NFPA 59

Utility LP-Gas Plant Code

2004 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA 59

Utility LP-Gas Plant Code

2004 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 NFPA at its November Association Technical Meeting held November 15–19, 2003, in Reno, NV. It was issued by the Standards Council on January 16, 2004, with an effective date of February 5, 2004, and supersedes all previous editions.

Note: The text of 10.3.5 and 10.3.5(B) was revised from that published in the ROP and ROC to reflect a Tentative Interim Amendment issued by the Standards Council on January 15, 2004.

This edition of NFPA 59 was approved as an American National Standard on January 16, 2004.

Origin and Development of NFPA 59

NFPA 58, *Standard on Liquefied Petroleum Gases*, was applied to utility gas plants to the degree it covered them 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, 1998, and 2001.

The first edition of NFPA 59 resulted from the formation of a special committee under the sponsorship of the American Gas Association (AGA), which was made up of utility engineers, specialists in gas plant construction, and engineers in 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 in 1966 of the Committee on Fuel Gases, NFPA 59 was assigned to that committee and then to a new Subcommittee on Utility Gas Plants. In 1972, responsibility for NFPA 59 was reassigned to the Committee on Liquefied Petroleum Gases, which retained the Subcommittee on Utility Gas Plants.

In 1992, the subcommittee was discharged, and NFPA 59 was assigned to the Technical Committee on LP-Gases at Utility Gas Plants. The committee maintains correlation with NFPA 58 by overlapping committee membership and concurrent or joint meetings.

Changes in the 2004 edition include reorganization of the document to conform to the NFPA *Manual of Style*. The former Chapter 1 has been split into three chapters: Chapter 1 Administration; Chapter 3, Definitions; and Chapter 4, General Requirements.

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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 Title 49, Code of Federal Regulations, Part 192, "Pipeline Safety Law," issued pursuant to the laws in 49 U.S.C. *et seq.*

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Utility LP-Gas Plant Code

2004 Edition

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex F lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex F.

Chapter 1 Administration

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 Purpose. (Reserved)

1.3 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.

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.4 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.

1.4.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.5 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority. *(See Annex E for sample wording for enabling legislation.)*

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2002 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,* 2004 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2002 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2003 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2001 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2003 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2002 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2003 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection,* 2003 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2002 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2003 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2003 edition.

NFPA 54, *National Fuel Gas Code,* 2002 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2004 edition.

NFPA 70, *National Electrical Code®,* 2002 edition.

NFPA *101®, Life Safety Code®,* 2003 edition.

NFPA 290, *Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers,* 2003 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2000 edition.

NFPA 1961, *Standard on Fire Hose,* 2002 edition.

NFPA 1962, *Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose,* 2003 edition.

NFPA 1963, *Standard for Fire Hose Connections,* 2003 edition.

NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting,* 2000 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services,* 2002 edition.

2.3 Other Publications.

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

API 607, *Fire Test for Soft-Seated Quarter-Turn Valves,* 1998 edition.

API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 2001 edition.

2.3.2 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,* 2002 edition.

2.3.3 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 2001 editions.

ASME B31.3, *Process Piping,* 2002 edition.

2.3.4 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.

2.3.5 UL Publication. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas,* 1997 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 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.

3.2.5* 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.

3.2.6 Shall. Indicates a mandatory requirement.

3.2.7 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

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

3.3.2 Container. Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for the transporting or storing of LP-Gases. [**58:**3.3]

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

3.3.4 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.

3.3.5* Fire Protection. Fire protection for the purposes of this code shall be defined in the broad sense to include fire prevention, fire detection, and fire suppression. [**58:**3.3]

3.3.6 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:**3.3]

3.3.7* 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:**3.3]

3.3.8 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:**3.3]

3.3.9 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 above-ground service installed above grade and covered with earth, sand, or other material. [**58:**3.3]

3.3.10 psia. Pounds per square inch, absolute. [**58:**3.3]

3.3.11 psig. Pounds per square inch gauge. [**58:**3.3]

3.3.12 Redundant Fail-Safe Product Control Measures (RFPCM). Specified product storage controls that 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.)

3.3.13 Refrigerated LP-Gas. LP-Gas that is maintained as a liquid at temperatures below ambient temperature to reduce the storage pressure including 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:**3.3]

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

3.3.15 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:**3.3]

3.3.16* 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:**3.3]

3.3.17 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.

3.3.18* Utility Gas Plant. A plant that stores and vaporizes LP-Gas for distribution that supplies either LP Gas or LP-Gas gas/air mixtures to a gas distribution system of 10 or more customers.

3.3.19 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:**3.3]

3.3.19.1 ***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:**3.3]

3.3.19.2 ***Electric Vaporizer.*** A vaporizer that uses electricity as a source of heat. [**58:**3.3]

3.3.19.2.1 ***Direct Immersion Electric Vaporizer.*** A vaporizer wherein an electric element is immersed directly in the LP-Gas liquid and vapor. [**58:**3.3]

3.3.19.2.2 ***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:**3.3]

3.3.19.3 ***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:**3.3]

3.3.19.4 ***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:**3.3]

Chapter 4 General Requirements

4.1 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.

4.2* 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.

4.3 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 3.2.1, Approved.)*

4.4 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 5.8.2.)*

4.5 Ignition Source Control. [**58:**6.20]

4.5.1 Scope. [**58:**6.20.1]

4.5.1.1 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:**6.20.1.1]

4.5.1.2* The installation of lightning protection equipment shall not be required on LP-Gas storage containers. [**58:**6.20.1.2]

4.5.1.3* Grounding and bonding shall not be required on LP-Gas systems. [**58:**6.20.1.3]

4.5.2 Electrical Equipment. [**58:**6.20.2]

4.5.2.1 Electrical equipment and wiring installed in unclassified areas shall be in accordance with NFPA 70, *National Electrical Code®*, for nonclassified locations. [**58:**6.20.2.1]

4.5.2.2* Fixed electrical equipment and wiring installed within a classified area specified in Table 4.5.2.2 shall be installed in accordance with NFPA 70, *National Electrical Code.* [**58:**6.20.2.2]

Table 4.5.2.2 Electrical Area Classification

Part	Location	Extent of Classified Area[a]	Equipment Shall be Approved for *National Electrical Code*, Class I[a], Group D[b]
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 4.5.2.2	Division 2
B	Refrigerated storage containers	Within 15 ft (4.6 m) in all directions from connections otherwise covered in Table 4.5.2.2	Division 2
		Area inside dike to the level of the top of the dike	Division 2
C[c]	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 A.4.5.2.2)*	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[c]	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 A.4.5.2.2)*	Division 2
G	Vehicle fuel dispenser	Entire space within dispenser enclosure, and 18 in. (460 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. (460 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

Table 4.5.2.2 *Continued*

Part	Location	Extent of Classified Area[a]	Equipment Shall be Approved for *National Electrical Code*, Class I[a], Group D[b]
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[c]	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 A.4.5.2.2)*	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 A.4.5.2.2)*	Division 2

[a]The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.
[b] See Article 500 Hazardous (Classified) Locations, in NFPA 70, *National Electrical Code*, for definitions of classes, groups, and divisions.
[c]See A.6.20.2.2 [of NFPA 58]. [**58:**Table 6.20.2.2]

4.5.2.3 The provisions of 4.5.2.2 shall apply to vehicle fuel operations. [**58:**6.20.2.3]

4.5.2.4 The provisions of 4.5.2.2 shall not apply to fixed electrical equipment at residential or commercial installations of LP-Gas systems or to systems covered by Section 6.21 [of NFPA 58]. [**58:**6.20.2.4]

4.5.2.5 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:**6.20.2.5]

4.5.2.6 Electrical equipment installed on LP-Gas cargo tank vehicles shall comply with Section 9.2 [of NFPA 58]. [**58:**6.20.2.6]

4.5.3 Other Sources of Ignition. [**58:**6.20.3]

4.5.3.1 Open flames or other sources of ignition shall not be used or installed in pump houses, cylinder filling rooms, or other similar locations. [**58:**6.20.3.1]

4.5.3.2 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:**6.20.3.2]

4.5.3.3 Open flames, cutting or welding tools, portable electric tools, and extension lights capable of igniting LP-Gas shall not be installed or used within classified areas specified in Table 4.5.2.2. [**58:**6.20.3.3]

4.5.3.4* Open flames or other sources of ignition shall not be prohibited where LP-Gas facilities have been purged of all liquid and vapor. [**58:**6.20.3.4]

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

4.7 Fixed Electrical Equipment in Classified Areas.

4.7.1 Fixed electrical equipment and wiring installed within the classified areas specified in Table 4.5.2.2 shall comply with Table 4.5.2.2 and shall be installed in accordance with NFPA 70, *National Electrical Code®*, for hazardous locations.

4.7.2 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.

4.8 Source of Ignition.

4.8.1 Smoking and nonprocess ignition sources within the protective enclosure shall be prohibited, unless in accordance with 4.8.2 through 4.8.4.

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

4.8.3 Welding, cutting, hotwork, use of portable electric tools and extension lights, and similar operations shall be conducted only at times and places specifically authorized.

4.8.3.1 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 4.5.2.2.

4.8.3.2 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.

4.8.4 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, except where specifically authorized and under constant supervision or where loading or unloading at facilities specifically designed for the purpose.

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

4.8.6* 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.

4.8.7 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 5 Nonrefrigerated Containers

5.1 Provision for Construction and Original Test of Nonrefrigerated Containers.

5.1.1 Shop-fabricated containers shall be designed, constructed, and tested in accordance with one of the following:

(1) ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for Construction of Unfired Pressure Vessels," excluding UG-125 through UG 136
(2) The rules of the authority under which the containers are installed, provided such rules conform to the rules of ASME *Boiler and Pressure Vessel Code*, Section VIII

5.1.2 The provisions of 5.1.1 shall not be construed as prohibiting the continued use or reinstallation of containers that are constructed and maintained in accordance with ASME *Boiler and Pressure Vessel Code* in effect at the time of fabrication. *(See Section 1.4.)*

5.2 Design Pressure and Classification of Nonrefrigerated Containers.

5.2.1* Shop-fabricated containers for nonrefrigerated storage shall be in accordance with Table 5.2.1.

5.2.2 Field-erected nonrefrigerated containers shall be built in accordance with ASME *Boiler and Pressure Vessel Code* except that construction using joint efficiencies in Table UW 12, Column C, Division 1, of ASME *Boiler and Pressure Vessel Code* shall not be permitted.

