

NFPA No.

59



LP GASES AT UTILITY GAS PLANTS 1976



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See Inside Back Cover for Official NFPA Definitions

Standard for the Storage and Handling of

Liquefied Petroleum Gases at Utility Gas Plants

NFPA No. 59 — 1976

1976 Edition of No. 59

The 1976 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 NFPA at the Fall Meeting on November 16, 1976. It supersedes the 1974 edition.

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

Origin and Development of No. 59

The Standard on Liquefied Petroleum Gases (No. 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 and 1974.

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 No. 59. In 1972, responsibility for NFPA No. 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.

Interpretation Procedure of the Committee on Liquefied Petroleum Gases

Those desiring an interpretation shall supply the Chairman with five identical copies of a statement in which shall appear specific reference to a single problem, paragraph, or section. Such a statement shall be on the business stationery of the inquirer and shall be duly signed.

When applications involve actual field situations they shall so state and all parties shall be named.

The Interpretations Committee will reserve the prerogative to refuse consideration of any application that refers specifically to proprietary items of equipment or devices. Generally inquiries should be confined to interpretation of the literal text or the intent thereof.

Requests for interpretations should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

Contents

<i>Section</i>	<i>Page</i>
Interpretation Procedure	59- 3
1. General Requirements	59- 5
2. Nonrefrigerated Containers	59-13
3. Refrigerated Containers	59-22
4. Piping, Valves, Gauging Devices	59-28
5. Vaporizers and Gas-Air Mixing	59-34
6. Relief Devices	59-38
7. Handling	59-42
8. Fire Protection	59-44
 <i>Appendix</i>	
A. Minimum Required Rate of Discharge	59-45
B. Minimum Required Rate of Discharge for Safety Relief Valves for Vaporizers	59-46
C. Calculating Maximum Liquid Volume of Containers	59-47
D. Calculating Maximum Volume of Container with Fixed Dip Tube	59-50
E. Discharge Rates of Safety Relief Valves (Refrigerated Containers).	59-52

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

NFPA No. 59 — 1976

SECTION 1. GENERAL REQUIREMENTS

11. Introduction.

110. 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.

111. 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.

112. 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.

113. 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.

114. In the case of pure product at atmospheric pressure and below 31 F., normal butane is a liquid. Propane is a liquid at atmospheric pressure at temperatures below minus 44 F. and normally does not present a flammable liquid hazard except when stored at or below its boiling point.

115. Commercially available butane and propane may have different liquefying points from those in Par. 114 because they normally contain various percentages of other hydrocarbon products.

116. Rapid vaporization takes place at temperatures above the boiling points (normal butane about 31 F.; propane about minus 44 F.). 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.

12. Application of Standard.

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

121. 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.

122. 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 Standard for the Storage and Handling of Liquefied Petroleum Gases, NFPA No. 58 (ANSI Z106.1).

123. Installations having an aggregate water capacity not exceeding 2,000 gallons shall conform to Standard for the Storage and Handling of Liquefied Petroleum Gases, NFPA No. 58 (ANSI Z106.1).

13. Definitions.

130. The term "gas" in this standard shall refer to liquefied petroleum gases in either the liquid or gaseous state.

131. The term "containers" includes all vessels such as tanks, cylinders or drums used for storing liquefied petroleum gases.

132. The term "systems" as used in this standard refers to 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.

133. The designation of containers used for storing any of the liquefied petroleum gases defined in this standard shall depend on the type of construction employed during its fabrication.

(a) Containers completely fabricated within a plant under shop controlled conditions shall be known as "shop fabricated containers."

(b) Containers fabricated in whole or in part at or near their final location shall be known as "field erected containers."

134. The term "buried" refers to installations in which the top of the container (excluding the manway) is below the surrounding grade. The term "partially buried" (or mounded) refers to installations in which the top of the container is above the surrounding grade and is covered with earth.

135. The abbreviations "psig" and "psia" as used in this standard refer to pounds per square inch gauge and pounds per square inch absolute, respectively.

136. The term "barrel" refers to a unit of volume. One barrel equals 42 U. S. Gallons or 5.615 cubic feet.

137. The term "gas-air mixer" refers to 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.

14. Odorizing Gases.

140. 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 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 per cent; Butane, approximately 1½ per cent. These figures represent volumetric percentages of gas in a gas-air mixture in each case.

