NFPA 59

Utility LP-Gas Plant Code

2001 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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Licensing Policy

NFPA 59

Utility LP-Gas Plant Code

2001 Edition

This edition of NFPA 59, *Utility LP-Gas Plant Code*, was prepared by the Technical Committee on LP-Gases at Utility Gas Plants and acted on by the National Fire Protection Association, Inc., at its November Meeting held November 12–15, 2000, in Orlando, FL. It was issued by the Standards Council on January 13, 2001, with an effective date of February 9, 2001, and supersedes all previous editions.

This edition of NFPA 59 was approved as an American National Standard on February 9, 2001.

Origin and Development of NFPA 59

NFPA 58, *Standard on Liquefied Petroleum Gases*, was used as a general guide until NFPA 59 was adopted in 1949. Subsequent editions were adopted in 1954, 1956, 1958, 1962, 1963, 1968, 1974, 1976, 1979, 1984, 1989, 1992, 1995, and 1998.

The cooperation of the American Gas Association was secured to facilitate the preparation of this standard. The result was the formation of a special committee under the sponsorship of the American Gas Association, which was 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, NFPA 59 was assigned to that committee. The committee established the Subcommittee on Utility Gas Plants, which was assigned working responsibility for NFPA 59. In 1972, working responsibility for NFPA 59 was reassigned to the Committee on Liquefied Petroleum Gases while maintaining the Subcommittee on Utility Gas Plants.

In 1992, NFPA 59 was assigned to the new Technical Committee on Liquefied Petroleum Gases at Utility Gas Plants. The committee maintains correlation with NFPA 58 by overlapping committee membership and concurrent or joint meetings. The new committee's initial membership was the former Subcommittee on Gas Plants.

The 2001 edition of NFPA 59 is a complete revision of the document. The revision was prepared by a joint effort of the NFPA LNG Committee and the Canadian Standards Association Z276 Technical Committee on Liquefied Natural Gas.

Changes in the 2001 edition include new chapters on operations and maintenance, the reformatting of the requirements for a design spill in Chapter 2 into a table for ease of use, and other editorial revisions for clarity.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the design, construction, location, installation, operation, and maintenance of refrigerated and nonrefrigerated liquefied petroleum gas plants to the point of introduction into the utility gas distribution system or those plants that are subject to the requirements of Part 192 of the *Code of Federal Regulations* (49 *CFR* 192) issued pursuant to the laws in 49 U.S.C. *et seq.* (Pipeline Safety Law).

Contents

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Utility LP-Gas Plant Code

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A.

A reference in brackets [ ] at the end of a section or paragraph indicates that the material has been extracted from another NFPA document. The bold number in brackets indicates the document number and is followed by the section number where the extracted material can be found in that document. The complete title and current edition of an extracted document can be found in the chapter on referenced publications.

Information on referenced publications can be found in Chapter 12 and Appendix E.

Chapter 1 General Provisions

1.1 Scope.

1.1.1* This code shall apply to the design, construction, location, installation, operation, and maintenance of refrigerated and nonrefrigerated utility gas plants.

Coverage of liquefied petroleum gas systems at utility gas plants shall extend to the point where LP-Gas or a mixture of LP-Gas and air is introduced into the utility distribution system.

1.1.2 When operations that involve the liquid transfer of LP-Gas from the utility gas plant storage into cylinders or portable tanks (as defined by NFPA 58, *Liquefied Petroleum Gas Code*) are carried out in the utility gas plant, these operations shall conform to NFPA 58.

1.1.3 Installations that have an aggregate water capacity of 4000 gal (15.14 m^3) or less shall conform to NFPA 58, *Liquefied Petroleum Gas Code.*

1.2 Qualification of Personnel. Persons engaged in gas operating and emergency procedures and in the handling of liquefied petroleum gases shall be trained in the properties and safe handling of these gases and in emergency procedures. This training shall be repeated at least annually.

1.3 Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.4 Retroactivity. The provisions of this code reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this code at the time the code was issued.

Unless otherwise specified, the provisions of this code shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the code. Where specified, the provisions of this code shall be retroactive.

In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this code deemed appropriate.

The retroactive requirements of this code shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Definitions.

1.5.1* Approved. Acceptable to the authority having jurisdiction.

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

1.5.3 Container. Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for the transporting or storing of LP-Gases. [**58:**1.7.16]

1.5.3.1 Field-Erected Container. A container that is fabricated in whole or in part at or near its final location.

1.5.3.2 Shop-Fabricated Container. A container that is completely fabricated within a plant under shop-controlled conditions.

1.5.4 Filling Density. 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.

1.5.5 Gas. Liquefied petroleum gas in either the liquid or vapor state. The more specific terms *liquid LP-Gas* or *vapor LP-Gas* are normally used for clarity. [**58:**1.7.29]

1.5.6 Gas–Air Mixer. A device or a system of piping and controls that mixes LP-Gas vapor with air to produce a mixed gas of a lower heating value than the LP-Gas. [**58:**1.7.30]

1.5.7 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is 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.

1.5.8 Liquefied Petroleum Gas (LP-Gas). Any material having a vapor pressure not exceeding that allowed for commercial propane that is composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. [**58:**1.7.38]

1.5.9* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

1.5.10 Mounded Container. An ASME container designed for underground service installed above the minimum depth required for underground service and covered with earth, sand, or other material, or an ASME container designed for aboveground service installed above grade and covered with earth, sand, or other material. [**58:**1.7.42]

1.5.11 psia. Pounds per square inch, absolute. [**58:**1.7.59]

1.5.12 psig. Pounds per square inch gauge. [**58:**1.7.60]

1.5.13 Redundant Fail-Safe Product Control Measures (RFPCM). Specified product storage controls are more stringent than the basic requirements of this standard. (RFPCM would be used to alleviate the requirement for special protection and to be a factor in reducing distance requirements.)

1.5.14 Refrigerated LP-Gas. LP-Gas that is maintained as a liquid at temperatures below ambient temperature to reduce the storage pressure. This includes fully refrigerated LP-Gas at pressures near atmospheric pressure but not exceeding 15 psig (103 kPag) and semi-refrigerated LP-Gas at pressures above 15 psig (103 kPag). [**58:**1.7.38.2]

1.5.15 Sources of Ignition. Devices or equipment that, 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 that will permit propagation of flame away from them. [**58:**1.7.65]

1.5.16 Special Protection. A means of limiting the temperature of an LP-Gas container for purposes of minimizing the possibility of failure of the container as the result of fire exposure. [**58:**1.7.66]

1.5.17 Systems. An assembly of equipment that consists essentially of liquefied petroleum gas unloading equipment; a container or containers; major devices such as vaporizers, relief valves, excess-flow valves, and regulators; and interconnecting piping. In the case of refrigerated storage, it also includes compressors, condensers, and other related equipment and controls. Such systems 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.

1.5.18 Utility Gas Plant. A plant that stores and vaporizes LP-Gas for distribution in a utility piping system. In the United States, utility gas plants are subject to the requirements of Part 192 of the *Code of Federal Regulations* (49 *CFR* Part 192).

1.5.19 Vaporizer. A device, other than a container, that receives LP-Gas in liquid form and adds sufficient heat to convert the liquid to a gaseous state. [**58:**1.7.72]

1.5.19.1 Direct-Fired Vaporizer. A vaporizer in which heat furnished by a flame is directly applied to some form of heat exchange surface in contact with the liquid LP-Gas to be vaporized. This classification includes submerged-combustion vaporizers. [**58:**1.7.72.1]

1.5.19.2 Electric Vaporizer. A vaporizer that uses electricity as a source of heat. [**58:**1.7.72.2]

1.5.19.2.1 Direct Immersion Electric Vaporizer. A vaporizer wherein an electric element is immersed directly in the LP-Gas liquid and vapor. [**58:**1.7.72.2.1]

1.5.19.2.2 Indirect Electric Vaporizer. An immersion-type vaporizer wherein the electric element heats an interface solution in which the LP-Gas heat exchanger is immersed or heats an intermediate heat sink. [**58:**1.7.72.2.2]

1.5.19.3 Indirect (or Indirect-Fired) Vaporizer. A vaporizer in which heat furnished by steam, hot water, the ground, surrounding air, or other heating medium is applied to a vaporizing chamber or to tubing, pipe coils, or other heat exchange surface containing the liquid LP-Gas to be vaporized; the heating of the medium used is at a point remote from the vaporizer. [**58:**1.7.72.3]

1.5.19.4 Waterbath (or Immersion-Type) Vaporizer. A vaporizer in which a vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing liquid LP-Gas to be vaporized is immersed in a temperature-controlled bath of water, water–glycol combination, or other noncombustible heat transfer medium that is heated by an immersion heater not in contact with the LP-Gas heat exchange surface. [**58:**1.7.72.4]

1.6* Odorizing Gases. 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.

Exception: Odorization shall not be 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.

1.7 Acceptance of Equipment. In systems containers of over 2000-gal (7.6-m^3) 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 be approved. *(See 1.5.1, Approved.)*

1.8 Damage from Vehicles. Where damage to liquefied petroleum gas systems from vehicular traffic is a possibility, precautions (such as warning signs or devices, or barricades) shall be taken against such damage. *(See 2.9.2.)*

1.9 Ignition Source Control. [**58**:3.7]

1.9.1 Scope. [**58**:3.7.1]

1.9.1.1 This section shall apply to the minimization of ignition of flammable LP-Gas–air mixtures resulting from the normal or accidental release of nominal quantities of liquid or vapor from LP-Gas systems installed and operated in accordance with this code. [**58**:3.7.1.1]

1.9.1.2* The installation of lightning protection equipment shall not be required on LP-Gas storage containers. [**58**:3.7.1.2]

1.9.1.3* Grounding and bonding shall not be required on LP-Gas systems. [**58**:3.7.1.3]

1.9.2 Electrical Equipment. [**58**:3.7.2]

1.9.2.1 Electrical equipment and wiring shall be of a type specified by, and installed in accordance with, NFPA 70, *National Electrical Code®*, for ordinary locations.

Exception: Fixed electrical equipment in classified areas shall comply with 1.9.2.2.

[**58**:3.7.2.1]

1.9.2.2* Fixed electrical equipment and wiring installed within classified areas specified in Table 1.9.2.2 shall comply with Table 1.9.2.2 and shall be installed in accordance with NFPA 70, *National Electrical Code*. The provision shall apply to vehicle fuel operations.

Exception: This provision shall not apply to fixed electrical equipment at residential or commercial installations of LP-Gas systems or to systems covered by Section 3.8 [of NFPA 58].

[**58**:3.7.2.2]

Table 1.9.2.2 Electrical Area Classification

Part	Location	Extent of Classified Area[1]	Equipment Shall be Approved for *National Electrical Code*, Class I[1], Group D[2]
A	Unrefrigerated containers other than cylinders and ASME vertical containers of less than 1000-lb (454-kg) water capacity	Within 15 ft (4.6 m) in all directions from connections, except connections otherwise covered in Table 1.9.2.2	Division 2
B	Refrigerated storage containers	Within 15 ft (4.6 m) in all directions from connections otherwise covered in Table 1.9.2.2	Division 2
		Area inside dike to the level of the top of the dike	Division 2
C[3]	Tank vehicle and tank car loading and unloading	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 within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 1.9.2.2)*	Division 2
D	Gauge vent openings other than those on cylinders and ASME vertical containers of less than 1000-lb (454-kg) water capacity	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 device discharge other than those on cylinders and ASME vertical containers of less than 1000-lb (454-kg) water capacity and vaporizers	Within direct path of discharge	Note: Fixed electrical equipment should preferably not be installed.
F[3]	Pumps, vapor compressors, gas–air mixers and vaporizers (other than direct-fired or indirect-fired with an attached or adjacent gas-fired heat source)		
	Indoors without ventilation	Entire room and any adjacent room not separated by a gastight partition	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 ventilation	Entire room and any adjacent room not separated by a gastight partition	Division 2
	Outdoors in open air at or above grade	Within 15 ft (4.6 m) in all directions from this equipment and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 1.9.2.2)*	Division 2
G	Vehicle fuel dispenser	Entire space within dispenser enclosure, and 18 in. (256 mm) horizontally from enclosure exterior up to an elevation 4 ft (1.2 m) above dispenser base; entire pit or open space beneath dispenser	Division 1
		Up to 18 in. (256 mm) above ground within 20 ft (6.1 m) horizontally from any edge of enclosure (Note: For pits within this area, see part H of this table.)	Division 2

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Table 1.9.2.2 Electrical Area Classification ***(Continued)***

Part	Location	Extent of Classified Area[1]	Equipment Shall be Approved for *National Electrical Code*, Class I[1], Group D[2]
H	Pits or trenches containing or located beneath LP-Gas valves, pumps, vapor compressors, regulators, and similar equipment		
	Without mechanical ventilation	Entire pit or trench	Division 1
		Entire room and any adjacent room not separated by a gastight partition	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors	Division 2
	With mechanical ventilation	Entire pit or trench	Division 2
		Entire room and any adjacent room not separated by a gastight partition	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors	Division 2
I	Special buildings or rooms for storage of cylinders	Entire room	Division 2
J	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	
K[3]	Cylinder filling		
	Indoors with ventilation	Within 5 ft (1.5 m) in all directions from a point of transfer	Division 1
		Beyond 5 ft (1.5 m) and entire room	Division 2
	Outdoors in open air	Within 5 ft (1.5 m) in all directions from a point of transfer	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of transfer and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 1.9.2.2)*	Division 2
L	Piers and wharves	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 within the cylindrical volume between the horizontal equator of the sphere and the vessel deck *(see Figure 1.9.2.2)*	Division 2

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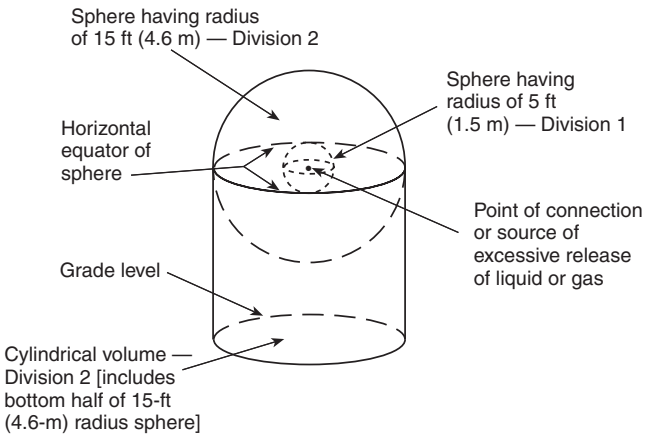
[1]The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.
[2]See Article 500 Hazardous (Classified) Locations in NFPA 70 *National Electrical Code*, for definitions of classes, groups, and divisions.
[3]See A.1.9.2.2.
[**58**:Table 3.7.2.2]

FIGURE 1.9.2.2 Extent of electrically classified area. ***(See Table 1.9.2.2.)*** **[58:Figure 3.7.2.2]**



1.9.2.3 Fired vaporizers, calorimeters with open flames, and other areas where open flames are present either intermittently or constantly shall not be considered electrically classified areas. [**58**:3.7.2.3]

1.9.2.4 Electrical equipment installed on LP-Gas cargo tank vehicles shall comply with 6.1.1.4 [of NFPA 58].[**58**:3.7.2.4]

1.9.3 Other Sources of Ignition. [**58**:3.7.3]

1.9.3.1 Open flames or other sources of ignition shall not be used or installed in pump houses, cylinder filling rooms, or other similar locations. [**58**:3.7.3.1]

1.9.3.2 Direct-fired vaporizers or indirect-fired vaporizers attached or installed adjacent to gas-fired heat sources shall not be installed in pump houses or cylinder filling rooms. [**58**:3.7.3.2]

1.9.3.3 Open flames, cutting or welding, portable electric tools, and extension lights capable of igniting LP-Gas shall not be installed or used within classified areas specified in Table 1.9.2.2.

Exception No. 1: Open flames or other sources of ignition shall not be prohibited where LP-Gas facilities have been freed of all liquid and vapor.

Exception No. 2: Vaporizers and vaporizing burners shall be installed in accordance with Section 3.6 [of NFPA 58].

[**58**:3.7.3.3]

1.10 Lighting. Adequate lighting shall be provided to illuminate operating facilities such as walkways, essential control valves, and loading and unloading facilities in particular.

1.11 Fixed Electrical Equipment in Classified Areas.

1.11.1 Fixed electrical equipment and wiring installed within the classified areas specified in Table 1.9.2.2 shall comply with Table 1.9.2.2 and shall be installed in accordance with NFPA 70, *National Electrical Code®*, for hazardous locations.

1.11.2 Direct-fired vaporizers, calorimeters with open flames, and other areas where open flames are present, either intermittently or constantly, shall not be considered electrically classified areas.

1.12 Source of Ignition.

1.12.1 Smoking and nonprocess ignition sources within the protective enclosure *(see 11.9.2)* shall be prohibited.

Exception: Smoking and nonprocess ignition sources within the protective enclosure shall be permitted if in accordance with 1.12.1.1 through 1.12.1.3.

1.12.1.1 Smoking shall be permitted only in designated and properly signposted areas.

1.12.1.2 Welding, cutting, hotwork, use of portable electric tools and extension lights, and similar operations shall be conducted only at times and places specifically authorized. Welding and cutting shall be conducted in accordance with the provisions of NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*. Portable electric tools and extension lights capable of igniting LP-Gas shall not be permitted within the classified areas specified in Table 1.9.2.2.

