ *F*
135 001 – 265 000	$\frac{D_L + D_S}{4}$	22,5	15	15	–	15	5	–	≤ *F*
> 265 000	D_L	30	15	15	10	15	5	–	≤ *F*
b) Cylinder filling and storage shed	–	–	15	–	10	15	–	–	≤ *F*
c) Cylinder storage area	–	–	15	–	10	15	–	3	≤ *F*
d) Intermediate LPG vessel filling point	–	–	–	–	–	15	–	–	≤ *F*

[a] May be reduced to 8 m if site boundary is a solid wall.

[b] *X* + *Y* shall not be less than 5 m in any case.

Figure 3 — Recommended safety distances for above-ground combined fuel/gas facilities

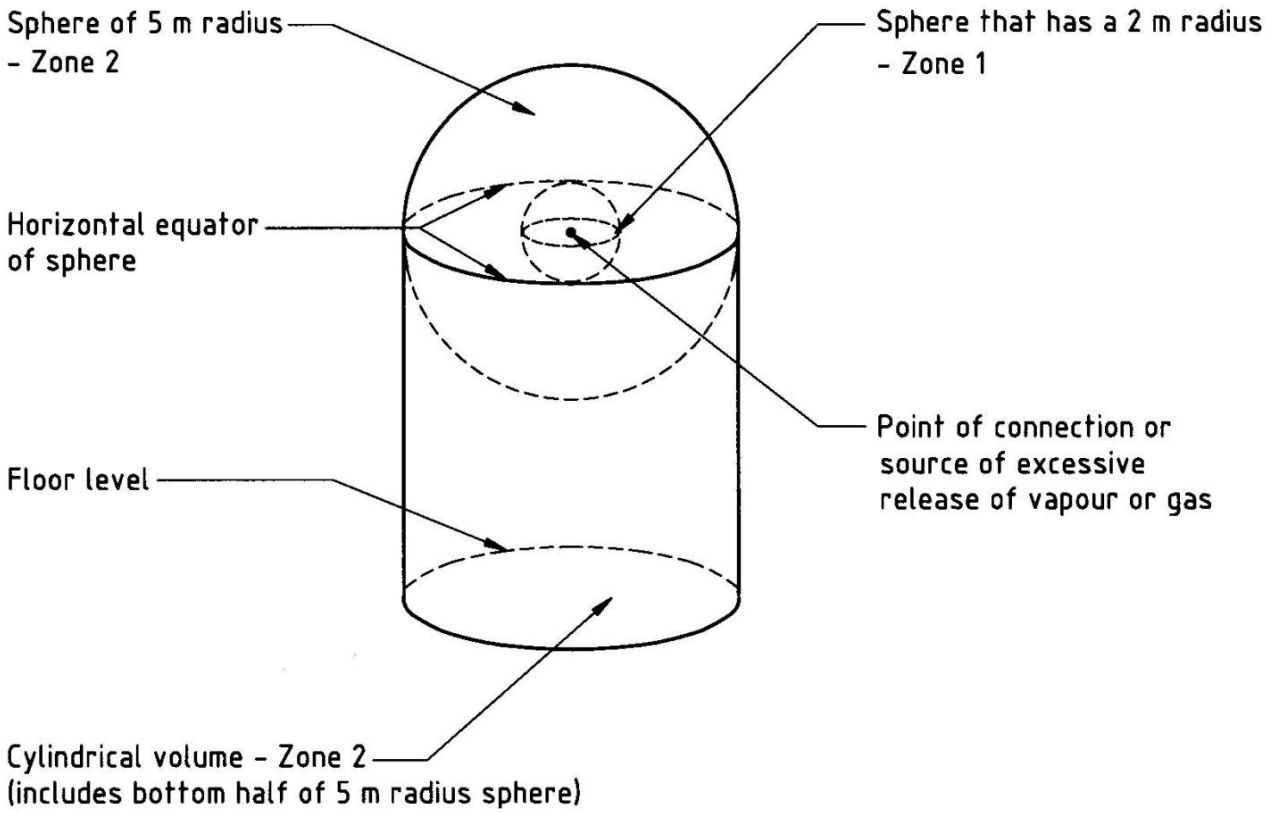


Figure 4 — Identification of zone levels

Annex A

(informative)
Rate of discharge of pressure relief devices

A.1 Surface mounted storage vessels

The minimum rate of discharge, in cubic metres of air per minute, of pressure relief devices at 120 % of the start-to-discharge pressure is given in Table A.1 for storage vessels of surface area up to 200 m^2.

For storage vessels with a total outside surface area greater than 200 m^2, the required flow rate in cubic metres of air per minute can be calculated from the following:

$10.658\ A^{0.82}$

where,

A is the surface area of the storage vessel, in square metres.