15. Approval of Equipment.

150. In systems utilizing containers of over 2,000 gallons water capacity, each container valve, excess flow valve, gauging device, relief device directly connected on the liquefied petroleum gas container and direct fired vaporizer shall have its correctness as to design, construction, and performance determined by:

- (a) Listing by Underwriters Laboratories Inc., or other nationally recognized testing laboratory, or,
- (b) The authority having jurisdiction.

16. Damage from Vehicles.

160. 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 291).

17. Electrical Equipment and Lighting.

170. Electrical equipment and wiring shall be of the type specified by and shall be installed in accordance with the National Electrical Code, NFPA No. 70 (ANSI C1) for ordinary locations except that fixed electrical equipment in classified areas shall comply with 18.

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

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

²It is recommended that odorants be qualified as to compliance with 140 by tests or experience. Where qualifying is by tests, such tests should be certified to by a nationally recognized laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan and thiophane (tetrahydrothiophene), in the ratio of 1.0 pound of odorant per 10,000 gallons of liquid LP-Gas, have been recognized as effective odorants. Other odorants and quantities meeting the provisions of 140 may be used.

18. Fixed Electrical Equipment in Classified Areas.

180. 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 No. 70 (ANSI C1) for hazardous locations.

181. 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 No. 58 (ANSI Z106.1).

19. Source of Ignition.

190. 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.

191. Liquefied petroleum gas storage containers do not require lightning protection (Code for Protection Against Lightning, NFPA No. 78).

192. 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 No. 77).

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

194. Open flames (except direct-fired vaporizers complying with 53), 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.

195. 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

<i>Part</i>	<i>Location</i>	<i>Extent of Classified Area¹</i>	<i>Equipment Shall Be Suitable for NEC, Class 1, Group D⁴</i>
A	Nonrefrigerated container.	Within 15 feet in all directions from connections, except for connections otherwise covered in this table.	Division 2
B	Refrigerated	Within 15 feet 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 feet in all directions from connections regularly made or disconnected for product transfer.	Division 1
		Beyond 5 feet but within 15 feet 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 feet in all directions from point of discharge.	Division 1
		Beyond 5 feet but within 15 feet 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 feet in all directions from point of discharge.	Division 1
		Beyond 5 feet but within 15 feet 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
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	Within 15 feet of the exterior side of any exterior wall or roof that is not vaportight or within 15 feet of any exterior opening.	Division 2
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Indoors with adequate ventilation. ²	Entire room and any adjacent room not separated by a gastight partition. ¹	Division 2
-------------------------------------------------	---------------------------------------------------------------------------------------	------------

Outdoors, at or abovegrade.	Within 15 feet in all directions from equipment and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure 1)	Division 2
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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
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	Entire room and any adjacent room not separated by a gastight partition when located indoors.	Division 2
--	-----------------------------------------------------------------------------------------------	------------

	Within 15 feet in all directions from pit or trench when located outdoors.	Division 2 ^b
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With adequate mechanical ventilation. ³	Entire pit or trench.	Division 2
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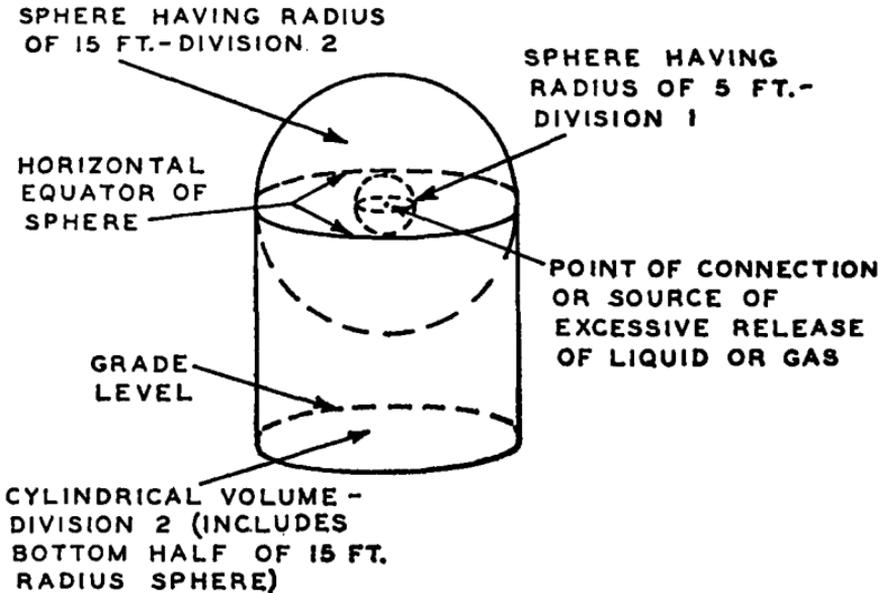
	Entire room and any adjacent room not separated by a gastight partition when located indoors.	Division 2
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	Within 15 feet in all directions from pit or trench when located outdoors.	Division 2
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H	Pipelines and connections containing operational bleeds, drips, vents or drains.	Within 5 feet in all directions from point of discharge.	Division 1
		Beyond 5 feet 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 No. 70 (ANSI C1) for definitions of Classes, Groups and Divisions.