Table 5.2.1 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

Table 5.4.1.2 Nonrefrigerated Container Installation Minimum Distances

Water Capacity of Each Container		Minimum Distances Between Containers		Minimum Distances from Container to Nearest Important Building or Group of Buildings Not Associated with the Utility Gas Plant or to a Line of Adjoining Property That Can Be Built Upon	
gal	m^3	ft	m	ft	m
2001–30,000	7.6–114	5	1.5	50	15
30,001–70,000	114–265	¼ sum of diameters of adjacent containers		75	23
70,001–90,000	265–341			100	30
90,001–120,000	341–454			125	38
120,001–200,000	454–757			200	61
200,001–1,000,000	757–3785			300	91
1,000,001 or more	Over 3785			400	122

5.2.3 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.

5.3 ASME Container Markings.

5.3.1 ASME containers shall be identified by the attachment of a nameplate.

5.3.1.1 The marking specified shall be on a stainless steel nameplate attached to the container and located to remain visible after the container is installed.

5.3.1.2 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.

5.3.1.3 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.

5.3.2 The container marking shall contain the following information:

(1) Name and address of the container supplier or the trade name of the container
(2) Water capacity of the 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 5.2.1)*
(5) Outside surface area in square feet
(6) Year of manufacture
(7) Shell thickness and head thickness
(8)*OL (overall length), OD (outside diameter), HD (head design)
(9) Manufacturer's serial number
(10) ASME *Boiler and Pressure Vessel Code* symbol

5.4 Location of Nonrefrigerated Containers.

5.4.1 Nonrefrigerated Aboveground Containers.

5.4.1.1 Containers shall be located outside of buildings.

5.4.1.2 Containers shall be located in accordance with Table 5.4.1.2 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.

5.4.1.3 Spacing of containers from buildings associated with utility gas plants shall be permitted to be reduced to 50 percent of the distances in Table 5.4.1.2, with a minimum separation of 50 ft (15 m).

5.4.1.4 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 5.4.1.4.

5.4.1.5 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 5.4.1.4 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 13.1.1.)*	6	50	15
Fixed monitor nozzles per 13.5.4.5	6	25	7.6
Fixed water spray per 13.5.4.4	9	25	7.6
Insulation per 13.5.4.18	9	25	7.6

5.4.1.6 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). [**58:**6.4.5.5]

5.4.1.7 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:**6.4.5.6]

5.4.1.8 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.

5.4.1.9* 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:**6.4.5.3]

5.4.2 Nonrefrigerated Underground Containers.

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

5.4.2.2 Containers shall be located outside of any buildings.

(A) Buildings or roadways shall not be constructed over any underground containers.

(B) Sides of adjacent containers shall be separated by not less than 3 ft (1 m).

5.4.2.3 The orientation of containers shall be in accordance with the following:

(1) Where containers are installed parallel with ends in line, any number of containers shall be permitted to be in one group.
(2) 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).

5.4.2.4 The location of containers shall be in accordance with the following:

(1) 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) Containers shall be located not less than 50 ft (15 m) from buildings associated with the utility gas plant.
(3) They shall be located not less than 10 ft (3 m) from flammable liquids storage containers.

5.4.2.5 When the provisions of 6.24.3 through 6.24.5 [of NFPA 58] are met, the minimum distance from an ASME container to a building 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.[**58:**6.3.2]

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

5.4.3 Stacking. Nonrefrigerated containers shall not be stacked one above the other.

5.4.4 Connection to a Common Manifold. Containers connected to a common manifold shall be installed so that their maximum liquid filling levels present the same plane to minimize the possibility of overfilling lower level tanks.

5.5 Installation of Nonrefrigerated Storage Containers.

5.5.1 Nonrefrigerated Aboveground Containers.

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

5.5.1.2 Supports for containers shall be of solid masonry, concrete, or steel.

(A) Structural metal supports shall be permitted to be employed where they are protected against fire in an approved manner.

(B) Metal supports shall be protected against fire with a material that has a fire resistance rating of at least 2 hours.

(C) Steel skirts that have only one opening that is 18 in. (460 mm) or less in diameter shall be protected in accordance with 5.5.1.2(B), but fireproofing shall be required to be applied only to the outside of the skirt.

5.5.1.3 Horizontal containers shall be mounted on not more than two saddles so as to permit expansion and contraction, not only of the container but also of the connected piping.

5.5.1.4 Means to minimize corrosion shall be provided on that portion of the container that is in contact with the foundations or saddles.

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

5.5.1.6 Vertical containers shall be designed to be self-supporting without the use of guy wires and shall take into account wind, seismic forces (earthquake), and hydrostatic test loads.

5.5.1.7 Design pressure *(see Table 5.2.1)* shall be 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.

5.5.1.8 Wind loading on containers of 10,000 gal (37.9 m^3) or larger shall 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.

5.5.1.9 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.

5.5.1.10* 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, and shall be resistant to weathering and the action of hose streams. *(See Annex D.)*

5.5.2 Nonrefrigerated Underground Containers.

5.5.2.1 Buried containers shall be placed so that the top of the container is not less than 6 in. (150 mm) below the grade of the surrounding area.

5.5.2.2 Partially buried (or mounded) containers shall have not less than 12 in. (300 mm) of cover, sufficient to provide surface drainage without erosion or other deterioration.

5.5.2.3 The container manway shall not be covered with the backfill or mounding material.

5.5.2.4 Where the container manway cover is below ground level, a manway that provides access shall be installed. No other part of the container shall be exposed.

5.5.2.5 Containers shall be set on a firm foundation and surrounded with earth or sand that is firmly tamped in place.

5.5.2.6 Foundations of firm earth shall be permitted to be used.

5.5.2.7 Backfill shall be free of rocks or other abrasive materials.

5.5.2.8 Provisions shall be made to take care of settling and rotation.

5.5.2.9* Containers shall be protected to minimize corrosion.

5.5.2.10 All connections shall be in the container manway or at openings along the top length of the container. Bottom connections to the container shall be prohibited, except as permitted in 5.5.2.10(A) or 5.5.2.10(B).

(A) 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.

(B) 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 ASME *Boiler and Pressure Vessel Code* and shall be designed for the forces that can act on the connection.

5.5.3 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. [**58:**6.21.3.4(D)]

5.5.4 Where necessary to prevent flotation due to possible high floodwaters around aboveground or mounded containers, or high water table for those underground and partially underground, containers shall be securely anchored. [**58:**6.6.1.6]

5.6 Reinstallation of Nonrefrigerated Containers.

5.6.1 Containers once installed underground or aboveground that have been out of service for more than 1 year shall not be reinstalled aboveground or underground unless they 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.

5.6.2 Reinstallation of containers in all other respects shall be in accordance with all the provisions of this code. *(See Section 5.5; see also Chapter 10 for relief valve requirements.)*

5.7 Filling Densities.

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

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

where:

V = maximum liquid volume (in percentage of total container capacity) at temperature T
D = filling density from Table 5.7.2 in percentage
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 *(For F values, see Table B.2.)*
T = temperature of liquid LP-Gas in container (in degrees Fahrenheit)

5.7.2 Filling densities of underground nonrefrigerated containers shall be in accordance with Table 5.7.2.

Table 5.7.2 Maximum Permitted Filling Density

	Aboveground Containers		
Specific Gravity at 60°F (15.6°C)	0 to 1200 U.S. gal (1000 imperial gal, 4.5 m^3) Total Water Capacity (%)	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

5.7.3 Where the maximum ground temperatures do not exceed 60°F (15.6°C), the filling density shall be based on Table 5.7.2 or on accepted engineering practices for the operating conditions involved with the approval of the authority having jurisdiction.

5.8 Loading and Unloading Facility Spacing.

5.8.1 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, other than equipment directly associated with the transfer operation.

5.8.2 Filling pipe inlet terminals shall meet all the following requirements:

(1) The filling pipe inlet terminal shall not be located inside a building.
(2) Such terminals shall be located at least 25 ft (7.6 m) from a container and shall be supported and protected from physical damage by vehicular movement.
(3) Filling pipe inlet terminals shall be located at least 5 ft (1.5 m) behind any barriers provided for such protection.

5.9 Supplemental Product Control.

5.9.1 Application. This section provides alternative 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.

5.9.2 Spacing Requirements. [**58:**6.24.2]

5.9.2.1 Where all the provisions of Section 6.24 [of NFPA 58] are complied with, the minimum distances from important buildings and the line of adjoining property that can be built upon to underground and mounded ASME containers of 2001 gal through 30,000 gal (7.6 m^3 through 114 m^3) water capacity shall be reduced to 10 ft (3.0 m). [**58:**6.24.2.1]

5.9.2.2 Distances for all underground and mounded ASME containers shall be measured from the container surface. [**58:**6.24.2.2]

5.9.2.3 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:**6.24.2.3]

5.9.3 ASME Container Appurtenances. The provisions in 5.9.3.1 through 5.9.3.5 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 6.24 [of NFPA 58]. [**58:**6.24.3]

5.9.3.1 All liquid withdrawal openings and all vapor withdrawal openings that are 1¼ in. (3.2 cm) or larger shall be equipped with an internal valve. [**58:**6.24.3.1]

5.9.3.2 The internal valves shall remain closed except during periods of operation. [**58:**6.24.3.2]

5.9.3.3 Internal valves shall be equipped for remote closure and automatic shutoff through thermal (fire) actuation. [**58:**6.24.3.3]

5.9.3.4 A positive manual shutoff valve shall be installed as close as practical to each internal valve. [**58:**6.24.3.4]

5.9.3.5 All liquid and vapor inlet openings shall be equipped in accordance with 5.9.3.1 and 5.9.3.4 or shall be equipped with a backflow check valve that is designed for the intended application and a positive manual shutoff valve installed as close as practical to the backflow check valve. [**58:**6.24.3.5]

5.9.4 Redundant Fail-Safe Product Control. [**58:**6.24.4]

5.9.4.1 At cargo tank vehicle and railroad tank car transfer points, protection shall be provided in accordance with Section 6.10 [of NFPA 58] using approved emergency shutoff valves or backflow check valves or a combination of the two. [**58:**6.24.4.1]

5.9.4.2 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:**6.24.4.2]

5.9.4.3 Remote shutdown capability, including power supply for the transfer equipment and all primary valves (internal and emergency shutoff), shall be provided. [**58:**6.24.4.3]

(A) A remote shutdown station shall be installed within 15 ft (4.6 m) of the point of transfer. [**58:**6.24.4.3(A)]

(B) At least one additional remote shutdown station shall be installed not less than 25 ft (7.6 m) or more than 100 ft (30.5 m) from the transfer point. [**58:**6.24.4.3(B)]

(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:**6.24.4.3(C)]

