NFPA®

59

Utility LP-Gas Plant Code

2021

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NFPA® 59

Utility LP-Gas Plant Code

2021 Edition

This edition of NFPA 59, *Utility LP-Gas Plant Code*, was prepared by the Technical Committee on LP-Gases at Utility Gas Plants. It was issued by the Standards Council on March 15, 2020, with an effective date of April 4, 2020, and supersedes all previous editions.

This edition of NFPA 59 was approved as an American National Standard on April 4, 2020.

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, 2001, 2004, 2008, 2012, and 2015.

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's 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 included reorganization of the document to conform to the *Manual of Style for NFPA Technical Committee Documents*.

For the 2008 edition, the committee expanded extracts from NFPA 58, where the coverage was similar, to provide users of NFPA 59 a more complete document. Many requirements of the code were clarified, and the organization of the document was simplified.

For the 2012 edition, a new section on corrosion protection was added that largely extracted existing requirements from 49 CFR 193. Those requirements were included in NFPA 59 to increase awareness of corrosion control requirements and to align requirements among similar types of gas process facilities. The committee also added a new section on training of personnel engaged in the maintenance or operation of propane-air mixing equipment. In addition, the 2012 edition included a new section on construction and modification records that required operators to maintain records of the materials of construction for process equipment piping systems containing LP-Gas and other flammable fluids, including their supporting system and foundations for plants that were built or modified after the effective date of the 2012 edition. The requirements for separation distances for containers less than 2000 gal (7.6 m^3) were extracted from NFPA 58 because more plants covered under the scope of NFPA 59 were using these smaller containers. The requirement for vent stacks on nonrefrigerated aboveground containers was removed because studies showed that the dispersion of discharged vapor was not a safety issue.

In the 2015 edition, the scope in 1.1.1 was clarified to identify the demarcation between NFPA 59 and applicable pipeline regulations published by the Department of Transportation (DOT). Building ventilation requirements in Chapter 8 were expanded to specify the purpose and activation of the ventilation system. In addition, Chapter 9 was restructured for clarity and a new subsection was created to consolidate requirements for gas-fired vaporizers. The sizing method for nonrefrigerated

container relief devices in Section 10.2 was modified for propane storage over 300 psi and butane storage over 250 psi to provide more accurate sizing for higher pressure and butane containment.

Finally, the corrosion protection requirements in Section 12.3 was expanded to reflect current DOT regulations and common practices. The requirements for Chapter 12 were retroactive to all facilities, and a schedule for retroactivity of corrosion control requirements was added in 12.3.8.

For the 2018 edition, the technical committee added a purpose statement. Various extracts were updated, and vehicular fuel operations were removed because it was determined that vehicular fuel operations were outside the scope of this code. For containers taken out of service for a year, the *National Board Inspection Code* was to be used to determine the suitability of placing it back into service. Chapter 6, the refrigerated container chapter, was updated to reflect industry practices and external standard development. The committee also determined that instead of protecting only outside piping from physical damage and corrosion, all piping must be protected.

In addition, it was determined that it was no longer appropriate to use operating malfunctions to detect leaks. Installation of corrosion protection was moved from Chapter 12 to Chapter 4. New definitions for *component*, *facility*, *plant*, and *process pressure vessel* were added, and several sections were also added or revised to reflect the new definitions. New piping cover requirements were added to Chapter 7. Table 4.5.2.2 was revised to match the 1998 version of this code for relief valve discharge electrical area classification.

Finally, clarification was added for fire protection systems citing additional existing NFPA standards, and the term *fire control* was replaced with *fire protection*.

The 2021 edition of NFPA 59 now has a table in the retroactivity section to identify the edition in which retroactive requirements were incorporated and the effective dates of those requirements. Additionally, whenever purging is conducted, it is to be done in accordance with the American Gas Association's *Purging Manual*.

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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.

Contents

NFPA 59

Utility LP-Gas Plant Code

2021 Edition

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

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced and extracted 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 including LP-Gas containers, piping, and associated process equipment, and controls and fire protection. Coverage begins at:

(A) The point of transfer when delivery is by cargo tank vehicle or railcar.
(B) The liquid inlet isolation valve located downstream of hazardous liquid pipeline under the jurisdiction of 49 CFR 195, "Transportation of Hazardous Liquids by Pipeline."
(C) Coverage shall extend to the point where LP-Gas vapor or a mixture of LP-Gas vapor and air is introduced into the utility distribution system under the jurisdiction of 49 CFR 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards."