**Figure 1**

(See Table 1)

SECTION 2. NONREFRIGERATED CONTAINERS.

21. Requirement for Construction and Original Test of Nonrefrigerated Containers.

210. 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 Code¹, 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-135 shall not apply.

211. The provisions of 210 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 121).

22. Design Pressure and Classification of Nonrefrigerated Containers.

220. 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 (37.8C) not to Exceed	Minimum Design Pressure in psig ASME Code, Section VIII, 1974 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 No. 58 — 1976 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.

¹Available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.

221. Field-erected nonrefrigerated containers shall be built in accordance with applicable provisions of the 1974 edition of the ASME Code, except that construction using joint efficiencies in Table UW 12, Column C, Division 1 is not permitted.

222. Field-erected containers for nonrefrigerated storage shall be designed for a pressure not less than 125% of the maximum vapor pressure of the product at 100 F. to be stored in the containers, but in no case shall the container be designed for a pressure of 25 psig or less.

23. Markings on Nonrefrigerated Containers.

230. 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 name plate.

Aboveground: Container.

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

Underground: Container and an accessible name plate.

Aboveground: Container.

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

Underground: Container and an accessible name plate.

Aboveground: Container.

(d) With the pressure in pounds per square inch for which the container is designed.

Underground: Container and an accessible name plate.

Aboveground: Container.

(e) With the wording "This container shall not contain a product having a vapor pressure in excess of — lbs. per sq. in. gauge at 100 F." (See 220 and 222.)

Underground and aboveground: A name plate or tag on filler connection.

(f) With the outside surface area in square feet.

Underground: Container and an accessible name plate.

Aboveground: Container.

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

Aboveground and underground: System name plate or on liquid level gauging device.

24. Location of Nonrefrigerated Containers.

240. Nonrefrigerated Aboveground Containers

(a) Containers shall be located outside of buildings.

(b) 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 gallons	Minimum Distances	
	Between containers in feet	From container to nearest im- portant 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	$\frac{1}{4}$ 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

¹In 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.

(c) If water for container fire protection is to be applied only by hose streams, the following shall apply:

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

(2) Each group shall be separated from the nearest container in another group by a distance of at least 50 feet.

(3) 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

(d) If water for container fire protection is to be applied by fixed monitor nozzles, the following shall apply:

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

(2) Each group shall be separated from the nearest container in another group by a distance of at least 25 feet.

(e) If water for container protection is to be applied by fixed water spray protection in compliance with NFPA No. 15, Water Spray Fixed Systems, the following shall apply:

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

(2) Each group shall be separated from the nearest container in another group by a distance of at least 25 feet.

(3) 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.

(f) A container or containers with an aggregate water capacity in excess of 120,000 gallons shall be located 100 feet 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 feet 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.

¹Container orientation should also be considered with respect to the buildings cited in 240(b).

(g) If any capacity container or containers associated with the LP-Gas plant are located closer than 100 feet 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.

(h) 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.

241. Nonrefrigerated Underground Containers

(a) Underground containers shall include both buried and partially buried (or mounded) containers.

(b) 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 feet.

(c) 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 feet.

(d) Containers shall be located not less than 50 feet from the nearest important building or group of buildings or line of adjacent property which may be built upon.