Chapter 6 Refrigerated Containers

6.1 Construction and Design of Refrigerated Containers. [**58:**12.1]

6.1.1 Container Material and Construction Requirements. [**58:**12.1.1]

6.1.1.1 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 VIII, except that construction using joint efficiencies listed in Table UW 12, Column C, shall not be permitted. [**58:**12.1.1.1]

6.1.1.2 Materials used in refrigerated containers 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:**12.1.1.2]

6.1.1.3 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:**12.1.1.3]

6.1.1.4 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:**12.1.1.4]

6.1.1.5 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:**12.1.1.5]

6.1.2 Container Design Temperature and Pressure. [**58:**12.1.2]

6.1.2.1 The maximum allowable working pressure shall include a margin above the operating pressure. [**58:**12.1.2.1]

6.1.2.2 Design Temperature and Pressure. [**58:**12.1.2.2]

6.1.2.3 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:**12.1.2.3]

6.1.2.4 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. A temperature allowance shall be made for the composition of the liquid to be stored when it is flashed into the vapor space of a tank. [**58:**12.1.2.4]

6.2 Marking on Refrigerated LP-Gas Containers. [**58:**12.2]

6.2.1 Each refrigerated LP-Gas container shall be identified by the attachment of a nameplate on the outer covering. [**58:**12.2.1]

6.2.2 The nameplate shall be in accordance with API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* Section 6. [**58:**12.2.2]

6.3 Container Installation. [**58:**12.3]

6.3.1 Wind Loading. [**58:**12.3.1]

6.3.1.1 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.* [**58:**12.3.1.1]

6.3.1.2 Design wind speeds shall be based on a mean occurrence interval of 100 years. [**58:**12.3.1.2]

6.3.2 Seismic Loading. [**58:**12.3.2]

6.3.2.1 The design seismic loading on refrigerated LP-Gas containers shall be in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures.* [**58:**12.3.2.1]

6.3.2.2 A seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction. [**58:**12.3.2.2]

6.3.3 Piping. [**58:**12.3.3]

6.3.3.1 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, *Process Piping.* [**58:**12.3.3.1]

6.3.3.2 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 [**58:**12.3.3.2]

6.3.3.3 Inert gas purge systems wholly within the insulation spaces shall be exempt from the provision in 6.3.3.1. [**58:**12.3.3.3]

6.3.3.4 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. [**58:**12.3.3.4]

6.3.3.5 Gaskets 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. [**58:**12.3.3.5]

6.3.3.6 When a flange is opened, the gasket shall be replaced. [**58:**12.3.3.6]

6.3.4 Foundations. [**58:**12.3.4]

6.3.4.1 Refrigerated aboveground containers shall be installed on foundations that have been engineered with consideration for soil conditions and loadings. [**58:**12.3.4.1]

6.3.4.2* 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:**12.3.4.2]

6.3.4.3 Where product storage is at less than 30°F (1.1°C), the foundation and the tank bottom shall comply with the following:

(1) The foundation design and the container bottom insulation shall prevent damage to the tank from frost heave.
(2) If the refrigerated LP-Gas tank under bottom foundation and insulation are in contact with the soil, and the soil temperature can be less than 32°F (0°C), a heating system shall be installed to prevent the soil temperature from going below 32°F (0°C).
(3) The under-tank heating system shall be designed to permit both functional and performance monitoring.
(4) The under-tank temperature shall be observed and logged at least weekly.
(5) Where there is a discontinuity in the foundation, such as bottom piping, the heating system in that zone shall be designed for the discontinuity.
(6) The under-tank 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.
(7) 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:**12.3.4.3]

6.3.4.4 The refrigerated LP-Gas container foundation shall be periodically monitored for settlement during the life of the facility. [**58:**12.3.4.4]

6.3.4.5 The monitoring shall include construction, hydrostatic testing, commissioning, and operation. [**58:**12.3.4.5]

6.3.4.6 Any settlement in excess of that anticipated in the design shall be investigated, and corrective action shall be taken if appropriate. [**58:**12.3.4.6]

6.3.4.7 For a tank having a double wall design, the bottom of the outer wall and the refrigerated LP-Gas container undertank insulation shall be above the groundwater table or protected from contact with groundwater at all times. It shall also be protected from floodwaters. [**58:**12.3.4.7]

6.3.4.8 Where two or more containers are sited in a common dike, the tank foundations shall be constructed of material resistant to the effects of refrigerated LP-Gas and the temperature to which they will be exposed. [**58:**12.3.4.8]

6.3.4.9 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 resistant to the effects of refrigerated LP-Gas and the temperatures to which they will be exposed. [**58:**12.3.4.9]

6.3.4.10 The material in contact with the bottom of the container shall be selected to minimize corrosion. [**58:**12.3.4.10]

6.4 Refrigerated LP-Gas Container Instruments and Controls. [**58:**12.4]

6.4.1 Gauging Devices. [**58:**12.4.1]

6.4.1.1 Each refrigerated LP-Gas container shall be equipped with at least two independent liquid level gauging devices. [**58:**12.4.1.1]

6.4.1.2 Liquid level gauging devices shall be installed so that they can be replaced without taking the container out of service. [**58:**12.4.1.2]

6.4.1.3 The refrigerated LP-Gas container shall be provided with an audible and visual high–liquid level alarm. [**58:**12.4.1.3]

6.4.1.4 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:**12.4.1.4]

6.4.1.5 The alarm shall be located so that it is visible and audible to the personnel who control the filling. [**58:**12.4.1.5]

6.4.1.6 A high–liquid level flow cutoff device shall not be a substitute for the alarm. [**58:**12.4.1.6]

6.4.2 High–Liquid Level Device. [**58:**12.4.2]

6.4.2.1 The refrigerated LP-Gas container shall be equipped with a high–liquid level flow cutoff device that is independent from all gauges. [**58:**12.4.2.1]

6.4.2.2 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:**12.4.2.2]

6.4.2.3 Each refrigerated LP-Gas container shall be provided with temperature-indicating devices that assist in controlling cooldown rates when placing the tank in service and monitoring product temperatures during operations. [**58:**12.4.2.3]

6.4.3 Pressure and Vacuum Control. [**58:**12.4.3]

6.4.3.1 Provisions shall be made to maintain the container pressure within the limits set by the design specifications by releasing or admitting gas as needed. Provision for admission and release of gas shall be by any means compatible with the gas handling facilities in the plant. [**58:**12.4.3.1]

6.4.3.2 The option of gas admission (or other gas or vapor if so designed) through the vacuum relief valves provided in API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, paragraph 7.2.3, shall not be permitted. [**58:**12.4.3.2]

6.5 Refrigerated LP-Gas Container Impoundment. [**58:**12.5]

6.5.1 Each refrigerated LP-Gas container shall be located within an impoundment that complies with Section 6.5. [**58:**12.5.1]

6.5.2 Enclosed drainage channels for LP-Gas shall be prohibited. [**58:**12.5.2]

6.5.3 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:**12.5.3]

6.5.4 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. [**58:**12.5.4]

6.5.5 Where more than one container is installed in a single impoundment and if an outside container wall is used as a spill containment dike, the material shall be selected to withstand exposure to the temperature of refrigerated LP-Gas liquid. [**58:**12.5.5]

6.5.6 Impoundment structures and any penetrations thereof shall be designed to withstand the full hydrostatic head of the impounded LP-Gas and the effects of the product composition and the resulting autorefrigeration temperatures. [**58:**12.5.6]

6.5.7 These structures shall also be nonporous and resistant to natural forces such as wind, rain, and fire. [**58:**12.5.7]

6.5.8 Impoundment structures shall also be nonporous and resistant to natural forces such as wind, rain, and fire. [**58:**12.5.8]

6.5.9 Provisions shall be made to clear rain or other water from the impounding area. [**58:**12.5.9]

6.5.9.1 Where automatically controlled sump pumps are used, they shall be equipped with an automatic shutoff device that prevents their operation when exposed to LP-Gas temperatures. [**58:**12.5.9.1]

6.5.9.2 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:**12.5.9.2]

6.5.9.3 Gravity drainage utilizing piping penetrations through or below impoundment dikes shall not be permitted. [**58:**12.5.9.3]

6.5.10 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:**12.5.10]

6.5.10.1 The grading shall move the spilled liquid to the toe of the dike system and as far away from the container as possible. [**58:**12.5.10.1]

6.5.10.2 The grading shall move the spilled liquid to a subimpoundment basin that is capable of holding the quantity of liquid spilled from line rupture, flange leak, or a source other than container failure. [**58:**12.5.10.2]

6.5.10.3 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:**12.5.10.3]

6.6 Inspection and Testing of Refrigerated LP-Gas Containers and Systems. [**58:**12.6]

6.6.1 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 the codes and standards referenced herein. [**58:**12.6.1]

6.6.2 The inspections or tests required shall be conducted by the operator or a third-party engineering, scientific, recognized insurance, or inspection organization. [**58:**12.6.2]

6.6.3 Each inspector shall be qualified in accordance with the code or standard that is applicable to the test or inspection being performed. [**58:**12.6.3]

6.6.4 After acceptance tests are completed, there shall be no field welding on the LP-Gas containers except where allowed by the code under which the container was fabricated. [**58:**12.6.4]

6.6.5 Retesting shall be required only if the retest tests the element affected and is necessary to demonstrate the adequacy of the repair or modification. [**58:**12.6.5]

6.7 Container Siting. [**58:**12.7]

6.7.1 Spacing of refrigerated LP-Gas containers designed to operate at greater than 15 psi (103 kPa) from occupied buildings, storage containers for flammable or combustible liquids, and lines of adjoining property that can be built upon shall be in accordance with Table 6.7.1. [**58:**12.7.1]

Table 6.7.1 Minimum Distances

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

[**58:**Table 12.7.1]

6.7.2 Spacing of refrigerated LP-Gas containers that operate at below 15 psi (103 kPa) from occupied buildings, storage containers for flammable or combustible liquids, and lines of adjoining property that can be built upon shall be in accordance with Table 6.7.2. [**58:**12.7.2]

Table 6.7.2 Minimum Distances

Water Capacity per Container		Aboveground Containers	
gal	m^3	ft	m
≤70,000	≤265	75	25
>70,000	>265	100	30

[**58:**Table 12.7.2]

6.7.3 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:**12.7.3]

6.7.4 Nonrefrigerated LP-Gas containers or flammable liquid tanks shall not be located within dikes or impoundments enclosing refrigerated LP-Gas containers. [**58:**12.7.4]

6.7.5 Refrigerated LP-Gas containers shall not be installed one above the other. [**58:**12.7.5]

6.7.6 The minimum distance between aboveground refrigerated LP-Gas containers shall be one-half the diameter of the larger container. [**58:**12.7.6]