A.2 Buried and mounded storage vessels

The minimum rate of discharge may be reduced to 50 % of the appropriate rates given Clause in A.1.

Table A.1 — Minimum rate of discharge for surface mounted storage vessels

1	2	3	4	5	6
Surface area of storage vessel m^2	**Flow rate** m^3 of air per min	**Surface area of storage vessel** m^2	**Flow rate** m^3 of air per min	**Surface area of storage vessel** m^2	**Flow rate** m^3 of air per min
1,5	14,9	16,5	106,2	55,0	285,0
2,0	18,8	17,0	108,8	60,0	306,0
2,5	22,6	17,5	111,4	65,0	326,8
3,0	26,2	18,0	114,0	70,0	347,3
3,5	29,8	18,5	116,6	75,0	367,5
4,0	33,2	19,0	119,6	80,0	387,4
4,5	36,6	19,5	121,8	85,0	407,2
5,0	39,9	20,0	124,3	90,0	426,7
5,5	43,1	21,0	129,4	95,0	446,1
6,0	46,3	22,0	134,4	100,0	465,2
6,5	49,5	23,0	139,4	105,0	484,2
7,0	52,6	24,0	144,4	110,0	503,1
7,5	55,6	25,0	149,3	115,0	521,7
8,0	58,6	26,0	154,2	120,0	540,3
8,5	61,7	27,0	159,0	125,0	558,7
9,0	64,6	28,0	163,8	130,0	576,9
9,5	67,5	29,0	168,6	135,0	595,0
10,0	70,4	30,0	173,3	140,0	613,1
10,5	73,3	31,0	178,1	145,0	631,0
11,0	76,1	32,0	182,8	150,0	648,7
11,5	79,0	33,0	187,4	155,0	666,4
12,0	81,8	34,0	192,1	160,0	684,0
12,5	84,6	35,0	197,7	165,0	701,5
13,0	87,3	36,0	201,3	170,0	718,9
13,5	90,1	37,0	205,9	175,0	736,2
14,0	92,8	38,0	210,4	180,0	753,4
14,5	95,5	39,0	215,0	185,0	770,5
15,0	98,2	40,0	219,5	190,0	787,5
15,5	100,9	45,0	241,7	195,0	804,5
16,0	103,5	50,0	263,5	200,0	821,3