1.1.2 Installations that have an aggregate water capacity of 4000 gal (15.14 m^3) or less shall conform to NFPA 58.

1.2 Purpose. The purpose of this standard is to provide minimum fire protection, safety, and related requirements for the location, design, construction, security, operation, and maintenance of utility LP-Gas plants.

1.3 Nonapplication of Code. This code shall not apply to the following:

(1) The design, construction, installation, and operation of marine terminals whose primary purpose is the receipt of LP-Gas for delivery to transporters, distributors, or users.
(2) The design, construction, installation, and operation of pipeline terminals whose primary purpose is the receipt of LP-Gas for delivery to transporters, distributors, or users
(3) Operations that involve the liquid transfer of LP-Gas into cylinders or portable tanks *(See NFPA 58)*
(4) Portions of LP-Gas systems covered by NFPA 54 where NFPA 54 is adopted, used, or enforced
(5) Frozen ground containers and underground storage in caverns including piping that is a part of or within the frozen ground container or cavern

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

1.4.1* 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.

1.4.2 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.

1.4.3 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.

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1.5 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.

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

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

1.6 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.)*

1.7 Pressure Measurement. All pressures expressed in this code are gauge pressures unless specifically noted otherwise.

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 10, *Standard for Portable Fire Extinguishers,* 2018 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2016 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2018 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2019 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2019 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2017 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2021 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2019 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection,* 2018 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2019 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2020 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2021 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2019 edition.

NFPA 54, *National Fuel Gas Code,* 2021 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2020 edition.

NFPA 70®, National Electrical Code®, 2020 edition.

NFPA 72®, National Fire Alarm and Signaling Code®, 2019 edition.

NFPA *101®, Life Safety Code®,* 2021 edition.

NFPA 290, *Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers,* 2018 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2020 edition.

NFPA 1961, *Standard on Fire Hose,* 2020 edition.

NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances,* 2018 edition.

NFPA 1963, *Standard for Fire Hose Connections,* 2019 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* 2018 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services,* 2019 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2018 edition.

2.3 Other Publications.

2.3.1 ACI Publications. American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331-3439.

ACI 376-11, *Code Requirements for Design and Construction of Concrete Structures for the Containment of Refrigerated Liquefied Gases,* 2013.

N **2.3.2 AGA Publications.** American Gas Association, 400 North Capitol Street, NW, Washington, DC 20001.

Purging Manual, 4th edition, 2018.

2.3.3 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API SPEC 6FA, *Standard for Fire Tests for Valves,* 4th edition, 2018.

API STD 607, *Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats,* 7th edition, 2016.

API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 12th edition, 2013, addendum 1, 2014, addendum 2, 2018.

API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage,* 1st edition, 2010, addendums 1–3, 2018.

Δ **2.3.4 ASCE Publications.** American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures,* 2016.

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

ASME B31.3, *Process Piping,* 2016.

ASME *Boiler and Pressure Vessel Code,* 2017.

2.3.6 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings,* 1999 (reapproved 2018).

ASTM A395/A395M, *Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* 1999 (reapproved 2018).

ASTM A536, *Specifications for Ductile Iron Castings,* 1984 (reapproved 2014).

2.3.7 CSA Group Publications. CSA Group, 178 Rexdale Boulevard, Toronto, ON M9W 1R3, Canada.

CSA B51, *Boiler, Pressure Vessel, and Pressure Piping Code,* 2014.

N **2.3.8 National Board Publications.** National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, OH 43229.

NBBI/NB23, *National Board Inspection Code,* 2017.

Δ **2.3.9 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 132, *Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, 2015.

2.3.10 US Government Publications. US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 49, Code of Federal Regulations, Part 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards."

Title 49, Code of Federal Regulations, Part 195, "Transportation of Hazardous Liquids by Pipeline."