6.7.7 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:**12.7.7]

6.8 Relief Devices. [**58:**12.8]

6.8.1 General. [**58:**12.8.1]

6.8.1.1 All containers shall be equipped with pressure and vacuum relief devices in accordance with Section 6.8. [**58:**12.8.1.1]

6.8.1.2 Relief devices shall communicate directly with the atmosphere. Vacuum relieving devices shall be installed if the container can be exposed to a lower vacuum than the container is designed for. [**58:**12.8.1.2]

6.8.1.3 Inlet and outlet piping connections to relief devices shall be included in the selection and sizing of relief devices. [**58:**12.8.1.3]

6.8.1.4 A manually operated full opening stop valve shall be installed between each pressure and vacuum safety relief valve and the LP-Gas container. [**58:**12.8.1.4]

6.8.1.5 All stop valves installed between a relief valve and a container shall be lockable or sealable in the fully open position. [**58:**12.8.1.5]

6.8.1.6 A sufficient number of pressure and vacuum relief valves shall be installed on the LP-Gas container to allow each relief valve to be isolated individually while maintaining the full relieving capacities required. [**58:**12.8.1.6]

6.8.1.7 Where only one relief device is required, either a full port opening three-way valve shall be installed between the container and two relief devices, or separate stop valves shall be beneath each relief device. [**58:**12.8.1.7]

6.8.1.8 Stop valves under individual safety relief valves shall be locked or sealed when opened and shall not be opened or closed except by an authorized person. [**58:**12.8.1.8]

6.8.1.9 No more than one stop valve shall be closed at one time. [**58:**12.8.1.9]

6.8.1.10 Safety relief valve discharge stacks or vents shall be designed and installed to prevent an accumulation of water, ice, snow, or other foreign matter and shall discharge vertically upward. [**58:**12.8.1.10]

6.8.1.11 All refrigerated storage container pressure and vacuum relief devices shall be tested or replaced at intervals not to exceed 5 years. [**58:**12.8.1.11]

6.8.2 Pressure Relief Device Sizing. 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 that follow:

(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 [**58:**12.8.2]

6.8.3 Vacuum Relief Device Sizing. [**58:**12.8.3]

6.8.3.1 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 that follow:

(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 with subcooled liquid [**58:**12.8.3.1]

6.8.3.2 Reduction in the vacuum relief capacity to allow for the rate of vaporization resulting from minimum normal heat gain to the contents of the container shall be allowed. [**58:**12.8.3.2]

6.8.3.3 No vacuum relief capacity credit shall be allowed for gas-repressuring or vapor make-up systems. [**58:**12.8.3.3]

6.8.4 Fire Exposure Sizing. [**58:**12.8.4]

6.8.4.1 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 or product vapor at relieving conditions.
F = environmental factor from Table 6.8.4.1.
L = latent heat of vaporization of the stored liquid at the relieving pressure and temperature, in Btu/lb.
A = exposed wetted surface area of the container in ft^2. In the case of large containers, the exposed wetted area is the area up to a height of 30 ft above grade.
H_n = normal heat leak in refrigerated tanks, in Btu/hr. [**58:**12.8.4.1]

Table 6.8.4.1 Environmental Factors

Basis	*F* Factor
Base container	1.0
Water application facilities	1.0
Depressuring and emptying facilities	1.0
Underground container	0
Insulation or thermal protection	$F = \frac{U(1660 - T_f)}{34{,}500}$
Insulation or thermal protection (metric)	$F = \frac{U(904 - T_f)}{71{,}000}$

Note: U is the overall heat transfer coefficient Btu/(hr × ft^2 × °F) [W/(m^2 × °C)] of the insulation system using the mean value for the temperature range from T_f to +1660°F (904°C). T_f is the temperature of vessel content at relieving conditions, °F (°C). [**58:**Table 12.8.4.1]

6.8.4.2 Where credit for insulation is taken in sizing of a relief valve for fire exposure, the insulation shall comply with the following:

(1) Resist dislodgment by fire-fighting equipment
(2) Be noncombustible
(3) Not decompose at temperatures up to 1000°F [**58:**12.8.4.2]

6.8.4.3 If the insulation does not meet the criteria of 6.8.4.2, no credit for the insulation shall be taken. [**58:**12.8.4.3]

6.8.4.4 The equivalent airflow for relieving capacity shall be calculated by the following equation:

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

where:

SCFM (air) = equivalent airflow in standard ft^3/min
W = relieving capacity of product vapor at relieving conditions, lb/hr
Z = compressibility factor product vapor at relieving conditions
T = absolute temperature of product vapor at relieving conditions, °R
M = product vapor molecular weight [**58:**12.8.4.4]

Chapter 7 Piping, Valves, and Equipment

7.1 General.

7.1.1 Piping, valves, and equipment shall be suitable for LP-Gas service at the minimum design temperature and the maximum pressure.

7.1.1.1 The design and fabrication of piping systems shall be in accordance with ASME B31.3, *Process Piping*, except as modified by the provisions of this chapter and any applicable federal pipeline regulations.

7.1.1.2 Where fire exposure to equipment is anticipated, the material shall be selected for fire exposure or protected from fire exposure.

7.1.1.3 Pressure-containing metal parts of equipment for application temperatures of –20°F (–29°C) or above shall be fabricated of one of the following materials:

(1) Steel
(2) Ductile (nodular) iron in accordance with ASTM A 395, *Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or malleable iron in accordance with ASTM A 536, *Specifications for Ductile Iron Castings*, Grade 60-40-18 or 65-45-12
(3) Malleable iron in accordance with ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings*; brass; bronze; or equivalent copper alloys

7.1.1.4 Piping that can contain liquid LP-Gas, that can be isolated by valving, and that requires hydrostatic relief valves, as specified in 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.

7.1.1.5 The piping specified in 7.1.1.4 shall be subjected to a pressure test, in accordance with 7.1.1.1, of no less than 150 percent of the design pressure.

7.1.2 Piping connections to the container for sizes over 2 in. nominal pipe diameter excluding excess-flow valves shall be made by welding or with welded flanges.

7.1.3 Cast-iron valves, pipe, and fittings shall be not be used in piping that carries LP-Gas and LP-Gas–air mixtures, except for container valves or fittings made of malleable or ductile iron used within the limitations set forth in 323.4.2 of ASME B31.3, *Process Piping*.

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

(1) Automatic shutoff through thermal (fire) actuation

(2) Manual shutoff from two or more remote locations
(3) Manual shutoff at the installed location

7.1.5 Fusible elements used for closing emergency shutoff valves shall have a melting point not exceeding 250°F (121°C).

7.1.6 Gaskets used to retain LP-Gas in flanged connections in piping containing liquid LP-Gas and LP-Gas vapor above 125 psi shall meet the following requirements:

(1) They be resistant to the action of LP-Gas.
(2) 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.
(3) Where a flange is opened, the gasket shall be replaced.
(4) Gaskets in flanged connections in piping containing LP-Gas vapor at 125 psi (0.86 MPa) or less shall be resistant to the action of LP-Gas.
(5) When a flange is opened, the gasket shall be replaced.

7.1.7 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.

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

7.1.9 Piping outside buildings shall be supported and protected against physical damage and corrosion.

7.1.10 Underground and submerged piping shall be protected and maintained to minimize corrosion.

7.2 Container Valves and Accessories.

7.2.1 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.

(A) 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).

(B) Cast-iron valves, piping, and fittings shall be prohibited on LP-Gas containers and their connections except for container valves or fittings that are made of malleable or nodular iron.

7.2.2 All connections to containers shall have shutoff valves located as close to the container as practical.

(A) The valves shall be accessible for operation and maintenance under normal and emergency conditions, either by location or by means of permanently installed special provisions.

(B) Valves installed in unobstructed locations that are not more than 6 ft (1.8 m) above ground level shall be considered accessible.

(C) Stairs, ladders, platforms, remote operators, extension handles, etc., shall be installed where valves are located 6 ft (1.8 m) or more above ground level.

(D) Safety relief connections, liquid level gauging devices, and plugged openings shall not be required to be accessible.

7.2.3 Excess-flow valves, where required by this code, shall close automatically at those rated flows of vapor or liquid as specified by the manufacturer.

7.2.4 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.

7.2.5 All liquid and vapor connections on containers, other than pressure relief valves, liquid level gauging devices, and openings not larger than No. 54 drill size as covered in 7.2.6 and 7.4.3, 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 with a fail closed hydraulic or pneumatically actuated valve in compliance with API 607, *Fire Test for Soft-Seated Quarter-Turn Valves*, equipped for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is located within 5 ft (1.5 m) of the valve.
(3) A quick-acting internal valve incorporating the means of closing specified in 7.1.4

7.2.6 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.

7.2.7 Excess-flow and back-pressure check valves, where required by this standard, shall be located inside 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 stress beyond the excess-flow or back-pressure check valve will not cause breakage between the container and such valve.

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

7.2.9 All inlet and outlet connections on any container shall be labeled or color coded, or valves connected to the connections shall be labeled to designate whether they are connected to a vapor or liquid space.

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

7.2.11 Each storage container shall be provided with a pressure gauge.

7.3 Filler and Discharge Pipes and Manifolds.

7.3.1 Piping connections between container and manifold shall be designed to provide allowances for contraction, expansion, vibration, and settlement. Compression-type couplings shall not be permitted for this purpose.

7.3.2 Liquid manifold connections shall be located at nonadjacent ends of parallel rows of containers.

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

7.3.4 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.

(A) Automatically or remotely controlled valves, or both, of the fail-safe type shall be used.

(B) 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.

(C) Fail-safe valves also shall be capable of being operated manually at the installed location.

(D) A remote closing control shall be located so as to be accessible during a fire or other emergency.

(E) Where installed in aboveground piping systems, fail-safe 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.

7.4 Liquid Level Gauging Device.

7.4.1 Each nonrefrigerated storage system shall be equipped with an approved liquid level gauging device in accordance with the following:

(1) If the liquid level gauging device is a float type or a pressure differential 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.
(2) Unlisted gauge glasses of the columnar type shall not be permitted.

7.4.2 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 determinable.

7.4.3 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.

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

7.4.5* 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, 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.

7.5 Hose Specifications for Nonrefrigerated LP-Gas.

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

7.5.2 Hose, hose connections, and flexible connections shall comply with 7.5.2.1 and 7.5.2.2.

7.5.2.1 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.

7.5.2.2 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).

7.5.2.3 Hose assemblies shall not be leak tested at pressures higher than the working pressure [350 psi (2.41 MPa) minimum] of the hose.

