NFPA

59

LP-GASES AT UTILITY GAS PLANTS 1979

NATIONAL FIRE PROTECTION ASSOCIATION, INC.
470 Atlantic Avenue, Boston, MA 02210

4M-7-79-FP
Printed in U.S.A.

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See Official NFPA Definitions at the back of this pamphlet.

Standard for the Storage and Handling of

Liquefied Petroleum Gases at Utility Gas Plants

NFPA 59 — 1979

1979 Edition of NFPA 59

The 1979 edition of the *Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants* incorporates amendments recommended by the Committee on Liquefied Petroleum Gases and adopted by the National Fire Protection Association, Inc. at the Annual Meeting on May 17, 1979. It was released by the Standards Council for publication on June 11, 1979.

Changes, other than editorial, are denoted by a vertical line in the margin at the page on which they appear.

Origin and Development of NFPA 59

The *Standard on Liquefied Petroleum Gases* (NFPA 58) was used as a general guide until this standard was adopted in 1949. Subsequent editions were adopted in 1954, 1956, 1958, 1962, 1963, 1968, 1974, and 1976.

To facilitate the preparation of this standard, the cooperation of the American Gas Association was secured. This resulted in the formation of a special committee under the sponsorship of the American Gas Association, made up of utility engineers, specialists in gas plant construction, and engineers of the liquefied petroleum gas industry. The standard was initially the result of the AGA Committee acting in an advisory capacity to the Sectional Committee on Utility Gas of the NFPA Committee on Gases.

With the formation of the Committee on Fuel Gases in 1966, this standard was assigned to that Committee. The Committee established a Subcommittee on Utility Gas Plants to have a working responsibility for NFPA 59. In 1972, responsibility for NFPA 59 was assigned to the Committee on Liquefied Petroleum Gases with the Subcommittee on Utility Gas Plants retained.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

Contents

Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants

NFPA 59 — 1979

NOTICE: Information on referenced documents may be found in Appendix F.

Chapter 1 General Provisions

1-1 Introduction.

1-1.1 The purpose of this standard is to outline methods for protection of persons and property by providing a standard of reference to serve as a guide to all persons concerned with the construction and operation of liquefied petroleum gas equipment at utility gas plants.

1-1.2 The term "liquefied petroleum gases" as used in this standard shall mean and include any material having a vapor pressure not exceeding that allowed for commercial propane which is composed predominantly of any of the following hydrocarbons, or mixtures of them: propane, propylene, butanes (normal butane or isobutane), and butylenes.

1-1.3 In the interest of safety, it is important that persons engaged in handling liquefied petroleum gases understand the properties of these gases and that they be thoroughly trained in safe practices for the handling and distribution of these products.

1-1.4 Under moderate pressure the gases liquefy, but upon relief of the pressure are readily converted into the gaseous phase. Under moderately low temperature the gases liquefy. Advantage of this characteristic is taken by the industry. Generally the gases are shipped and stored under pressure as liquids. The escape of liquid into the atmosphere normally results in instantaneous vaporization, with the volume of gases being between 200 and 300 times the volume of escaping liquid. When in the gaseous state these gases are heavier than air and have a narrower range of flammability than natural or manufactured gas.

1-1.5 In the case of pure product at atmospheric pressure and below 31°F (minus 0.6°C), normal butane is a liquid. Propane is a liquid at atmospheric pressure at temperatures below minus 44°F (minus 42.2°C) and normally does not present a flammable liquid hazard except when stored at or below its boiling point.

1-1.6 Commercially available butane and propane may have different liquefying points from those in 1-1.5 because they normally contain various percentages of other hydrocarbon products.

1-1.7 Rapid vaporization takes place at temperatures above the boiling points (normal butane about 31°F [minus 0.6°C]; propane about minus 44°F [minus 42.2°C]). Normally these gases are stored as a liquid under pressure; however, in refrigerated storage these gases are frequently stored at or below the boiling point at practically atmospheric pressure.

1-2 Application of Standard.

1-2.1 This standard applies to utility gas plants for the design, construction, location, installation, and operation of refrigerated and nonrefrigerated liquefied petroleum gas systems.

1-2.2 It is recognized that advancement in engineering and improvements in equipment may result in equipment fabrication methods and operating practices which differ from those specifically called for in this standard. Yet, such deviations or improvements may provide desirable safety and compatible operation meeting the intent of this standard. Such deviations may be accepted when the authority having jurisdiction has made a special investigation of all factors and, based on sound experience and engineering judgment, concludes that the proposed deviations meet the intent of this standard.

1-2.3 Where existing plants, equipment, buildings, structures and installations meet the applicable design, fabrication or construction layout provisions of the edition of this standard in effect at the time of installation, they are permitted to be continued in use provided they do not constitute a distinct hazard to life or adjoining property.

1-2.4 When operations involving container charging or transportation of liquefied petroleum gas in liquid form are carried out on the same property, these operations shall conform to the *Standard for the Storage and Handling of Liquefied Petroleum Gases,* NFPA 58 (ANSI).

1-2.5 Installations having an aggregate water capacity not exceeding 2,000 gal (7.57 m^3) shall conform to the *Standard for the Storage and Handling of Liquefied Petroleum Gases,* NFPA 58 (ANSI).

1-3 Definitions.

Approved. Acceptable to the authority having jurisdiction.[1]

Barrel. A unit of volume. One barrel equals 42 U. S. gal (0.159 kL) or 5.615 cu ft (0.159 cu m).

Buried. Installations in which the top of the container (excluding the manway) is below the surrounding grade.

Buried, Partially (or Mounded). Installations in which the top of the container is above the surrounding grade and is covered with earth.

Containers. Vessels, such as tanks, cylinders or drums, used for storing liquefied petroleum gases.

Containers, Field Erected. Containers fabricated in whole or in part at or near their final location.

Containers, Shop Fabricated. Containers completely fabricated within a plant under shop controlled conditions.

Gas. Liquefied petroleum gases in either the liquid or gaseous state.

Gas-Air Mixer. A device or system of piping and controls, which mixes LP-Gas vapor with air to produce a mixed gas of certain heating value but not within the flammable range. Any gas-air mixer which is designed to produce a mixture containing more than 85 percent air by volume shall be considered a combustion device not subject to the provisions of this standard.

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[1]The National Fire Protection Association, Inc. does not approve, inspect or certify any installations, procedures, equipment or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or materials meets appropriate standards or has been tested and found suitable for use in a specified manner.[1]

Psig and Psia. Pounds per square inch gage and pounds per square inch absolute, respectively.

Sources of Ignition. Devices or equipment which, because of their modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable LP-Gas vapor-air mixtures when introduced into such a mixture or when such a mixture comes into contact with them, and which will permit propagation of flame away from them.

Systems. An assembly of equipment consisting essentially of liquefied petroleum gas unloading equipment, container or containers, major devices such as vaporizers, relief valves, excess flow valves,regulators, and interconnecting piping. In the case of refrigerated storage, it would also include compressors, condensers, and other related equipment and controls. Such systems shall include any unloading equipment, storage equipment or interconnecting piping up to the outlet of the first stage regulator, vaporizer or mixing device, whichever is the last unit before the liquefied petroleum gas enters other plant equipment or distribution lines.

1-4 Odorizing Gases.

1-4.1 All LP-Gases shall be odorized by the addition of a warning agent of such character that they are detectable, by a distinct odor, down to a concentration in air of not over one-fifth the lower limit of

[1]The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

flammability;[1, 2] provided, however, that odorization is not required if harmful in the use or further processing of the liquefied petroleum gas, or if odorization will serve no useful purpose as a warning agent in such use or further processing.

NOTE: The lower limits of flammability of the more commonly used liquefied petroleum gases are: Propane, approximately 2 percent; Butane, approximately 1½ percent. These figures represent volumetric percentages of gas in a gas-air mixture in each case.

1-5 Acceptance of Equipment.

1-5.1 In systems utilizing containers of over 2,000-gal (7.57-m³) water capacity, each container valve, excess flow valve, gaging device, relief device directly connected on the liquefied petroleum gas container and direct fired vaporizer shall be approved *(see Section 1-3, Approved).*

1-6 Damage from Vehicles.

1-6.1 Where damage to liquefied petroleum gas systems from vehicular traffic is a possibility, precautions against such damage (such as warning signs or devices, or barricades) shall be taken *(see 2-9.2).*

1-7 Electrical Equipment and Lighting.

1-7.1 Electrical equipment and wiring shall be of the type specified by and shall be installed in accordance with the *National Electrical Code®*, NFPA 70 (ANSI), for ordinary locations except that fixed electrical equipment in classified areas shall comply with Section 1-8.

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[1]It is recognized that no odorant will be completely effective as a warning agent in all circumstances.