Exception: Portable electric tools and extension lights capable of igniting LP-Gas shall be permitted where the LP-Gas facilities have been freed of all liquid and vapor or where special precautions are observed under carefully controlled conditions.

1.12.1.3 Vehicles and other mobile equipment that constitute potential ignition sources shall be prohibited within diked areas or within 50 ft (15 m) of containers that contain LP-Gas, flammable liquids, or flammable refrigerants.

Exception: Vehicles and other mobile equipment that constitute potential ignition sources shall not be prohibited where specifically authorized and under constant supervision or where loading or unloading at facilities specifically designed for the purpose.

1.12.2* Electrical grounding and bonding shall be provided as required by NFPA 70, *National Electrical Code*.

1.12.3* If stray currents are present or if impressed currents are used on loading and unloading systems (such as for cathodic protection), protective measures shall be taken to prevent ignition.

1.12.4 Metallic storage containers for LP-Gas generally do not require lightning protection. Grounding systems shall be provided for LP-Gas storage containers in accordance with Chapter 3, Section 4.4, and 6.3.2 of NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

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 the ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for Construction of Unfired Pressure Vessels," or in accordance with the rules of the authority under which the containers are installed, provided such rules conform to the rules of the ASME *Boiler and Pressure Vessel Code*, Section VIII.

Exception: UG-125 through UG-136 of the ASME Boiler and Pressure Vessel Code 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 that are constructed and maintained in accordance with the ASME *Boiler and Pressure Vessel Code* in effect at the time of fabrication. *(See Section 1.4.)*

2.2 Design Pressure and Classification of Nonrefrigerated Containers.

2.2.1* Shop-fabricated containers for nonrefrigerated storage shall be in accordance with Table 2.2.1.

Table 2.2.1 Minimum Design Pressure for Shop-Fabricated Nonrefrigerated Containers

For Gases with Vapor Pressure at 100°F (37.8°C) Not to Exceed		Minimum Design Pressure (ASME *Boiler and Pressure Vessel Code*, Section VIII)	
psi	kPa	psi	kPa
80	552	100	689
100	689	125	862
125	862	156	1076
150	1034	187	1289
175	1207	219	1510
215	1482	250	1724

2.2.2 Field-erected nonrefrigerated containers shall be built in accordance with the ASME *Boiler and Pressure Vessel Code.*

Exception: Construction using joint efficiencies in Table UW 12, Column C, Division 1, of the ASME Boiler and Pressure Vessel Code shall not be permitted.

2.2.3 Field-erected containers for nonrefrigerated storage shall be designed for a pressure of not less than 125 percent of the maximum vapor pressure of the product at 100°F (37.8°C) to be stored in the containers, but in no case shall the container be designed for a pressure of 25 psi (172 kPa) or less.

2.3 ASME Container Markings.

2.3.1 ASME containers shall be identified by the attachment of a nameplate. The marking specified shall be on a stainless steel metal nameplate attached to the container and located to remain visible after the container is installed. The nameplate shall be attached so as to minimize corrosion of the nameplate or its fastening means and so as not to contribute to corrosion of the container.

Exception: Where the container is buried, mounded, insulated, or otherwise covered so as to obscure the nameplate, the information contained on the nameplate shall be duplicated and installed on adjacent piping or on a structure in a clearly visible location.

2.3.2 The marking shall contain the following information:

(1) Name and address of container supplier or trade name of container
(2) Water capacity of container in pounds or U.S. gallons
(3) Design pressure in pounds per square inch (psi)
(4) The wording "This container shall not contain a product having a vapor pressure in excess of psi at 100°F" *(see Table 2.2.1)*
(5) Outside surface area in square feet
(6) Year of manufacture
(7) Shell thickness _____ ; head thickness _____.
(8)* OL (overall length), OD (outside diameter), HD (head diameter design)
(9) Manufacturer's serial number
(10) ASME *Boiler and Pressure Vessel Code* symbol

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 2.4.1.2 with respect to the distance between containers, 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 that can be built upon.

Table 2.4.1.2 Nonrefrigerated Container Installation Minimum Distances

Water Capacity of Each Container		Between Containers		Minimum Distances From Container to Nearest Important Building or Group of Buildings Not Associated with the Utility Gas Plant, or a Line of Adjoining Property That Can Be Built Upon	
gal	m^3	ft	m	ft	m
2001 to 30,000	7.6 to 114	5	1.5 m	50	15
30,001 to 70,000	114 to 265	$^1/_4$ of sum of diameters of adjacent containers		75	23
70,001 to 90,000	265 to 341	"	"	100	30
90,001 to 120,000	341 to 454	"	"	125	38
120,001 to 200,000	454 to 757	"	"	200	61
200,001 to 1,000,000	747 to 3785	"	"	300	91
1,000,001 or more	over 3785	"	"	400	122

Note: The spacing of containers from buildings associated with utility gas plants shall be permitted to be reduced to 50 percent of the distances in Table 2.4.1.2, with a minimum separation of 50 ft (15 m).

2.4.1.3 Multiple aboveground containers (or groups of containers) installed for use in a single location shall be limited to the number of containers in one group, with each group separated from the next group in accordance with the degree of fire protection provided in Table 2.4.1.3.

Containers shall be oriented so that their longitudinal axes do not point toward other containers, aboveground liquefied natural gas tanks, and flammable liquid storage tanks on the same or adjoining property.

Table 2.4.1.3 Fire Protection Requirements for Container Groups

Fire Protection Provided by	Maximum Number of Containers in One Group	Minimum Separation Between Groups	
		ft	m
Hose streams only *(See 11.1.1.)*	6	50	15
Fixed monitor nozzles per 11.5.4.5	6	25	7.6
Fixed water spray per 11.5.4.4	9	25	7.6
Insulation per 11.5.4.1	9	25	7.6

2.4.1.4 The minimum horizontal separation between aboveground LP-Gas containers and aboveground tanks containing liquids having flash points below 200°F (93.4°C) shall be 20 ft (6 m). No horizontal separation shall be required between aboveground LP-Gas containers and underground tanks containing flammable or combustible liquids installed in accordance with NFPA 30, *Flammable and Combustible Liquids Code.* [**58:** 3.2.2.6(e)]

2.4.1.5 Nonrefrigerated LP-Gas containers shall not be located within dikes that enclose flammable liquid tanks and shall not be located within dikes that enclose refrigerated LP-Gas tanks.

2.4.1.6 The ground within 25 ft (7.6 m) of any underground, nonrefrigerated container manway and appurtenances shall be kept clear of readily ignitable material such as weeds and long, dry grass.

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 Where containers are installed parallel with ends in line, any number of containers shall be permitted to be in one group. Where 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 m) from the nearest important building or group of buildings or line of adjacent property that can be built upon.

2.4.2.5 Containers shall be located not less than 50 ft (15 m) from buildings associated with the utility gas plant. They shall be located not less than 50 ft (15 m) from flammable liquids storage containers.

2.4.2.6 When the provisions of 2.10.2 are met, the minimum distance from a container to a building [specified in Table 2.4.1.2] shall be reduced by one-half for ASME containers of 2001 gal through 30,000 gal (7.6 m^3 through 114 m^3) water capacity used in systems complying with Section 2.10. [**58**:3.2.2.2 Exception No. 1]

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

2.4.4 Containers connected to a common manifold shall be installed so that their maximum liquid filling levels present substantially the same plane. This method of installation 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 shall be permitted to be employed where they are protected against fire in an approved manner. Metal supports shall be protected against fire with a material that has a fire resistance rating of at least 2 hours. Steel skirts that have only one opening that is 18 in. (462 mm) or less in diameter shall be protected in accordance with the preceding, but fireproofing shall be required to be applied only to the outside of the skirt.

2.5.1.3 Horizontal containers shall be mounted on saddles so 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 Means to minimize corrosion shall be provided on that portion of the container that is in contact with the foundations or saddles.

2.5.1.5 Containers shall be kept properly painted or otherwise protected from the elements.

2.5.1.6 Vertical 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 forces (earthquake), and hydrostatic test loads.

2.5.1.7 Design pressure *(see Table 2.2.1)* shall be interpreted as the pressure at the top head with allowance made for increased pressure on the lower shell sections and bottom head due to the static pressure of the product.

2.5.1.8 Wind loading on containers of 10,000 gal (37.9 m^3) or larger shall be based on wind pressures on the projected area at various height zones above ground in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures.* Wind speeds shall be based on a mean occurrence interval of 100 years.

2.5.1.9 A seismic design for installations of containers of 10,000 gal (37.9 m^3) or larger shall be made that meets the approval of the authority having jurisdiction.

2.5.1.10* If insulation is used, it shall be capable of limiting the container temperature to not over 800°F (427°C) for a minimum of 50 minutes, as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate. The insulation system shall be inherently resistant to weathering and the action of hose streams. *(See Appendix D.)*

2.5.2 Nonrefrigerated Underground Containers.

2.5.2.1 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.

2.5.2.2 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 that provides sufficient access shall be installed. No other part of the container shall be exposed.

2.5.2.3 Containers shall be set on a firm foundation and surrounded with earth or sand that is firmly tamped in place. Foundations of firm earth shall be permitted to be used. Backfill shall be free of rocks or other abrasive materials. Provisions shall be made to take care of settling and rotation.

2.5.2.4* Containers shall be protected to minimize corrosion.

2.5.2.5 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.

Exception No. 1: Where tanks are mounded and the bottom of the tank is 30 in. (0.76 m) or more above the surrounding grade, bottom connections shall be permitted where access to connections is provided by an opening or tunnel with a 4-ft (1.2-m) minimum diameter and a 3-ft (0.9-m) minimum clear area.

Exception No. 2: Bottom connections shall be permitted on mounded tanks where they extend beyond the mound. The connection shall be part of the ASME tank or shall be installed in compliance with the ASME Boiler and Pressure Vessel Code and shall be designed for the forces that can act on the connection.

2.5.2.6 If the area above a container is to be used for purposes permitted by this standard, consideration shall be given to depth of cover and loads that can be imposed.

2.5.3 Field welding on containers shall be limited to [attachments to] nonpressure parts such as saddle plates, wear plates, or brackets applied by the container manufacturer. Welding to the container [proper] shall comply with [the regulations, rules, or code under which the container was fabricated]. [**58:**3.2.4.3]

2.5.4 Where necessary to prevent flotation due to possible high flood waters around aboveground or mounded containers, or high water table for those underground and partially underground, containers shall be securely anchored. [**58**:3.2.2.6(h)]

2.5.5 The area under containers shall be graded or shall have dikes or curbs installed so that the flow or accumulation of flammable liquids with flash points below 200°F (93.4°C) is prevented. [**58**:3.2.2.6(c)]

2.6 Reinstallation of Nonrefrigerated Containers. Containers once installed underground or above ground that have been out of service for more than 1 year shall not be reinstalled above ground 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 they were constructed and they 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 7 for relief valve requirements.)*

2.7 Gaskets. Gaskets used to retain LP-Gas in flanged connections in piping shall be resistant to the action of LP-Gas. They shall be made of metal confined in metal having a melting point over 1500°F (816°C) or shall be protected against fire exposure. When a flange is opened, the gasket shall be replaced.

Exception No. 1: Aluminum O-rings and spiral wound metal gaskets shall be permitted.

Exception No. 2: Nonmetallic gaskets used in insulating fittings shall be permitted.

[**58**:3.2.15.3(d)]

2.8 Filling Densities.

2.8.1 Nonrefrigerated containers shall be filled in accordance with the following formula:

$$V = D/(G \times F)$$

where:

V = maximum liquid volume (in percent of total container capacity) that should be placed in a container when the liquid temperature is T

D = filling density from Table 2.8.1 in percent

G = specific gravity of LP-Gas at 60°F (15.6°C) to be placed in container

F = correction factor for correcting liquid volume from 60°F (15.6°C) to volume at temperature, T. (Some F values are located in Table B.2)

T = temperature of liquid LP-Gas in container (in degrees Fahrenheit)

2.8.2 Filling densities of underground nonrefrigerated containers shall be in accordance with Table 2.8.1.

2.8.3 Where the maximum ground temperatures do not exceed 60°F (15.6°C), the filling density shall be based on Table 2.8.1 or on accepted engineering practices for the operating conditions involved with the approval of the authority having jurisdiction.

2.9 Loading and Unloading Facility Spacing.

2.9.1 Loading and unloading connections shall be at least 75 ft (23 m) from uncontrolled sources of ignition, process areas, control buildings, offices, shops, and other occupied or important plant structures. This shall 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 (7.6 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.

Table 2.8.1 Maximum Permitted Filling Density

Specific Gravity at 60°F (15.6°C)	Aboveground Containers: 0 to 1200 U.S. gal (1000 imperial gal, 4.5 m^3) Total Water Capacity (%)	Aboveground Containers: Over 1200 U.S. gal (1000 imperial gal, 4.5 m^3) Total Water Capacity (%)	Underground Containers All Capacities (%)
0.496–0.503	41	44	45
0.504–0.510	42	45	46
0.511–0.519	43	46	47
0.520–0.527	44	47	48
0.528–0.536	45	48	49
0.537–0.544	46	49	50
0.545–0.552	47	50	51
0.553–0.560	48	51	52
0.561–0.568	49	52	53
0.569–0.576	50	53	54
0.577–0.584	51	54	55
0.585–0.592	52	55	56
0.593–0.600	53	56	57

2.10 Supplemental Product Control.

2.10.1 Application. This section provides alternate provisions for the location and installation of ASME containers that incorporate the use of redundant fail-safe product control measures for the purpose of enhancing safety and to mitigate distance and special protection requirements.

2.10.2 Spacing Requirements. Where the provisions of this section are complied with, the minimum distances for underground and mounded ASME containers of 2001 gal through 30,000 gal (7.6 m^3 through 114 m^3) water capacity shall be permitted to be reduced to 10 ft (3.0 m). Distances for all underground and mounded ASME containers shall be measured from the relief valve and the filling connection.

No part of an underground ASME container shall be less than 10 ft (3.0 m) from a building or line of adjoining property that can be built upon, and no part of a mounded ASME container that is installed above grade shall be less than 5 ft (1.5 m) from a building or line of adjoining property that can be built upon.

[**58**:3.11.2]

2.10.3 ASME Container Appurtenances. The following provisions shall be required for ASME containers of 2001 gal through 30,000 gal (7.6 m^3 through 114 m^3) water capacity referenced in Section 3.11 [of NFPA 58]. [**58**:3.11.3]

2.10.3.1 All liquid withdrawal openings and all vapor withdrawal openings that are $1^1/_4$ in. (3.2 cm) or larger shall be equipped with an internal valve with an integral excess flow valve or excess flow protection. The internal valves shall remain closed except during periods of operation. As required, the internal valves shall be equipped for remote closure and automatic shutoff through thermal (fire) actuation. [**58**:3.11.3.1]

2.10.3.2 In addition, a positive manual shutoff valve shall be installed as close as practical to each internal valve. [**58**:3.11.3.2]

2.10.3.3 All liquid and vapor inlet openings shall be equipped in accordance with 2.10.3.1 and 2.10.3.2 or shall be equipped with a backflow check valve and a positive manual shutoff valve installed as close as practical to the backflow check valve. [**58**:3.11.3.3]

2.10.4 Facility Piping Requirements. The following redundant fail-safe product control measures shall be required for systems covered in this section. [**58**:3.11.4]

2.10.4.1 At cargo tank and railroad tank car transfer points, protection shall be provided in accordance with 3.2.19 [of NFPA 58] using approved emergency shutoff valves or backflow check valves or a combination of the two. [**58**:3.11.4.1]

2.10.4.2 Automatic system shutdown of all primary valves (internal valves and emergency shutoff valves) shall be provided through thermal (fire) actuation and in the event of a hose pull-away. [**58**:3.11.4.2]

2.10.4.3 Remote shutdown capability, including power supply for the transfer equipment and all primary valves (internal and emergency shutoff), shall be provided as follows:

(a) A remote shutdown station shall be installed within 15 ft (4.6 m) of the point of transfer.

(b) At least one additional remote shutdown station shall be installed not less than 25 ft (7.6 m) nor more than 100 ft (30.5 m) from the transfer point.

(c) Emergency remote shutdown stations shall be identified as such by a sign incorporating the words "Propane" and "Emergency Shutoff" in block letters of not less than 2 in. (5.1 cm) in height on a background of contrasting color to the letters. The sign shall be visible from the point of transfer.