7.6 Drips, Pits, and Drains.

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

7.6.2 If pits are used, they shall be fitted with continuous automatic flammable vapor–detecting devices equipped with an alarm.

7.6.3 No drains or blow-off lines shall be directed into or in proximity to sewer systems other than those specified in 7.6.2.

7.7 Pumps and Compressors.

7.7.1 Each pump and compressor shall be recommended by the manufacturer for the LP-Gas service intended.

7.7.2 Each pump and compressor shall be marked with its maximum working pressure.

7.7.3 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.

(A) 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.

(B) Compressor capacity provided for standby service shall be capable of handling the volume of vapors necessary to be evolved to maintain operating pressure.

(C) 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.

7.7.4 Means shall be available for operating equipment in the event of failure of normal facilities.

7.8 Protection of Container Accessories.

7.8.1 Valves and regulating, gauging, and other container accessory equipment shall be protected against tampering and physical damage, and where locks are used, they shall be of the frangible shank type.

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

Chapter 8 Buildings or Structures Housing LP-Gas Distribution Facilities

8.1 Scope. [**58:**10.1]

8.1.1 Application. This chapter applies 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:**10.1.1]

8.1.2 Nonapplication. This chapter does not apply to buildings constructed or converted before December 31, 1972. [**58:**10.1.2]

8.2 Separate Structures or Buildings. [**58:**10.2]

8.2.1 Construction of Structures or Buildings. [**58:**10.2.1]

8.2.1.1 Separate buildings or structures shall be one story in height and shall have walls, floors, ceilings, and roofs constructed of noncombustible materials. [**58:**10.2.1.1]

8.2.1.2 Either of the following shall apply to the construction of exterior walls, ceilings, and roofs:

(1) Exterior walls and ceilings shall be of lightweight material designed for explosion venting.
(2) 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:**10.2.1.2]

8.2.1.3 The floor of separate structures shall not be below ground level. [**58:**10.2.1.3]

8.2.1.4 Any space beneath the floor shall be of solid fill, or the perimeter of the space shall be left entirely unenclosed. [**58:**10.2.1.4]

8.2.2 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:

(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.
(2) Outlets shall discharge at least 5 ft (1.5 m) from any opening into the structure or any other structure.
(3) Where natural ventilation is used, each exterior wall shall be provided with one opening for each 20 ft (6.1 m) of length.
(4) 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:**10.2.2]

8.2.3 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 6.20 [of NFPA 58])*, or by electrical appliances listed for Class I, Group D, Division 2 locations, in accordance with NFPA 70, *National Electrical Code*. [**58:**10.2.3]

8.3 Attached Structures or Rooms Within Structures. [**58:**10.3]

8.3.1 Construction of Attached Structures. [**58:**10.3.1]

8.3.1.1 Attached structures shall be spaces where 50 percent or less of the perimeter of the enclosed space is comprised of common walls. [**58:**10.3.1.1]

8.3.1.2 Attached structures shall comply with 8.2.1. [**58:**10.3.1.2]

8.3.1.3 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, 1½ hour (B) fire doors
(3) A design that withstands a static pressure of at least 100 lb/ft^2 (4.8 kPa) [**58:**10.3.1.3]

8.3.1.4 Where the building to which the structure is attached is occupied by operations or processes having a similar hazard, the provisions of 8.3.1.3 shall not apply. [**58:**10.3.1.4]

8.3.1.5 Ventilation and heating shall comply with 8.2.2 and 8.2.3. [**58:**10.3.1.5]

8.3.2 Construction of Rooms Within Structures. [**58:**10.3.2]

8.3.2.1 Rooms within structures shall be spaces where more than 50 percent of the perimeter of the space enclosed is comprised of common walls. [**58:**10.3.2.1]

8.3.2.2 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:**10.3.2.2]

8.3.2.3 Walls, floors, ceilings, or roofs of the rooms shall be constructed of noncombustible materials. [**58:**10.3.2.3]

8.3.2.4 Exterior walls and ceilings shall be of lightweight material designed for explosion venting. [**58:**10.3.2.4]

8.3.2.5 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:**10.3.2.5]

8.3.2.6* 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, 1½ hour (B) fire doors
(3) A design that withstands a static pressure of at least 100 lb/ft^2 (4.8 kPa) [**58:**10.3.2.6]

8.3.2.7 Where the building to which the structure is attached is occupied by operations or processes having a similar hazard, the provisions of 8.3.2.6 shall not apply. [**58:**10.3.2.7]

8.3.2.8 Ventilation and heating shall comply with 8.2.2 and 8.2.3. [**58:**10.3.2.8]

Chapter 9 Vaporizers, Heat Exchangers, and Gas-Air Mixers

9.1 General.

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

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

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

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

9.2 Buildings or Rooms Housing Vaporizers or Gas-Air Mixers. Buildings or rooms housing vaporizers or gas-air mixers shall be in accordance with Chapter 8.

9.3 Vaporizers.

9.3.1 Section 9.3 shall not apply to engine fuel vaporizers or to integral vaporizer-burners such as those used with weed burners or tar kettles.

9.3.2 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 10.7. Fusible plug devices shall not be used.

9.3.3 Indirect vaporizers with an inside diameter of more than 6 in. (150 mm) shall be constructed in accordance with the applicable provisions of ASME *Boiler and Pressure Vessel Code* for a design pressure of not less than 250 psi (1.7 MPa) and shall be permanently 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

9.3.4 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 9.5.1.6 and 9.5.1.7.)*

9.3.5 Design and construction of direct-fired vaporizers shall be in accordance with the applicable requirements of 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

9.3.6 Direct-fired vaporizers shall be provided with automatic means to prevent liquid from passing through the vaporizer to the vapor discharge piping.

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

(B) 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.

(C)* 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 9.3.6(C), which corresponds with the design pressure of the container (or its ASME *Boiler and Pressure Vessel Code* equivalent).

Table 9.3.6(C) 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

9.3.7 Waterbath vaporizers shall comply with 9.3.7.1 through 9.3.7.10.

9.3.7.1 The vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing the LP-Gas to be vaporized, hereinafter referred to as the heat exchanger, shall be constructed in accordance with the applicable provisions of the ASME Code for a MAWP 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 MAWP and temperature for which the heat exchanger is designed
(3) The name or symbol of the manufacturer [**58:**5.19.6.1]

9.3.7.2 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. [**58:**5.19.6.2]

9.3.7.3 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. [**58:**5.19.6.3]

9.3.7.4 Heat exchangers for waterbath vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 5.19.9 [of NFPA 58]. Fusible plug devices shall not be used. [**58:**5.19.6.4]

9.3.7.5 Waterbath sections of waterbath vaporizers shall be designed to prevent a pressure from exceeding the design pressure. [**58:**5.19.6.5]

9.3.7.6 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. [**58:**5.19.6.6]

9.3.7.7 A control to limit the temperature of the waterbath shall be provided. [**58:**5.19.6.7]

9.3.7.8 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. [**58:**5.19.6.8]

9.3.7.9 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 valve and pilot upon flame failure. [**58:**5.19.6.9]

9.3.7.10 The heat source shall be shut off if the level of the heat transfer medium falls below the top of the heat exchanger. [**58:**5.19.6.10]

9.3.8 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 by one of the following:

(1) The maximum vapor-generating capacity (rate) shall be determined when maximum heat is available, assuming that the vaporizing chamber is liquid full, converted to an equivalent air rate.
(2) If the vaporizer is direct fired or if a substantial exterior surface is in contact with the LP-Gas, the pressure relief valve shall be permitted to be sized as if the vaporizer is a pressure vessel.
(3) 150 percent of the rated vaporizing capacity.

9.4* Gas-Air Mixers.

9.4.1 LP-Gas–air mixers shall be designed for the air, vapor, and mixture pressures to which they can be subjected. Piping shall comply with 7.1.1.

9.4.2 LP Gas–air mixers used to supplement (peak-shave) a natural gas supply shall comply with the following:

(1) Gas-air mixers shall be designed to produce a mixture of natural gas, air, and LP-Gas vapor that is interchangeable with the natural gas.
(2) 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 could cause improper combustion in consumer appliances.

9.4.3 A positive valving arrangement, such as a double-block-and-bleed, 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.

(A) Check valves shall not be used to prevent backflow.

(B) 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 permitted to be used as shutdown devices but not as isolation devices.

9.4.4 Where it is possible for condensation to take place between the vaporizer and the LP-Gas–air mixer, a separator or other means shall be provided to prevent LP-Gas liquid from entering the LP-Gas–air mixer.

9.4.5 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.

(A) Mixers using kinetic energy shall be provided with pressure regulation and associated interlocks to prevent significant departure from the design ratio of LP-Gas–air mixture.

(B) Mixers receiving air from a blower, compressor, or any source of air other than directly from the atmosphere shall comply with 9.4.3.

9.5 Vaporizer Installation.

9.5.1 Installation of Indirect-Fired Vaporizers.

9.5.1.1 Separate buildings or structures in which indirect-fired vaporizers are installed shall comply with Section 8.3.

9.5.1.2 Attached structures or rooms in which indirect-fired vaporizers are installed shall comply with Section 8.3.

9.5.1.3 A building or structure in which indirect-fired vaporizers are installed shall not have any unprotected drains to sewers or sump pits.

9.5.1.4 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.

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

(1) If installed within a structure, the structure shall comply with Section 8.2.
(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 8.2.
(3) If installed outdoors, the heat-supplying device 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 9.5.2.
(5) If the heat source serving an indirect vaporizer utilizes a noncombustible heat transfer fluid, such as steam, water, or a water-glycol mixture, it shall be installed outdoors or shall comply with one of the following:
    (a) A source of heat for an indirect vaporizer shall be permitted to be installed in an industrial occupancy complying with Chapter 40 of NFPA *101*, *Life Safety Code*, and Section 9.3 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.

9.5.1.6 The heating-medium piping into and from the vaporizer shall be provided with a 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.

9.5.1.7 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.

9.5.1.8 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 fails.

9.5.1.9 Vaporizers shall be permitted to be an integral part of a fuel storage container, directly connected to either the liquid or the vapor space, or to both.

9.5.1.10 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 9.3.6(C) corresponding with the design pressure of the container or the 1980 ASME *Boiler and Pressure Vessel Code* equivalent.

9.5.2 Installation of Direct Gas-Fired Vaporizers.

9.5.2.1 Direct gas-fired vaporizers shall be permitted to be installed outdoors or in separate structures constructed in accordance with 8.2.1.

9.5.2.2 Where direct gas-fired vaporizers are installed in structures attached to or in rooms within a gas manufacturing or distributing structure (but not buildings used for other purposes), the following criteria shall be met:

(1) The housing provided shall comply with Section 8.2.
(2) The building shall be ventilated near the floor line and the roof.
(3) The wall separating the attached structure or room from all other compartments or rooms containing LP-Gas vaporizers, pumps, and central gas mixing devices shall have no openings.