[2]It is recommended that odorants be qualified as to compliance with 1-4.1 by tests or experience. Where qualifying is by tests, such tests should be certified to by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb (0.45 kg) per 10,000 gal (37.8 kL) of liquid LP-Gas has been recognized as an effective odorant. Other odorants and quantities meeting the provisions of 1-4.1 may be used. Research* on odorants has shown that thiophane (tetrahydrothiophene) in a ratio of at least 6.4 lb (2.9 kg) per 10,000 gal (37.8 kL) of liquid LP-Gas may satisfy the requirements of 1-4.1.

*"A New Look at Odorization Levels for Propane Gas," BERC/RI-77/1, United States Energy Research & Development Administration, Technical Information Center, September, 1977. Available from National Technical Information Service, U.S. Dept. of Commerce, Springfield, VA 22161.

1-7.2 Adequate lighting shall be provided to illuminate operating facilities, such as walkways and essential control valves, and particularly loading and unloading facilities.

1-8 Fixed Electrical Equipment in Classified Areas.

1-8.1 Fixed electrical equipment and wiring installed within classified areas specified in Table 1 shall comply with Table 1 and shall be installed in accordance with the *National Electrical Code,* NFPA 70 (ANSI) for hazardous locations.

1-8.2 Fixed electrical equipment on LP-Gas cargo vehicles shall comply with the provisions of Chapter 6 of the *Standard for the Storage and Handling of Liquefied Petroleum Gases,* NFPA 58 (ANSI).

1-9 Source of Ignition.

1-9.1 Open flames and other sources of ignition shall not be permitted in vaporizer rooms (except those housing direct fired vaporizers), gas mixing rooms, or similar confined rooms or buildings containing LP-Gas facilities.

1-9.2 Liquefied petroleum gas storage containers do not require lightning protection *(Lightning Protection Code,* NFPA 78).

1-9.3 Since liquefied petroleum gas is contained in a closed system of piping and equipment, the system need not be electrically conductive or electrically bonded for protection against static electricity *(Static Electricity,* NFPA 77).

1-9.4 If the presence of stray electric currents is indicated as a cause of corrosion due to electrolysis, proper provisions shall be made for suitable protection.

1-9.5 Open flames (except direct fired vaporizers complying with Section 5-3), welding, cutting, portable electric tools and extension lights capable of igniting LP-Gas shall not be permitted within classified areas specified in Table 1 unless the LP-Gas facilities have been freed of all liquid and vapor, or special precautions observed under carefully controlled conditions.

1-9.6 Smoking shall be prohibited in the vicinity of LP-Gas facilities and suitable signs to that effect shall be displayed at each point of entry.

Table 1

Part	Location	Extent of Classified Area[1]	Equipment Shall Be Suitable for NEC, Class 1, Group D[4]
A	Nonrefrigerated container.	Within 15 ft (4.6 m) in all directions from connections, except for connections otherwise covered in this table.	Division 2
B	Refrigerated	Within 15 ft (4.6 m) in all directions from connections, except for connections otherwise covered in this table.	Division 2
		Area inside dike to a level of the top of the dike.	Division 2
C	Tank Vehicle and Tank Car Unloading[2]	Within 5 ft (1.5 m) in all directions from connections regularly made or disconnected for product transfer.	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from a point where connections are regularly made or disconnected and with the cylindrical volume between the horizontal equator of the sphere and grade. (*See Figure 1.*)	Division 2
D	Gage Vent Openings.	Within 5 ft (1.5 m) in all directions from point of discharge.	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of discharge.	Division 2
E	Relief Valve Discharge.	Within direct path of discharge.	Division 1 *Note:* Fixed electrical equipment should preferably not be installed.
		Within 5 ft (1.5 m) in all directions from point of discharge.	Division 1

(Cont. next page)

Table 1 — *(Cont.)*

		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of discharge except within path of discharge.	Division 2
F	Pumps, compressors, gas-air mixers, meter areas, calorimeters other than open flame types, and vaporizers other than direct fired.		
	Indoors without ventilation.	Entire room and any adjacent room not separated by a gastight partition.[1]	Division 1
		Within 15 ft (4.6 m) of the exterior side of any exterior wall or roof that is not vaportight or within 15 ft (4.6 m) of any exterior opening.	Division 2
	Indoors with adequate ventilation.[3]	Entire room and any adjacent room not separated by a gastight partition.[1]	Division 2
	Outdoors, at or above grade.	Within 15 ft (4.6 m) in all directions from equipment and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure 1.)	Division 2
G	Pits or trenches containing equipment such as pumps, compressors, other than direct fired vaporizers, and similar equipment. (Also pits or trenches located beneath classified areas.)		
	Without mechanical ventilation.	Entire pit or trench.	Division 1

(Cont. next page)

Table 1 — *(Cont.)*

		Entire room and any adjacent room not separated by a gastight partition when located indoors.	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors.	Division 2
	With adequate mechanical ventilation.[3]	Entire pit or trench.	Division 2
		Entire room and any adjacent room not separated by a gastight partition when located indoors.	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors.	Division 2
H	Pipelines and connections containing operational bleeds, drips, vents, or drains.	Within 5 ft (1.5 m) in all directions from point of discharge.	Division 1
		Beyond 5 ft (1.5 m) from point of discharge, same as Part F of this table.	

Notes:

[1] The classified area shall not extend beyond an unpierced wall, roof or solid vaportight partition.

[2] When determining extent of classified area, consideration shall be given to possible variations in the spotting of tank cars and tank vehicles at the unloading point and the effect that these variations of actual spotting point may have on the point of connection.

[3] Ventilation is considered adequate when provided in accordance with the provisions of this standard.

[4] See Article 500 — "Hazardous Locations," NFPA 70 (ANSI), for definitions of Classes, Groups and Divisions.

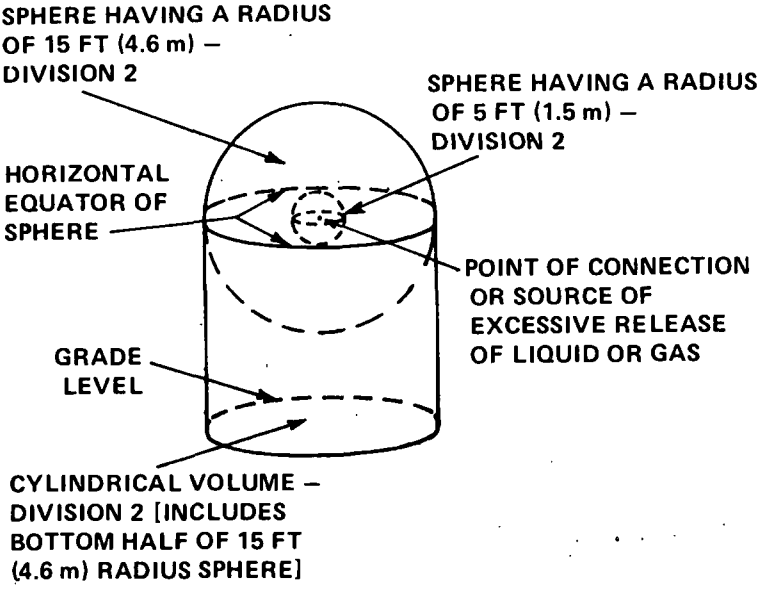

Figure 1
(See Table 1)

Chapter 2 Nonrefrigerated Containers

2-1 Provision for Construction and Original Test of Nonrefrigerated Containers.

2-1.1 Shop fabricated containers shall be designed, constructed and tested in accordance with *Rules for Construction of Unfired Pressure Vessels, Section VIII, ASME Boiler and Pressure Vessel Code,* or in accordance with the rules of the authority under which the containers are installed provided such rules substantially conform to the rules of the *ASME (Section VIII) Code,* except that UG-125 through UG-136 shall not apply.

2-1.2 The provisions of 2-1.1 shall not be construed as prohibiting the continued use or reinstallation of containers constructed and maintained in accordance with the *Code* in effect at the time of fabrication. *(See 1-2.3.)*

2-2 Design Pressure and Classification of Nonrefrigerated Containers.

2-2.1 Shop fabricated containers for nonrefrigerated storage shall be in accordance with Table 2.

Table 2

For gases with vapor pressure in psig at 100°F (37.8°C) not to exceed	Minimum design pressure in psig *ASME Code Section VIII,* 1977 Edition (Notes 1, 3)
80	100 (Note 2)
100	125
125	156
150	187
175	219
215	250

NOTE 1: See Appendix C of NFPA 58 for information on earlier ASME or API-ASME Codes.

NOTE 2: New containers for 100 psig design pressure (or equivalent under earlier codes) not authorized after December 31, 1947.