2.3.11 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 54, *National Fuel Gas Code,* 2018 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2017 edition.
NFPA 5000®, Building Construction and Safety Code®, 2018 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 defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

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 API. American Petroleum Institute. [**58,** 2017]

3.3.2 ASME. American Society of Mechanical Engineers. [**58,** 2017]

3.3.3 ASME Code. The American Society of Mechanical Engineers *Boiler and Pressure Vessel Code.* [**58,** 2017]

3.3.4 ASME Container. A container constructed in accordance with the *ASME Code.* [**58,** 2017]

3.3.5 ASTM. American Society for Testing and Materials.

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

3.3.7 Cargo Tank. A container that is used to transport LP-Gas as liquid cargo that either is mounted on a conventional truck chassis or is an integral part of a cargo transporting vehicle. [**58,** 2017]

3.3.8 Competent Person. One who is trained in identifying existing and predictable hazards and who has authorization to take prompt corrective measures to eliminate them.

3.3.9* Component. A uniquely identifiable part, piece, assembly, or subassembly that performs a distinctive and necessary function in the operation of a LP-Gas facility or system.

3.3.10 Container. Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for the transporting or storing of LP-Gases. [**58,** 2017]

3.3.11 Container Appurtenances. Devices installed in container openings for safety, control, or operating purposes. [**58,** 2017]

3.3.12 Corrosion.

3.3.12.1 ***Localized Corrosion.*** Type of corrosion where all or most of the metal loss occurs at discrete areas.

3.3.12.2 ***Uniform Corrosion.*** Type of corrosion characterized by an even, regular loss of metal over large areas of the component.

3.3.13 Facility. A number of components installed and designed to function as an independent process as part of an LP-Gas plant.

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

3.3.15 Filling Density. The percent ratio of the weight of the LP-Gas in a container to the weight of water at 60°F (16°C) that the container will hold.

3.3.16* Fire Protection. Methods used to achieve any of the following: fire prevention, fire detection, and fire suppression.

3.3.17 Gallon, U.S. Standard. 1 U.S. gal = 0.833 Imperial gal = 231 $in.^3$ = 3.785 L. [**58,** 2017]

3.3.18* Gas. For the purposes of this code, liquefied petroleum gas (LP-Gas) in either the liquid or vapor state. [**58,** 2017]

3.3.19* 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,** 2017]

3.3.20 Gauge.

3.3.20.1 ***Fixed Liquid Level Gauge.*** A liquid level indicator that uses a positive shutoff vent valve to indicate that the liquid level in a container being filled has reached the point at which the indicator communicates with the liquid level in the container. [**58,** 2017]

3.3.20.2 ***Fixed Maximum Liquid Level Gauge.*** A fixed liquid level gauge that indicates the liquid level at which the container is filled to its maximum permitted filling limit. [**58,** 2017]

3.3.20.3 ***Float Gauge.*** A gauge constructed with an element installed inside the container that floats on the liquid surface and transmits its position to a device outside the container to indicate the liquid level. [**58,** 2017]

3.3.20.4 ***Rotary Gauge.*** A variable liquid level gauge consisting of a small positive shutoff vent valve located at the outside end of a tube that has a bent end inside the container and can be manually rotated to determine the liquid level in the container. It is equipped with a pointer and an outside dial to indicate the liquid level.

3.3.20.5 ***Slip Tube Gauge.*** A variable liquid level gauge in which a small positive shutoff valve is located at the outside end of a straight tube, normally installed vertically, that communicates with the container interior, and can be manually moved to determine the liquid level in the container.

3.3.21 Industrial Occupancy. An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted. [**5000,** 2018]

3.3.22 kPa. Absolute pressure in kilo-Pascals. [**58,** 2017]

3.3.23 kPag. Gauge pressure in kilo-Pascals. [**58,** 2017]

3.3.24 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 (except propylene) or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. [**58,** 2017]

3.3.25 Maximum Allowable Working Pressure (MAWP). The maximum pressure at which a pressure vessel is to operate as described by the ASME *Boiler and Pressure Vessel Code*. [**58,** 2017]

3.3.26 Mounded Container. An ASME container designed for underground service installed above the minimum depth required for underground service and covered with earth, sand, or other material, or an ASME container designed for aboveground service installed above grade and covered with earth, sand, or other material. [**58,** 2017]

3.3.27 Permitted. Allowed or acceptable, and not requiring a permit (a document granting permission) to be secured. [**58,** 2017]

3.3.28 Plant. The entirety of facilities, buildings, and related structures co-located on a single or adjacent property.

3.3.29 Point of Transfer. The location where connections and disconnections are made or where LP-Gas is vented to the atmosphere in the course of transfer operations. [**58,** 2017]