9.5.2.3 Vapor and liquid connections to vaporizers shall have a manually operated shutoff valve.

9.5.2.4 Direct gas-fired vaporizers of any capacity shall be located in accordance with Table 9.5.2.4.

Table 9.5.2.4 Separation of Vaporizers from Exposures

Exposure	Minimum Distance Required Between Vaporizer and Exposure	
	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

9.5.3 Installation of Waterbath Vaporizers. If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class I, Group D locations, the unit shall be installed in accordance with 9.5.1. All other waterbath vaporizers shall be installed in accordance with 9.5.2.

9.5.4 Installation of Electric Vaporizers. Electric vaporizers shall be installed in accordance with 9.5.1.

9.5.5 Installation of Gas-Air Mixers.

(A) Where a gas-air mixer is installed in a building without a vaporizer, the building shall comply with Section 8.2.

(B) Where a gas-air mixer is installed in a building with an indirect heated vaporizer, the building shall comply with Section 8.2.

(C) Where a gas-air mixer is installed in a building remotely from a vaporizer, the building shall comply with 8.3.2.

(D) Where used with a direct-fired vaporizer, the mixer shall be installed as follows:

(1) Where the mixer is listed or approved, outdoors, in a common cabinet with the vaporizer outdoors, in accordance with 9.5.2.4
(2) Outdoors on a common skid with the vaporizer, in accordance with 9.3.4
(3) Adjacent to the vaporizer to which it is connected, in accordance with 9.3.4
(4) In a building complying with Section 9.2, with no direct-fired vaporizer in the same room

(E) Listed vaporizer-mixers in a common cabinet having a direct-fired-type vaporizer shall be installed outdoors in accordance with the distance provisions in 9.5.2.

(F) Where a listed vaporizer-mixer is not in a common cabinet having a indirect-fired vaporizer and is installed in a building with no sources of ignition, the structure shall comply with 9.1.4.

Chapter 10 Relief Devices

10.1 General.

10.1.1* Relief devices on containers shall be arranged so that the possibility of tampering is minimized.

10.1.2 If the pressure setting or adjustment is external, the relief devices shall be provided with an approved means for sealing the adjustment.

10.1.3 Each container relief device shall be marked with the pressure in pounds per square inch 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).

10.1.4 Testing Relief Devices. Relief devices, other than hydrostatic relief valves, shall be tested for proper operation at intervals not exceeding 5 years.

10.2 Relief Devices for Nonrefrigerated Containers.

10.2.1 ASME containers shall be equipped with one or more pressure relief valves that are designed to relieve vapor. [**58:**5.7.2.1]

10.2.2 ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with applicable requirements of UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas,* or other equivalent pressure relief valve standards. [**58:**5.7.2.4]

(A) The start-to-leak setting of such pressure relief valves, in relation to the pressure rating of the container, shall be in accordance with Table 10.2.2(A). [**58:**5.7.2.4(A)]

Table 10.2.2(A) Start-to-Leak Pressure Settings of Pressure Relief Valves in Relation to Container Pressure Rating

Containers	Minimum	Maximum
All ASME codes prior to the 1949 edition, and the 1949 edition, paragraphs U-68 and U-69	110%	125%*
ASME code, 1949 edition, paragraphs U-200 and U-201, and all ASME codes later than 1949	100%	100%*

*Manufacturers of pressure relief valves are allowed a plus tolerance not exceeding 10 percent of the set pressure marked on the valve. [**58:** Table 5.7.2.4(A)]

(B) Containers of 40,000 gal (151 m^3) or more water capacity shall be equipped with either a spring-loaded pressure relief valve or a pilot-operated pressure relief valve, as follows:

(1) The pilot-operated relief valve shall be combined with and controlled by a self-actuated, direct, spring-loaded pilot valve that complies with Table 10.2.2(A).
(2) The use of a pilot-operated pressure relief valve shall be approved.
(3) Pilot-operated pressure relief valves shall be inspected and maintained by persons with training and experience, and shall be tested for operation at intervals not exceeding 5 years. [**58:**5.7.2.4(B)]

10.2.3 The minimum rate of discharge of pressure relief valves shall be in accordance with Table 10.2.3 or shall be calculated using the following formula:

$$\text{Flow rate } \left(\text{ft}^3/\text{min air}\right) = 53.632 \times A^{0.82}$$

where:
A = total outside surface area of container in square feet [**58:**5.7.2.5]

10.2.4 Relief valves for aboveground ASME containers shall relieve at not less than the flow rate specified in 10.2.3 before the pressure exceeds 120 percent of the minimum permitted start-to-leak pressure setting of the device. This does not include the 10 percent tolerance in Table 10.2.2(A). [**58:**5.7.2.6]

10.2.5 The flow capacity of pressure relief valves installed on underground or mounded containers shall be permitted to be reduced to 30 percent of the flow specified in Table 10.2.3. [**58:**5.7.2.7]

10.2.6 Each pressure relief valve shall be plainly and permanently marked with the following:

(1) The pressure in psig at which the valve is set to start-to-leak
(2) Rated relieving capacity in cubic feet per minute of air at 60°F (16°C) and 14.7 psia (101 kPa)
(3) The manufacturer's name and catalog number [**58:**5.7.2.8]

10.2.7 Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold meeting the requirements of 6.7.2.9 [of NFPA 58] is used. [**58:**5.7.2.9]

10.2.8 Pressure relief valves shall be designed to minimize the possibility of tampering. [**58:**5.7.2.10]

10.2.9 Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment. [**58:**5.7.2.11]

10.2.10 Where used on aboveground containers of 1200 gal (4.5 m^3) or less in addition to spring-loaded pressure relief valves, fusible plugs shall be in accordance with the following:

(1) Have a yield point between 208°F and 220°F (98°C and 104°C)
(2) Have a total discharge area not exceeding 0.25 $in.^2$ (16,100 mm^2)
(3) Communicate directly with the vapor space of the container [**58:**5.7.2.12]

Table 10.2.3 Pressure Relief Valve Flow Capacity as a Function of Container Surface Area

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	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	—	—

[**58:**Table 5.7.2.5]

10.3 Relief Devices for Refrigerated Containers.

10.3.1 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)

10.3.2 Relief devices shall communicate directly with the atmosphere.

10.3.3 Vacuum-relieving devices shall be installed if the container can be exposed to a vacuum condition in excess of that for which the container is designed.

10.3.4 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.

10.3.5* Each pressure and vacuum pressure relief valve for refrigerated LP-Gas containers shall be able to be isolated from the container for maintenance or other purposes by means of a manual full-opening isolation valve.

(A) This isolation valve shall be lockable or sealable in the fully open position.

(B) Sufficient pressure and vacuum relief valves shall be installed on the refrigerated LP-Gas container to allow each relief valve to be isolated individually for testing or maintenance while maintaining the full relieving capacities required.

(C) 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.

10.3.6 Isolation 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.

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

10.4 Relief Device Sizing.

10.4.1 Aboveground Containers. Pressure relief devices shall be sized based on the largest flow capacity determined by the largest single condition or any reasonable and probable combination of conditions, including 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

10.4.2 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.

10.4.3 Vacuum Relief. The vacuum relief devices shall be sized to relieve the flow capacity determined for the largest single condition or any reasonable and probable combination of conditions 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

(A) The requirement for vacuum relief capacity by the rate of vaporization that results from minimum normal heat gain to the contents.

(B) No vacuum relief capacity credit shall be permitted for gas repressuring or vapor make-up systems.

10.5 Fire Exposure.

10.5.1 The pressure relieving capacity required for fire exposure in uninsulated containers 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
F = environmental factor as provided in Table 10.5.1
L = latent heat of vaporization of the stored liquid at the relieving pressure and temperature in Btu/lb (J/g)
A = exposed wetted surface area of the container in ft^2 (m^2) in the case of large containers, the area up to a height of 30 ft above grade
H_n = normal heat leak in refrigerated tanks in Btu/hr (W)

Table 10.5.1 Environmental Factor, *F*

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	$F = U\frac{(1660 - T_f)}{34{,}599}$

Note: U is the overall heat transfer coefficient Btu/(hr × ft^2 × °F) [W/(m^2 × °C)] of the insulation system using the mean value for the temperature range from T_f to +1660°F (904°C). T_f is the temperature of vessel content at relieving conditions, °F (°C).

10.5.2 Insulated Containers.

10.5.2.1 Insulation shall meet the following criteria:

(1) It shall resist dislodgement by fire-fighting equipment, as determined by the user.
(2) It shall be noncombustible.
(3) It shall not decompose at temperatures up to 1000°F.

10.5.2.2 If the insulation does not meet the criteria in 10.5.2.1, no credit for the insulation shall be taken.

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

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

where:
SCFM (air) = equivalent air flow in standard ft^3/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

10.5.3 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.

10.6 Pressure Relief Valve Discharge Vents.

10.6.1 All discharge vents from the pressure relief valves or common discharge headers shall be as follows:

(1) They shall lead to the open air.
(2) They shall be protected against mechanical damage.
(3) 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.

10.6.2 All discharge vents from the pressure relief valves or common discharge headers shall be installed to achieve discharge in an area that meets the following:

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

10.6.3 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.

10.7 Aboveground Containers.

10.7.1 The discharge from the relief devices shall be vented away from the container and shall be unobstructed to the open air.

(A) The vents shall be fitted with loose-fitting rain caps.

(B) 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.

(C) The vent piping shall extend upward at least 7 ft (2.2 m) above the top of the container.

10.8 Underground and Mounded Containers.

10.8.1 The discharge pipe from pressure relief devices shall extend directly and vertically upward at least 7 ft (2.2 m) above the ground.

10.8.2 If liquid product is placed in containers while they are not buried, the pressure relief valve sizing shall be that of aboveground containers.

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

10.9 Vaporizers.

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

10.9.2 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.

10.10 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.

10.10.1 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).

10.10.2 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 11 Operations

11.1 Operating Procedures Manuals.

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

11.1.2 Operating procedures manuals shall include operator actions to be taken if flammable concentrations of flammable liquids or gases are detected in the facility using the following:

(1) Fixed detectors
(2) Portable detectors
(3) Operating malfunctions
(4) Human senses

11.1.3 Where human senses are relied on, a schedule of tours of the facility shall be included in the operating procedures.