[**58**:3.11.4.3]

Chapter 3 Refrigerated Containers

3.1 Provisions for Construction, Design, Installation, and Testing of Refrigerated Containers. [**58**:9.1]

3.1.1 General Requirements. Refrigerated LP-Gas containers shall be designed, constructed, and tested in accordance with the following codes. [**58**:9.1.1]

3.1.1.1 Containers designed to operate at greater than 15 psig (103 kPag) shall be designed and constructed in accordance with the ASME *Boiler and Pressure Vessel Code*, Section VII, except that construction using joint efficiencies listed in Table UW 12, Column C, Division 1, shall not be permitted. Materials shall be selected from those included in the following:

(1) ASME *Boiler and Pressure Vessel Code*, Section VIII (materials that maintain their integrity at the boiling temperature of the liquid stored)
(2) API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Appendix R, or Appendix Q

[**58**:9.1.1.1]

3.1.1.2 Containers designed to operate at below 15 psig (103 kPag) shall be in accordance with API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, including Appendix R. [**58**:9.1.1.2]

3.1.1.3 Where austenitic stainless steels or nonferrous materials are used, API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Appendix Q, shall be used in the selection of materials. [**58**:9.1.1.3]

3.1.1.4 Marking on Refrigerated LP-Gas Containers. Each refrigerated LP-Gas container shall be identified by the attachment of a nameplate on the outer covering. The nameplate shall be in an accessible, visible place and shall be marked with the following information:

(1) Manufacturer's name and date built
(2) Liquid volume of the container in U.S. gallons (U.S. standard) or barrels
(3) Maximum allowable working pressure in pounds per square inch
(4) Minimum temperature (in degrees Fahrenheit) for which the container was designed
(5) Density of the product to be stored in pounds per cubic foot or specific gravity for which the container was designed
(6) Maximum level to which the container is permitted to be filled with the LP-Gas for which it was designed

[**58**:9.1.1.4]

3.1.2 Design Temperature and Pressure. The maximum allowable working pressure and the maximum vacuum of a container shall be specified. It shall include a margin above the operating pressure. [**58**:9.1.2]

3.1.2.1 The positive margin for design pressure of ASME containers shall be at least 5 percent of the absolute vapor pressure of the LP-Gas at the design storage temperature. The margin (both positive and vacuum) for low-pressure API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, vessels shall include the following:

(1) The control range of the boil-off handling system
(2) The effects of flash or vapor collapse during filling operations
(3) The flash that can result from withdrawal pump recirculation
(4) The normal range of barometric pressure changes

[**58**:9.1.2.1]

3.1.2.2 The design temperature for those parts of a refrigerated LP-Gas container that are in contact with the liquid or refrigerated vapor shall be equal to or lower than the boiling point of the product to be stored at atmospheric pressure. [**58**:9.1.2.2]

3.1.3 Installation. [**58**:9.1.3]

3.1.3.1 The design wind loading on refrigerated LP-Gas containers shall be in accordance with the projected area at various height zones above ground in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. Design wind speeds shall be based on a mean occurrence interval of 100 years. [**58**:9.1.3.1]

3.1.3.2 The design seismic loading on refrigerated LP-Gas containers shall be based on forces recommended in the ICBO *Uniform Building Code (UBC)*. For 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 that meets the approval of the authority having jurisdiction shall be made. [**58**:9.1.3.2]

3.1.3.3 All piping that is part of a refrigerated LP-Gas container and refrigerated LP-Gas systems, including transfer and process piping, shall be in accordance with ASME B 31.3, *Chemical Plant and Petroleum Refinery Piping*. The container piping shall include the following:

(1) All piping internal to the container
(2) All piping within the insulation spaces
(3) All external piping attached or connected to the container up to the first circumferential external joint of the piping.

Exception: Inert gas purge systems wholly within the insulation spaces shall be exempt from this provision.

[**58**:9.1.3.3]

3.1.3.4 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. They shall be of metal or other material confined in metal, including spiral-wound metal gaskets, having a melting point over 1500°F (816°C) or shall be protected against fire exposure. When a flange is opened, the gasket shall be replaced. [**58**:9.1.3.4]

3.1.4 Foundations. [**58**:9.1.4]

3.1.4.1 Refrigerated aboveground containers shall be installed on foundations that have been engineered with consideration for soil conditions and loadings. [**58**:9.1.4.1]

3.1.4.2* Prior to the start of design and construction of the foundation, a subsurface investigation shall be conducted by a soils engineer. Foundations shall be designed by an engineer who is experienced in foundations and soils. [**58**:9.1.4.2]

3.1.4.3 For product storage at less than 30°F (–1.1°C), the foundation and the tank bottom shall comply with the following:

(a) The foundation design and the container bottom insulation shall prevent damage to the tank from frost heave.

(b) The bottom of the container shall be constructed of materials that are not weakened at the temperatures to which they will be exposed.

(c) If the bottom of the refrigerated LP-Gas container is in contact with the soil, a heating system shall be provided to prevent the 32°F (0°C) isotherm from extending into the soil.

(d) The heating system shall be designed to permit both functional and performance monitoring.

(e) The undertank temperature shall be observed and logged at least weekly.

(f) Where there is a discontinuity in the foundation, such as bottom piping, the heating system in that zone shall be designed for the discontinuity.

(g) Heating systems shall be installed so that any heating elements or temperature sensors used for control can be replaced while the tank is in service.

(h) Provisions shall be incorporated to minimize the effects of moisture accumulation in the conduit, and other forms of deterioration within the conduit or heating element.

[**58**:9.1.4.3]

3.1.4.4 The refrigerated LP-Gas container foundation shall be periodically monitored for settlement during the life of the facility. The monitoring shall include construction, hydrostatic testing, commissioning, and operation. Any settlement in excess of that anticipated in the design shall be investigated, and corrective action shall be taken if appropriate. [**58**:9.1.4.4]

3.1.4.5 Where two or more containers are sited in a common dike, the container foundations shall be constructed of materials resistant to weakening by LP-Gas. [**58**:9.1.4.5]

3.1.4.6 If the foundation of a refrigerated LP-Gas container is designed to provide air circulation in lieu of a heating system, the foundation and insulating material under the bottom of the container shall be constructed of materials that are not weakened for the temperatures to which they will be exposed.

The material in contact with the bottom of the container shall be selected to minimize corrosion. [**58**:9.1.4.6]

3.1.5 Other Requirements. [**58**:9.1.5]

3.1.5.1 The bottom of the outer tank of a refrigerated LP-Gas container or the bottom of the undertank insulation shall be above the ground water table or protected from contact with ground water at all times. It shall also be protected from flood waters. Secure anchorage or pier height above flood levels shall be provided where high water might occur. [**58**:9.1.5.1]

3.1.5.2 All new construction shall incorporate on any bottom or side penetrations that communicate with the liquid space of the container either an internal emergency shut-off valve or a back check valve. Any emergency shut off valve shall be incorporated into a facility emergency shutdown system and be capable of being operated remotely. [**58**:9.1.5.2]

3.2 Refrigerated LP-Gas Container Instruments and Controls. [**58**:9.2]

3.2.1 Each refrigerated LP-Gas container shall be equipped with at least two independent liquid level gauging devices. These devices shall be installed so that they can be replaced without taking the container out of service. [**58**:9.2.1]

3.2.2 The refrigerated LP-Gas container shall be provided with an audible and visual high-liquid level alarm that complies with the following subsections. [**58**:9.2.2]

3.2.2.1 The alarm shall be set so that the operator will have sufficient time based on the maximum allowable filling rate to stop the flow without exceeding the maximum permissible filling height. [**58**:9.2.2.1]

3.2.2.2 The alarm shall be located so that it is visible and audible to the personnel who control the filling. [**58**:9.2.2.2]

3.2.2.3 A high-liquid level flow cutoff device shall not be a substitute for the alarm. [**58**:9.2.2.3]

3.2.3 The refrigerated LP-Gas container shall be equipped with a high-liquid level flow cutoff device that is independent from all gauges.

Exception: Refrigerated LP-Gas containers of 70,000 gal (265 m^3) or less, if attended during the filling operation, shall be permitted to be equipped with liquid trycocks in lieu of the high-liquid level alarm, and manual flow cutoff shall be permitted.

[**58**:9.2.3]

3.2.4 Each refrigerated LP-Gas container shall be provided with temperature-indicating devices that assist in controlling cooldown rates when placing the container in service. [**58**:9.2.4]

3.3 Refrigerated LP-Gas Container Impoundment. [**58**:9.3]

3.3.1 Each refrigerated LP-Gas container shall be located within an impoundment that complies with this section, in order to minimize the possibility that the accidental release of liquid LP-Gas from the container would endanger adjoining property or lives, process equipment, or structures, or that an accidental release could reach waterways or enclosed drainage systems. [**58**:9.3.1]

3.3.2 Enclosed drainage channels for LP-Gas shall be prohibited.

Exception: Enclosure of container downcomers used to conduct spilled LP-Gas away from materials subject to failure upon exposure to liquid LP-Gas shall be permitted.

[**58**:9.3.2]

3.3.3 Impoundment for refrigerated LP-Gas containers shall have a volumetric holding capacity, with an allowance made for the displacement of snow accumulation, other containers, or equipment that is equal to the total liquid volume of the largest container served, assuming that container is full to the high-liquid level flow cutoff device required in 3.2.3. [**58**:9.3.3]

3.3.4 Where more than one container is installed in a single impoundment the following shall apply.

If an outside container wall is used as a spill containment dike, the material shall be suitable for exposure to the temperature of refrigerated LP-Gas liquid, taking into account the effects of product composition and the resulting auto-refrigeration temperature.

[**58**:9.3.4]

3.3.5 Impoundment structures, and any penetrations thereof, shall be designed to withstand the full hydrostatic head of impounded LP-Gas and the effect of rapid cooling to the temperature of the liquid to be confined. These structures shall also be resistant to natural forces such as wind, rain, or earthquake and be fire resistant. [**58**:9.3.5]

3.3.6 Provisions to clear rain or other water from the impounding area shall be in accordance with the following: [**58**:9.3.6]

3.3.6.1 Automatically controlled sump pumps shall be permitted if equipped with an automatic shut-off device that prevents their operation when exposed to LP-Gas temperatures. [**58**:9.3.6.1]

3.3.6.2 LP-Gas vapors shall not exceed 25 percent of the lower flammable limit, or other approved methods of LP-Gas liquid or vapor detection. [**58**:9.3.6.2]

3.3.6.3 Gravity drainage utilizing piping penetrations through or below impoundment dikes shall not be permitted. [**58**:9.3.6.3]

3.3.7 If the container impounding area is an earthen dike system, the area topography of the impounding area floor shall be graded away from the container to prevent the accumulation of liquid under or around the container. [**58**:9.3.7]

3.3.7.1 The grading shall move the spilled liquid to the toe of the dike system and as far away from the container as possible. [**58**:9.3.7.1]

3.3.7.2 The grading shall move the spilled liquid to a subimpoundment basin that is capable of holding the quantity of liquid spilled in a credible incident — that is, line rupture, flange leak, and so on. The duration of the incident shall be the amount of time that automatic systems or plant personnel could effect emergency procedures and stop the leak. The subimpoundment basin shall be located as far away from the container as possible. [**58**:9.3.7.2]

3.4 Inspection of Refrigerated LP-Gas Containers and Systems. [**58**:9.4]

3.4.1 During construction and prior to the initial operation or commissioning, each refrigerated LP-Gas container and system shall be inspected or tested in accordance with the provisions of this code and other applicable referenced codes and standards. [**58**:9.4.1]

3.4.2 The inspections or tests required shall be the responsibility of the operator. Where any part of the inspections or tests is delegated to the operator's employees or a third-party engineering, scientific, recognized insurance, or inspection organization, each inspector shall be qualified in accordance

with the code or standard that is applicable to the test or inspection being performed. [**58**:9.4.2]

3.4.3 After acceptance tests are completed, there shall be no field welding on the LP-Gas containers. Retesting shall be required only if the retest tests the element affected and is necessary to demonstrate the adequacy of the repair or modification.

Exception: Welding on saddle plates or brackets that are provided for the purpose or that are permitted by the code under which the container was fabricated.

[**58**:9.4.3]

3.5 Locating Aboveground Refrigerated LP-Gas Containers.

3.5.1 Spacing of refrigerated propane containers from important buildings, storage containers for flammable or combustible liquids, and lines of adjoining property that can be built upon shall be in accordance with Table 3.5.1.

Table 3.5.1 Minimum Distances

Water Capacity per Container gal (m^3)	Aboveground Containers	
	ft	(m)
Up to 70,000 (265)	75	(23)
70,001 to 90,000 (265 to 341)	100	(30)
90,001 to 120,000 (341 to 454)	125	(38)
120,001 to 200,000 (454 to 757)	200	(61)
200,001 to 1,000,000 (757 to 3785)	300	(91)
Over 1,000,000 (3785)	400	(122)

Note: Minimum distances for mounded or underground containers of 2001 gal to 30,000 gal (7.6 m^3 to 114 m^3) water capacity incorporating RFPCM provisions shall be permitted to be reduced to 10 ft (3 m). Distances for all underground and mounded containers shall be measured from the relief valve and filling connection, except that no part of an underground container shall be less than 10 ft (3 m) from a building or line of adjoining property that can be built upon and no part of a mounded container, installed above grade, shall be less than 5 ft (1.5 m) from a building or line of adjoining property that can be built upon.

3.5.2 The edge of a dike, impoundment, or drainage system that is intended for a refrigerated LP-Gas container shall be 100 ft (31 m) or more from a property line that can be built upon, a public way, or a navigable waterway. [**58**:9.5.3]

3.5.3 Nonrefrigerated LP-Gas containers or flammable liquid tanks shall not be located within dikes or impoundments enclosing refrigerated LP-Gas containers. [**58**:9.5.4]

3.5.4 Refrigerated LP-Gas containers shall not be installed one above the other. [**58**:9.5.5]

3.5.5 The minimum distance between aboveground refrigerated LP-Gas containers shall be one-half the diameter of the larger container. [**58**:9.5.6]

3.5.6 The ground within 25 ft (7.6 m) of any aboveground refrigerated LP-Gas container and all ground within a dike, impoundment, or drainage area shall be kept clear of readily ignitable materials such as weeds and long, dry grass. [**58**:9.5.7]

3.6 Relief Devices. Pressure control and relief devices shall be in accordance with Chapter 7.

Chapter 4 Piping, Valves, and Equipment

4.1 General.

4.1.1 Piping, valves, and equipment shall be suitable for their 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 they can be subjected.

4.1.1.1 The design and fabrication of piping systems shall be in accordance with ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*, except as modified by the provisions of this chapter and any applicable federal pipeline regulations. Special consideration shall be given to the behavior of the piping material upon possible fire exposure.

4.1.1.2 Pressure-containing metal parts of equipment for application temperatures of –20°F (–29°C) or above shall be fabricated of materials compatible with LP-Gas. They shall be of steel; ductile (nodular) iron in accordance with ASTM A 395, *Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or ASTM A 536, *Specifications for Ductile Iron Castings*, Grade 60-40-18 or 65-45-12; malleable iron in accordance with ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings*; brass; bronze; or equivalent copper alloys.

4.1.1.3 Piping that can contain liquid LP-Gas and that can be isolated by valving and that requires hydrostatic relief valves, as specified under Section 7.6, shall have as a minimum a design pressure of 350 psi (2400 kPa), or the maximum discharge pressure of any pump or other source feeding that piping system, whichever is greater. Such piping shall be subjected to a pressure test, in accordance with 4.1.1.1, of no less than 150 percent of the design pressure.

4.1.2 Piping connections to the container for sizes over 2 in. nominal pipe diameter shall be made by welding or with welded flanges.

Exception: Piping connections for excess-flow valves.

4.1.3 The use of cast-iron valves, pipe, and fittings shall be prohibited in piping that carries LP-Gas and LP-Gas air–mixtures. This shall not prohibit the use of container valves or fittings made of malleable or ductile iron used within the limitations set forth in 323.4.2 of ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*.

4.1.4 Emergency shutoff valves shall be approved and shall incorporate all of the following means of closing:

(1) Automatic shutoff through thermal (fire) actuation [Where fusible elements are used, they shall have a melting point not exceeding 250°F (121°C).]
(2) Manual shutoff from two or more remote locations
(3) Manual shutoff at the installed location

4.1.5 Gaskets used to retain LP-Gas in flanged connections in piping shall be resistant to the action of LP-Gas. They shall be of metal or other suitable material that is confined in metal that has a melting point over 1500°F (816°C) or shall be protected against fire exposure. When a flange is opened, the gasket shall be replaced.

4.1.6 All piping, tubing, fittings, and valves shall be leak tested after assembly and proved to be free of leaks at not less than normal operating pressures. Tests shall not be made with a flame.

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

4.1.8* Piping outside buildings shall be supported and protected against physical damage and corrosion. Underground and submerged piping shall be protected and maintained to minimize corrosion.

4.1.9 Equipment selection for application temperatures below 20°F (29°C) shall be based on sound engineering practices for the individual design and operating conditions involved. Special consideration shall be given to the behavior of material upon possible fire exposure.

4.2 Container Valves and Accessories.

4.2.1 All shutoff valves and accessory equipment (liquid or gas) shall be compatible with LP-Gas and designed for not less than the maximum extreme pressure and temperature to which they can be subjected. Valves for use with nonrefrigerated containers that can be subjected to container pressure shall have a rated working pressure of at least 250 psi (1.7 MPa). Cast-iron valves, piping, and fittings shall be prohibited on LP-Gas containers and their connections. This shall not prohibit the use of container valves or fittings that are made of malleable or nodular iron.

4.2.2 All connections to containers shall have shutoff valves located as close to the container as practical. The valves shall be readily accessible for operation and maintenance under normal and emergency conditions, either by location or by means of permanently installed special provisions. Valves installed in unobstructed locations that are not more than 6 ft (1.8 m) above ground level shall be considered accessible. Special provisions shall include stairs, ladders, platforms, remote operators, extension handles, and so forth.