3.3.30 Portable Tank. A container of more than 1000 lb (454 kg) water capacity that is equipped with protected container appurtenances, is used to transport LP-Gas, and is designed and fabricated with permanently mounted skids or runners or is fabricated and installed within a full framework. [**58,** 2017]

3.3.31 Pressure Relief Device. A device designed to open to prevent a rise of internal pressure in excess of a specified value. [**58,** 2017]

3.3.32 Process Pressure Vessel. A vessel, other than that used as an LP-Gas container *(as defined in 3.3.10)*, operating at pressures exceeding 15 psig (103 kPa) that is used as, but is not limited to, part of the LP-Gas loading/unloading process or for separation, filtering, and mixing/blending in the LP-Gas/LP-Gas–air supply process.

3.3.33 psia. Pounds per square inch, absolute. [**58,** 2017]

3.3.34 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 psi (103 kPa) and semi-refrigerated LP-Gas at pressures above 15 psi (103 kPa).

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

3.3.36 Sources of Ignition. Appliances or equipment that, because of their intended modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable gas–air mixtures. [**54,** 2018]

3.3.37* 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,** 2017]

3.3.38 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.

3.3.39 UL. Underwriters Laboratories Inc. [**58,** 2017]

3.3.40* 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.

3.3.41 Valve.

3.3.41.1 ***Excess-Flow Valve (or Excess-Flow Check Valve).*** A valve designed to close when the liquid or vapor passing through it exceeds a prescribed flow rate. [**58,** 2017]

3.3.41.2 ***Internal Valve.*** A container primary shutoff valve that can be closed remotely, which incorporates an internal excess flow valve with the seat and seat disc located within the container so that they remain in place should external damage occur to the valve. [**58,** 2017]

3.3.41.3 ***Pressure Relief Valve.*** A type of pressure relief device designed to both open and close to maintain internal fluid pressure. [**58,** 2017]

3.3.42 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,** 2017]

3.3.42.1* ***Direct-Fired Vaporizer.*** A vaporizer in which heat furnished by a flame is directly applied to a heat exchange surface in contact with the liquid LP-Gas to be vaporized. [**58,** 2017]

3.3.42.2 ***Electric Vaporizer.*** A vaporizer that uses electricity as a source of heat. [**58,** 2017]

3.3.42.2.1 ***Direct Immersion Electric Vaporizer.*** A vaporizer wherein an electric element is immersed directly in the LP-Gas liquid and vapor. [**58,** 2017]

3.3.42.2.2 ***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,** 2017]

3.3.42.3 ***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,** 2017]

3.3.42.4 ***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,** 2017]

3.3.43 Water Capacity. The amount of water at 60°F (16°C) required to fill a container. [**58,** 2017]

Chapter 4 General Requirements

4.1 Personnel Training. Persons engaged in gas operating and emergency procedures and in the handling of LP-Gas shall be trained at least annually in the properties and safe handling of LP-Gas and in emergency procedures.

4.1.1* Persons engaged in the maintenance or operation of the propane–air mixing equipment, which can affect the safety of the connected utility pipeline, shall be trained to perform those tasks.

4.1.2 Persons engaged in the design, installation, operation, and maintenance of corrosion control systems shall be qualified to perform those tasks.

Δ **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.

N **4.2.1** Odorization shall not be required when it is harmful in the use or further processing of the LP-Gas.

N **4.2.2** Odorization shall not be required when it will serve no useful purpose as a warning agent in such use or further processing.

4.3 Acceptance of Equipment. In systems with containers greater than 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 LP-Gas systems from vehicular traffic is a possibility, precautions (such as warning signs, barricades or other devices) shall be taken against such damage.

4.5 Ignition Source Control. [**58:**6.25]

4.5.1 Scope. [**58:**6.25.1]

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:**6.25.1.1]

4.5.1.2* Grounding and bonding for static protection shall not be required on LP-Gas systems.

4.5.2 Electrical Equipment. [**58:**6.25.2]

4.5.2.1 Electrical equipment and wiring shall be installed in accordance with *NFPA 70*.

4.5.2.2* 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*.

N **4.5.2.3** The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

4.5.2.4 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:**6.25.2.5]

4.5.3* Other Sources of Ignition.