(e) Containers shall be located not less than 50 feet 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 feet 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 feet 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.

242. Nonrefrigerated containers shall not be stacked one above the other.

243. The ground within 25 feet of any aboveground nonrefrigerated container shall be kept clear of readily ignitable material such as weeds and long dry grass.

244. 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.

25. Installation of Nonrefrigerated Storage Containers.

250. Nonrefrigerated Aboveground Containers

(a) Every container shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell or heads.

(b) 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 inches or less in diameter shall be protected in accordance with the preceding, but fireproofing need only be applied to the outside of the skirt.

(c) 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.

(d) Suitable means to prevent corrosion shall be provided on that portion of the container in contact with the foundations or saddles.

(e) Containers shall be kept properly painted or otherwise protected from the elements.

251. Nonrefrigerated Underground Containers

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

(b) 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.

(c) 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.

(d) Containers shall be adequately protected against corrosion.

(e) 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.

(f) 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.

252. 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.

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

254. 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.

255. 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:

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

(b) 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.

(c) Locks with frangible shanks shall be used.

26. Reinstallation of Nonrefrigerated Containers.

260. 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 25. See also Section 6 for relief valve requirements.)

27. Gaskets.

270. 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 1500 F. 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.

28. Filling Densities.

280. The "filling density" is defined as the per cent ratio of the weight of the gas in a container to the weight of water at 60 F. that the container will hold. Except as noted in 282, nonrefrigerated containers shall be filled in accordance with Table 4.

281. The maximum liquid volume in per cent 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.

282. 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. These filling densities shall be based upon sound engineering practices for the operating conditions involved.

Table 4

MAXIMUM PERMITTED FILLING DENSITY

Specific Gravity at 60 F. (15.6 C.)	Aboveground Containers		Underground Containers
	0 to 1200 U.S. Gals. (1000 Imp. gal., 4550 liters) Total Water Cap.	Over 1200 U.S. Gals. (1000 Imp. gal., 4550 liters) Total Water Cap.	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

29. Loading and Unloading Facility Spacing

290. Loading and unloading connections shall be at least 75 feet 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.

291. The filling pipe inlet terminal shall not be located inside a building. Such terminals shall be located at least 25 feet from a container, shall be properly supported and protected from physical damage by vehicular movement, and shall be located at least 5 feet behind any barriers provided for such protection.

SECTION 3. REFRIGERATED CONTAINERS.

31. Requirements for Construction, Design and Original Test of Refrigerated Containers.

310. 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:

(a) For pressures of 15 psig or more, use the 1974 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 API Standard 620.

(b) For pressures below 15 psig, use API Standard 620, Recommended Rules for the Design and Construction of Large, Welded, Low Pressure Storage Tanks, 1973 Edition, including Appendix R.¹

311. Field-erected containers for refrigerated storage shall be designed as an integral part of the storage system including tank insulation, 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.

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

32. Markings on Refrigerated Containers.

320. 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 gallons (U. S. Standard) or barrels.

(c) With the maximum allowable working pressure in pounds per square inch.

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

¹Available from American Petroleum Institute, 2101 L St. N.W., Washington, DC 20037.

(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 pounds per cubic 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.

33. Location of Refrigerated Containers.

330. Refrigerated Aboveground Containers.

(a) Containers shall be located outside of buildings.

(b) Containers shall be located in accordance with Table 5.¹

Table 5

Water capacity of each container (gallons)	Minimum Distances	
	Between containers (feet)	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 (feet)
125,001-200,000		200
200,001-1,000,000	$\frac{1}{4}$ of sum of diameters of adjacent containers	300
Over 1,000,000		400

(c) A container or containers with an aggregate water capacity in excess of 120,000 gallons shall be located 100 feet 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

¹In 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.

maintenance of operation in such buildings. Such a container or containers shall be 100 feet or 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.

(d) Refrigerated liquefied petroleum gas containers shall not be located within dikes enclosing flammable liquid tanks or within dikes enclosing nonrefrigerated liquefied petroleum gas containers.

331. Refrigerated containers shall not be installed one above the other.

332. The ground within 25 feet of any aboveground refrigerated container and all ground within a diked area shall be kept clear of readily ignitable material such as weeds and long dry grass.

34. Installation of Refrigerated Containers.

340. 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.