Exception: Safety relief connections, liquid level gauging devices, and plugged openings shall not be considered to be special provisions.

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 lines, including valves, fittings, and so forth, downstream of an excess-flow valve shall have a greater capacity than the rated flow of the excess-flow valve.

4.2.4 All liquid and vapor connections on containers shall be equipped with one of the following:

(1) A back-pressure check valve and either a manual valve or an emergency shutoff valve
(2) An excess-flow valve and an emergency shutoff valve
(3) A quick-acting internal valve incorporating the means of closing as specified in 4.1.4

Exception: Pressure relief valves, liquid level gauging devices, and openings not larger than No. 54 drill size as covered in 4.2.5 and 4.4.4.

4.2.5 Openings from a container or through fittings attached directly on the container to which pressure gauge connection is made shall not be required to 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 on any container shall be labeled or color coded to designate whether they are connected to a vapor or liquid space. Labels shall be permitted to be on valves.

Exception: Labels shall not be required to be on safety valves, liquid level gauging devices, and pressure gauges.

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

4.3 Filler and Discharge Pipes and 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 Liquid manifold connections shall be located at nonadjacent ends of parallel rows of containers.

4.3.3 The use of nonmetallic hose shall be prohibited for interconnecting stationary containers.

4.3.4 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 250°F (121°C) melting point] that will cause the valve to close automatically in case of fire. Such valves also shall be capable of being operated manually at the installed location. A remote closing control shall be located so as to be accessible during a fire or other emergency. On aboveground piping systems, such valves shall be arranged to limit the quantity that could be discharged within 300 ft (91.4 m) of a container, important building, or line of adjoining property that can be built upon to a maximum of 500 gal (1.89 m^3) of liquid.

4.3.5 By December 31, 2001, all new utility gas plants providing hose for loading and unloading of LP-Gas shall have a means to automatically stop the flow of product to or from a bulk plant or industrial plant without the need for human intervention within 20 seconds of an unintentional release caused by a complete separation of a liquid hose during the transfer of product in addition to any required excess flow valve.

All utility gas plants in service shall meet this requirement by July 1, 2004.

4.4 Liquid Level Gauging Device.

4.4.1 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, a slip tube, or a 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 also shall be provided with an auxiliary gauging device, such as a fixed dip tube, slip tube, rotary gauge, or similar device.

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

4.4.2 Refrigerated containers shall be equipped with a liquid level gauging device of approved design. An auxiliary gauging

device shall not be required for refrigerated containers. However, in lieu of an auxiliary gauge, 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 gauging devices shall be arranged so that the maximum liquid level to which the container can be filled for butane, for a 50-50 mixture of butane and propane, and for propane is readily determinable.

4.4.4 Gauging devices that require bleeding of the product to the atmosphere, such as the rotary tube, fixed tube, and slip tube, shall be designed so 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 Gauging 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* Where used, the length of a fixed tube device shall be designed to indicate the maximum level to which the container can be filled for the product contained. The length or location of the fixed tube that indicates 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.

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 1750 psi (12.1 MPa) [350 psi (2.41 MPa) working pressure] and shall be marked with "LP-Gas" or "LPG," with the working pressure in psi marked 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 psi (4.8 MPa). If a test is made, such assemblies shall not be leak tested at pressures higher than the working pressure [350 psi (2.41 MPa) minimum] of the hose.

4.6 Drips, Pits, and Drains.

4.6.1 Where vaporized gas can condense, suitable means shall be provided for revaporization or disposal of the condensate.

4.6.2 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 LP-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 for safely disposing of vented vapors while the refrigeration system is inoperative, at least two 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 ensure that prolonged failure of refrigeration can be prevented.

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

4.8 Protection of Container Accessories.

4.8.1 Valves and 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.

4.8.2 All connections on underground containers shall be located within a substantial dome, housing, or manhole and shall be protected by a substantial, round cover. *(See 7.6.2.)*

Chapter 5 Buildings or Structures Housing LP-Gas Distribution Facilities

5.1 Scope. [**58**:7.1]

5.1.1 Application. [**58**:7.1.1]

5.1.1.1 This chapter shall apply to the construction, ventilation, and heating of structures, parts of structures, and rooms housing LP-Gas systems where specified by other parts of the code. [**58**:7.1.1.1]

5.1.1.2 The provisions of this chapter apply only to buildings constructed or converted after December 31, 1972.

Exception: Buildings previously constructed under the provisions of 5.3.3 [of NFPA 58]. (Also see 1.1.4 [of NFPA 58].)
[**58***:7.1.1.2]*

5.2 Separate Structures or Buildings. [**58**:7.2]

5.2.1 Construction of Structures or Buildings. [**58**:7.2.1]

5.2.1.1 Separate buildings or structures shall be one story in height and shall have walls, floors, ceilings, and roofs constructed of noncombustible materials. Either of the following shall apply to the construction of exterior walls, ceilings, and roofs:

(a) Exterior walls and ceilings shall be of lightweight material designed for explosion venting.

(b) Walls or roofs of heavy construction, such as solid brick masonry, concrete block, or reinforced concrete construction, shall be provided with explosion venting windows that have an explosion venting area of at least 1 ft^2 (0.1 m^2) for each 50 ft^3 (1.4 m^3) of the enclosed volume.
[**58**:7.2.1.1]

5.2.1.2 The floor of separate structures shall not be below ground level. Any space beneath the floor shall be of solid fill, or the perimeter of the space shall be left entirely unenclosed. [**58**:7.2.1.2]

5.2.2 Structure or Building Ventilation. The structure shall be ventilated using air inlets and outlets, the bottom of which shall be not more than 6 in. (150 mm) above the floor, and ventilation shall be provided in accordance with the following: [**58**:7.2.2]

5.2.2.1 Where mechanical ventilation is used, the rate of air circulation shall be at least 1 $ft^3/min \cdot ft^2$ (0.3 $m^3/min \cdot m^2$) of

floor area. Outlets shall discharge at least 5 ft (1.5 m) from any opening into the structure or any other structure. [**58**:7.2.2.1]

5.2.2.2 Where natural ventilation is used, each exterior wall shall be provided with one opening for each 20 ft (6.1 m) of length. Each opening shall have a minimum size of 50 $in.^2$ (32,250 mm^2), and the total of all openings shall be at least 1 $in.^2/ft^2$ (720 mm^2/m^2) of floor area. [**58**:7.2.2.2]

5.2.3 Structure or Building Heating. Heating shall be by steam or hot water radiation or other heating transfer medium, with the heat source located outside of the building or structure *(see Section 1.9),* or by electrical appliances listed for Class I, Group D, Division 2 locations, in accordance with NFPA 70, *National Electrical Code.* [**58**:7.2.3]

5.3 Attached Structures or Rooms Within Structures. [**58**:7.3]

5.3.1 Construction of Attached Structures. Attached structures shall be spaces where 50 percent or less of the perimeter of the enclosed space is comprised of common walls. [**58**:7.3.1]

5.3.1.1 Attached structures shall comply with 5.2.1. [**58**:7.3.1.1]

5.3.1.2 Common walls of structures shall have the following features:

(1) A fire resistance rating of at least 1 hour
(2) Where openings are required in common walls for rooms used only for storage of LP-Gas, $1^1/_2$ hour (B) fire doors
(3) A design that withstands a static pressure of at least 100 lb per ft^2 (4.8 kPa)

[**58**:7.3.1.2]

5.3.1.3 Where the building to which the structure is attached is occupied by operations or processes having a similar hazard, the provisions of 5.3.1.2 shall not apply. [**58**:7.3.1.3]

5.3.1.4 Ventilation and heating shall comply with 5.2.2 and 5.2.3. [**58**:7.3.1.4]

5.3.2 Construction of Rooms Within Structures. Rooms within structures shall be spaces where more than 50 percent of the perimeter of the space enclosed is comprised of common walls. [**58**:7.3.2]

5.3.2.1 Rooms within structures shall be located in the first story and shall have at least one exterior wall with unobstructed free vents for freely relieving explosion pressures. [**58**:7.3.2.1]

5.3.2.2 Walls, floors, ceilings, or roofs of the rooms shall be constructed of noncombustible materials. [**58**:7.3.2.2]

5.3.2.3 Exterior walls and ceilings shall be of lightweight material designed for explosion venting. [**58**:7.3.2.3]

5.3.2.4 Walls and roofs of heavy construction (such as solid brick masonry, concrete block, or reinforced concrete construction) shall be provided with explosion venting windows or panels that have an explosion venting area of at least 1 ft^2 (0.1 m^2) for each 50 ft^3 (1.4 m^3) of the enclosed volume. [**58**:7.3.2.4]

5.3.2.5* Walls and ceilings common to the room and to the building within which it is located shall have the following features:

(1) A fire resistance rating of at least 1 hour
(2) Where openings are required in common walls for rooms used only for storage of LP-Gas, $1^1/_2$ hour (B) fire doors
(3) A design that withstands a static pressure of at least 100 lb per ft^2 (4.8 kPa)

[**58**:7.3.2.5]

5.3.2.6 Where the building to which the structure is attached is occupied by operations or processes having a similar hazard, the provisions of 5.3.1.2 shall not apply. [**58**:7.3.2.6]

5.3.2.7 Ventilation and heating shall comply with 5.2.2 and 5.2.3. [**58**:7.3.2.7]

Chapter 6 Vaporizers, Heat Exchangers, and Gas–Air Mixers

6.1 General.

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

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

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

6.1.4 Vaporizer pressure relief valve outlets located within buildings shall be piped to a point outside the building and shall discharge vertically upward.

6.2 Buildings or Rooms Housing Vaporizers or Gas–Air Mixers. Buildings or rooms housing vaporizers or gas–air mixers shall be in accordance with Chapter 5.

6.3 Vaporizers, Heat Exchangers, and Gas–Air Mixers.

6.3.1 Vaporizers shall be of the indirect type (utilizing steam, hot water, or other heating medium) or direct fired. This subsection shall not apply to engine fuel vaporizers or to integral vaporizer-burners such as those used with weed burners or tar kettles.

6.3.2 All vaporizers, including atmospheric-type vaporizers that use heat from the surrounding air or the ground, shall be equipped, at or near the discharge, with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with Section 7.7. Fusible plug devices shall not be used.

6.3.3 Indirect vaporizers and heat exchangers shall comply with the following.

(a) Indirect vaporizers with an inside diameter of more than 6 in. (152 mm) shall be constructed in accordance with the applicable provisions of the ASME *Boiler and Pressure Vessel Code* for a design pressure of not less than 250 psi (1.7 MPa) and shall be permanently and legibly marked with the following:

(1) The markings required by the ASME Code
(2) The outside surface area in square feet
(3) The area of the heat exchange surface in square feet
(4) The maximum vaporizing capacity in gallons per hour
(5) The rated heat input in British thermal units per hour
(6) The name or symbol of the manufacturer

(b) Indirect vaporizers shall be provided with a suitable automatic means to prevent liquid from passing through the vaporizer to the vapor discharge piping. This means shall be permitted to be integral with the vaporizer or otherwise provided in the external piping. *(See 6.4.2.4.)*

6.3.4 Direct-fired vaporizers shall comply with the following.

(a) Design and construction of direct-fired vaporizers shall be in accordance with the applicable requirements of the ASME *Boiler and Pressure Vessel Code* for the working conditions to which the vaporizer will be subjected. The vaporizer shall be permanently and legibly marked with the following information:

(1) The markings required by the ASME Code
(2) The outside surface area in square feet
(3) The area of the heat exchange surface in square feet
(4) The maximum vaporizing capacity in gallons per hour
(5) The rated heat input in British thermal units per hour
(6) The name or symbol of the manufacturer

(b) Direct-fired vaporizers shall be provided with automatic means to prevent liquid the passage of liquid from the vaporizer to its vapor discharge piping.

(c) A means for manually turning off the gas to the main burner and pilot shall be provided.

(d) Direct-fired vaporizers shall be equipped with an automatic safety device to shut off the flow of gas to the main burner if the pilot light is extinguished. If the pilot flow exceeds 2000 Btu/hr (2 mJ/hr), the safety device also shall shut off the flow of gas to the pilot.

(e)*Direct-fired vaporizers shall be equipped with a limit control to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment and to prevent raising the pressure within the storage container above the pressure shown in the first column of Table 6.3.4(e) corresponding with the design pressure of the container [or its ASME *Boiler and Pressure Vessel Code* equivalent; *see Table 6.3.4(e)*].

Table 6.3.4(e) ASME *Boiler and Pressure Vessel Code* Minimum Design Pressure

For Gases with Vapor Pressure at 100°F (37.8°C) Not to Exceed		Minimum Design Pressure from ASME Code, Section VIII, Division 1, 1986 Edition	
psi	**MPa**	**psi**	**MPa**
80	0.6	100	0.7
100	0.7	125	0.9
125	0.9	156	1.1
150	1.0	187	1.3
175	1.2	219	1.5
215	1.5	250	1.7

6.3.5 Waterbath vaporizers shall comply with the following:

(a) The vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing the LP-Gas to be vaporized, hereinafter referred to as *heat exchanger*, shall be constructed in accordance with the applicable provisions of the ASME Code for a minimum design pressure of 250 psig (1.7 MPag) and shall be permanently and legibly marked with the following:

(1) The marking required by the ASME Code
(2) The allowable working pressure and temperature for which the heat exchanger is designed
(3) The name or symbol of the manufacturer

Exception: Heat exchangers for waterbath vaporizers that have an inside diameter of 6 in. (150 mm) or less are exempt from the ASME Code and shall not be required to be marked.

(b) Heat exchangers for waterbath vaporizers shall be provided with automatic control to prevent the passage of liquid through the heat exchanger to the vapor discharge piping. This control shall be integral with the vaporizer.

(c) Heat exchangers for waterbath vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 2.5.5.4 [of NFPA 58]. Fusible plug devices shall not be used.

(d) Waterbath sections of waterbath vaporizers shall be designed to prevent a pressure from exceeding the design pressure.

(e) The immersion heater that provides heat to the waterbath shall be installed so as not to contact the heat exchanger and shall be permitted to be electric or gas-fired.

(f) A control to limit the temperature of the waterbath shall be provided.

(g) Gas-fired immersion heaters shall be equipped with an automatic safety device to shut off the flow of gas to the main burner and pilot in the event of flame failure.

(h) Gas-fired immersion heaters with an input of 400,000 Btu/hr (422 MJ/hr) or more shall be equipped with an electronic flame safeguard and with programming to provide for prepurge prior to ignition, proof of pilot before the main burner valve opens, and full shutdown of the main gas and pilot upon flame failure.

(i) The heat source shall be shut off if the level of the heat transfer medium falls below the top of the heat exchanger. [**58**:2.5.5.3]

6.3.6 The minimum rate of discharge in cubic feet of air per minute for pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct fired, shall be determined as follows.

(a) Based on conservative heat transfer calculations (assuming that the vaporizing chamber is liquid full), the maximum vapor-generating capacity (rate) shall be determined when maximum heat is available. That vapor rate shall be converted to an equivalent air rate.

(b) If the vaporizer is direct fired or if a substantial exterior surface is in contact with the LP-Gas, the sum of the vaporizer surface and the LP-Gas wetted exterior surface shall be permitted to be used in conjunction with Table D.1.

6.3.7* LP-Gas–air mixers shall comply with the following:

6.3.7.1 LP-Gas–air mixers shall be designed for the air, vapor, and mixture pressures to which they can be subjected. Piping shall comply with 4.1.1.

6.3.7.2 LP-Gas–air mixers that are to be used to supplement (peak-shave) a natural gas supply shall be designed to produce a mixture of natural gas, air, and LP-Gas vapor that is safely interchangeable with the natural gas. If necessary, redundant controls or interlocks shall be provided to prevent the introduction of either undiluted air or vapor into the gas distribution lines in quantities that would create interchangeability problems.

6.3.7.3 A positive valving arrangement, such as a double-block-and-bleed (check valves shall not be considered to be sufficient for this purpose), shall be installed close to the mixer to prevent backflow of gas into the air supply lines or of air into the LP-Gas system when the plant is not in operation. LP-Gas–air mixer control valves in the LP-Gas and air supply lines that are arranged to fail closed when actuated by safety interlock or other trip devices shall be considered as acceptable shutdown devices but not as isolation devices as specified in this paragraph.

6.3.7.4 Where it is possible for condensation to take place between the vaporizer and LP-Gas–air mixer, a separator or

other means shall be provided to prevent LP-Gas liquid from entering the LP-Gas–air mixer.

6.3.7.5 LP-Gas–air mixers that use the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere shall require only a shutoff that will minimize the leakage of either gas or LP-Gas vapors to the atmosphere when the mixer is not operating. Such mixers also shall be provided with sufficient pressure regulation and associated interlocks to prevent significant departure from the design ratio of LP-Gas–air mixture.

Exception: Mixers receiving air from a blower, compressor, or any source of air other than directly from the atmosphere shall comply with 6.3.7.3.

6.4 Vaporizer Installation.

6.4.1 Application. This section applies to the installation of vaporizing devices covered in Section 6.3.

6.4.2 Installation of Indirect-Fired Vaporizers.

6.4.2.1 Indirect-fired vaporizers shall comply with 6.3.3 and shall be installed in accordance with the following.

6.4.2.2 Where an indirect-fired vaporizer is installed in a building or structure, the building or structure shall comply with the following:

(a) Separate buildings or structures shall comply with Section 5.3.