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

11.1.5 Operating procedures for vaporizers shall include the following:

(1) Maintenance of vaporization rate
(2) Pressure control
(3) Temperature control
(4) Specific actions to be taken when parameters exceed normal operating limits and criteria for emergency shutdown

11.1.6 Where LP-Gas is stored as a refrigerated liquid, operating procedures shall include procedures to minimize the release of flammable gases to the atmosphere, including monitoring of liquid temperature and pressure and procedures to be taken if these exceed operating limits.

11.2 Handling.

11.2.1 Transfer of Liquids Within a Utility Plant.

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

11.2.1.2 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.

11.2.1.3 Transfer operations shall be conducted by individuals 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.

11.2.1.4 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.

11.2.1.5 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 5.2.1 or 5.2.2 and with 5.2.3.

11.2.1.6 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.

11.2.1.7 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.

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

11.2.2 Tank Car Loading and Unloading Point, Railroad Tank Car and Cargo Tank Vehicle Transfer Areas. Transfer areas in new installations and all existing installations as of December 31, 2005, shall meet the requirements of 11.2.2.1 through 11.2.2.7.

11.2.2.1 Where a hose or swivel-type piping 1½ in. (38 mm) or larger is used for liquid transfer or a 1¼ in. (32 mm) or larger vapor hose or swivel-type piping is used in this service, an emergency shutoff valve complying with 7.1.4 shall be installed in the fixed piping of the transfer system within 20 ft (6.1 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.

11.2.2.2 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.

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

11.2.2.4* 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.

11.2.2.5 Emergency shutoff valves shall be maintained in working order.

11.2.2.6 Emergency shutoff valves and check valves required by Section 11.2 shall be tested annually for proper operation. The results of the tests shall be documented.

11.2.2.7 All new installations and by December 31, 2005, all 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.

11.2.3 Tank Car Loading and Unloading Point.

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

11.2.3.2* 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.

11.2.3.3 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.

11.2.4 Cargo Tank Vehicle Loading and Unloading.

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

11.2.4.2 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.

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

11.2.5 Tank Truck Loading and Unloading.

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

11.2.5.2 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.

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

11.3 Operating Records.

11.3.1 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 request during normal office hours.

11.3.2 Operating log sheets required under 11.3.1 shall be retained for at least 5 years.

Chapter 12 Maintenance

12.1 Maintenance Manuals.

12.1.1 Maintenance manuals for normally attended facilities shall be kept at the facility and shall be available to maintenance personnel.

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

12.1.3 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

12.2 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 as soon as maintenance is complete.

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

12.4 Purging Prior to Maintenance. All equipment that contains flammable or hazardous materials shall be purged in accordance with 11.1.4 prior to beginning maintenance procedures.

12.5 Maintenance Records.

12.5.1 Each facility shall maintain a record of all maintenance log sheets of process equipment.

(A) The records shall be made available to the authority having jurisdiction upon reasonable request.

(B) Maintenance records for normally unattended facilities shall be permitted to be stored at the unattended facility or at another location.

12.5.2 Records that are required under 12.5.1 shall be retained for the life of the equipment, while in use, and for 3 years thereafter.

Chapter 13 Fire Protection, Safety, and Security

13.1 General.

13.1.1* Fire protection shall be provided for all utility gas plants.

(A) The extent of fire protection shall be determined by an evaluation based on the following:

(1) Type (refrigerated or nonrefrigerated), quantity, and size of storage containers
(2) Local conditions
(3) Hazards within the facility
(4) Exposure to and from other property

(B) The evaluation shall consider the following, as a minimum:

(1) Time of response and effectiveness of local emergency response agencies
(2) Type, quantity, and location of equipment necessary for the detection and control of potential nonprocess and electrical fires
(3) Methods necessary for protection of 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) Availability and duties of individual plant personnel and availability of external response personnel during an emergency
(8)*Protective equipment and special training needed by individual plant personnel for their respective emergency duties
(9) Need for permanently mounted combustible gas detection system or permanently mounted fire detection system

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

13.1.3 A detailed emergency procedures manual shall be prepared to cover the potential emergency conditions that can develop whether or not a fire has occurred.

(A) Emergency 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

(B) The emergency procedures manual shall be kept in the operating control room or at a constantly attended location if the plant site is not continually manned.

(C) The emergency procedures manual shall be reviewed and updated annually and as required by changes in equipment or procedures.

13.1.4 All personnel shall be trained in their respective duties contained in the emergency procedures manual.

13.1.5 Those personnel responsible for the use of fire protection or other plant emergency equipment shall be trained annually in the use of that equipment.

13.1.6 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, which are expected to respond to such emergencies.

13.2 Fire and Leak Detection.

13.2.1 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 13.1.1.

13.2.2 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.

13.2.3 Flammable gas detection systems shall alarm at not more than 25 percent of the lower flammable limit of the gas or vapor being monitored.

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

13.3 Container Protection. Nonrefrigerated storage containers shall be protected against fire exposure by one of the following means, unless an evaluation in accordance with 5.5.2 indicates that protection is not needed.

13.4 Fire Protection Water Systems.

13.4.1 General. 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 13.1.1 indicates that the use of water is unnecessary or impractical.

13.4.2 Design. The design of fire water supply and distribution systems, where used, shall provide for the simultaneous supply of those fixed fire protection systems involved in the maximum single incident expected in the plant, including monitor nozzles, at their design flow and pressure.

(A) 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.

(B) Manually actuated monitors shall be permitted to be used to augment hand hose streams.

13.4.3 General.

13.4.3.1 The planning for the response to incidents, including the inadvertent release of LP-Gas, fire, or security breaches, shall be coordinated with local emergency response agencies such as fire and police departments. Planning shall include the safety of emergency personnel, workers, and the public.

13.4.3.2* Fire protection shall be provided for installations with an aggregate water capacity of more than 4000 gal (15.1 m^3) and of ASME containers on roofs. The modes of such protection shall be specified in a written product release prevention and incident preparedness review. The review shall be made available to the authority having jurisdiction and local emergency responders upon request. The product release prevention and incident preparedness review shall be reviewed and revised when storage capacity or transfer equipment is modified.

(A) A primary consideration in any such product release prevention and incident preparedness review shall be an evaluation of the total product control system, including emergency shutoff and internal valves equipped for remote closure and automatic shutoff using thermal (fire) actuation pullaway protection and the optional requirements of Section 5.9, if used.

(B) Where a written fire safety analysis exists, a product release prevention and incident preparedness review shall not be required.

(C) If in the preparation of the product release prevention and incident preparedness review it is determined that a hazard to adjacent structures exists that exceeds the protection provided by the provisions of this code, special protection shall be provided in accordance with 13.4.2.

13.4.4 Special Protection.

13.4.4.1* If insulation is used, it shall comply with NFPA 290, *Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers.*

13.4.4.2 If mounding is used, the provisions of 6.6.6.3 of NFPA 58, *Liquefied Petroleum Gas Code*, shall constitute adequate protection.

13.4.4.3 If burial is used, the provisions of 6.6.6.1 of NFPA 58 shall constitute adequate protection.

13.4.4.4 If water spray fixed systems are used, they shall 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.

13.4.4.5 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.

13.4.5 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 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 Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose*
(9) NFPA 1963, *Standard for Fire Hose Connections*

13.5 Fire-Extinguishing and Other Fire Control Equipment.

13.5.1 Portable or wheeled fire extinguishers that are recommended for gas fires of the dry chemical type shall be available at strategic locations, as determined in accordance with 13.1.1, within the facility.

13.5.2 The minimum size portable dry chemical extinguisher shall be 18 lb (8.2 kg) with a B:C rating.

13.5.3 Fixed fire-extinguishing and other fire control systems can be appropriate for the protection of specific hazards as determined in accordance with 13.1.1. 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-, Medium-, and High-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*

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

13.7 Personnel Safety.

13.7.1 Employees assigned personal protective equipment shall be trained in its proper use.

13.7.2 Each utility gas plant shall have first-aid materials to handle a reasonably anticipated emergency.

13.7.3 Personnel shall be advised of the danger of frostbite, which can result from contact with LP-Gas liquid or cold refrigerants.

13.7.4 Protective clothing and equipment shall be available.

13.7.5 Those employees who will be involved in emergency activities, as determined in accordance with 13.1.1, shall be equipped with the necessary clothing and equipment.

13.7.6 Protective clothing shall comply with NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, and shall have an impermeable outer shell.

13.7.7 Those employees requiring such protective clothing also shall be equipped with helmets, face shields, gloves, and boots that are recommended for LP-Gas.

13.7.8 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.

13.7.9 Such apparatus shall comply with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services*, and shall be maintained in accordance with the manufacturer's instructions.

13.7.10 A portable flammable gas detector shall be readily available.

13.8 Security.

13.8.1 Each facility operator shall have a security system with controlled access, which shall be designed to minimize entry by unauthorized persons.

13.8.2 A protective enclosure including a peripheral fence, building wall, or natural barrier shall be provided to enclose 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

(A) The location and arrangement of protective structures shall minimize the following:

(1) Pocketing of escaping gas
(2) Interference with the application of cooling water by fire departments
(3) Redirection of flames against containers
(4) Impeding egress of personnel in an emergency

(B) As an alternative to fencing the operating area, devices that can be locked in place shall be provided.

(C) Such devices, when in place, shall prevent unauthorized operation of any of the container appurtenances, system valves, or equipment.

13.8.3 The provisions of 13.8.2 shall be met by either one continuous enclosure or several independent enclosures or other approved means.

13.8.4 At least two exit gates or doors shall be provided for rapid escape of personnel in the event of an emergency.

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

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

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex 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 U.S. Department of Transportation, 49 CFR 192. *(See Figure A.1.1.1.)*

A.3.2.1 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.