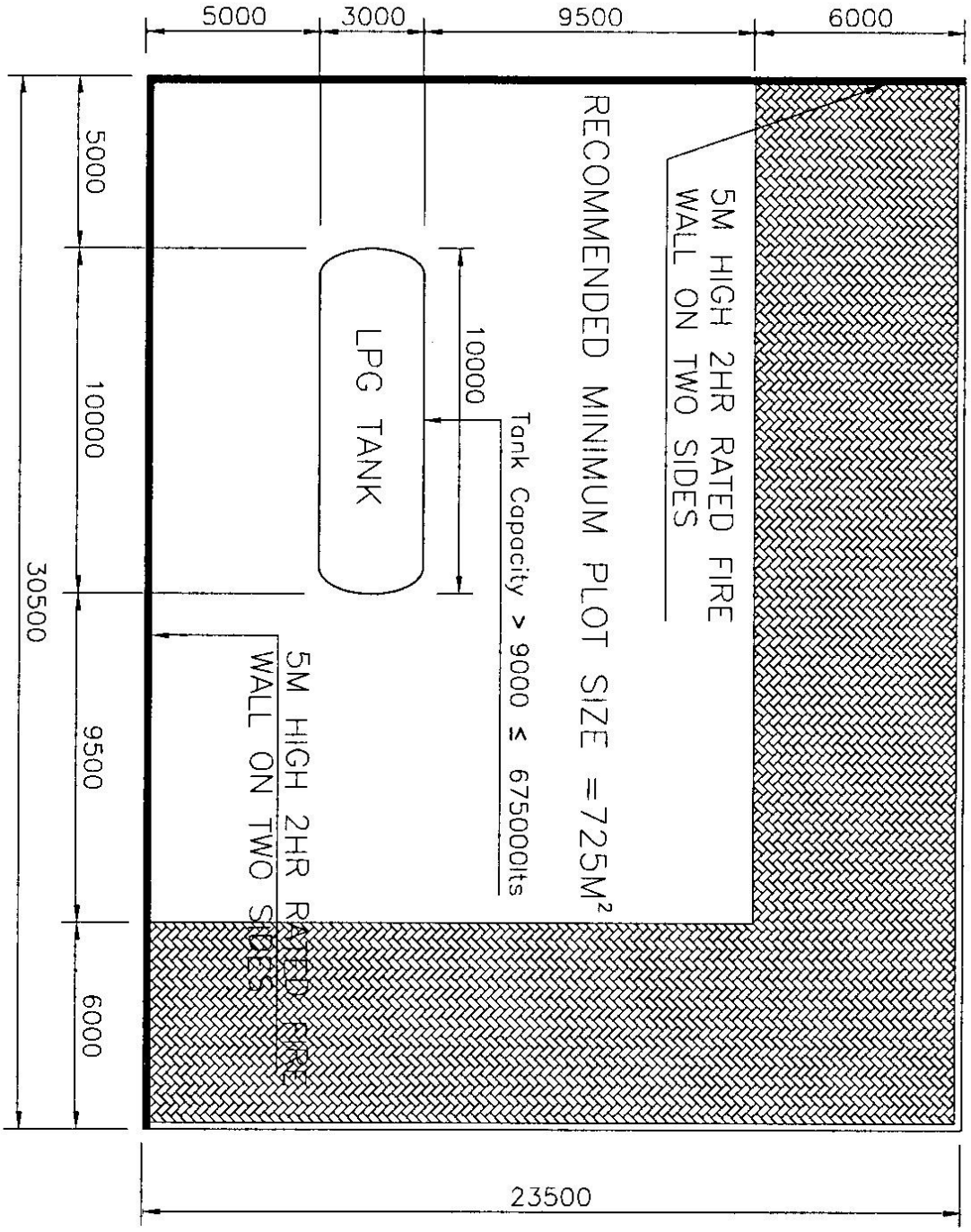


Figure A.1 —Recommended minimum plot sizes for LPG storage plants (>9000 L ≤67500 L)

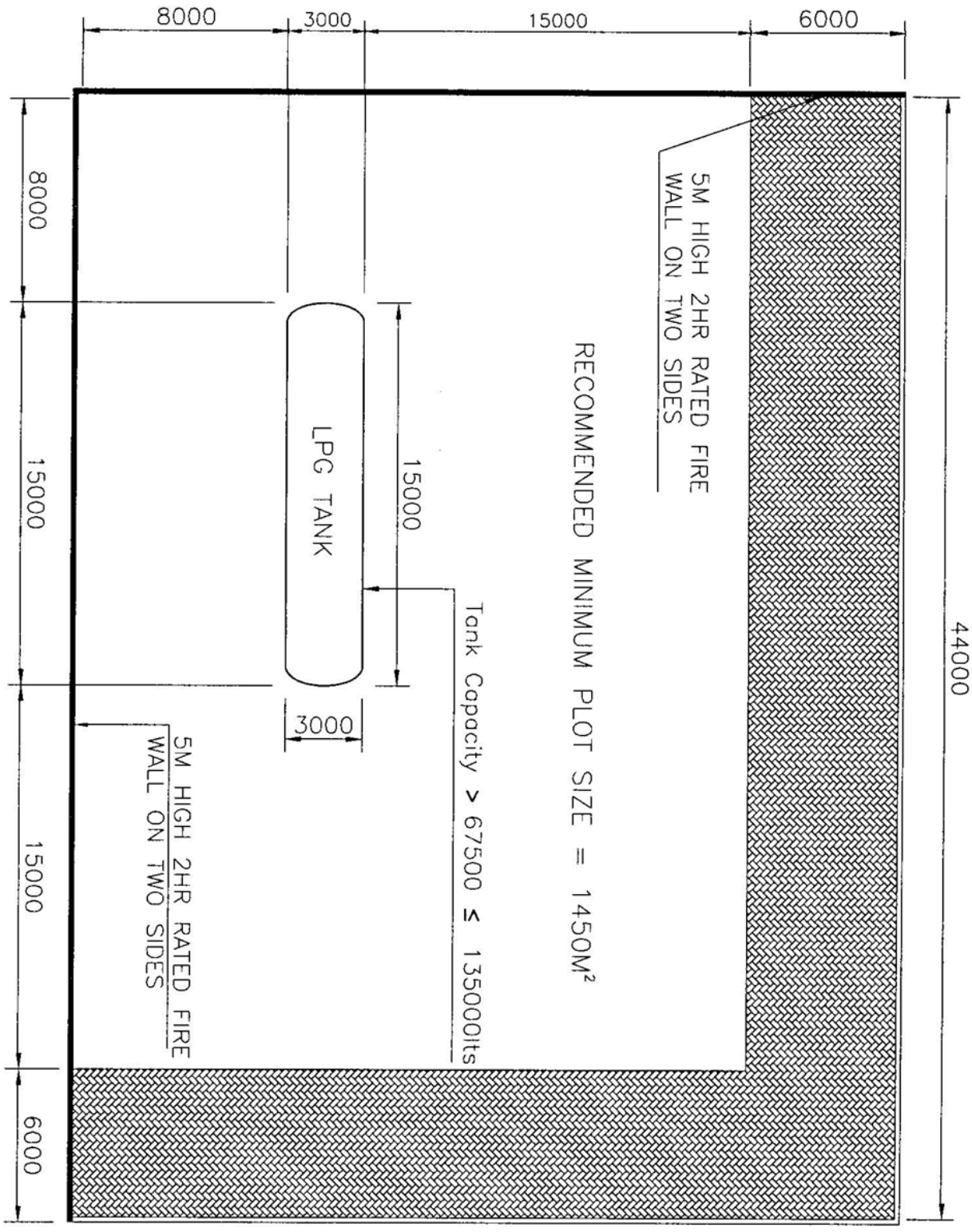


Figure A.2 — Recommended minimum plot sizes for LPG storage plants (>67500 L ≤135000L)