(b) Attached structures or rooms shall comply with Section 5.3.

(c) The building or structure shall not have any unprotected drains to sewers or sump pits. Pressure relief valves on vaporizers within buildings in industrial or gas manufacturing plants shall be piped to a point outside the building or structure and shall discharge vertically upward.

6.4.2.3 The installation of a heat source serving an indirect vaporizer that utilizes noncombustible heat transfer fluid shall be installed outdoors or shall comply with one of the following:

(1) If installed within a structure, the structure shall comply with Section 5.2.
(2) If installed in structures attached to or in rooms within another gas manufacturing or distribution building (but not buildings used for other purposes), the structure shall comply with Section 5.2.
(3) The heat supplying device, if outdoors, or the housing in which it is installed, shall be located at least 50 ft (15 m) from other LP-Gas facilities and operations.
(4) If the heat source of an indirect vaporizer is gas fired and is located within 15 ft (4.6 m) of the vaporizer, the vaporizer and its heat source shall be installed as a direct-fired vaporizer and shall be subject to the requirements of 6.4.3.
(5) The installation of a heat source serving an indirect vaporizer that utilizes a noncombustible heat transfer fluid, such as steam, water, or a water-glycol mixture, shall be installed outdoors or shall comply with the following:
    a. A source of heat for an indirect vaporizer shall be permitted to be installed in an industrial occupancy complying with Chapter 28 of NFPA *101®*, *Life Safety Code®*, and Section 6.3 of NFPA 54, *National Fuel Gas Code*, where the heat transfer fluid is steam or hot water and is not recirculated and a backflow preventer is installed between the vaporizer and the heat source.
    b. If the heat transfer fluid is recirculated after leaving the vaporizer, a phase separator shall be installed with the gas vented to a safe location.

6.4.2.4 The heating medium piping into and from the vaporizer shall be provided with a suitable means for preventing the flow of gas into a heating system that is supplying heat to areas other than the LP-Gas facility in the event of a tube rupture in the vaporizer. If the device supplying the heat to the vaporizer is for that purpose only, the device, or the piping to and from the device, shall contain a relief valve, vented to the outside, to relieve excessive pressure in the event of a tube rupture in the vaporizer.

6.4.2.5 Gas-fired heating systems that supply heat for vaporization purposes shall be equipped with automatic safety devices to shut off gas to the main burners if the pilot light should fail.

6.4.2.6 Vaporizers shall be permitted to be an integral part of a fuel storage container, directly connected to either the liquid or vapor space, or to both. A limit control shall be provided to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, or the pressure within the storage container above the pressure shown in the first column of Table 6.3.4(e) corresponding with the design pressure of the container [or its 1980 code equivalent; *see Table 6.3.4(e)*].

6.4.3 Installation of Direct Gas-Fired Vaporizers. Direct gas-fired vaporizers shall comply with 6.3.4 and shall be installed in accordance with the following.

6.4.3.1 Direct gas-fired vaporizers shall be permitted to be installed outdoors or in separate structures constructed in accordance with Section 5.2.1.

6.4.3.2 Direct gas-fired vaporizers also shall be permitted to be installed in structures attached to or in rooms within a gas manufacturing or distributing structure (but not buildings used for other purposes), provided the following:

(1) The housing provided shall comply with Section 5.2 and shall be well ventilated near the floor line and roof.
(2) The wall separating it from all other compartments or rooms containing LP-Gas vaporizers, pumps, and central gas mixing devices shall have no openings.

6.4.3.3 Direct gas-fired vaporizers shall be permitted to be connected to the liquid space or to both the liquid and the vapor space of the container, but in any case there shall be a manually operated shutoff valve in each connection at the container to permit shutting off completely all flow of vapor or liquid.

6.4.3.4 Direct gas-fired vaporizers of any capacity shall be located in accordance with Table 6.4.3.4.

6.4.4 Installation of Waterbath Vaporizers. Waterbath vaporizers shall comply with 6.3.5 and shall be installed as follows:

(1) If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class 1, Group D, locations, the unit shall be treated as indirect fired and shall be installed in accordance with 6.4.2.
(2) All others shall be treated as direct-fired vaporizers and shall be installed in accordance with 6.4.3.

6.4.5 Installation of Electric Vaporizers. Electric vaporizers, whether direct immersion or indirect immersion, shall be treated as indirect fired and shall be installed in accordance with 6.4.2.

Table 6.4.3.4 Separation of Vaporizers from Exposures

Exposure	Minimum Distance Required ft	m
Container	50	15
Container shutoff valves	50	15
Point of transfer	50	15
Nearest important building or group of buildings or line of adjoining property that can be built upon [except buildings in which vaporizer is installed *(see Section 6.4)*]	50	15
Building or room housing gas–air mixer	10	3
Cabinet housing gas–air mixer outdoors	0	0

6.4.6 Installation of Gas–Air Mixers.

6.4.6.1 Gas–air mixing equipment shall comply with 6.3.7.2 and shall be installed as follows:

(1) Where used without the vaporizer(s), the mixer(s) shall be permitted to be installed outdoors or in buildings that comply with Section 5.2.
(2) Where used with the indirect heated vaporizer(s), the mixer(s) shall be permitted to be installed outdoors, or in the same compartment or room with the vaporizer(s), in a building(s) that complies with Section 5.2, or shall be permitted to be installed remotely from the vaporizer(s) and shall be located in accordance with 5.3.2.
(3) Where used with the direct-fired vaporizer(s), the mixer(s) shall be installed as follows:
   a. Listed or approved in a common cabinet with the vaporizer(s) outdoors in accordance with 6.4.3.4
   b. Outdoors on a common skid with the vaporizer(s) in accordance with 6.3.3
   c. Installed adjacent to the vaporizer(s) to which it is connected in accordance with 6.3.3
   d. In a building complying with Section 6.2 with no direct-fired vaporizer in the same room

6.4.6.2 Listed vaporizer-mixers in a common cabinet having a direct-fired-type vaporizer shall be installed outdoors in accordance with the distance provisions in 6.4.3. Listed vaporizer-mixers not in a common cabinet having an indirect-fired-type vaporizer shall be permitted to be installed in a building or structure that complies with 6.1.4, provided there is no source of ignition in such building or structure.

Chapter 7 Relief Devices

7.1 General.

7.1.1* All containers shall be equipped with pressure and vacuum relief devices in accordance with the requirements of the code applicable to the container as follows:

(1) API 620 *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, for containers designed to operate at 15 psig (a gauge pressure of 103 kPa) and below
(2) ASME *Boiler and Pressure Vessel Code,* Section VIII, for containers designed to operate at above 15 psig (13 kPag)

7.1.2 Relief devices shall communicate directly with the atmosphere. Vacuum relieving devices shall be installed if the container can be exposed to a vacuum condition in excess of what the container is designed for.

7.1.3 Inlet and outlet piping connected to relief devices will cause pressure losses that shall be included in the selection and sizing of relief devices to ensure proper functioning and sufficient relieving capacity.

7.1.4* Each pressure and vacuum pressure relief valve for LP-Gas containers shall be able to be isolated from the container for maintenance or other purposes by means of a manual full-opening stop valve. This stop valve shall be lockable or sealable in the fully open position. Sufficient pressure and vacuum relief valves shall be installed on the LP-Gas container to allow each relief valve to be isolated individually for testing or maintenance while maintaining the full relieving capacities required. Where only one relief device is required, a full port opening three-way valve shall be permitted to be used under the relief device and its required spare in lieu of individual valves beneath each relief device.

7.1.5 Stop valves under individual pressure relief valves shall be locked or sealed when opened and shall not be opened or closed except by an authorized person.

7.1.6 No more than one stop valve shall be closed at one time, thus maintaining the full relieving capacity required at all times.

7.1.7 Relief devices on containers shall be arranged so 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.

7.1.8 Each container relief device shall be marked with the pressure in psi 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 (16°C) and 14.7 psia (an absolute pressure of 0.101 MPa).

7.2 Relief Device Sizing.

7.2.1 Aboveground Containers. Conditions to be evaluated in determining the capacity of pressure relief devices shall include the following:

(1) Fire exposure
(2) Operational upset, such as failure of a control device
(3) Other circumstances resulting from equipment failures and operating errors
(4) Vapor displacement during filling
(5) Flash vaporization during filling, as a result of filling or as a consequence of mixing of products of different compositions
(6) Loss of refrigeration
(7) Heat input from pump recirculation
(8) Drop in barometric pressure

The pressure relief devices shall be sized to relieve the flow capacity determined for the largest single contingency or any reasonable and probable combination of contingencies.

7.2.2 Insulated Containers. The minimum pressure relieving capacity for insulated containers shall be not less than 3 percent of the full tank contents in 24 hours.

7.2.3 Underground and Mounded Containers. The minimum pressure relieving capacity for underground and

mounded containers shall be not less than 30 percent of the relieving capacity for aboveground uninsulated containers.

7.2.4 Vacuum Relief. The vacuum relief devices shall be sized to relieve the flow capacity determined for the largest single contingency or any reasonable and probable combination of contingencies including the following:

(1) Withdrawal of liquid or vapor at the maximum rate
(2) Rise in barometric pressure
(3) Reduction in vapor space pressure as a result of filling

It shall be permitted to reduce the requirement for vacuum relief capacity by the rate of vaporization that results from minimum normal heat gain to the contents. No vacuum relief capacity credit shall be permitted for gas repressuring or vapor make-up systems.

7.2.5 Fire Exposure. The pressure relieving capacity required for fire exposure shall be computed by the following formula:

$$W = 34,500 \frac{F}{L} A^{0.82} + \frac{H_n}{L}$$

where:

W = relieving capacity in lb/hr (g/sec) or product vapor at relieving conditions

H_n = normal heat leak in refrigerated tanks in Btu/hr (W)

A = exposed wetted surface area of the container in ft^2 (m^2)

In the case of large containers, the exposed wetted area is the area up to a height of 30 ft above grade.

L = Latent heat of vaporization of the stored liquid at the relieving pressure and temperature in Btu/lb (J/g)

F = Environmental factor as follows:

Basis	*F* Factor
Base container	1.0
Water application facilities	1.0
Depressuring and emptying facilities	1.0
Underground container	0
Earth-covered abovegrade container	0.03

Insulation or thermal protection:

$$F = U \frac{(1660 - T_f)}{34,500}$$

where:

U = the overall heat transfer coefficient [Btu/hr ft^2°F (Wm^2°C)] of the insulation system using the mean value for the temperature range from T_f to +1660°F

T_f = temperature of vessel content at relieving conditions in °F

The insulation shall resist dislodgment by fire-fighting equipment, shall be noncombustible, and shall not decompose at temperatures up to 1000°F. It shall be the responsibility of the user to determine if the insulation will resist dislodgment by the available fire-fighting equipment. If the insulation does not meet these criteria, no credit for the insulation shall be taken.

Once the relieving capacity, W, has been determined, the equivalent airflow can be calculated by:

$$\text{SCFM (Air)} = 3.09\, W \left(\frac{ZT}{M}\right)^{0.5}$$

where:

SCFM (Air) = equivalent air flow in standard ft^3 per min

W = relieving capacity of product vapor at relieving conditions in lb/hr (g/sec)

Z = compressibility factor product vapor at relieving conditions

T = absolute temperature of product vapor at relieving conditions in °R (°K)

M = product vapor molecular weight

7.3 Pressure Relief Valve Discharge Vents.

7.3.1 All discharge vents from the pressure relief valves or common discharge headers shall be installed in such a manner as to allow the following:

(a) They shall lead to the open air.
(b) They shall be protected against mechanical damage.
(c) They shall exclude or remove moisture and condensate, which shall be permitted to be done by the use of loose-fitting rain caps and drains. Drains shall be installed so as to prevent possible flame impingement on the containers, piping, equipment, and structures.

7.3.2 All discharge vents from the pressure relief valves or common discharge headers shall be installed in such a manner as to discharge in an area as follows:

(1) Prevents possible flame impingement on containers, piping, equipment, and structures
(2) Prevents possible vapor entry into enclosed spaces
(3) Is located above the heads of personnel who can be on the container or adjacent containers, stairs, platforms, or ground if located above the possible water level, if discharging from underground containers where there is a possibility of flooding

7.3.3 All discharge vents from the pressure relief valves or common discharge headers shall be installed in such a manner as to prevent malfunction due to freezing or icing.

7.4 Testing Relief Devices. Relief devices shall be tested for proper operation at intervals not exceeding 5 years.

7.5 Aboveground Containers.

7.5.1 The discharge from the relief devices shall be vented away from the container and shall be unobstructed to the open air. The vents shall be fitted with loose-fitting rain caps. A means shall be provided to protect the container, adjacent containers, and piping of equipment against impingement of flame resulting from ignition of released product. The vent piping shall extend upward at least 7 ft (2.2 m) above the top of the container.

7.5.2 Relief devices on containers shall be constructed to discharge at not less than the required rate before the pressure is in excess of 120 percent of the maximum permitted start-to-discharge pressure setting in accordance with Table 7.5.2. This pressure setting shall not include the 10 percent plus tolerance in the set point allowed by Table 7.5.2.

Table 7.5.2 Relief Valve Pressure Setting

Containers	Minimum (%)	Maximum (%)
All ASME codes prior to the 1949 edition, and the 1949 edition, paragraphs U-68 and U-69	110	125*
ASME *Boiler and Pressure Vessel Code*, 1949 edition, paragraphs U-200 and U-201, and all ASME codes later than 1949	88	100*
API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*		100*

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

7.6 Underground and Mounded Containers.

7.6.1 The discharge pipe from pressure 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, the pressure relief valve sizing shall be that of aboveground containers.

7.6.2 Where there is a probability of the manhole or housing becoming flooded, the discharge from regulator vent lines shall be above such water level.

7.7 Vaporizers.

7.7.1 The minimum rate of discharge in cubic feet of air per minute for pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct fired, shall be at least 150 percent of the rated vaporizing capacity.

7.7.2 Where portions of the vaporizer containing LP-Gas can be exposed to external fire, the vaporization rate from the exposed surface area under fire exposure conditions shall be added to the discharge rate determined in 7.5.1.

7.8 Hydrostatic Relief Valves. A hydrostatic relief valve shall be installed between each pair of shutoff valves on LP-Gas liquid piping so as to relieve the pressure that could develop from the trapped liquid to a safe atmosphere or other portion of the system that can safely accept it. Hydrostatic relief valves shall have pressure settings not less than 400 psi (2.76 MPa) or more than 500 psi (3.45 MPa) unless installed in systems designed to operate above 350 psi (2.41 MPa). Hydrostatic relief valves for use in systems designed to operate above 350 psi (2.41 MPa) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

Chapter 8 Handling

8.1 Transfer of Liquids within a Utility Plant.

8.1.1 Pumps and compressors used for transferring LP-Gas shall be suitable for the product handled.

8.1.2 The transfer of LP-Gases by pressure differential using fuel gas or inert gas at a pressure higher than the pressure of the LP-Gas in the container being filled shall be permitted in accordance with the following:

(1) Two backflow check valves and a manually operated shutoff valve shall be installed in the fuel gas or inert gas line or system in series to prevent LP-Gas from flowing back into the fuel gas or inert gas line or system.
(2) Any fuel gas or inert gas used to obtain a pressure differential to move liquid LP-Gas shall be noncorrosive and dried to avoid stoppage by freezing.
(3) Before any fuel gas or inert gas is placed in a tank car for unloading LP-Gas by pressure differential, permission shall be obtained and documented from the vendor of the LP-Gas to introduce such vapors into the tank car or a tank truck.

8.1.3 Transfer operations shall be conducted by employees familiar with the properties of the material and instructed in transfer and emergency procedures. At least one competent person shall remain in attendance during the entire period of transfer from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

8.1.4 Written procedures shall be available to cover all transfer operations, and they shall cover emergency as well as normal operating procedures. Written procedures shall be reviewed and updated at least annually and shall be available to all personnel engaged in transfer operations.

8.1.5 The maximum vapor pressure of nonrefrigerated product at 100°F (37.8°C) that can be transferred into a container shall be in accordance with 2.2.1 or 2.2.2 and 2.2.3.

8.1.6 Isolation valving and bleed connections shall be provided at the loading or unloading manifold for both liquid and vapor return lines so that hoses and arms can be blocked off, drained of liquid, and depressured before disconnecting. Bleeds or vents shall discharge to a safe area.

8.1.7 Caution shall be exercised to ensure that only those gases for which the system is designed, examined, and listed are employed in its operation, particularly with regard to pressures.

8.1.8 Transfer of refrigerated product shall be made only into systems that are designed to accept refrigerated product.

8.2 Tank Car Loading and Unloading Point Railroad Tank Car and Cargo Tank Vehicle Transfer Areas.

8.2.1 On new installations, and by December 31, 2005 on existing installations, the transfer areas shall comply with 8.2.1.1 through 8.2.1.8.

8.2.1.1 Where a hose or swivel-type piping $1^1/_2$ in. (38 mm) or larger is used for liquid transfer or a $1^1/_4$-in. (32-mm) or larger vapor hose or swivel-type piping is used in this service, an emergency shutoff valve complying with 4.1.4 shall be installed in the fixed piping of the transfer system within 20 ft (6 m) of lineal pipe from the nearest end of the hose or swivel-type piping to which the hose or swivel-type piping is connected. Where either a liquid or vapor line has two or more hose or swivel-type piping of the sizes designated, an emergency shutoff valve or a backflow check valve shall be installed in each leg of the piping.