341. For product storage at less than 30 F., 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.

342. 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.

3421. If natural gas is used to purge any insulation space, it shall be vented to a safe location.

343. 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.

3431. The usable volume of the diked area or topographical enclosure shall be at least 100 percent of the capacity of the largest container enclosed.

3432. 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 3431.

(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.

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

3433. 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.

3434. The walls of the dikes shall be not less than 5 feet in height. Where topography can provide suitable containment, dike walls, where required, need only be as high as the containment capacity requires.

3435. Provision shall be made to drain rain water 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.

344. 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.

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

346. 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.

347. 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:

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

(b) 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.

(c) Locks with frangible shanks shall be used.

35. Reinstallation of Refrigerated Containers.

350. 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 34. See also Section 6 for relief valve requirements.)

36. Gaskets.

360. 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 1500 F. 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.

37. Filling Densities.

370. 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 per cent of the total container capacity is greater for a refrigerated container than normally employed for a nonrefrigerated container.

38. Loading and Unloading Facility Spacing

380. Loading and unloading connections shall be at least 75 feet 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.

381. The filling pipe inlet terminal shall not be located inside a building or diked area. Such terminals shall be located at least 25 feet from a container, shall be properly supported and protected from physical damage by vehicular movement, and shall be located at least 5 feet behind any barriers provided for such protection.

SECTION 4. PIPING, VALVES, GAUGING DEVICES.

41. Piping Materials.

410. Piping shall be suitable for its intended use at the temperatures of the application and shall be designed for not less than the maximum pressure and for the minimum temperature to which it may be subjected. The temperature change occurring during the conversion from the gaseous to the liquid phase permits the use of several materials, each having its own specific utilization temperature range. The design and fabrication of piping systems shall be in accordance with ANSI B31.3, Petroleum Refinery Piping, 1973¹, except as modified by the provisions of this Section and any applicable Federal pipeline regulations.

4101. Special consideration shall be given to the behavior of the piping material upon possible fire exposure.

411. Piping connections to the container for sizes over 2 inches nominal pipe diameter shall be made by welding or with welded flanges with the possible exception of piping connections for excess flow valves.

412. The use of cast iron valves, pipe and fittings shall be prohibited in piping carrying LP-Gas. This does not prohibit the use of container valves or fittings made of malleable or ductile iron if used within the limitations set forth in Paragraph 323.3 of ANSI B31.3 — 1973¹.

413. Valve seat material, packing, gaskets, etc., shall be resistant to the action of liquefied petroleum gas in the liquid phase.

414. All piping, tubing, fittings and the valves shall be leak tested after assembly and proved free from leaks at not less than normal operating pressures. Test shall not be made with a flame.

415. Provision shall be made for expansion, contraction, jarring and vibration, and for settling.

416. Piping outside buildings is permitted to be buried, above-ground, or both, but shall be well supported and protected against physical damage and corrosion.

¹Available from American Society of Mechanical Engineers, 345 East 47th Street, New York, N. Y. 10017.

417. Piping, valves, fittings and gauging 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.

42. Container Valves and Accessories.

420. 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.

421. All connections to containers, except safety relief connections, liquid level gauging devices, and plugged openings, shall have shutoff valves located as close to the container as practicable.

422. 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.

423. Except as provided in 424 and 443, 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. melting point) which will cause the quick-closing valve to close automatically in case of fire.

424. Openings from a container or through fittings attached directly on the container to which pressure gauge connection is made, need not be equipped with an excess flow valve if such openings are not larger than No. 54 drill size.

425. Excess flow and back pressure check valves where re-

quired 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.

426. Excess flow valves shall be designed with a by-pass, not to exceed a No. 60 drill size opening to allow equalization of pressures.

427. All inlet and outlet connections except safety valves, liquid level gauging devices and pressure gauges 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.

428. Each storage container shall be provided with a suitable pressure gauge.

43. Filler and Discharge Pipes, Manifolds.

430. 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.

431. Where practical, liquid manifold connections shall be located at non-adjacent ends of parallel rows of containers.

432. The use of non-metallic hose is prohibited for interconnecting stationary containers.

433. The pipe inlet terminal shall be labeled to designate its purpose.

434. 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 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 feet of a container or important structure shall be arranged to limit the quantity that could be discharged to a maximum of 300 cubic feet of liquid. In no case shall there be more than 150 feet between valves on the same line within 300 feet of a container or important structure.