4.5.3.1 Smoking shall be permitted only in designated and signposted areas.

4.5.3.2 Welding, cutting, and hot work shall be conducted in accordance with the provisions of NFPA 51B.

4.5.3.3 Portable electric tools and extension lights capable of igniting LP-Gas shall not be permitted within classified areas except where the area has been identified as free of flammable gases.

Δ Table 4.5.2.2 Electrical Area Classification

Part	Location	Extent of Classified Area	Equipment Shall Be Approved for *National Electrical Code*, Class I, Group D[a]
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[b]	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	Division 1
		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, except within path of discharge	Division 2
F[b]	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

(continues)

Δ Table 4.5.2.2 *Continued*

Part	Location	Extent of Classified Area	Equipment Shall Be Approved for *National Electrical Code*, Class I, Group D[a]
G	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
H	Pipelines and connections containing operational bleeds, drips, vents, or drains	Within 5 ft (1.5 m) in all directions from point of discharge	Division 1
		Beyond 5 ft (1.5 m) from point of discharge, same as part F of this table	
I	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]See Article 500 in *NFPA 70* for definitions of classes, groups, and divisions.
[b]See A.4.5.2.2.

4.5.4 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 authorized and at loading or unloading at facilities specifically designed for the purpose.

4.5.5* 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.

4.5.6 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 4, Section 5.4, 7.3.2, and 7.4.1.4 of NFPA 780.

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 Construction and Modification Records.

4.7.1 Facilities subject to the U.S. Department of Transportation, 49 CFR 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards," shall retain records in accordance with those requirements.

4.7.2 Each new and modified facility shall retain records of materials of construction for process equipment piping systems containing LP-Gas and other flammable fluids, including their supporting system and foundations.

4.7.2.1 The records shall verify that the material properties meet the requirements of this standard and other referenced standards.

4.7.2.2 Components such as pumps, compressors, valves, or similar assemblies are not required to have records of materials of construction. These records shall document that the assembled component has been designed and constructed per design with materials appropriate for the duty they serve.

4.7.2.3 The records shall be retained for the life of the component, building, foundation, and support system, while in use, and for 5 years thereafter.

4.8 Design and Installation.

4.8.1 All metallic components (containers, piping, valves, vaporizers, heat exchangers, etc.) containing LP-Gas (liquid or vapor state) that could have their integrity or reliability adversely affected by external, internal, or atmospheric corrosion during their intended service life shall be protected from corrosion.

4.8.2 The design and the installation procedure of external corrosion control cathodic protection systems shall be documented.

4.8.3 Components whose integrity or reliability could be adversely affected by corrosion shall be:

(1) Protected from corrosion in accordance with Sections 4.8 through 4.12 as applicable
(2) Inspected under a program of scheduled maintenance in accordance with 12.3.1 and 12.3.2

4.9 Atmospheric Corrosion Control.

4.9.1 Each exposed component that is subject to atmospheric corrosion shall be protected from atmospheric corrosion by either of the following:

(1) A material that has been designed to resist the corrosive atmosphere involved; or
(2) Coating or jacketing suitable for the prevention of atmospheric corrosion

4.9.2 Where coatings are used, the component being coated shall be prepared to accept the coating and the coating shall be applied as required by the coating manufacturer to ensure performance of the coating.

4.10* External Corrosion Control: Buried or Submerged Components.

4.10.1 Each buried or submerged component that is subject to external corrosion shall be protected from external corrosion by:

(1) Material that has been designed to resist the corrosive environment involved; or
(2) Both of the following means:
    (a)* An external protective coating designed for operating conditions and for the environmental conditions of the installation site, and installed to prevent corrosion of the protected component
    (b)* A cathodic protection system (impressed current type or galvanic anode system) designed to protect components in their entirety in accordance with the following:
        i. The cathodic protection system shall be controlled so not to damage the component or its coating.
        ii. Each component under cathodic protection shall be installed with test stations to determine the adequacy of the cathodic protection.
        iii. Each test station shall have test leads installed that remain mechanically secure and electrically conductive; are attached to a component to minimize stress conditions on that component; and are coated with electrically insulating material compatible with the coating on the component.

4.10.1.1 Prior to installation, each container, length of pipe, and other components shall be visually inspected at the installation site to identify damage.

4.10.1.1.1 Damage to the container, pipe, or component that could impair its serviceability shall be repaired as permitted by pressure vessel, pipe, and component codes.