8.2.1.2 Where a hose or swivel-type piping is used for loading or unloading railroad tank cars, it shall be protected as follows:

(1) An emergency shutoff valve shall be installed at the tank car end of the hose or swivel-type piping where flow into or out of the tank car is possible.

(2) An emergency shutoff valve or a check valve with a metal-to-metal seat or a primary resilient seat with a secondary metal seat not hinged with combustible material shall be installed on the tank car end of the hose or swivel piping where flow is only into the tank car.

8.2.1.3 Emergency shutoff valves shall be supplemented with a thermal sensor mounted along the entire length of the hose or swivel piping.

8.2.1.4 Temperature-sensitive elements of emergency shutoff valves shall not be painted nor shall they have any ornamental finishes applied after manufacture.

8.2.1.5* The emergency shutoff valve(s) or backflow check valve(s) specified in 8.2.1.1 shall be installed in the plant piping so that any break resulting from a pull will occur on the hose or swivel-type piping side of the connection while retaining intact the valves and piping on the plant side of the connection.

Exception: Such anchorage shall not be required for tank car side.

8.2.1.6 Emergency shutoff valves shall be maintained in working order.

8.2.1.7 Emergency shutoff valves and check valves required in this section shall be tested annually for proper operation. The results of the tests shall be documented.

8.2.1.8 All new installations, and by December 31, 2005 existing installations, shall have at least two clearly identified and easily accessible manually operated remote emergency shutoff devices. One shutoff device shall be located not less than 20 ft (6.1 m) nor more than 100 ft (30.5 m) in the path of egress from the emergency shutoff valve.

8.2.2 Tank Car Loading and Unloading Point.

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

8.2.2.2* A "tank car connected" sign, as covered by U.S. Department of Transportation rules, shall be installed at the active end or ends of the siding while the tank car is connected for unloading.

8.2.2.3 When cars are on a side track for unloading, the wheels at both ends shall be blocked on the rail. Operating personnel shall remain in attendance during the transfer operation.

8.2.3 Cargo Tank Vehicle Loading and Unloading.

8.2.3.1 The cargo tank vehicle transfer area shall be relatively level.

8.2.3.2 A cargo tank vehicle transfer area shall be of sufficient size to accommodate the vehicles without excessive movement or turning. Cargo tank vehicles that unload into or load from storage containers shall be at least 25 ft (7.6 m) from the container and positioned so that the shutoff valves on both the truck cargo tank vehicle and the transfer station are readily accessible.

8.2.3.3 When cargo tank vehicles are loading or unloading, the wheels shall be blocked and operating personnel shall remain in attendance.

8.3 Tank Truck Loading and Unloading.

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

8.3.2 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 that unload into storage containers shall be at least 25 ft (7.6 m) from the container and positioned so that the shutoff valves on both the truck and the container are readily accessible.

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

Chapter 9 Operations

9.1 Operating Procedures Manuals.

9.1.1 Each facility shall prepare and maintain written operating procedures manuals that cover facility start-up, operation, and shutdown.

9.1.2 Operating procedures manuals shall include operator actions to be taken if flammable concentrations of flammable liquids or gases are detected in the facility using fixed detectors, portable detectors, operating malfunctions, and human senses. Where human senses are relied on, a schedule of tours of the facility shall be included in the operating procedures.

9.1.3* Operating procedures shall include procedures for purging and inerting equipment.

9.1.4 Operating procedures for vaporizers shall include maintenance of vaporization rate, pressure control, and temperature. Procedures shall include specific actions to be taken when parameters exceed normal operating limits and criteria for emergency shutdown.

9.1.5 In facilities where propane is stored as a refrigerated liquid, operating procedures shall include monitoring of liquid temperature and pressure and procedures to be taken if these exceed operating limits. These procedures shall minimize the release of flammable gases to the atmosphere.

9.2 Personnel Safety.

9.2.1* Employees assigned and trained to perform emergency actions shall be assigned personal protective equipment for use when responding to emergencies that have progressed beyond the incipient stage. Employees assigned personal protective equipment shall be trained in its proper use.

9.2.2 Each utility gas plant shall have first-aid materials on hand in sufficient quantity to handle a reasonably anticipated emergency.

9.3 Transfer Procedures.

9.3.1 The procedures required in Section 9.1 shall include all aspects of LP-Gas transfer, including the following:

(1) Verification of connections to ensure proper delivery of LP-Gas
(2) Verification of gas tightness of connections
(3) Inspection of hoses and fittings
(4) Valve sequencing
(5) Disconnection procedures
(6) Purging procedures, if used

9.3.2 All LP-Gas transfers shall be attended by plant personnel in accordance with 8.1.3.

9.3.3 Provisions shall be implemented to prevent moving of tank vehicles during transfer.

9.4 Operating Records.

9.4.1 Each facility shall maintain a record of all operating log sheets and recorded data. These records shall be made available to the authority having jurisdiction upon reasonable request.

9.4.2 Operating log sheets required under 9.4.1 shall be retained for at least 5 years.

Chapter 10 Maintenance

10.1 Maintenance Manuals.

10.1.1 Maintenance manuals for all equipment at the facility shall be kept at the facility and shall be available to maintenance personnel.

Exception: Manuals for normally unattended facilities shall be permitted to be stored at a location where they will be accessible for maintenance personnel servicing the unattended location.

10.1.2 Maintenance manuals shall include the following:

(1) Drawings, procedures, and parts lists provided by the manufacturer or installer
(2) Routine and preventative maintenance procedures and schedules
(3) Routine inspections to be performed
(4) Corrosion inspection and control procedures, where applicable

10.2 Maintenance of Fire Protection Equipment. Maintenance activities on fire control equipment shall be scheduled so that a minimum of equipment is taken out of service at any time and is returned to service in a reasonable period of time.

10.3 Auxiliary Power Sources. Each auxiliary power source shall be tested at least monthly to verify its operational capability.

10.4 Purging Prior to Maintenance. All equipment that contains flammable or hazardous materials shall be purged in accordance with 9.1.3 prior to beginning maintenance procedures.

10.5 Maintenance Records.

10.5.1 Each facility shall maintain a record of all maintenance log sheets of process equipment. These records shall be made available to the authority having jurisdiction upon reasonable request.

Exception: Maintenance records for normally unattended facilities shall be permitted to be stored at another location.

10.5.2 Records that are required under 10.5.1 shall be retained for the life of the equipment, while in use, and for 3 years thereafter.

Chapter 11 Fire Protection, Safety, and Security

11.1 General.

11.1.1* Fire protection shall be provided for all utility gas plants. The extent of such protection shall be determined by an evaluation based on the type (refrigerated or nonrefrigerated), quantity, and size of storage containers; an analysis of local conditions; hazards within the facility; and exposure to and from other property. The evaluation shall consider the following, as a minimum:

(1) The time of response and effectiveness of local emergency response agencies
(2) The type, quantity, and location of equipment necessary for the detection and control of potential nonprocess and electrical fires
(3) The methods necessary for protection of the equipment and structures from the effects of fire exposure
(4) Fire protection water systems
(5) Fire extinguishing and other fire control equipment
(6) Automatic shutdown equipment, including the types and location of sensors to initiate manual or automatic operation
(7) The availability and duties of individual plant personnel and the availability of external response personnel during an emergency
(8)* The protective equipment and special training needed by the individual plant personnel for their respective emergency duties
(9) The need for a permanently mounted combustible gas detection system or a permanently mounted fire detection system

11.1.2 The wide range in size, design, and location of facilities covered by this standard precludes the inclusion of detailed fire protection provisions completely applicable to all facilities.

11.1.3 A detailed emergency procedures manual shall be prepared to cover the potential emergency conditions that can develop whether or not a fire has occurred. Such procedures shall include, but not necessarily be limited to, the following:

(1) Shutdown or isolation of various portions of the equipment and other applicable steps to ensure that the escape of gas or liquid is promptly cut off or reduced as much as possible
(2) Use of fire protection facilities
(3) Notification of public authorities
(4) First aid
(5) Duties of personnel

The emergency procedures manual shall be kept readily available in the operating control room or at a constantly attended location if the plant site is not continually manned. It shall be reviewed and updated annually and as required by changes in equipment or procedures.

11.1.4 All personnel shall be trained in their respective duties contained in the emergency procedures manual. Those personnel responsible for the use of fire protection or other plant emergency equipment shall be trained annually in the use of that equipment.

11.1.5 The planning of effective fire control measures shall be coordinated with the authority having jurisdiction and local emergency handling agencies, such as fire and police departments, who are expected to respond to such emergencies.

11.1.6 Gas fires normally shall not be extinguished until the source of the burning gas has been shut off.

11.2 Ignition Source Control. Control of ignition sources shall comply with Section 1.11.

11.3 Fire and Leak Detection.

11.3.1 Those areas, including enclosed buildings, that have a potential for flammable gas concentrations and fire shall be monitored as determined by the evaluation required in 11.1.1.

11.3.2 Continuously monitored flammable gas detection systems shall alarm at the plant site and at a constantly attended location if the plant site is not continuously manned. Flammable gas detection systems shall alarm at not more than 25 percent of the lower flammable limit of the gas or vapor being monitored.

11.3.3 Fire detectors shall alarm at the plant site and at a constantly attended location if the plant site is not continually manned.

11.3.4 Detection systems, where used, shall be designed, installed, and maintained in accordance with NFPA 72, *National Fire Alarm Code®*, and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems.*

11.4 Container Protection. Nonrefrigerated storage containers shall be considered adequately protected against fire exposure if they are buried or mounded in accordance with 2.5.2 or if they are insulated.

11.5 Fire Protection Water Systems.

11.5.1 A water supply and a system for distributing and applying water shall be provided for protection of exposures; cooling containers, equipment, and piping; and controlling unignited leaks and spills unless an evaluation in accordance with 11.1.1 indicates that the use of water is unnecessary or impractical.

11.5.2 The design of fire water supply and distribution systems, if provided, shall provide for the simultaneous supply of those fixed fire protection systems, including monitor nozzles, at their design flow and pressure, involved in the maximum single incident expected in the plant. An additional supply of 1000 gal/min (63 L/sec) shall be available for hand hose streams for a period of not less than 2 hours. Manually actuated monitors shall be permitted to be used to augment hand hose streams.

11.5.3 Nonrefrigerated storage containers that are not adequately protected per Section 11.4 shall be analyzed based on the availability of water supply, the probable effectiveness of the plant fire brigades, and the time of response and probable effectiveness of the fire department. The first consideration in such an analysis shall consist of the use of water applied by the fire brigade or fire department for effective control of hazardous leakage or fire exposing storage tanks, cargo vehicles, or railroad tank cars that can be present. If the analysis indicates that additional water protection is needed, the protection shall comply with 11.5.4.

11.5.4 Special Protection.

11.5.4.1* If insulation is used, it shall be capable of limiting the container temperature to not over 800°F (427°C) for a minimum of 50 minutes as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate. The insulation system shall be inherently resistant to weathering and the action of hose streams.

11.5.4.2 If mounding is used, the provisions of 3.2.9.3 of NFPA 58, *Liquefied Petroleum Gas Code*, shall constitute adequate protection.

11.5.4.3 If burial is used, the provisions of 2.4.2 shall constitute adequate protection.

11.5.4.4 If water spray fixed systems are used, they shall comply with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection.* Such systems shall be automatically actuated by fire-responsive devices and also shall have a capability for manual actuation.

11.5.4.5 If monitor nozzles are used, they shall be located and arranged so that container surfaces likely to be exposed to fire will be wetted. Such systems shall otherwise comply with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and shall be automatically actuated by fire-responsive devices and also shall have a capability for manual actuation.

11.5.5 Fire protection water systems, where used, shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable, considering the fire control problems in facilities covered by this standard:

(1) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(2) NFPA 14, *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems*
(3) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
(4) NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
(5) NFPA 22, *Standard for Water Tanks for Private Fire Protection*
(6) NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
(7) NFPA 1961, *Standard on Fire Hose*
(8) NFPA 1962, *Standard for the Care, Use, and Service Testing of Fire Hose Including Couplings and Nozzles*
(9) NFPA 1963, *Standard for Fire Hose Connections*

11.6 Fire Extinguishing and Other Fire Control Equipment.

11.6.1 Portable or wheeled fire extinguishers that are suitable for gas fires, preferably of the dry chemical type, shall be available at strategic locations, as determined in accordance with 11.1.1, within the facility. The minimum size portable dry chemical extinguisher shall be 18 lb (8.2 kg) with a B:C rating. These extinguishers shall be provided and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers.*

11.6.2 Fixed fire extinguishing and other fire control systems can be appropriate for the protection of specific hazards as determined in accordance with 11.1.1. If provided, such systems shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable:

(1) NFPA 11, *Standard for Low-Expansion Foam*
(2) NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*
(3) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(4) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
(5) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
(6) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*

11.7 Maintenance of Fire Protection Equipment. Facility operators shall prepare and implement a maintenance program for all plant fire protection equipment.

11.8 Personnel Safety.

11.8.1 Personnel shall be advised of the danger of frostbite, which can result upon contact with LP-Gas liquid or cold refrigerants. Suitable protective clothing and equipment shall be available.

11.8.2 Those employees who will be involved in emergency activities, as determined in accordance with 11.1.1, shall be equipped with the necessary clothing and equipment. Protective clothing shall comply with NFPA 1971, *Standard on Protective*

Ensemble for Structural Fire Fighting, and shall have an impermeable outer shell. Those employees requiring such protective clothing also shall be equipped with helmets, face shields, gloves, and boots that are suitable for the intended exposure.

11.8.3 Self-contained breathing apparatus shall be provided for those employees who are required to enter an atmosphere that could be injurious to health during an emergency. Such apparatus shall comply with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service,* and shall be maintained in accordance with the manufacturer's instructions.

11.8.4 A portable flammable gas detector shall be readily available.

11.9 Security.

11.9.1 The facility operator shall provide a security system with controlled access, which shall be designed to minimize entry by unauthorized persons.

11.9.2 A protective enclosure including a peripheral fence, building wall, or natural barrier shall be provided enclosing major facility components, such as the following:

(1) LP-Gas storage containers
(2) Flammable refrigerant storage tanks
(3) Flammable liquid storage tanks
(4) Other hazardous materials storage areas
(5) Outdoor process equipment areas
(6) Buildings that house process or control equipment
(7) Onshore loading and unloading facilities

The location and arrangement of protective structures shall minimize pocketing of escaping gas, interference with the application of cooling water by fire departments, redirection of flames against containers, and impeding egress of personnel in an emergency.

Exception: As an alternative to fencing the operating area, suitable devices that 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.

11.9.3 The provisions of 11.9.2 shall be permitted to be met by either one continuous enclosure or several independent enclosures. At least two exit gates or doors shall be provided for rapid escape of personnel in the event of an emergency.

11.9.4 Provisions shall be made for the ready access to the facility by emergency personnel or services.

11.9.5 Illumination shall be provided as necessary in the vicinity of protective enclosures and in other areas to promote security of the facility.

Chapter 12 Referenced Publications

12.1 The following documents or portions thereof are referenced within this code as mandatory requirements and shall be considered part of the requirements of this code. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this code. Some of these mandatory documents might also be referenced in this code for specific informational purposes and, therefore, are also listed in Appendix E.

12.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers,* 1998 edition.
NFPA 11, *Standard for Low-Expansion Foam,* 1998 edition.
NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems,* 1999 edition.
NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2000 edition.
NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 1997 edition.
NFPA 13, *Standard for the Installation of Sprinkler Systems,* 1999 edition.
NFPA 14, *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems,* 2000 edition.
NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 1996 edition.
NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 1999 edition.
NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 1998 edition.
NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 1999 edition.
NFPA 22, *Standard for Water Tanks for Private Fire Protection,* 1998 edition.
NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 1995 edition.
NFPA 30, *Flammable and Combustible Liquids Code,* 2000 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 1999 edition.
NFPA 54, *National Fuel Gas Code,* 1999 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2001 edition.
NFPA 70, *National Electrical Code®,* 1999 edition.
NFPA 72, *National Fire Alarm Code®,* 1999 edition.
NFPA *101®, Life Safety Code®,* 2000 edition.
NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 1997 edition.
NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems,* 1999 edition.
NFPA 1961, *Standard on Fire Hose,* 1997 edition.
NFPA 1962, *Standard for the Care, Use, and Service Testing of Fire Hose Including Couplings and Nozzles,* 1998 edition.
NFPA 1963, *Standard for Fire Hose Connections,* 1998 edition.
NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting,* 2000 edition.
NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service,* 1997 edition.

12.1.2 Other Publications.

12.1.2.1 API Publication. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 2000 edition.

12.1.2.2 ASCE Publication. American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017.

ASCE 7, *Minimum Design Loads for Buildings and Other Structures,* 1995 edition.

12.1.2.3 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code,* 1949, 1980, 1986, and 1999 editions.

ASME B31.3, *Chemical Plant and Petroleum Refinery Piping,* 1998 edition.

12.1.2.4 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings,* 1999 edition.

ASTM A 395, *Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* 1999 edition.