NOTE 3: Because of low soil temperature usually encountered, and the insulating effect of the earth, the average vapor pressure of products stored in underground containers will be materially lower than when stored aboveground. This reduction in actual operating pressure therefore provides a substantial corrosion allowance for these containers when installed underground.

2-2.2 Field-erected nonrefrigerated containers shall be built in accordance with applicable provisions of the 1977 edition of the *ASME Code,* except that construction using joint efficiencies in Table UW 12, Column C, Division 1 is not permitted.

2-2.3 Field-erected containers for nonrefrigerated storage shall be designed for a pressure not less than 125 percent of the maximum vapor pressure of the product at 100°F (38°C) to be stored in the containers, but in no case shall the container be designed for a pressure of 25 psig or less.

2-3 Markings on Nonrefrigerated Containers.

2-3.1 Each container for nonrefrigerated storage shall be marked as specified in the following:

(a) With a marking identifying compliance with and other markings required by the rules of the code under which the container is constructed; or with the stamp and other markings required by the National Board of Boiler & Pressure Vessel Inspectors.

Underground: Container and an accessible nameplate.
Aboveground: Container.

(b) With notation as to whether system is designed for underground or aboveground installation.

Underground: Container and an accessible nameplate.
Aboveground: Container.

(c) With the water capacity of the container in gal, U. S. Standard.

Underground: Container and an accessible nameplate.
Aboveground: Container.

(d) With the pressure in lb per sq in. for which the container is designed.

Underground: Container and an accessible nameplate.
Aboveground: Container.

(e) With the wording "This container shall not contain a product having a vapor pressure in excess of — — lb per sq in. gage at 100°F." *(See 2-1.2 and 2-2.3.)*

Underground and aboveground: A nameplate or tag on filler connection.

(f) With the outside surface area in sq ft.

Underground: Container and an accessible nameplate.
Aboveground: Container.

(g) With marking indicating the maximum level to which the container may be filled with liquid at temperatures between 20°F (6.7°C) and 130°F (54°C) except on containers provided with fixed maximum level indicators. Markings shall be in increments of 20 Fahrenheit degrees.

Aboveground and underground: System nameplate or on liquid level gaging device.

2-4 Location of Nonrefrigerated Containers.

2-4.1 Nonrefrigerated Aboveground Containers.

2-4.1.1 Containers shall be located outside of buildings.

2-4.1.2 Containers shall be located in accordance with Table 3 with respect to the distance between containers and the distance between containers and the nearest important building or group of buildings not associated with the LP-Gas plant, or a line of adjoining property which may be built upon.[1]

Table 3

Water capacity of each container in gal	Minimum Distances	
	Between containers in ft	From container to nearest important building or groups of buildings not associated with the LP-Gas plant, or a line of adjoining property which may be built upon.
2,001 to 30,000	5	50
30,001 to 70,000	¼ of sum of diameters of adjacent containers	75
70,001 to 90,000	"	100
90,001 to 120,000	"	125
120,001 to 200,000	"	200
200,001 to 1,000,000	"	300
1,000,001 or more	"	400

2-4.1.3 If water for container fire protection is to be applied only by hose streams, the following shall apply:

[1]In heavily populated or congested areas, where serious mutual exposures between container(s) and adjacent properties prevail, it is recommended that greater distances or special protection in accordance with good fire protection engineering practices be provided. Special protection may consist of mounding or burying containers, or providing fixed water spray or monitor nozzle protection.

(a) Containers shall be arranged into groups with each group limited to a maximum of six containers.

(b) Each group shall be separated from the nearest container in another group by a distance of at least 50 ft (15.4 m).

(c) Containers shall be oriented so that their longitudinal axes do not point toward other containers, vital process equipment, control rooms, loading stations and flammable liquid storage tanks.[1]

2-4.1.4 If water for container fire protection is to be applied by fixed monitor nozzles, the following shall apply:

(a) Containers shall be arranged into groups with each group limited to a maximum of six containers.

(b) Each group shall be separated from the nearest container in another group by a distance of at least 25 ft (7.7 m).

2.4.1.5 If water for container protection is to be applied by fixed water spray protection in compliance with NFPA 15, *Water Spray Fixed Systems for Fire Protection,* the following shall apply:

(a) Containers shall be arranged into groups with each group limited to a maximum of nine containers.

(b) Each group shall be separated from the nearest container in another group by a distance of at least 25 ft (7.7 m).

(c) In the design of water spray fixed systems, the area of container surface to be protected may reflect portions of containers not likely to be subject to fire exposure as determined by good fire protection engineering practice.

2-4.1.6 A container or containers with an aggregate water capacity in excess of 120,000 gal (454 m^3) shall be located 100 ft (31 m) or more from buildings associated with the LP-Gas plant which are occupied for generation, compression or purification of manufactured gas, or from natural gas compressor buildings, or from outdoor installations essential to the maintenance of operation in such buildings.

Such a container or containers shall be 100 ft (31 m) or more from aboveground storage of flammable liquids and from any building of such construction or occupancy which constitutes a material hazard of exposure to the containers in the event of fire or explosion in said buildings.

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[1]Container orientation should also be considered with respect to the buildings cited in 2-4.1.2.

2-4.1.7 If any capacity container or containers associated with the LP-Gas plant are located closer than 100 ft (31 m) or the distances in Table 3, whichever is less, to buildings occupied for generation, compression or purification of manufactured gas, or from natural gas compressor buildings, then such buildings shall be protected by walls adjacent to such storage containers or by other appropriate means against the entry of escaped liquefied petroleum gas, or of drainage from the storage container area and its loading points — all in such a manner as may be required and approved by the authority having jurisdiction.

2-4.1.8 Nonrefrigerated liquefied petroleum gas containers shall not be located within dikes enclosing flammable liquid tanks, and shall not be located within dikes enclosing refrigerated liquefied petroleum gas tanks.

2-4.2 Nonrefrigerated Underground Containers.

2-4.2.1 Underground containers shall include both buried and partially buried (or mounded) containers.

2-4.2.2 Containers shall be located outside of any buildings. Buildings or roadways shall not be constructed over any underground containers. Sides of adjacent containers shall be separated by not less than 3 ft (1 m).

2-4.2.3 When containers are installed parallel with ends in line, any number of containers are permitted to be in one group. When more than one row is installed, the adjacent ends of the tanks in each row shall be separated by not less than 10 ft (3 m).

2-4.2.4 Containers shall be located not less than 50 ft (15.4 m) from the nearest important building or group of buildings or line of adjacent property which may be built upon.

2-4.2.5 Containers shall be located not less than 50 ft (15.4 m) from buildings occupied for generation, compression or purification of gas, or from outdoor installations essential to the maintenance of operation in such buildings. They shall be located not less than 50 ft (15.4 m) from aboveground storage of flammable liquids and from any buildings of such construction or occupancy which constitutes a severe exposure to any aboveground appurtenances of the underground installation in the event of fire or explosion in said buildings. If the underground installations by necessity are located closer than 50 ft (15.4 m) to any such buildings or installations, then the latter shall be protected against the entry of escaping liquefied petroleum gas, in such a manner as may be required and approved by the authority having jurisdiction.

2-4.3 Nonrefrigerated containers shall not be stacked one above the other.

2-4.4 The ground within 25 ft (7.7 m) of any aboveground nonrefrigerated container shall be kept clear of readily ignitible material such as weeds and long dry grass.

2-4.5 Containers connected to a common manifold shall be installed so that their maximum liquid filling levels present substantially the same plane. This minimizes the possibility of overfilling lower level tanks.

2-5 Installation of Nonrefrigerated Storage Containers.

2-5.1 Nonrefrigerated Aboveground Containers.

2-5.1.1 Every container shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell or heads.

2-5.1.2 Supports for containers shall be of solid masonry, concrete or steel. Structural metal supports are permitted to be employed when they are protected against fire in an approved manner. Metal supports shall be protected against fire with a material having a fire resistance rating of at least two hours. Steel skirts having only one opening 18 in. (462 mm) or less in diameter shall be protected in accordance with the preceding, but fireproofing need only be applied to the outside of the skirt.

2-5.1.3 Horizontal containers shall be mounted on saddles in such a manner as to permit expansion and contraction, not only of the container but also of the connected piping. Only two saddles shall be used.

2-5.1.4 Suitable means to prevent corrosion shall be provided on that portion of the container in contact with the foundations or saddles.

2-5.1.5 Containers shall be kept properly painted or otherwise protected from the elements.

2-5.2 In addition to the applicable provisions for horizontal ASME storage containers, vertical ASME storage containers over 2,000-gal (7.57-m^3) water capacity shall comply with 2-5.2.1 through 2-5.2.5.

2-5.2.1 Containers shall be designed to be self-supporting without the use of guy wires and shall satisfy proper design criteria taking into account wind, seismic (earthquake) forces, and hydrostatic test loads.