4.10.1.1.2 Any coating damage shall be repaired using materials compatible with the existing coating following manufacturer's procedures.

4.10.1.2 Components shall be surrounded by earth or sand that is free of rocks and abrasives, and firmly tamped in place.

4.10.1.3 The portions of a partially underground, unmounded ASME container that are below the surface of the ground and for a vertical distance of at least 3 in. (75 mm) above that surface shall comply with Section 4.8. The remaining aboveground portion of the container shall be coated against atmospheric corrosion.

4.10.1.4 The part of an aboveground ASME container in contact with saddles or foundation shall be provided a means to minimize corrosion.

4.10.2 Where cathodic protection is applied, components that are electrically interconnected shall be protected as a unit.

4.10.3 The requirements of Section 4.10 shall be installed and placed in operation within 1 year after completion of initial system installation.

4.10.3.1 The requirements of Section 4.10 shall not apply where technical documentation that a corrosive environment does not exist is approved by the AHJ. Such documentation shall be based on testing, investigation, or experience in the area of application and shall include, as a minimum, soil resistivity measurements and tests for corrosion accelerating bacteria.

4.10.4 Where insulating devices (flange, fitting, union) for cathodic protection are installed, precaution shall be taken to prevent arcing in areas where combustible atmospheres are anticipated.

4.10.5 Where components are located in close proximity to electric transmission tower footings, ground cables, or counterpoises, or in areas where fault currents or unusual risk of lightning is anticipated, they shall be provided with protection against damage due to fault currents or lightning, and protective measures shall be taken at insulating devices.

4.11 Internal Corrosion Control. Each component that is subject to internal corrosive attack shall be protected from internal corrosion by one of the following:

(1) Material that has been designed to resist the corrosive fluid involved; or
(2) Coating, inhibitor, or other means

4.12 Interference Currents.

4.12.1 Each component that is subject to electrical current interference shall be protected by a continuing program to minimize the detrimental effects of interference currents.

4.12.2 Each cathodic protection system shall be designed and installed so as to minimize any adverse effects it might cause to adjacent metal components.

4.12.3 Each impressed current power source shall be installed to prevent adverse interference with communications and control 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 1.5.)*

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.

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.

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

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 utility 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).

Δ **5.4.1.4** Where multiple aboveground containers or groups of containers are installed for use in a single location, the number of containers in one group and the separation between groups shall be in accordance with Table 5.4.1.4, based on the degree of fire protection provided.

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
<125	<0.5	0	0	0	0
125–250	0.5–1.0	0	0	10	3
251–500	>1.0–1.9	3	1	10	3
501–2000	>1.9–7.6	3	1	25	7.6
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

5.4.1.5 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:**6.5.3.6]

5.4.1.6 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. [**58:**6.5.3.8]

5.4.1.7 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.

5.4.1.8* 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:**6.5.3.4]

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:

Δ 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	15.0
Fixed monitor nozzles per 13.6.4	6	25	7.6
Fixed water spray per 13.6.3	9	25	7.6
Insulation per 13.6.1	9	25	7.6

(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) Containers shall be located not less than 10 ft (3 m) from flammable liquids storage containers.
(4) Underground containers of 2000 gal (7.6 m^3) and less shall be located at least 10 ft (3 m) from the nearest important building or group of buildings, line of adjacent property that can be built upon, or buildings associated with the utility gas plant.

5.4.2.5 The ground within 25 ft (7.6 m) of any underground nonrefrigerated container manway and appurtenances shall be kept clear of ignitible 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 In addition to the applicable provisions for horizontal ASME storage containers, vertical ASME storage containers shall comply with 5.5.1.6.1 and 5.5.1.6.2.

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

5.5.1.6.2 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.

Δ **5.5.1.7** Wind loading on containers of 10,000 gal (37.9 m^3) or larger shall be in accordance with ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. Wind speeds shall be based on a mean occurrence interval of 100 years.

Δ **5.5.1.8** Seismic loading on containers shall be in accordance with ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. 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.

5.5.2 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 of earth, sand, or other noncombustible material and shall 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 level 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.