ASTM A 536, *Specifications for Ductile Iron Castings,* 1999 edition.

12.1.2.5 ICBO Publication. International Conference of Building Officials, 5360 Workman Mill Road, Whitter, CA 90601-2298.

Uniform Building Code, 1997 edition.

12.1.2.6 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 49, *Code of Federal Regulations,* Part 192.

Appendix A Explanatory Material

Appendix A is not a part of the requirements of this NFPA document but is included for informational purposes only. This appendix contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 Those portions of LP-Gas systems downstream of the point where LP-Gas or a mixture of LP-Gas and air is introduced into the utility distribution system are covered in the United States by the Department of Transportation, 49 *CFR* 192. (*See Figure A.1.1.1.*)

A.1.5.1 Approved. The National Fire Protection Association 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, 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 that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.1.5.9 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations 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.

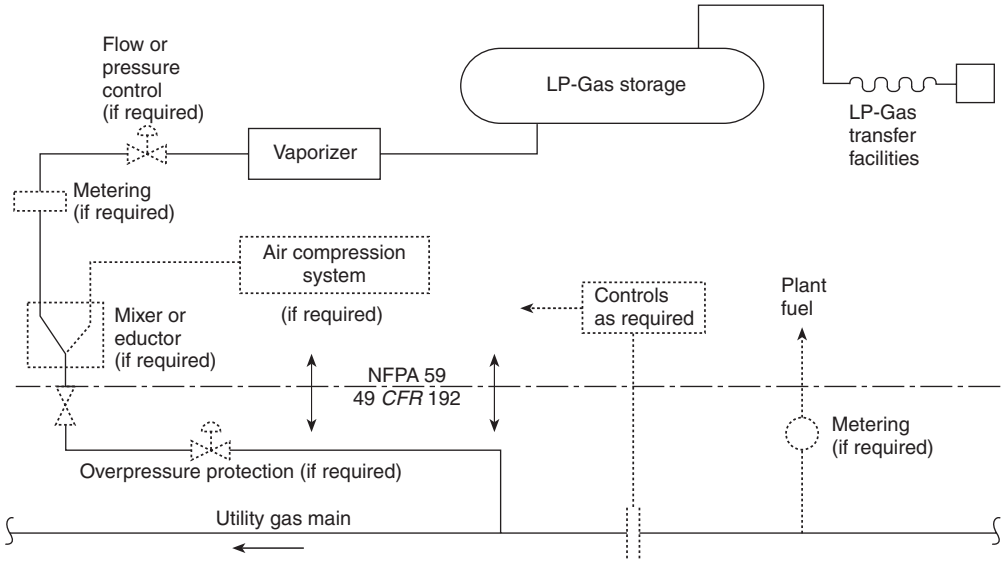
A.1.6 It is recognized that no odorant will be completely effective as a warning agent in all circumstances.

It is recommended that odorants be qualified as to compliance with Section 1.6 by tests or experience. Where qualifying is by tests, such tests should be certified by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb/10,000 gal (0.0119 kg/m^3) of liquid LP-Gas has been recognized as an effective odorant. Other odorants and quantities that meet the provisions of Section 1.6 can be used. Research on odorants has shown that thiophane (tetrahydrothiopene) in a ratio of at least 6.4 lb/10,000 gal (0.0767 kg/m^3) of liquid LP-Gas can satisfy the requirements of Section 1.6. The lower limits of flammability of the more commonly used liquefied petroleum gases are approximately 2 percent for propane and approximately $1^1/_2$ percent for butane. These figures represent volumetric percentages of gas in a gas–air mixture in each case. (Odorant research includes B BERC/RI-77-1, *A New Look at Odorization Levels for Propane Gas.*)

A.1.9.1.2 For information on lightning protection, see NFPA 780, *Standard for the Installation of Lightning Protection Systems.* [**58**:A.3.7.1.2]

A.1.9.1.3 Because 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. For information on grounding and bonding for protection against static electricity, see NFPA 77, *Recommended Practice on Static Electricity.* [**58**:A.3.7.1.3]

FIGURE A.1.1.1 Typical installation of an LP-Gas air base or peaking facility, LP-Gas vapor base load, or enrichment facility.



A.1.9.2.2 When classifying the extent of hazardous area, consideration should be given to possible variations in the spotting of railroad tank cars and cargo tank vehicles at the unloading points and the effect these variations of actual spotting point may have on the point of connection.

Where specified for the prevention of fire or explosion during normal operation, ventilation is considered adequate where provided in accordance with the provisions of this code.

[**58**:A.3.7.2.2]

A.1.12.2 Static grounding or bonding protection is not required when tank cars, tank vehicles, or marine equipment are loaded or unloaded by conductive or nonconductive hose, flexible metallic tubing, or pipe connections through or from tight outlets (top or bottom) where both halves of metallic couplings are in contact.

For additional information on grounding and bonding to reduce the hazards due to static electricity, see NFPA 77, *Recommended Practice on Static Electricity.*

A.1.12.3 For additional information, see API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents.*

A.2.2.1 See Appendix D of NFPA 58, *Liquefied Petroleum Gas Code,* for information on earlier ASME or API/ASME codes.

New containers for 100-psi (689-kPa) design pressure (or equivalent under earlier codes) were not authorized after December 31, 1947.

A.2.3.2(8) Head design refers to the shape of the head. Shapes include hemispherical, semi-ellipsoidal, and others. Refer to the ASME *Boiler and Pressure Vessel Code* for more information.

A.2.5.1.10 For LP-Gas fixed storage facilities of 60,000-gal (227-m^3) water capacity or less, a competent fire safety analysis *(see 11.1.1)* could indicate that applied insulating coatings are quite often the most practical solution for special protection.

A.2.5.2.4 For information on corrosion protection, see NACE RP-01-69, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems.*

A.3.1.4.2 See ASCE 56, *Sub-Surface Investigation for Design and Construction of Foundation for Buildings,* and API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* Appendix C, for further information. [**58**:A.9.1.4.2]

A.4.1.7 It should be recognized that the temperature of liquid propane will drop to about 40°F (40°C) when released to the atmosphere.

A.4.1.8 For information on corrosion protection, see NACE RP-01-69, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems.*

A.4.4.6 Refer to Appendix B for information on calculating the filling point for which the tube should be designed.

A.5.3.2.5 See NFPA 80, *Standard for Fire Doors and Fire Windows.* [**58**:A.7.3.2.5]

A.6.3.4(e) See NFPA 58, *Liquefied Petroleum Gas Code*, Appendix D, for information on earlier ASME or API-ASME codes.

New containers for 100 psi (0.7 MPa) design pressure (or equivalent under earlier codes) were not authorized after December 31, 1947.

A.6.3.7 For information on interchangeability of LP-Gas–air mixtures with natural gas, see the AGA publications *Interchangeability — What it Means*, and *Interchangeability of Other Fuel Gases with Natural Gas.*

A.7.1.1 Experience has indicated that a vertical and unimpeded vent of high-velocity hydrocarbon gases will entrain sufficient air within a very short distance so that the resultant plume will be diluted below the lower flammable limit. This behavior is documented in API 521, *Guide for Pressure-Relieving and Depressuring Systems.* This document was based, in part, on a study that was commissioned by API, "The Effect of Velocity, Temperature, and Gas Molecular Weight on Flammability Limits in Wind-Blown Jets of Hydrocarbon Gases," by Battelle Memorial Institute, April 1, 1970.

These reports clearly indicate that a vertical and unimpeded jet will be diluted below its lower flammable limit within 50 pipe diameters of the issuing jet and that the effects of "wind-tilt" can be safely neglected if a 50-ft (15-m) horizontal clearance is provided between the jet and a source of ignition. A high-velocity jet is defined as a jet having an exit velocity in excess of 100 ft/sec (30.5 m/sec), which is slightly more than an order of magnitude less than the acoustic velocity that can be anticipated at the throat of an operating relief valve. API 521 also indicates that a partially open relief valve will produce a velocity sufficient to achieve the necessary dilution.

Once such a mixture has been diluted below its flammable limit, there are no known natural forces (including gravitational forces) that will cause the reconcentration of the LP-Gases so as to create a flammable cloud. The application of water, either as a fog or heavy stream, will not hasten and can actually inhibit the dilution of the jet stream. It is recommended that this information be included in any emergency procedure manual and that the responding emergency services be made aware of this information.

A.7.1.4 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 allows either of the relief valves to be closed but does 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 that allows full required flow from one relief valve at all times.

A.8.2.1.5 Anchorage can be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting.

A.8.2.2.2 The U.S. Department of Transportation (DOT) was formerly the ICC (Interstate Commerce Commission), and its rules are published in 49 *CFR* 171–190. In Canada, the regulations of the Canadian Transport Commission for Canada apply.

A.9.1.3 For information on purging and inerting equipment, see NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair,* and AGA *Purging Principles and Practice.*

A.9.2.1 For more information on personnel safety, see AGA *Introduction to LPG Safety for Propane Air Plant Operators.*

A.11.1.1 The first consideration in such an analysis should consist of the use of water applied by hose streams by the fire brigade or fire department for the effective control of hazardous leakage or fire exposing storage tanks, cargo vehicles, or railroad tank cars that can be present.

Experience has indicated that hose stream application of water in adequate quantities as soon as possible after the initiation of flame contact is an effective way to prevent container failure from fire exposure. The majority of large containers exposed to sufficient fire to result in container failure have failed in from 10 to 30 minutes after the start of the fire when water was not applied. Water in the form of a spray also can be used to control unignited gas leakage.

A.11.1.1(8) 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 can consist of mounding or burying containers or providing fixed water spray or monitor nozzle protection.

A.11.5.4.1 It is recommended that insulation systems be evaluated on the basis of experience or listings by an approved testing laboratory.

Appendix B Method of Calculating Maximum Liquid Volume That Can Be Placed in a Container at Any Liquid Temperature

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 The quantity of gas that can be placed in a container depends on the temperature of the liquid in the container and the maximum permitted filling density, in addition to the size of the container.

B.2 The filling density depends on the size of the container, whether it is installed above ground or underground, and the specific gravity at 60°F (15.6°C) of the LP-Gas placed in the container. Filling density values for these conditions are given in Table 2.8.1. Since the temperature of the liquid in the container is seldom exactly 60°F (15.6°C), it is necessary to measure the actual liquid temperature and then obtain a correction factor from Table B.2 and insert this in the following formula given in Section B.3. The average liquid temperature can be obtained by one of two ways. One procedure is to measure the liquid temperature in the container after the container is almost filled to its permissible liquid content. This liquid temperature is secured by inserting a thermometer into a thermometer well installed in the container so as to be in the liquid. The other procedure can be used only if the container is essentially empty prior to filling. In this case, the liquid temperature is measured by a thermometer placed in a thermometer well or other device installed in the filling line at a place near the container. The temperature should be read at intervals and averaged.

B.3 Knowing the filling density, the liquid specific gravity at 60°F (15.6°C) of the product to be placed in the container, the correction factor for the temperature of the liquid in the container, and the container capacity, the maximum quantity that can be placed in a container is determined as follows:

$$V = \frac{D}{G \times F}$$

where:

V = maximum liquid volume (in percent of total container capacity) that should be placed in a container when the liquid temperature is T

D = filling density from 2.8.1 (in percent)

G = specific gravity of LP-Gas at 60°F (15.6°C) to be placed in container

F = correction factor from Table B.2 for correcting liquid volume from 60°F (15.6°C) to volume at temperature, T. The correction factor is determined by finding the specific gravity at 60°F (15.6°C), G, in the column at the top of the table and coming down this column until the actual liquid temperature, T, is found. The correction factor corresponding to this specific gravity and the temperature is then read. Interpolation is permitted.

T = temperature of liquid LP-Gas in container (in degrees Fahrenheit)

After obtaining V from the above formula, the actual maximum gallons, Q_T, of LP-Gas that can be placed in a container is obtained by multiplying the water capacity of the container by the following:

$$\frac{V}{100}$$

where:

Q_T = actual gallons at liquid temperature, T.

Example: Assume an aboveground container with 10,000-gal (37.8-m^3) water capacity. Propane with a specific gravity of 0.508 at 60°F (15.6°C) is to be placed in container. The filling density from 2.8.1 for an aboveground container that has a capacity greater than 1200 gal (4.5 m^3) in which a product that has a specific gravity of 0.508 at 60°F (15.6°C) is to be placed is 45 percent. To determine the maximum quantity that can be placed in the container when the liquid temperature is 60°F (15.6°C), use the following formula:

$$Q_{60}F = \frac{45 \times 10,000}{0.058 \times 100} = 8860 \text{ gal } (33.5\text{m}^3)$$

When the liquid temperature is 82°F (27.8°C), find the correction factor in Table B.2 for specific gravity of 0.508 at 60°F (15.6°C) and a liquid temperature of 82°F (27.8°C), which is 0.963, as follows:

$$Q_{82}F = \frac{45 \times 10,000}{0.058 \times 0.963 \times 100} = 9200 \text{ gal } (34.8\text{m}^3)$$

Table B.2 Liquid Volume Correction Factors

Specific Gravities at 60°F/60°F													
Observed Temperature	0.500	Propane 0.5079	0.510	0.520	0.530	0.540	0.550	0.560	iso-Butane 0.5631	0.570	0.580	n-Butane 0.5844	0.590
(°F)	Volume Correction Factors												
–50	1.160	1.155	1.153	1.146	1.140	1.133	1.127	1.122	1.120	1.116	1.111	1.108	1.106
–45	1.153	1.148	1.146	1.140	1.134	1.128	1.122	1.117	1.115	1.111	1.106	1.103	1.101
–40	1.147	1.142	1.140	1.134	1.128	1.122	1.117	1.111	1.110	1.106	1.101	1.099	1.097
–35	1.140	1.135	1.134	1.128	1.122	1.116	1.112	1.106	1.105	1.101	1.096	1.094	1.092
–30	1.134	1.129	1.128	1.122	1.116	1.111	1.106	1.101	1.100	1.096	1.092	1.090	1.088
–25	1.127	1.122	1.121	1.115	1.110	1.105	1.100	1.095	1.094	1.091	1.087	1.085	1.083
–20	1.120	1.115	1.114	1.109	1.104	1.099	1.095	1.090	1.089	1.086	1.082	1.080	1.079
–15	1.112	1.109	1.107	1.102	1.097	1.093	1.089	1.084	1.083	1.080	1.077	1.075	1.074
–10	1.105	1.102	1.100	1.095	1.091	1.087	1.083	1.079	1.078	1.075	1.072	1.071	1.069
–5	1.098	1.094	1.094	1.089	1.085	1.081	1.077	1.074	1.073	1.070	1.067	1.066	1.065
0	1.092	1.088	1.088	1.084	1.080	1.076	1.073	1.069	1.068	1.066	1.063	1.062	1.061
2	1.089	1.086	1.085	1.081	1.077	1.074	1.070	1.067	1.066	1.064	1.061	1.060	1.059
4	1.086	1.083	1.082	1.079	1.075	1.071	1.068	1.065	1.064	1.062	1.059	1.058	1.057
6	1.084	1.080	1.080	1.076	1.072	1.069	1.065	1.062	1.061	1.059	1.057	1.055	1.054
8	1.081	1.078	1.077	1.074	1.070	1.066	1.063	1.060	1.059	1.057	1.055	1.053	1.052
10	1.078	1.075	1.074	1.071	1.067	1.064	1.061	1.058	1.057	1.055	1.053	1.051	1.050
12	1.075	1.072	1.071	1.068	1.064	1.061	1.059	1.056	1.055	1.053	1.051	1.049	1.048
14	1.072	1.070	1.069	1.066	1.062	1.059	1.056	1.053	1.053	1.051	1.049	1.047	1.046
16	1.070	1.067	1.066	1.063	1.060	1.056	1.054	1.051	1.050	1.048	1.046	1.045	1.044
18	1.067	1.065	1.064	1.061	1.057	1.054	1.051	1.049	1.048	1.046	1.044	1.043	1.042
20	1.064	1.062	1.061	1.058	1.054	1.051	1.049	1.046	1.046	1.044	1.042	1.041	1.040
22	1.061	1.059	1.058	1.055	1.052	1.049	1.046	1.044	1.044	1.042	1.040	1.039	1.038
24	1.058	1.056	1.055	1.052	1.049	1.046	1.044	1.042	1.042	1.040	1.038	1.037	1.036
26	1.055	1.053	1.052	1.049	1.047	1.044	1.042	1.039	1.039	1.037	1.036	1.036	1.034
28	1.052	1.050	1.049	1.047	1.044	1.041	1.039	1.037	1.037	1.035	1.034	1.034	1.032
30	1.049	1.047	1.046	1.044	1.041	1.039	1.037	1.035	1.035	1.033	1.032	1.032	1.030
32	1.046	1.044	1.043	1.041	1.038	1.036	1.035	1.033	1.033	1.031	1.030	1.030	1.028
34	1.043	1.041	1.040	1.038	1.036	1.034	1.032	1.031	1.030	1.029	1.028	1.028	1.026
36	1.039	1.038	1.037	1.035	1.033	1.031	1.030	1.028	1.028	1.027	1.025	1.025	1.024
38	1.036	1.035	1.034	1.032	1.031	1.029	1.027	1.026	1.025	1.025	1.023	1.023	1.022
40	1.033	1.032	1.031	1.029	1.028	1.026	1.025	1.024	1.023	1.023	1.021	1.021	1.020
42	1.030	1.029	1.028	1.027	1.025	1.024	1.023	1.022	1.021	1.021	1.019	1.019	1.018
44	1.027	1.026	1.025	1.023	1.022	1.021	1.020	1.019	1.019	1.018	1.017	1.017	1.016
46	1.023	1.022	1.022	1.021	1.020	1.018	1.018	1.017	1.016	1.016	1.015	1.015	1.014
48	1.020	1.019	1.019	1.018	1.017	1.016	1.015	1.014	1.014	1.013	1.013	1.013	1.012
50	1.017	1.016	1.016	1.015	1.014	1.013	1.013	1.012	1.012	1.011	1.011	1.011	1.010
52	1.014	1.013	1.012	1.012	1.011	1.010	1.010	1.009	1.009	1.009	1.009	1.009	1.008
54	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.007	1.007	1.006	1.006	1.006
56	1.007	1.007	1.006	1.006	1.005	1.005	1.005	1.005	1.005	1.005	1.004	1.004	1.004
58	1.003	1.003	1.003	1.003	1.003	1.003	1.002	1.002	1.002	1.002	1.002	1.002	1.002
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
62	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.998	0.998	0.998	0.998
64	0.993	0.993	0.994	0.994	0.994	0.994	0.995	0.995	0.995	0.995	0.996	0.996	0.996
66	0.990	0.990	0.990	0.990	0.991	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.993
68	0.986	0.986	0.987	0.987	0.988	0.989	0.990	0.990	0.990	0.990	0.991	0.991	0.991
70	0.983	0.983	0.984	0.984	0.985	0.986	0.987	0.988	0.988	0.988	0.989	0.989	0.989
72	0.979	0.980	0.981	0.981	0.982	0.983	0.984	0.985	0.986	0.986	0.987	0.987	0.987