2-5.2.2 Design pressure *(see Table 2)* shall be interpreted as the pressure at the top head with allowance made for increased pressure on lower shell sections and bottom head due to the static pressure of the product.

2-5.2.3 Wind loading on containers shall be based on wind pressures on the projected area at various height zones aboveground as recommended in *Building Code Requirements for Minimum Design Loads in Buildings and Other Structures,* ANSI A58.1. Wind speeds shall be based on a Mean Occurrence Interval of 100 years.

2-5.2.4 Seismic loading on containers shall be based on forces recommended in the *Uniform Building Code (UBC).* In those areas identified as zones 3 and 4 on the Seismic Risk Map of the United States, Figures 1, 2 and 3 of Chapter 23 of the *UBC,* a seismic analysis of the proposed installation shall be made which meets the approval of the authority having jurisdiction.

2-5.2.5 Containers shall be fabricated with lifting lugs or some other suitable means to facilitate erection in the field.

2-5.3 Nonrefrigerated Underground Containers.

2-5.3.1 Buried containers shall be placed so that the top of the container is not less than 6 in. (154 mm) below the grade of the surrounding area. Partially buried (or mounded) containers shall have not less than 12 in. (308 mm) of cover, sufficient to provide surface drainage without erosion or other deterioration.

2-5.3.2 The container manway shall not be covered with the backfill or mounding material. Under conditions where the container manway cover is below the ground level, a manway providing sufficient access shall be installed. No other part of the container shall be exposed.

2-5.3.3 Containers shall be set upon a firm foundation (firm earth is permitted to be used) and surrounded with earth or sand firmly tamped in place. Backfill shall be free of rocks or other abrasive materials. Provision shall be made to take care of settling and rotation.

2-5.3.4 Containers shall be adequately protected against corrosion.

2-5.3.5 Bottom connections to the container shall be prohibited. All connections shall be in the container manway or at openings along the top length of the container.

2-5.3.6 If the area above a container is to be used for purposes not prohibited by this standard, consideration shall be given to depth of cover and loads that may be imposed.

2-5.4 Field welding where necessary shall be made only on saddle plates or brackets which were applied by manufacturer of container, except as provided by the code under which the container was fabricated.

2-5.5 Secure anchorage or adequate pier height shall be provided to protect against container flotation wherever sufficiently high water might occur.

2-5.6 When flammable liquid storage tanks are in the same general area as liquefied petroleum gas containers, the flammable liquid storage tanks shall be diked or diversion curbs or grading used to prevent accidentally escaping flammable liquids from flowing into liquefied petroleum gas container areas.

2-5.7 To minimize the possibilities for trespassing and tampering, the area which includes container appurtenances, pumping equipment and loading and unloading facilities shall be protected by one of the following methods:

2-5.7.1 Enclosure with at least a 6-ft (1.85-m) high industrial-type fence unless otherwise adequately protected. There shall be at least two means of emergency access through the fenced or other enclosure.

2-5.7.2 As an alternative to fencing the operating area, suitable devices which can be locked in place shall be provided. Such devices, when in place, shall effectively prevent unauthorized operation of any of the container appurtenances, system valves or equipment.

2-5.7.3 Locks with frangible shanks shall be used.

2-6 Reinstallation of Nonrefrigerated Containers.

2-6.1 Containers once installed underground or aboveground which have been out of service for more than one year shall not be reinstalled aboveground or underground, unless they successfully withstand without distortion hydrostatic pressure retests at the

pressure specified for the original hydrostatic test as required by the code under which constructed, and show no evidence of serious corrosion. Reinstallation of containers in all other respects shall be in accordance with all the provisions listed in this standard. *(See Section 2-5. See also Chapter 6 for relief valve requirements.)*

2-7 Gaskets.

2-7.1 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. They shall be made of metal or other suitable material confined in metal having a melting point over 1,500°F (816°C) or shall be protected against fire exposure, except that aluminum O-rings and spiral wound metal gaskets are acceptable. When a flange is opened, the gasket shall be replaced.

2-8 Filling Densities.

2-8.1 The "filling density" is defined as the percent ratio of the weight of the gas in a container to the weight of water at 60°F (15.6°C) that the container will hold. Except as noted in 2-8.3, nonrefrigerated containers shall be filled in accordance with Table 4.

Table 4

Maximum Permitted Filling Density

Specific Gravity at 60°F (15.6°C)	Aboveground Containers 0 to 1,200 U.S. Gal (1,000 Imp. gal, 4,550 L) Total Water Cap.	Aboveground Containers Over 1,200 U.S. Gal (1,000 Imp. gal, 4,550 L) Total Water Cap.	Underground Containers All Capacities
.496—.503	41%	44%	45%
.504—.510	42	45	46
.511—.519	43	46	47
.520—.527	44	47	48
.528—.536	45	48	49
.537—.544	46	49	50
.545—.552	47	50	51
.553—.560	48	51	52
.561—.568	49	52	53
.569—.576	50	53	54
.577—.584	51	54	55
.585—.592	52	55	56
.593—.600	53	56	57

2-8.2 The maximum liquid volume in percent of the total container capacity may be determined for nonrefrigerated liquefied petroleum gases at any liquid temperature by using the formula shown in Appendix C.

2-8.3 For individual underground nonrefrigerated installations, the authority having jurisdiction is permitted to authorize the use of increased filling densities where the maximum ground temperatures do not exceed 60°F (15.6°C). These filling densities shall be based upon sound engineering practices for the operating conditions involved.

2-9 Loading and Unloading Facility Spacing.

2-9.1 Loading and unloading connections shall be at least 75 ft (23.1 m) from uncontrolled sources of ignition, process areas, control buildings, offices, shops and other occupied or important plant structures. This does not apply to structures or equipment directly associated with the transfer operation.

2-9.2 The filling pipe inlet terminal shall not be located inside a building. Such terminals shall be located at least 25 ft (7.7 m) from a container, shall be properly supported and protected from physical damage by vehicular movement and shall be located at least 5 ft (1.5 m) behind any barriers provided for such protection.

Chapter 3 Refrigerated Containers

3-1 Provisions for Construction, Design and Original Test of Refrigerated Containers.

3-1.1 Refrigerated containers shall be built in accordance with applicable provisions of one of the following codes as appropriate for conditions of maximum allowable working pressure, design temperature, and hydrostatic testing:

3-1.1.1 For pressures of 15 psig or more, use the 1977 edition of the *ASME Code, Section VIII,* except that construction using joint efficiencies in Table UW 12, Column C, Division 1 is not permitted. Material shall be selected from those recognized by ASME which meet the requirements of Appendix R of ANSI/API 620.

3-1.1.2 For pressures below 15 psig, use ANSI/API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low Pressure Storage Tanks,* including Appendix R.

3-1.2 Field-erected containers for refrigerated storage shall bedesigned as an integral part of the storage system including tank in-sulation, compressors, condensers, controls, and piping. Proper allowance shall be made for the service temperature limits of the particular process and the products to be stored when determining material specifications and the design pressure. Welded construction shall be used.

3-1.3 When austenitic steels or nonferrous materials are used, ANSI/API 620, Appendix Q shall be used as a guide in the selection of materials for use at the design temperature.

3-2 Markings on Refrigerated Containers.

3-2.1 Each refrigerated container shall be identified by the attachment of a nameplate on the outer covering in an accessible place marked as specified in the following:

(a) Manufacturer's name and date built.

(b) With liquid volume of the container in gal (U.S. Standard) or barrels.

(c) With the maximum allowable working pressure in lbs per sq in.

(d) With the minimum temperature in degrees Fahrenheit for which the container was designed.

(e) The maximum allowable water level to which the container may be filled for test purposes.

(f) With the density of the product to be stored in lbs per cu ft for which the container was designed.

(g) With the maximum level to which the container is permitted to be filled with the liquefied petroleum gas for which it was designed.

3-3 * Location of Refrigerated Containers.

3-3.1 Refrigerated Aboveground Containers.

3-3.1.1 Containers shall be located outside of buildings.