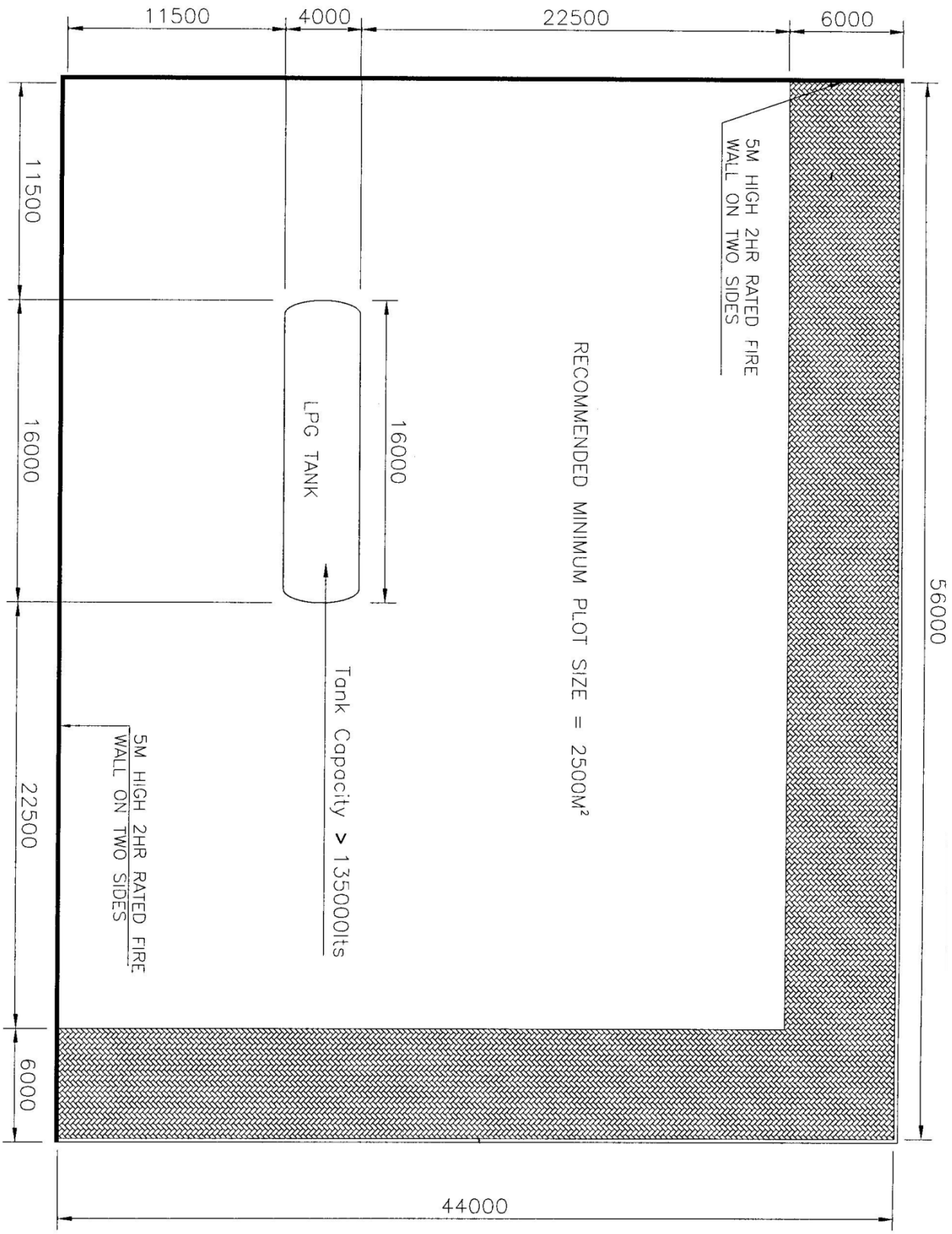


Figure A.3 — Recommended minimum plot sizes for LPG storage plants (>135000L)

Bibliography

[1] KS 1938-3: 2012, Handling, storage and distribution of liquefied petroleum gas in domestic, commercial, and industrial installations — Code of practice — Part 3: Liquefied petroleum gas installations involving storage vessels of individual water capacity exceeding 9000 L