Table B.2 Liquid Volume Correction Factors ***(Continued)***

Specific Gravities at 60°F/60°F													
Observed Temperature	**0.500**	**Propane 0.5079**	**0.510**	**0.520**	**0.530**	**0.540**	**0.550**	**0.560**	**iso-Butane 0.5631**	**0.570**	**0.580**	**n-Butane 0.5844**	**0.590**
(°F)	**Volume Correction Factors**												
74	0.976	0.976	0.977	0.978	0.980	0.980	0.982	0.983	0.983	0.984	0.985	0.985	0.985
76	0.972	0.973	0.974	0.975	0.977	0.978	0.979	0.980	0.981	0.981	0.982	0.982	0.983
78	0.969	0.970	0.970	0.972	0.974	0.975	0.977	0.978	0.978	0.979	0.980	0.980	0.981
80	0.965	0.967	0.967	0.969	0.971	0.972	0.974	0.975	0.976	0.977	0.978	0.978	0.979
82	0.961	0.963	0.963	0.966	0.968	0.969	0.971	0.972	0.973	0.974	0.976	0.976	0.977
84	0.957	0.959	0.960	0.962	0.965	0.966	0.968	0.970	0.971	0.972	0.974	0.974	0.975
86	0.954	0.956	0.956	0.959	0.961	0.964	0.966	0.967	0.968	0.969	0.971	0.971	0.972
88	0.950	0.952	0.953	0.955	0.958	0.961	0.963	0.965	0.966	0.967	0.969	0.969	0.970
90	0.946	0.949	0.949	0.952	0.955	0.958	0.960	0.962	0.963	0.964	0.967	0.967	0.968
92	0.942	0.945	0.946	0.949	0.952	0.955	0.957	0.959	0.960	0.962	0.964	0.965	0.966
94	0.938	0.941	0.942	0.946	0.949	0.952	0.954	0.957	0.958	0.959	0.962	0.962	0.964
96	0.935	0.938	0.939	0.942	0.946	0.949	0.952	0.954	0.955	0.957	0.959	0.960	0.961
98	0.931	0.934	0.935	0.939	0.943	0.946	0.949	0.952	0.953	0.954	0.957	0.957	0.959
100	0.927	0.930	0.932	0.936	0.940	0.943	0.946	0.949	0.950	0.952	0.954	0.955	0.957
105	0.917	0.920	0.923	0.927	0.931	0.935	0.939	0.943	0.943	0.946	0.949	0.949	0.951
110	0.907	0.911	0.913	0.918	0.923	0.927	0.932	0.936	0.937	0.939	0.943	0.944	0.946
115	0.897	0.902	0.904	0.909	0.915	0.920	0.925	0.930	0.930	0.933	0.937	0.938	0.940
120	0.887	0.892	0.894	0.900	0.907	0.912	0.918	0.923	0.924	0.927	0.931	0.932	0.934
125	0.876	0.881	0.884	0.890	0.898	0.903	0.909	0.916	0.916	0.920	0.925	0.927	0.928
130	0.865	0.871	0.873	0.880	0.888	0.895	0.901	0.908	0.909	0.913	0.918	0.921	0.923
135	0.854	0.861	0.863	0.871	0.879	0.887	0.894	0.901	0.902	0.907	0.912	0.914	0.916
140	0.842	0.850	0.852	0.861	0.870	0.879	0.886	0.893	0.895	0.900	0.905	0.907	0.910

Appendix C Method of Calculating Maximum Volume of Liquefied Petroleum Gas That Can be Placed in a Container for Which Length of Fixed Dip Tube Is Set

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 It is impossible to set out in a table the length of a fixed dip tube for various capacity containers because of the varying container diameters and lengths and because the container can be installed in either a vertical or horizontal position. Knowing the maximum permitted filling volume in gallons, however, the length of the fixed tube can be determined by the use of a strapping table obtained from the container manufacturer. The length of the fixed tube should be such that, when its lower end touches the surface of the liquid in the container, the contents of the container will be the maximum permitted volume.

C.2 The following formula is used for determining the maximum volume of LP-Gas for which a fixed length of dip tube should be set.

$$\frac{\text{Water capacity of container (gal)} * \times \text{Filling density} **}{\text{Specific gravity of LP-Gas}* \times \text{Volume Correction Factor}^{\dagger} \times 100} = \text{Maximum volume of LP-Gas (gal)}$$

* Measured at 60°F (15.6°C)

** From Table 2.8.1

†For aboveground containers, the liquid temperature is assumed to be 40°F (4.4°C); for underground containers, the liquid temperature is assumed to be 50°F (10°C). To correct the liquid volumes at these temperatures to 60°F (15.6°C), the factors in 4.4.6 should be used.

Example: Assume a 30,000-gal (113.6-m^3) total water capacity container for aboveground storage of propane having a specific gravity of 0.510 at 60°F (15.6°C), which is the maximum amount permitted to be placed in a 30,000-gal (113.6-m^3) total water capacity aboveground container equipped with a fixed dip tube.

$$\frac{30,000 \times 45}{0.510 \times 1.031 \times 100} = \frac{1,350,000}{52.58}$$

$$\frac{1,350,000}{52.58} = 5675\text{gal } (21.5\text{m}^3) \text{ propane}$$

C.3 The maximum volume of LP-Gas that can be placed in a container when determining the length of the dip tube expressed as a percentage of total water content of the container is calculated by the following formula:

$$\frac{\text{(Result of formula in Section C.2)} \times 100}{\text{Total water content of container (gal)}} = \text{Maximum volume of LP-Gas (gal)}$$

C.4 The maximum weight of LP-Gas that can be placed in a container for determining the length of a fixed dip tube is determined by multiplying the maximum volume of LP-Gas obtained by the formula in Section C.2 by the pounds of LP-Gas in a gallon at 40°F (4.4°C) for aboveground containers and at 50°F (10°C) for underground containers. For example, pounds per gallon (lb/gal) are specified in Tables C.4(a) and (b).

Table C.4(a) Weights for LP-Gases

	Aboveground lb/gal	Underground lb/gal
Propane	4.37	4.31
Butane	4.97	4.92

Table C.4(b) Volume Correction Factors

Specific Gravity	Aboveground	Underground
0.500	1.033	1.017
0.510	1.031	1.016
0.520	1.029	1.015
0.540	1.026	1.013
0.560	1.024	1.012
0.570	1.023	1.011
0.580	1.021	1.011
0.590	1.020	1.010

Appendix D Relief Device Sizing

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Nonrefrigerated Containers. Table D.1 should be used to size pressure relief valves.

Surface area equals the total outside surface area of the container in square feet. Where the surface area is not stamped on the name plate or where 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.
(2) Cylindrical container with other than hemispherical heads. Area = (overall length 0.3 outside diameter) outside diameter 3.1416.
(3) Spherical container. Area = outside diameter squared 3.1416.

Flow rate — ft^3/min air = required flow capacity in cubic feet per minute of air at standard conditions, 60°F (15.6°C), and atmospheric pressure [14.7 psia (an absolute pressure of 101 kPa)].

The rate of discharge can be interpolated for intermediate values of surface area. For containers with a total outside surface area that is greater than 2000 ft^2 (186 m^2), the required flow rate can be calculated using the following formula:

Flow rate — ft^3/min air = $53.632A^{0.82}$

where:

A = total outside surface area of the container in square feet

D.2 Refrigerated Containers.

NOTE: The safety relief valve capacity, in addition to preventing excessive pressure in the event of fire exposure, also protects the container from excessive pressure in the event the refrigeration system does not function.

The minimum required rate of discharge in cubic feet per minute of air at 120 percent of the maximum permissible start-to-discharge pressure as specified in Table 7.5.2 for safety relief devices to be used on refrigerated containers should be computed by the following formula. *(See Figure D.2 for values of $A^{0.82}$.)*

$$Q_a = \frac{633,000FA^{0.82}}{LC}\sqrt{\frac{ZT}{M}}$$

where:

Q_a = minimum required flow capacity of air, in cubic feet per minute, at 60°F (15.6°C) and 14.7 psia [an absolute pressure of (101 kPa)]

F = a composite environmental factor *[see Table D.2(a)]*, as tabulated in Table D.2(b). To receive credit for reduced heat input, the insulation should resist dislodgement by fire hose streams, should be noncombustible, and should not decompose at temperatures up to 1500°F (816°C). If insulation does not comply with these criteria, the environmental factor F for a bare container should be used.

A = total exposed wetted surface, in the case of spheres or spheroids, to the elevation of maximum horizontal diameter of the tank, in square feet

L = latent heat of gas at flowing conditions in British thermal units per pound

C = constant for gas, which is a function of the ratio of specific heats at standard conditions. [While not strictly applicable to flows at pressures under 15 psi (103 kPa), its use will produce conservative results.]

$k = f(C_p, C_v)$ [value for C is then taken the chart of k versus C as shown in Table D.2(a)]

Z = compressibility factor at flowing conditions

T = absolute temperature at flowing conditions

M = molecular weight of gas

Table D.1 Minimum Required Rate of Discharge in Cubic Feet per Minute 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 Transportation Specifications

Surface Area (ft^2)	Flow Rate ft^3/min Air	Surface Area (ft^2)	Flow Rate ft^3/min Air	Surface Area ft^2	Flow Rate ft^3/min Air
20 or less	626	170	3620	600	10,170
25	751	175	3700	650	10,860
30	872	180	3790	700	11,550
35	990	185	3880	750	12,220
40	1100	190	3960	800	12,880
45	1220	195	4050	850	13,540
50	1330	200	4130	900	14,190
55	1430	210	4300	950	14,830
60	1540	220	4470	1000	15,470
65	1640	230	4630	1050	16,100
70	1750	240	4800	1100	16,720
75	1850	250	4960	1150	17,350
80	1950	260	5130	1200	17,960
85	2050	270	5290	1250	18,570
90	2150	280	5450	1300	19,180
95	2240	290	5610	1350	19,780
100	2340	300	5760	1400	20,380
105	2440	310	5920	1450	20,980
110	2530	320	6080	1500	21,570
115	2630	330	6230	1550	22,160
120	2720	340	6390	1600	22,740
125	2810	350	6540	1650	23,320
130	2900	360	6690	1700	23,900
135	2990	370	6840	1750	24,470
140	3080	380	7000	1800	25,050
145	3170	390	7150	1850	25,620
150	3260	400	7300	1900	26,180
155	3350	450	8040	1950	26,750
160	3440	500	8760	2000	27,310
165	3530	550	9470		

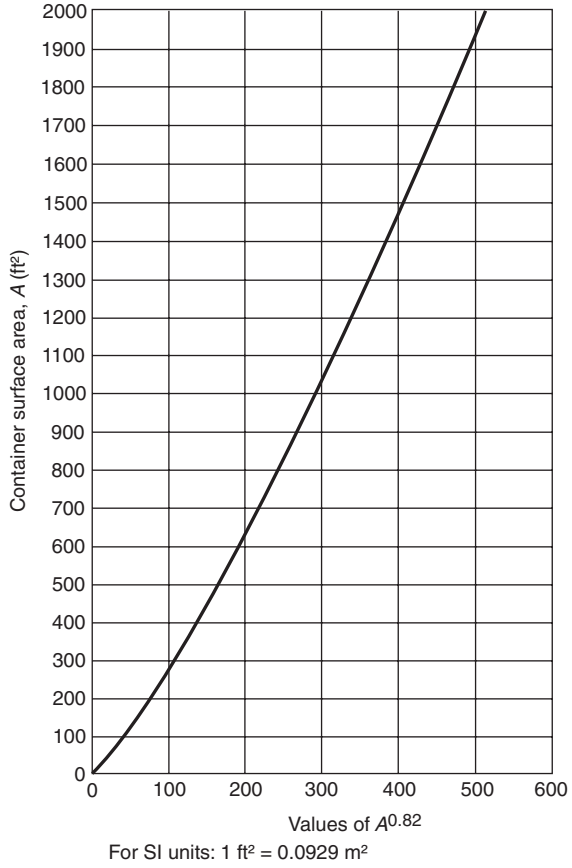
Table D.2(a) *k*-Factor Chart

k	*C*	*k*	*C*	*k*	*C*
1.00	315	1.26	343	1.52	366
1.02	318	1.28	345	1.54	368
1.04	320	1.30	347	1.56	369
1.06	322	1.32	349	1.58	371
1.08	324	1.34	351	1.60	372
1.10	327	1.36	352	1.62	374
1.12	329	1.38	354	1.64	376
1.14	331	1.40	356	1.66	377
1.16	333	1.42	358	1.68	379
1.18	335	1.44	359	1.70	380
1.20	337	1.46	361	2.00	400
1.22	339	1.48	363	2.20	412
1.24	341	1.50	364		

Table D.2(b) Environmental Factors

Environment	Factor, *F*
Bare container	1.0
Insulated containers with the following typical conductance values in Btu per hour per square foot per degrees Fahrenheit based on 1600°F temperature difference:	
4.0	0.3
2.0	0.15
1.0	0.075

FIGURE D.2 Chart for determining value of $A^{0.82}$ for containers with surface area, A (in square feet).



Appendix E Referenced Publications

E.1 The following documents or portions thereof are referenced within this code for informational purposes only and are thus not considered part of the requirements of this code unless also listed in Chapter 12. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this code.

E.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 58, *Liquefied Petroleum Gas Code,* 2001 edition.

NFPA 77, *Recommended Practice on Static Electricity,* 2000 edition.

NFPA 80, *Standard for Fire Doors and Fire Windows,* 1999 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair,* 1999 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 1997 edition.

E.1.2 Other Publications.

E.1.2.1 AGA Publications. American Gas Association, 400 North Capitol Street, NW, Washington, DC 20001.

Interchangeability of Other Fuel Gases with Natural Gas, Research Bulletin 36, AGA Catalog No. X50284, 1946.

Interchangeability — What it Means, AGA Catalog No. XL0884, 1984.

Introduction to LPG Safety for Propane Air Plant Operators, AGA Catalog No. XO9608, 1996.

Purging Principles and Practice, AGA Catalog No. XKO775, 1998.

E.1.2.2 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

API 521, *Guide for Pressure-Relieving and Depressuring Systems,* 1997 edition.

API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 1990 edition.

API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents,* 1991 edition.

API, "The Effect of Velocity, Temperature, and Gas Molecular Weight on Flammability Limits in Wind-Blown Jets of Hydrocarbon Gases," Battelle Memorial Institute, April 1, 1970.

E.1.2.3 ASCE Publication. American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017.

ASCE 56, *Sub-Surface Investigation for Design and Construction of Foundation for Buildings,* 1976.

E.1.2.4 ASME Publication. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code,* 1992 edition.

E.1.2.5 NACE Publication. National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77084.

RP-01-69, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*, 1992.

E.1.2.6 Technical Information Center Publication. National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.

B BERC-R1-77-1, *A New Look at Odorization Levels for Propane Gas,* United States Energy Research and Development Administration, Technical Information Center, September 1977.

E.1.2.7 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 49, *Code of Federal Regulations*, Parts 171–190.

Title 49, *Code of Federal Regulations*, Part 192.

Index

Formal Interpretation

NFPA 59

Liquefied Petroleum Gases at Utility Gas Plants

2001 Edition

Reference: 2.5.2.5
F.I. 84-1

Question: Is it the intent of 2.5.2.5 that permanently plugged bottom openings to which nothing can be connected be considered as "bottom connections to the container"?

Answer: Yes.

Issue Edition: 1984
Reference: 2-5.3.5
Date: September 1985