3-3.1.2 Containers shall be located in accordance with Table 5.[1]

Table 5

Water capacity of each container (gal)	Minimum Distances	
	Between containers (ft)	*From container to nearest important building, or group of buildings, not associated with the LP-Gas plant, or a line of adjoining property which may be built upon (ft)*
125,001-200,000	¼ of sum of diameters of adjacent containers	200
200,001-1,000,000		300
Over 1,000,000		400

3-3.1.3 A container or containers with an aggregate water capacity in excess of 120,000 gal (454 m^3) shall be located 100 ft (31 m) or more from buildings associated with the LP-Gas plant which are occupied for generation, compression or purification of manufactured gas, or from natural gas compressor buildings, or from outdoor installations essential to the maintenance of operation in such buildings. Such a container or containers shall be 100 ft (31 m) or

[1]In heavily populated or congested areas, where serious mutual exposures between container(s) and adjacent properties prevail, it is recommended that greater distances or special protection in accordance with good fire protection engineering practices be provided. Special protection may consist of mounding or burying containers, or providing fixed water spray or monitor nozzle protection.

more from aboveground storage of flammable liquids and from any buildings of such construction or occupancy which constitute a material hazard of exposure to the containers in the event of fire or explosion in said buildings. If the container or containers are located closer to any such buildings or installations, then the latter shall be protected by walls adjacent to such storage containers or by other appropriate means against the entry of escaped liquefied petroleum gas, or of drainage from the storage container area and its loading points — all in such a manner as may be required and approved by the authority having jurisdiction.

3-3.1.4 Refrigerated liquefied petroleum gas containers shall not be located within dikes enclosing flammable liquid tanks or within dikes enclosing nonrefrigerated liquefied petroleum gas containers.

3-3.2 Refrigerated containers shall not be installed one above the other.

3-3.3 The ground within 25 ft (7.7 m) of any aboveground refrigerated container and all ground within a diked area shall be kept clear of readily ignitible material such as weeds and long dry grass.

3-4 Installation of Refrigerated Containers.

3-4.1 Refrigerated aboveground containers shall be installed on the ground, or on foundations or supports of concrete, masonry piling, or steel. Foundations and supports shall be protected to have a fire-resistance rating of not less than two hours.

3-4.2 For product storage at less than 30°F (minus 1.1°C), the foundation design or the container bottom insulation shall be such that damage from frost heave will be prevented. Ambient or supplied heat is permitted to be utilized.

3-4.3 Any exposed insulation shall be fire resistant and shall resist dislodgment by fire hose streams. When an outer shell is used to retain loose insulation, the shell shall be constructed of steel or concrete.

3-4.3.1 If natural gas is used to purge any insulation space, it shall be vented to a safe location.

3-4.4 Aboveground LP-Gas containers shall be inside a diked area except where spillage of hydrocarbon can be contained in a designated area within the plant site by topography.

3-4.4.1 The usable volume of the diked area or topographical enclosure shall be at least 100 percent of the capacity of the largest container enclosed.

3-4.4.2 More than one container is permitted to be installed in a single diked area or topographical enclosure provided:

(a) The volume of the enclosure complies with 3-4.4.1.

(b) When an outer shell is used to contain loose insulation:

1. Containers shall be elevated above grade so that liquid will not reach the outside container wall in the event of a liquid spill; or

2. If liquid can reach the outside container wall, the material that can be wetted by spilled liquid shall be suitable for use at minus 44°F (minus 42.2°C).

(c) Container foundations are constructed of concrete properly designed for fire exposure.

3-4.4.3 Dikes shall be constructed of earth, concrete, solid masonry or other suitable material designed to prevent the escape of liquid and to withstand a full hydraulic head. The dikes shall be constructed to withstand thermal shock.

3-4.4.4 The walls of the dikes shall be not less than 5 ft (1.5 m) in height. Where topography can provide suitable containment, dike walls, where required, need only be as high as the containment capacity requires.

3-4.4.5 Provision shall be made to drain rainwater from the diked area and drains shall be equipped with a positive closure which shall be closed except when manually opened for draining. The valve and other parts of the drain system that may be subject to LP-Gas temperature shall be of suitable material to withstand low temperatures. Such drains shall not permit drainage of tank contents to enter natural water courses, public sewers, or public drains. When pumps control drainage from the diked area, they shall be manually controlled and provided with an open sight discharge.

3-4.5 After acceptance tests are completed, there shall be no field welding on the LP-Gas containers except upon saddle plates or brackets provided therefor or as otherwise provided for by the code under which the container was fabricated.

3-4.6 Secure anchorage or adequate pier height shall be provided to protect against container flotation wherever sufficiently high water might occur.

3-4.7 When flammable liquid storage tanks are in the same general area as liquefied petroleum gas containers, the flammable liquid storage tanks shall be diked or diversion curbs or grading used to prevent accidentally escaping flammable liquids from flowing into liquefied petroleum gas container areas.

3.4.8 To minimize the possibility for trespassing and tampering, the area which includes container appurtenances, pumping equipment and loading and unloading facilities shall be protected by one of the following methods:

3-4.8.1 Enclosure with at least a 6-ft (1.85-m) high industrial-type fence unless otherwise adequately protected. There shall be at least two means of emergency access through the fenced or other enclosure.

3-4.8.2 As an alternative to fencing the operating area, suitable devices which can be locked in place shall be provided. Such devices, when in place, shall effectively prevent unauthorized operation of any of the container appurtenances, system valves or equipment.

3-4.8.3 Locks with frangible shanks shall be used.

3-5 Reinstallation of Refrigerated Containers.

3-5.1 Containers once installed, which have been out of service for more than one year, shall not be put back in service, unless they successfully withstand without distortion hydrostatic pressure retests at the pressure specified for the original hydrostatic test as required by the code under which constructed, and show no evidence of serious corrosion. Reinstallation of containers in all other respects shall be in accordance with all the provisions listed in this standard. *(See Section 3-4. See also Chapter 6 for relief valve requirements.)*

3-6 Gaskets.

3-6.1 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. They shall be made of metal or other suitable material confined in metal having a melting point over 1,500°F (816°C) or shall be protected against fire exposure, except that aluminum O-rings and spiral wound metal gaskets are acceptable. When a flange is opened, the gasket shall be replaced.

3-7 Filling Densities.

3-7.1 The filling limits for refrigerated storage containers shall be based upon sound engineering practice for the individual design and operating conditions involved. Since negligible expansion of the liquid can take place within the possible range of operating pressure and temperature of a refrigerated container, the maximum liquid volume in percent of the total container capacity is greater for a refrigerated container than normally employed for a nonrefrigerated container.

3-8 Loading and Unloading Facility Spacing.

3-8.1 Loading and unloading connections shall be at least 75 ft (23.1 m) from uncontrolled sources of ignition, process areas, control buildings, offices, shops and other occupied or important plant structures. This does not apply to structures or equipment directly associated with the transfer operation.

3-8.2 The filling pipe inlet terminal shall not be located inside a building or diked area. Such terminals shall be located at least 25 ft (7.7 m) from a container, shall be properly supported and protected from physical damage by vehicular movement, and shall be located at least 5 ft (1.5 m) behind any barriers provided for such protection.

4-1.8 Piping, valves, fittings and gaging devices for the refrigerated portion of the liquefied petroleum gas system shall be based on sound engineering practices for the individual design and operating conditions involved.

4-2 Container Valves and Accessories.

4-2.1 All shutoff valves and accessory equipment (liquid or gas) shall be suitable for use with liquefied petroleum gas, and designed for not less than the maximum extreme pressure and temperature to which they may be subjected. Valves for use with nonrefrigerated containers which may be subjected to container pressure shall have a rated working pressure of at least 250 psig. Cast-iron valves, piping, and fittings shall be prohibited on liquefied petroleum gas containers and their connections. This does not prohibit the use of container valves or fittings made of malleable or nodular iron.

4-2.2 All connections to containers, except safety relief connections, liquid level gaging devices, and plugged openings, shall have shutoff valves located as close to the container as practicable. The valves shall be readily accessible for operation and maintenance under normal and emergency conditions, either because of location or by means of permanently installed special provisions. Valves installed in an unobstructed location not more than 6 ft (1.85 m) above ground level shall be considered accessible. Special provisions include, but are not limited to, stairs, ladders, platforms, remote operators or extension handles.

4-2.3 Excess flow valves where required by this standard shall close automatically at those rated flows of vapor or liquid as specified by the manufacturer. The connections or line including valves, fittings, etc., downstream of an excess flow valve shall have a greater capacity than the rated flow of the excess flow valve.

4-2.4 Except as provided in 4-2.5 and 4-4.4, all liquid and vapor connections on containers except safety relief connections shall be equipped with approved automatic excess flow valves, or with back pressure check valves, or a remotely controlled automatic quick-closing valve which shall remain closed except during operating periods. The mechanism for remotely controlled, quick-closing valves shall be provided with a secondary control equipped with a fusible release (not over 220°F [104°C] melting point) which will cause the quick-closing valve to close automatically in case of fire.

4-2.5 Openings from a container or through fittings attached directly on the container to which pressure gage connection is made

need not be equipped with an excess flow valve if such openings are not larger than No. 54 drill size.

4-2.6 Excess flow and back pressure check valves where required by this standard shall be located inside of the container or at a point outside where the line enters the container; in the latter case, installation shall be made in such a manner that any undue stress beyond the excess flow or back pressure check valve will not cause breakage between the container and such valve.