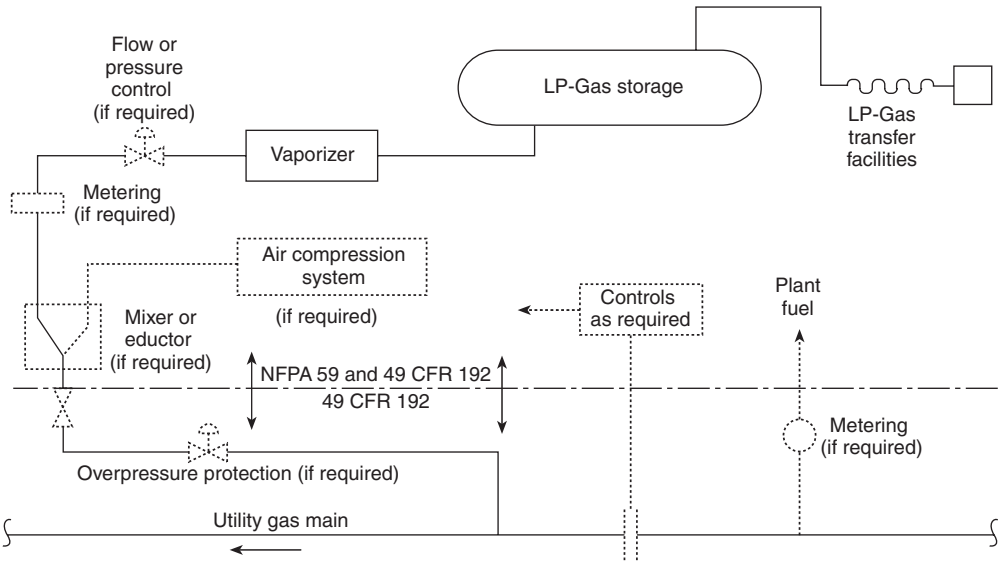

FIGURE A.1.1.1 Typical Installation of an LP-Gas Air Base or Peaking Facility, LP-Gas Vapor Base Load, or Enrichment Facility.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.5 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.3.3.5 Fire Protection. *Fire prevention* covers measures directed at avoiding the inception of fire or the escalation of an incident following the accidental or inadvertent release of LP-Gas. Such measures could include product control equipment and the insulation, mounding, or burial of containers.

Fire detection covers equipment that detects the presence of fire or heat to either initiate automated operation of the product control or other process equipment, or to initiate local or remote alarms.

Fire suppression covers means of supplying water or other agents providing for fire control, exposure protection, or fire extinguishment. [**58:**A.3.3.24]

A.3.3.7 Gas-Air Mixer. A gas-air mixture normally is used in industrial or commercial facilities as a substitute for another fuel gas. [**58:**A.3.3.29]

A.3.3.16 Special Protection. Where required in this code, special protection consists of one of the following:

(1) Applied insulating coating
(2) Mounding
(3) Burial
(4) Water spray fixed systems
(5) Fixed montor nozzles that meet the criteria specified in this code
(6) Any means listed for this purpose

See Section 6.23 [of NFPA 58] for more information on fire protection and special protection. [**58:**A.3.3.68]

A.3.3.18 Utility Gas Plant. In the United States, utility gas plants and gas distribution systems are subject to the requirements of 49 CFR Part 192, "Pipeline Safety Law."

A.4.2 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 4.2 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 4.2 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 4.2. The lower limits of flammability of the more commonly used liquefied petroleum gases are approximately 2 percent for propane and approximately 1.5 percent for butane. These figures represent volumetric percentages of gas in a gas-air mixture in each case. (Odorant research includes BERC/RI-77/1, *A New Look at Odorization Levels for Propane Gas.*)

A.4.5.1.2 For information on lightning protection, see NFPA 780, *Standard for the Installation of Lightning Protection Systems.* [**58:**A.6.20.1.2]

A.4.5.1.3 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.6.20.1.3]

A.4.5.2.2 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 can 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:**6.20.2.2]

See Figure A.4.5.2.2. [**58:**A.6.20.2.3]

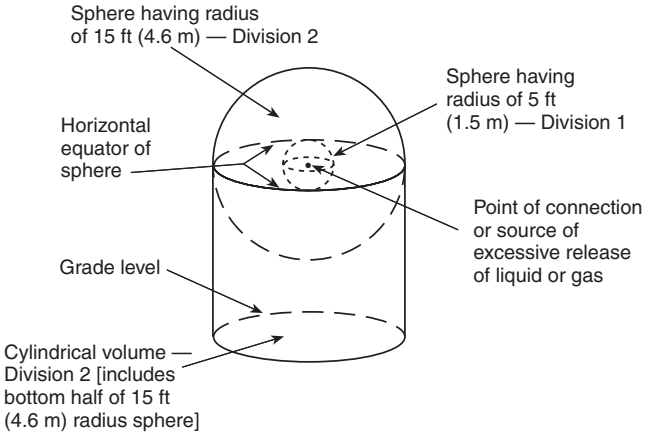

FIGURE A.4.5.2.2 Extent of Electrically Classified Area. ***(See Table 4.5.2.2.)*** **[58:Figure A.6.20.2.3]**

A.4.5.3.4 The installation of vaporizers and vaporizing burners is covered in Section 6.19 [of NFPA 58]. [**58:**A.6.20.3.4]

A.4.8.5 Static grounding or bonding protection is not required where 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.4.8.6 For additional information, see API RP 2003, *Protection Against Ignitions Arising out of Static, Lightning and Stray Currents.*

A.5.2.1 See Annex 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.5.3.2(8) Head design refers to the shape of the head. Shapes include hemispherical, semi-ellipsoidal, and others. Refer to ASME *Boiler and Pressure Vessel Code* for more information.

A.5.4.1.9 For information on determination of flash points see NFPA 30, *Flammable and Combustible Liquids Code.* [**58:**A.6.4.5.3]

A.5.5.1.10 For LP-Gas fixed storage facilities of 60,000 gal (227 m^3) water capacity or less, a competent fire safety analysis *(see 13.1.1)* could indicate that applied insulating coatings are often the most practical solution for special protection.

A.5.5.2.9 For information on corrosion protection, see NACE RP-01-69, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems.*

A.6.3.4.2 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*, Annex C, for further information. [**58:**A.12.3.4.2]

A.7.1.8 It should be recognized that the temperature of liquid propane will drop to about −40°F (−40°C) when released to the atmosphere.

A.7.4.5 Refer to Annex B for information on calculating the filling point for which the tube should be designed.

A.8.3.2.6 See NFPA 80, *Standard for Fire Doors and Fire Windows.*

A.9.3.6(C) See NFPA 58, *Liquefied Petroleum Gas Code*, Annex 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.9.4 For more information on personnel safety, see AGA *Introduction to LPG Safety for Propane Air Plant Operators.*

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.10.1.1 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 an API-commissioned study by Battelle Memorial Institute, "The Effect of Velocity, Temperature, and Gas Molecular Weight on Flammability Limits in Wind-Blown Jets of Hydrocarbon Gases."

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, as either a fog or a 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.10.3.5 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.

A.11.1.4 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.11.2.2.4 Anchorage can be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting.

A.11.2.3.2 The U.S. Department of Transportation (DOT) was formerly the Interstate Commerce Commission (ICC), and its rules are published in 49 CFR 171–190. In Canada, the regulations of the Canadian Transport Commission for Canada apply.

A.13.1.1 The first consideration in such an analysis should be the use of water applied by hose streams 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.

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 fire sufficient to result in container failure failed 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.13.1.1(B)(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.13.2.4 Information on detection systems can be found in *NFPA 72, National Fire Alarm Code®*, and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*.

A.13.4.3.2 In recent years the concept of total product control systems has been developed. Facilities that have redundant automatic product control systems provide a high level of confidence that propane will not be released during an emergency. Therefore, not only would the storage be protected from a fire that could lead to container rupture, but major fires at the facility would be prevented. The public would be protected, fire-fighting operations would be safer, and applications of large quantities of water would not be needed to prevent tank failure.

An incident prevention review should include the following:

(1) The effectiveness of product control measures
(2) An analysis of local conditions of hazard within the container site
(3) Exposure to or from other properties, population density, and congestion within the site
(4) The probable effectiveness of plant personnel or local fire departments based on available water supply, response time, resources, and training.

In the preparation of the incident prevention review, the owner/operator of the installation should cooperate with the local emergency response agencies in the preparation of their own preplanning and emergency response plans. To the extent practical, the owner/operator should promote pre-incident visits to the installation by members of the responding agencies.

A.13.4.4.1 It is recommended that insulation systems be evaluated on the basis of experience or listings by an approved testing laboratory.

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

This annex 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 aboveground 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 5.7.2. 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 that factor into Equation [B.3(a)]. The average liquid temperature can be obtained in 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 method, 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.

Table B.2 Liquid Volume Correction Factors

Observed Temperatures	Specific Gravities at 60°F/60°F												
	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

(continues)

Table B.2 *Continued*

Observed Temperatures (°F)	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
	Specific Gravities at 60°F/60°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

B.3 If 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 are known, the maximum quantity that can be placed in a container is determined as follows:

$$V = \frac{D}{G \times F} \qquad \textbf{[B.3(a)]}$$

where:

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

D = filling density from Table 5.7.2 (percentage)

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, at the top of Table B.2 and going down that column to the actual liquid temperature, T. 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, 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:

$$\frac{V}{100} \qquad \textbf{[B.3(b)]}$$

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 the container. The filling density from Table 5.7.2 for an aboveground container with a capacity greater than 1200 gal (4.5 m^3) in which a product with 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:

$$Q_{60}F = \frac{45 \times 10{,}000}{0.058 \times 100} = 8860 \text{ gal } (33.5 \text{ m}^3) \qquad \textbf{[B.3(c)]}$$

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:

$$Q_{82}F = \frac{45 \times 10{,}000}{0.058 \times 0.963 \times 100} = 9200 \text{ gal } (34.8 \text{ m}^3) \qquad \textbf{[B.3(d)]}$$

Annex C Method of Calculating Maximum Volume of Liquefied Petroleum Gas That Can Be Placed in a Container for Which Length of Fixed Drip Tube Is Set

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

C.1 It is impossible to list in a table the lengths of a fixed dip tube for containers of various capacities because of the varying container diameters and lengths and because a container can be installed in either a vertical or a horizontal position. If the maximum permitted filling volume in gallons is known, 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.

$$\frac{\text{Water capacity of container (gal)}^{*} \times \text{Filling density}^{**}}{\text{Specific gravity of LP-Gas}^{*} \times \text{Volume Correction Factor}^{\dagger} \times 100} = \text{Maximum volume of LP-Gas (gal)} \quad \textbf{[C.2(a)]}$$

*Measured at 60°F (15.6°C)

**From Table 5.7.2

†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 7.4.5 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.

$$\frac{30{,}000 \times 45}{0.510 \times 1.031 \times 100} = \frac{1{,}350{,}000}{52.58} \quad \textbf{[C.2(b)]}$$

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

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:

$$\frac{(\text{Result of Equation [C.2(a)]}) \times 100}{\text{Total water content of container (gal)}} = \text{Maximum volume of LP-Gas (gal)}$$

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 Equation [C.2(b)] 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. The weights for LP-Gases are specified in Table C.4(a), and volume correction factors are listed in Table C.4(b).

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

	For Aboveground Containers (lb/gal)	For Underground Containers (lb/gal)
Propane	4.37	4.31
Butane	4.97	4.92

Table C.4(b) Volume Correction Factors

Specific Gravity	Aboveground Containers	Underground Containers
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

Annex D Relief Device Sizing

This annex 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:

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

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.