435. In addition to the valving specified in 434, 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:

(a) The connection, or connecting piping, into which the liquid or vapor is being transferred shall be equipped with:

- (1) A back-flow check valve, or
- (2) An excess flow valve properly sized in accordance with 422.

(b) The connection, or connecting piping, from which the liquid or vapor is being withdrawn shall be equipped with an excess flow valve properly sized in accordance with 422.

436. When the liquid line manifold connecting containers in a group has a volumetric capacity of more than 100 gallons, such container manifolds shall be located not less than 100 feet 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.

44. Liquid Level Gauging Device.

440. Each nonrefrigerated storage system shall be equipped with a liquid level gauging device of approved design, such as a pressure differential type, a float gauge, a rotary gauge, slip tube, magnetic or fixed tube device. If the liquid level gauging 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 gauging device, such as a fixed dip tube, slip tube, rotary gauge, or similar device.

4401. Unlisted gauge glasses of the columnar type shall not be permitted.

441. Refrigerated containers shall be equipped with a liquid level gauging device of approved design. An auxiliary gauging device is not required for refrigerated containers. However, in lieu of an auxiliary gauge, refrigerated containers, if subject to

overflowing, shall be equipped with an automatic device to interrupt filling of the tank when the maximum filling level is reached.

442. All gauging 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.

443. Gauging 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.

444. Gauging devices for containers shall have a maximum allowable working pressure at least equal to that of the containers to which they are attached.

445. 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. This level shall be based on the volume of the product at 40 F. at its maximum permitted filling density for aboveground containers and at 50 F. for buried containers. Refer to Appendix D for calculating filling point for which tube shall be designed.

45. Hose Specifications for Nonrefrigerated LP-Gas.

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

451. Hose, hose connections and flexible connections shall comply with 451(a) and (b).

(a) Hose shall be designed for a minimum bursting pressure of 1,750 psig (350 psi working pressure) and shall be identified "LP-Gas" or "LPG" at not greater than 10-foot intervals.

(b) Hose assemblies, after the application of connections, shall be capable of withstanding a test pressure of not less than 700 psig.

46. Drips, Pits and Drains.

460. Where vaporized gas may condense, suitable means shall be provided for re-vaporization or disposal of the condensate.

461. 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.

47. Pumps and Compressors.

470. 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.

471. 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 stand-by 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 stand-by 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 stand-by facilities sufficient to insure that prolonged failure of refrigeration may be prevented.

472. Adequate means shall be available for operating equipment in event of failure of normal facilities.

48. Protection of Container Accessories.

480. Valves, regulating, gauging, 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.

481. All connections on underground containers shall be located within a substantial dome, housing, or manhole and protected by a substantial round cover. (See 641.)

SECTION 5. VAPORIZERS AND GAS-AIR MIXING

51. General.

510. Liquefied petroleum gas storage containers shall not be directly heated with open flames.

511. Heating or cooling coils shall not be installed inside of a storage container.

512. Vaporizers shall not be equipped with fusible plugs for pressure relief.

513. Vaporizer houses shall not have drains to sewers or sump pits.

52. Vaporizers Not Directly Heated With Open Flames.

520. 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 square feet.

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

521. Vaporizers having an inside diameter of 6 inches or less exempted by the ASME Unfired Pressure Vessel Code¹ shall have a design working pressure not less than 250 psig and need not be permanently marked.

522. Building or structural enclosures in which vaporizers and/or gas-air mixers are installed shall be of lightweight non-combustible construction with nonload-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, 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

¹See footnote, p. 59-13.

of a combination of wall openings near the floor line and roof ventilators. The ventilation rate shall be at least 1 cfm of air per square foot of floor area.

523. A shutoff valve shall be installed on the liquid line to a vaporizer at least 50 feet away from the vaporizer or a building housing a vaporizer.

524. 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.

53. Direct Fired Vaporizers.

530. 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 square feet; and the maximum vaporizing capacity in gallons per hour, and date and serial number.

531. No direct fired vaporizers shall be located closer than 50 feet to line of adjoining property upon which structures may be built. They shall also be located a minimum distance of 50 feet away from any liquefied petroleum gas storage container.