4-2.7 Excess flow valves shall be designed with a bypass, not to exceed a No. 60 drill size opening to allow equalization of pressures.

4-2.8 All inlet and outlet connections except safety valves, liquid level gaging devices and pressure gages on any container shall be labeled or color coded to designate whether they are connected to vapor or liquid space. Labels are permitted to be on valves.

4-2.9 Each storage container shall be provided with a suitable pressure gage.

4-3 Filler and Discharge Pipes, Manifolds.

4-3.1 Piping connections between container and manifold shall be designed to provide adequate allowances for contraction, expansion, vibration, and settlement. Compression-type couplings shall not be considered suitable for this purpose.

4-3.2 Where practical, liquid manifold connections shall be located at nonadjacent ends of parallel rows of containers.

4-3.3 The use of nonmetallic hose is prohibited for interconnecting stationary containers.

4-3.4 The pipe inlet terminal shall be labeled to designate its purpose.

4-3.5 In the design of the liquid piping system, shutoff or block valves shall be installed to limit the volume of liquid that could be discharged in the vicinity of containers or important structures in the event of a liquid line failure. Automatically or remotely controlled valves, or both, of the fail-safe type shall be used. The mechanism for such valves shall be provided with a secondary control equipped with a fusible release (not over 220°F [104°C] melting point) which will cause the valve to close automatically in case of fire. Such valves shall also be capable of being manually operated at the installed location.

Such valves within 300 ft (93 m) of a container or important structure shall be arranged to limit the quantity that could be discharged to a maximum of 300 cu ft (8.5 m^3) of liquid. In no case shall there be more than 150 ft (46.2 m) between valves on the same line within 300 ft (93 m) of a container or important structure.

4-3.6 In addition to the valving specified in 4-3.5, suitable safeguards shall be provided to prevent the uncontrolled discharge of LP-Gas in the event of failure in the flexible connecting hose or swivel-type piping, located as close as practicable to the points where connections are made between the flexible and fixed parts of the piping system, as follows:

4-3.6.1 The connection, or connecting piping, into which the liquid or vapor is being transferred shall be equipped with:

(a) A back-flow check valve, or
(b) An excess flow valve properly sized in accordance with 4-2.3.

4-3.6.2 The connection, or connecting piping, from which the liquid or vapor is being drawn shall be equipped with an excess flow valve properly sized in accordance with 4-2.3.

4-3.7 When the liquid line manifold connecting containers in a group has a volumetric capacity of more than 100 gal (0.38 m^3), such container manifolds shall be located not less than 100 ft (31 m) from the nearest adjacent property owned by others which may be built upon. The manifold piping terminates at the first line valve which may be used to isolate the manifolded containers from any other part of the liquid line system.

4-4 Liquid Level Gaging Device.

4-4.1 Each nonrefrigerated storage system shall be equipped with a liquid level gaging device of approved design, such as a pressure differential type, a float gage, a rotary gage, slip tube, magnetic or fixed tube device. If the liquid level gaging device is a float type or a pressure differential type and the container is a nonrefrigerated type, the container shall also be provided with an auxiliary gaging device, such as a fixed dip tube, slip tube, rotary gage, or similar device.

4-4.1.1 Unlisted gage glasses of the columnar type shall not be permitted.

4-4.2 Refrigerated containers shall be equipped with a liquid level gaging device of approved design. An auxiliary gaging device is not

required for refrigerated containers. However, in lieu of an auxiliary gage, refrigerated containers, if subject to overfilling, shall be equipped with an automatic device to interrupt filling of the tank when the maximum filling level is reached.

4-4.3 All gaging devices shall be arranged so that the maximum liquid level for butane, for a 50-50 mixture of butane and propane, and for propane, to which the container may be filled is readily determinable.

4-4.4 Gaging devices that require bleeding of the product to the atmosphere, such as the rotary tube, fixed tube and slip tube, shall be so designed that the bleed valve maximum opening is not larger than a No. 54 drill size, unless provided with an excess flow valve.

4-4.5 Gaging devices for containers shall have a maximum allowable working pressure at least equal to that of the containers to which they are attached.

4-4.6 When used, the length of a fixed tube device shall be designed to indicate the maximum level to which the container may be filled for the product contained. The length or location of the fixed tube to indicate this level shall be based on the volume of the product at 40°F (4.4°C) at its maximum permitted filling density for aboveground containers and at 50°F (10°C) for buried containers. Refer to Appendix D for calculating filling point for which tube shall be designed.

4-5 Hose Specifications for Nonrefrigerated LP-Gas.

4-5.1 Hose shall be fabricated of materials that are resistant to the action of LP-Gas and shall be approved.

4-5.2 Hose, hose connections and flexible connections shall comply with 4-5.2.1 and 4-5.2.2.

4-5.2.1 Hose shall be designed for a minimum bursting pressure of 1,750 psig (12.1 MPa) (350 psi [2.41 MPa] working pressure) and shall be marked with "LP-Gas" or "LPG" and with the working pressure in psig at not greater than 10-ft (3-m) intervals.

4-5.2.2 Hose assemblies, after the application of connections, shall have a design capability of withstanding a pressure of not less than 700 psig (4.8 MPa). If a test is made, such assemblies shall not be leak tested at pressures higher than the working pressure (350 psig [2.41 MPa] minimum) of the hose.

4-6 Drips, Pits and Drains.

4-6.1 Where vaporized gas may condense, suitable means shall be provided for revaporization or disposal of the condensate.

4-6.2 Avoid the use of pits containing LP-Gas equipment. If pits are used they shall be fitted with continuous automatic flammable vapor detecting devices equipped with an alarm. No drains or blow-off lines shall be directed into or in proximity to sewer systems used for other purposes.

4-7 Pumps and Compressors.

4-7.1 Each pump and compressor shall be suitable for the liquefied petroleum gas service intended. Each pump and compressor shall be marked with its maximum working pressure.

4-7.2 Refrigerated storage systems shall be provided with sufficient capacity to maintain all containers at a pressure not in excess of the operating pressure under summer weather conditions and shall be provided with additional capacity for filling or standby service. Unless facilities are provided to safely dispose of vented vapors while the refrigeration system is inoperative, at least two (2) compressors shall be installed where compressors and condensers are used. Compressor capacity provided for standby service shall be capable of handling the volume of vapors necessary to be evolved to maintain operating pressure. Auxiliary equipment, such as fans, circulating water pumps, and instrument air compressors, shall be provided with spare or standby facilities sufficient to insure that prolonged failure of refrigeration may be prevented.

4-7.3 Adequate means shall be available for operating equipment in event of failure of normal facilities.

4-8 Protection of Container Accessories.

4-8.1 Valves, regulating, gaging, and other container accessory equipment shall be protected against tampering and physical damage. If locks are used, they shall be of the frangible shank type.

4-8.2 All connections on underground containers shall be located within a substantial dome, housing, or manhole and protected by a substantial round cover. *(See 6-4.2.)*

Chapter 5 Vaporizers and Gas-Air Mixing

5-1 General.

5-1.1 Liquefied petroleum gas storage containers shall not be directly heated with open flames.

5-1.2 Heating or cooling coils shall not be installed inside of a storage container.

5-1.3 Vaporizers shall not be equipped with fusible plugs for pressure relief.

5-1.4 Vaporizer houses shall not have drains to sewers or sump pits.

5-2 Vaporizers Not Directly Heated with Open Flames.

5-2.1 Vaporizers constructed in accordance with the requirements of the *ASME Unfired Pressure Vessel Code* shall be permanently marked as follows:

(a) With the code marking signifying the specifications to which vaporizer is constructed.

(b) With the maximum allowable working pressure and temperature for which the vaporizer is designed.

(c) With the sum of the outside surface area and the inside heat exchange surface area expressed in sq ft.

(d) With the name or symbol of the manufacturer, date of manufacture, and serial number.

5-2.2 Vaporizers having an inside diameter of 6 in. or less exempted by the *ASME Unfired Pressure Vessel Code* shall have a design working pressure not less than 250 psig and need not be permanently marked.

5-2.3 Building or structural enclosures in which vaporizers and/or gas-air mixers are installed shall be of lightweight noncombustible construction with non-load-bearing walls. If rooms containing such equipment are located within or attached to buildings in which LP-

Gases are not handled, i.e., control rooms, shops, boiler rooms, etc., the common walls shall be limited to no more than two in number, shall be designed to withstand a static pressure of at least 100 psf (4.8 kPa), have no doors or other communicating openings, and shall have a fire resistant rating of at least one hour. Such buildings or structural enclosures shall be ventilated to minimize the possibility of hazardous accumulations of flammable vapors by a gravity system composed of a combination of wall openings near the floor line and roof ventilators. The ventilation rate shall be at least 1 cfm (0.47 L/s) of air per sq ft (0.09 m^2) of floor area.