532. No direct fired vaporizer shall be connected to a container that has a storage capacity in gallons, less than 10 times the hourly capacity of the vaporizer in gallons. 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, all flow of gas or liquid from container to vaporizer.

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

5331. Such buildings or structural enclosures in which vaporizers are installed shall be constructed and ventilated in accordance with 522.

5332. These structures shall not have interior drains to sewers or sump pits.

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

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

536. 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.

537. No direct fired vaporizer shall raise the product pressure over the designed working pressure of the vaporizer equipment.

54. Gas-Air Mixing

540. 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 Section 4 of this standard. Gas-air mixers shall be so designed as to prevent the accidental formation of a flammable mixture.

541. 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.

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

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

544. 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.

545. 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 541 and 542, 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.

546. 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 522.

SECTION 6. RELIEF DEVICES.

61. General.

610. 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.

611. Each container relief device shall be plainly and permanently marked with the pressure in pounds per square inch gauge at which the device is set to start to discharge, with the actual rate of discharge in cubic feet per minute 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 cubic feet per minute of air.

612. 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.

613. 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.

614. 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.

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

616. 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.

617. 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.

6171. Return bends and restrictive pipe fittings shall not be permitted in relief device discharge vents.

618. 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% of the lowest start-to-discharge pressure setting for conventional relief valves, and (b) not exceeding 50% 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.

6181. Relief valve piping shall be designed so that liquid which may be trapped will not create dangerous back pressure when the relief valve operates.

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

6191. Lead to the open air.

6192. Be protected against mechanical damage.

6193. 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.

6194. 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.

6195. Prevent malfunction due to freezing or icing.

62. Testing Relief Devices.

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

63. On Aboveground Containers.

630. Every container shall be provided with spring loaded relief valves or their equivalent.

631. 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, piping of equipment against impingement of flame resulting from ignition of product escaping from the drain. The vent piping shall extend upward at least 7 feet above the top of the container.

632. 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%*
API Standard 620		100%*

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

633. 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.

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

64. On Underground Containers.

640. 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 per cent 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 feet above the ground. If liquid product is placed in containers while they are not buried, these containers shall be considered as aboveground containers.

641. 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.

65. On Vaporizers.

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

651. 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. (see 61 for other requirements on relief devices).

66. Between Shutoff Valves.

660. 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. The start to discharge pressure of such relief devices shall be not in excess of 500 psig.

67. At Discharge of Final Stage Regulators.

670. When the discharge pressure from the final stage regulator is not more than 5 pounds, the low pressure side shall be equipped with a relief device, set to relieve at not less than two times, and not more than three times the discharge pressure but not more than 5 lbs. in excess of the discharge pressure. When the discharge pressure is more than 5 pounds, the relief shall be set to not less than $1\frac{1}{4}$ times and not more than two times the discharging pressure. Regulator breather vents shall be piped outside the building and equipped with insect-proof terminal screens.

SECTION 7. HANDLING.

71. Transfer of Liquids Within a Utility Plant.

710. 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.

(a) Pumps and compressors used for transferring liquefied petroleum gas shall be designed for the product handled.

711. 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:

(a) 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.

(b) 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.

(c) 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.

712. 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.

713. The maximum vapor pressure of the product at 100 F. which may be transferred into a container shall be in accordance with 220 or 221 and 222.

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

715. 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.

72. Tank Car Loading and Unloading Point.

720. The track of tank car siding shall be relatively level.

721. A TANK CAR CONNECTED sign, as covered by D.O.T. (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.

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

73. Tank Truck Loading and Unloading

730. The area of tank truck transfer shall be relatively level.

731. 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 feet from the container and so positioned that the shutoff valves on both the truck and the container are readily accessible.

732. While trucks are loading or unloading, the wheels shall be blocked.

¹Formerly ICC (Interstate Commerce Commission). Published in Federal Code of Regulations — Title 49 — Parts 171-190. Available from Government Printing Office, Washington, D.C. 20401 or from Bureau of Explosives, 1920 L Street N.W., Washington, D.C. 20036. In Canada, the regulations of the Canadian Transport Commission for Canada apply.

SECTION 8. FIRE PROTECTION.

81. Fire Protection.

810. 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.

811. 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.

812. 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.

813. 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.

814. 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.

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

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

817. 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.