5-2.4 A shutoff valve shall be installed on the liquid line to a vaporizer at least 50 ft (15.4 m) away from the vaporizer or a building housing a vaporizer.

5-2.5 The heating medium lines into and leaving the vaporizer shall be provided with suitable means for minimizing the effect of flow of gas into the heat system in the event of tube rupture in the vaporizer. Vaporizers shall be provided with suitable automatic means to prevent liquid passing from the vaporizers to the gas discharge piping.

5-3 Direct Fired Vaporizers.

5-3.1 Each vaporizer shall be marked to show the name of the manufacturer; rated British Thermal Unit input to burners; the area of the heat exchange surface in sq ft; the maximum vaporizing capacity in gal per hour; and date and serial number.

5-3.2 No direct fired vaporizers shall be located closer than 50 ft (15.4 m) to line of adjoining property upon which structures may be built. They shall also be located a minimum distance of 50 ft (15.4 m) away from any liquefied petroleum gas storage container.

5-3.3 No direct fired vaporizer shall be connected to a container that has a storage capacity in gal less than 10 times the hourly capacity of the vaporizer in gal. Vaporizers are permitted to be connected to the liquid section or the gas section of the storage container, or both; but in any case, there shall be at the container a manually operated valve in each connection to permit complete shutting off, when desired, of all flow of gas or liquid from container to vaporizer.

5-3.4 Vaporizers may be installed in buildings, rooms, housings, sheds, or lean-tos used exclusively for vaporizing LP-Gas.

5-3.4.1 Such buildings or structural enclosures in which vaporizers are installed shall be constructed and ventilated in accordance with 5-2.3.

5-3.4.2 These structures shall not have interior drains to sewers or sump pits.

5-3.5 Vaporizers shall be provided with suitable automatic means to prevent liquid passing from the vaporizer to the gas discharge piping of the vaporizer.

5-3.6 Vaporizers shall be provided with a means for turning off the gas to the main burner and pilot from a remote location.

5-3.7 Vaporizers shall be equipped with automatic safety devices to shut off the flow of fuel to main burners and pilot, if the ignition device should fail.

5-3.8 No direct fired vaporizer shall raise the product pressure over the designed working pressure of the vaporizer equipment.

5-4 Gas-Air Mixing.

5-4.1 Gas-air mixers shall be designed for air, vapor and mixture pressures in accordance with good engineering design practice. Piping materials shall be in accordance with Chapter 4 of this standard. Gas-air mixers shall be so designed as to prevent the accidental formation of a flammable mixture.

5-4.2 Gas-air mixers shall be equipped with safety interlocks on both the LP-Gas and air supply lines to shut down the system if flammable limits are approached. Gas mixing control valves which provide tight shutoff of the LP-Gas and air supply lines when actuated by safety interlocks shall be considered as acceptable shutdown devices. Such valves shall fail in closed position.

5-4.3 A means shall be provided to prevent air from entering mixed gas lines without LP-Gas being present.

5-4.4 A means, such as a check valve installed in the air supply line close to the mixer, shall be provided to prevent backflow of gas into the air supply system.

5-4.5 Where it is possible for condensation to take place between the vaporizer and the gas-air mixer, an interlock shall be provided to prevent LP-Gas liquid from entering the gas-air mixer.

5-4.6 Gas-air mixers which utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere, and are so designed that maximum air entrainment is less than 85 percent of the mixture, need not include the interlocks mentioned in 5-4.2 and 5-4.3, but shall be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down. Gas-air mixers of this type receiving air from a blower, compressor, or any source of air other than direct from atmosphere shall include a means for preventing air without LP-Gas from entering the gas system.

5-4.7 Gas-air mixers may be installed in buildings or structural enclosures used exclusively for gas-air mixing or for vaporizing LP-Gas and mixing, provided that the vaporizer is not directly heated with open flame. Such buildings or structural enclosures shall be constructed in accordance with 5-2.3.

Chapter 6 Relief Devices

6-1 General.

6-1.1 Relief devices on containers shall be so arranged that the possibility of tampering will be minimized; if the pressure setting or adjustment is external, the relief devices shall be provided with an approved means for sealing the adjustment.

6-1.2 Each container relief device shall be plainly and permanently marked with the pressure in lbs per sq in. gage at which the device is set to start to discharge, with the actual rate of discharge in cu ft per min of air at 60°F and 14.7 psia, and with the manufacturer's name and catalog number. For example, a safety relief valve marked "250-15,000 AIR" indicates that it is set to start to discharge at 250 psig and that its rate of discharge is 15,000 cu ft per min of air.

6-1.3 The rate of discharge of container relief valves shall be in accordance with the provisions of Appendix A for nonrefrigerated containers and Appendix E for refrigerated containers.

6-1.4 Connections to which relief devices are attached, such as couplings, flanges, nozzles, and discharge lines for venting, shall have internal dimensions that will not restrict the net relief area.

6-1.5 The size of the relief device outlet connection shall not be smaller in diameter than the nominal size of the relief outlet connection and shall not appreciably restrict flow through the relief.

6-1.6 All container relief devices shall be located on the containers and shall be connected with the vapor space of the container.

6-1.7 No shutoff valve shall be installed between the relief device and the container, equipment, or piping to which the relief device is connected except that a shutoff valve may be used where the arrangement of this valve is such that full required capacity flow through the relief device is always afforded.

This exception is made to cover such arrangements as a three-way valve installed under two relief devices, each of which has the required rate of discharge. The installation shall allow either of the relief valves to be closed, but shall not allow both to be closed at the same time. In another arrangement, two separate relief valves are

permitted to be installed with individual shutoff valves if the shutoff valve stems are mechanically interconnected in a manner which will allow full required flow from one relief valve at all times.

6-1.8 Any outlet piping shall be directed horizontally or upward so as not to cause flame impingement or endanger personnel. It shall have at least the area of the valve outlet and shall be so arranged as not to unduly restrict the flow.

6-1.8.1 Return bends and restrictive pipe fittings shall not be permitted in relief device discharge vents.

6-1.9 Discharge lines from two or more relief devices located on the same unit, or similar lines from two or more different units, except those located on storage containers, are permitted to be run into a common discharge header provided the header is designed with a flow capacity sufficient to limit the maximum back pressure to (a) not exceeding 10 percent of the lowest start-to-discharge pressure setting for conventional relief valves, and (b) not exceeding 50 percent of the lowest start-to-discharge pressure setting for balanced valves. Header design shall assume that all valves connected to the header are discharging at the same time.

6-1.9.1 Relief valve piping shall be designed so that liquid which may be trapped will not create dangerous back pressure when the relief valve operates.

6-1.10 All discharge vents from the safety relief valves or common discharge headers shall be installed in such a manner as to:

(a) Lead to the open air.

(b) Be protected against mechanical damage.

(c) Exclude or remove moisture and condensate. This may be done by the use of loose-fitting rain caps and drains. Drains shall be so installed as to prevent possible flame impingement on the containers, piping, equipment, and structures.

6-1.10.1 Discharge in an area which:

(a) Will prevent possible flame impingement on containers, piping, equipment, and structures.

(b) Will prevent possible vapor entry into enclosed spaces.

(c) Will be above the heads of personnel who may be on the container or adjacent containers, stairs, platforms, or ground.

(d) Will be above the possible water level, if from underground containers where there is a possibility of flooding.

6-1.10.2 Prevent malfunction due to freezing or icing.

6-2 Testing Relief Devices.

6-2.1 Relief devices shall be tested for proper operation at intervals not exceeding five (5) years.

6-3 On Aboveground Containers.

6-3.1 Every container shall be provided with spring-loaded relief valves or their equivalent. ASME containers for LP-Gas shall be equipped with spring-loaded safety relief valves conforming with applicable requirements of the *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas,* UL 132; *Standards for Safety Relief Valves of the Factory Mutual Research Corporation;* or other equivalent safety relief valve standards.

6-3.2 The discharge from the relief devices shall be vented away from the container, and unobstructed to the open air in a manner to prevent any impingement of escaping gas upon the container, adjacent containers, piping and other equipment. The vents shall be fitted with loose fitting rain caps. Suitable provision shall be made to prevent any liquid or condensate that may accumulate inside the relief device or its vent from rendering the relief device inoperative. If a bottom drain is used, a means shall be provided to protect the container, adjacent containers, and piping of equipment against impingement of flame resulting from ignition of product escaping from the drain. The vent piping shall extend upward toward at least 7 ft (2.2 m) above the top of the container.

6-3.3 Container relief valves shall be set to start to discharge with relation to the design pressure of the container in accordance with Table 6.

Table 6

Containers	Minimum	Maximum
All *ASME Codes* prior to the 1949 Edition, and the 1949 Edition, paragraphs U-68 and U-69	110%	125%*
ASME Code, 1949 Edition, paragraphs U-200 and U-201, and all *ASME Codes* later than 1949	88%	100%*
ANSI/API 620		100%*

*Manufacturers of relief valves are allowed a plus tolerance not exceeding 10 percent of the set pressure marked on the valve.

6-3.4 Relief devices on containers shall be constructed to discharge at not less than the rates shown in Appendix A or E before the pressure is in excess of 120 percent of the maximum (not including the 10 percent referred to in the asterisked note of Table 6) permitted start to discharge pressure setting of the devices.

6-3.5 For refrigerated storage, consideration shall be given to making proper provisions for vacuum conditions.

6-4 On Underground Containers.

6-4.1 Relief devices shall meet all the conditions outlined for aboveground containers except the rate of discharge for relief devices installed thereon may be reduced to a minimum of 30 percent of the specified rate of discharge shown in Appendix A. The discharge pipe from safety relief devices shall extend directly, vertically upward at least 7 ft (2.2 m) above the ground. If liquid product is placed in containers while they are not buried, these containers shall be considered as aboveground containers.

6-4.2 Where there is a probability of the manhole or housing becoming flooded, the discharge from regulator vent lines shall be above such water level. All manholes or housings shall be provided with ventilated louvers or their equivalent.

6-5 On Vaporizers.

6-5.1 Each vaporizer shall be provided with a relief device providing an effective rate of discharge in accordance with Appendix B.

6-5.2 Relief valves on direct fired vaporizers shall be located so that they shall not be subjected to normal operating temperatures in excess of 140°F (60°C) *(see Section 6-1 for other requirements on relief devices).*

6-6 Between Shutoff Valves.

6-6.1 A hydrostatic relief valve shall be installed between each pair of shutoff valves on liquefied petroleum gas liquid piping so as to relieve into a safe atmosphere. Hydrostatic relief valves shall have pressure settings not less than 400 psig (2.76 MPa) or more than 500 psig (3.45 MPa) unless installed in systems designed to operate above 350 psig (2.41 MPa). Hydrostatic relief valves for use in systems designed to operate above 350 psig (2.41 MPa) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

Chapter 7 Handling

7-1 Transfer of Liquids Within a Utility Plant.

7-1.1 Liquefied petroleum gas in liquid form is permitted to be transferred from tank cars, or tank trucks, or storage within a utility plant either by liquid pump or by pressure differential.

7-1.1.1 Pumps and compressors used for transferring liquefied petroleum gas shall be designed for the product handled.

7-1.2 Under certain conditions, it may be necessary to create a pressure differential by using fuel gas, or inert gas, which is at a pressure higher than the pressure of the liquefied petroleum gas in the container being filled. This is permitted to be done under the following conditions:

7-1.2.1 Adequate precautions shall be taken to prevent liquefied petroleum gas from flowing back into the fuel gas, or inert gas line or system by installing two back flow check valves in series in these lines at the point where they connect into the liquefied petroleum gas system. In addition, a manually operated positive shutoff valve shall be installed at this point.

7-1.2.2 Any fuel gas or inert gas used to obtain a pressure differential to move liquid liquefied petroleum gas shall be noncorrosive and dried to avoid stoppage by freezing.

7-1.2.3 Before any fuel gas or inert gas is placed in a tank car for unloading liquefied petroleum gas by pressure differential, permission shall be obtained from the vendor of the liquefied petroleum gas to introduce such vapors into the tank car or a tank truck.

7-1.3 Transfer operations shall be conducted by competent trained personnel. At least one qualified person shall remain at or near the transfer operation from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

7-1.4 The maximum vapor pressure of the product at 100°F (37.8°C) which may be transferred into a container shall be in accordance with 2-2.1 or 2-2.2 and 2-2.3.

7-1.5 Unloading piping or hoses shall be provided with suitable bleeder valves or other means for relieving pressure before disconnection.

7-1.6 Precaution shall be exercised to assure that only those gases for which the system is designed, examined, and listed are employed in its operation, particularly with regard to pressures.

7-2 Tank Car Loading and Unloading Point.

7-2.1 The track of tank car siding shall be relatively level.

7-2.2 A TANK CAR CONNECTED sign, as covered by DOT (U.S. Dept. of Transportation)[1] rules, shall be installed at the active end or ends of the siding while the tank car is connected for unloading.

7-2.3 While cars are on side-track for unloading, the wheels at both ends shall be blocked on the rail.

7-3 Tank Truck Loading and Unloading.

7-3.1 The area of tank truck transfer shall be relatively level.

7-3.2 A tank truck loading and unloading area shall be of sufficient size to accommodate the vehicles without excessive movement or turning. Tank trucks or transports unloading into storage containers shall be at least 10 ft (3 m) from the container and so positioned that the shutoff valves on both the truck and the container are readily accessible.

7-3.3 While trucks are loading or unloading, the wheels shall be blocked.

[1]Formerly ICC (Interstate Commerce Commission). Published in Federal Code of Regulations — Title 49 — Parts 171-190. In Canada, the regulations of the Canadian Transport Commission for Canada apply.

Chapter 8 Fire Protection

8-1 Fire Protection.

8-1.1 The wide range in the size, design, and location of utility plant liquefied petroleum gas installations makes the recommendations of any specific kind or method of fire protection impractical. The planning of effective fire protection shall initially be coordinated with the protection practice followed in other sections of the particular utility company and shall give due consideration to the requirements of the authority having jurisdiction.

8-1.2 Gas fires shall normally not be extinguished until the source of the burning gas has been shut off. Remotely operated or remotely located pipeline valves are advantageously used for fire control under many circumstances.

8-1.3 Hand or wheeled fire extinguishers designed for gas fires, preferably of the dry chemical type, shall be available at each strategic location within a liquefied petroleum gas plant.

8-1.4 Supplies of water may be utilized through hose lines preferably equipped with combination (spray and straight stream) nozzles to permit widest adaptability in fire control. If sufficient quantities of water can be made available, complete water spray protection can be given consideration. The water is used for the sole purpose of cooling equipment, foundations, and piping. It shall not be relied upon for extinguishing gas fires.

8-1.5 Fire-resistive insulation is permitted to be utilized for protecting metal against heat. Care in selecting and applying such insulation is necessary since effectiveness is dependent on its ability to stay in place on a container during a fire.

8-1.6 Where standard watchman service is provided it shall be extended to the liquefied petroleum gas installation; such personnel shall be properly trained.

8-1.7 Suitable roadways or means of access shall be provided for extinguishing equipment such as wheeled extinguishers or other fire department apparatus.

8-1.8 Routine fire drills and inspections shall be scheduled and operating personnel thoroughly trained in the use of available fire fighting equipment and the location and use of all gas and liquid piping and valves.

Appendix A

Minimum required rate of discharge in cu ft per min of air at 120 percent of the maximum permitted start to discharge pressure for safety relief devices to be used on nonrefrigerated containers other than those constructed in accordance with U.S. Department of Transporation specifications.

Surface Area Sq Ft	Flow Rate CFM Air	Surface Area Sq Ft	Flow Rate CFM Air	Surface Area Sq Ft	Flow Rate CFM Air
20 or less	626	170	3620	600	10170
25	751	175	3700	650	10860
30	872	180	3790	700	11550
35	990	185	3880	750	12220
40	1100	190	3960	800	12880
45	1220	195	4050	850	13540
50	1330	200	4130	900	14190
55	1430	210	4300	950	14830
60	1540	220	4470	1000	15470
65	1640	230	4630	1050	16100
70	1750	240	4800	1100	16720
75	1850	250	4960	1150	17350
80	1950	260	5130	1200	17960
85	2050	270	5290	1250	18570
90	2150	280	5450	1300	19180
95	2240	290	5610	1350	19780
100	2340	300	5760	1400	20380
105	2440	310	5920	1450	20980
110	2530	320	6080	1500	21570
115	2630	330	6230	1550	22160
120	2720	340	6390	1600	22740
125	2810	350	6540	1650	23320
130	2900	360	6690	1700	23900
135	2990	370	6840	1750	24470
140	3080	380	7000	1800	25050
145	3170	390	7150	1850	25620
150	3260	400	7300	1900	26180
155	3350	450	8040	1950	26750
160	3440	500	8760	2000	27310
165	3530	550	9470		

Surface Area = Total outside surface area of container in sq ft. When the surface area is not stamped on the nameplate or when the marking is not legible, the area can be calculated by using one of the following formulas:

1. Cylindrical container with hemispherical heads
   Area = Overall length × outside diameter × 3.1416