5.5.2.11 Any damage to the coating shall be repaired before backfilling.

5.5.3 Field welding on containers shall be limited to attachments to nonpressure parts such as saddle plates, wear plates, or brackets installed by the container manufacturer. [**58:**6.8.1.3]

5.5.4 Containers shall be securely anchored where necessary to prevent flotation due to possible high floodwaters around aboveground or mounded containers or high water table for underground and partially underground containers.

5.6 Reinstallation of Nonrefrigerated Containers.

5.6.1 Once installed underground or aboveground, containers that have been out of service for more than 1 year shall not be reinstalled aboveground or underground unless they pass an inspection in accordance with the NBBI/NB23, *National Board of Inspection Code*.

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:

[5.7.1]

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

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.

5.7.3 Where the maximum ground temperatures do not exceed 60°F (16°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 Point of Transfer Spacing.

5.8.1 Point of transfer 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 Point of transfer shall meet all the following requirements:

(1) It shall not be located inside a building.
(2) It 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) It shall be located at least 5 ft (1.5 m) behind any barriers provided for such protection.

Table 5.7.2 Maximum Permitted Filling Density

Specific Gravity at 60°F (15.6°C)	Aboveground Containers: 0 to 1200 U.S. gal (1000 Imperial gal, 4.5 m³) Total Water Capacity (%)	Aboveground Containers: Over 1200 U.S. gal (1000 Imperial gal, 4.5 m³) 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

Chapter 6 Refrigerated Containers

6.1 Scope. This chapter shall present the requirements for the design, engineering, construction, marking, inspection, testing, and operation of stationary low-pressure LPG refrigerated storage tanks systems in accordance with API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, and refrigerated ASME LPG storage containers.

6.2 Refrigerated Containers Designed to Operate Below 7 psi (103 kPa) and Above 5000 bbls (800 m³).

6.2.1 Container Design, Material, Construction, and Examination, Tank Commissioning Testing, and Monitoring Requirements.

6.2.1.1 Storage tank systems designed to operate below 7 psi (103 kPa) and above 5000 bbls (800 m³) shall be in accordance with the requirements of API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, and the additional provisions of this chapter.

6.2.1.2 In accordance with API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, metal containers that are part of a refrigerated storage tank system shall comply with API STD 620, *Design and Construction of Large, Welded, Low-Pressure Tanks*, and any additional provisions of this chapter.

6.2.1.3 If a conflict exists between the above requirements in 6.2.1.1 and 6.2.1.2 and others in this chapter, the most stringent requirement shall apply.

6.2.1.4 Materials used in refrigerated metallic containers shall be selected according to the following:

(1) API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, requires that Appendix R or Appendix Q of API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, be utilized.
(2) Containers designed to operate below 15 psi (103 kPa) shall be in accordance with API STD 620, including Appendix R.
(3) Where austenitic stainless steels or nonferrous materials are used, Appendix Q of API STD 620 shall be used in the selection of materials.

6.2.2 Design Temperature and Pressure.

6.2.2.1 The design pressure and vacuum maximums and minimums shall include a margin above and below the operating pressure.

6.2.2.2 The margin, both positive and vacuum, for low-pressure vessels in accordance with API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, shall include the following:

(1) Control range of the boil-off handling system
(2) Effects of flash or vapor collapse during filling operations
(3) Flash that can result from withdrawal pump recirculation
(4) Normal range of barometric pressure changes

6.2.2.3 The design temperature for parts of a refrigerated LP-Gas container that are in contact with liquid or refrigerated vapor shall be equal to or lower than the boiling point of the product to be stored at atmospheric pressure.

6.2.2.4 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.

6.2.3 Design Load and Load Combinations.

Δ **6.2.3.1** Design load and load combinations, including but not limited to the following, shall be based upon requirements in API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, and API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*:

(1) The dead load or weight of the tank or tank component, including any insulation and lining
(2) Hydrostatic and pneumatic tests — the load due to conducting the tank commissioning tests
(3) Loads from connected piping
(4) Loads from platforms and stairways
(5) Minimum roof live load — 20 lb/ft^2 (98 kg/m^2) on the horizontal projected area of the roof
(6) Pressure — the maximum positive gauge pressure
(7) Pressure — the maximum partial vacuum given, which is at least 1 in. w.c. (2.49 kPa)
(8) Stored liquid — Gauge pressure [lb/in.^{2} (kPa)] resulting from the head of the liquid, including maximum product density and with all liquid levels from empty to maximum considered
(9) The ground snow load [lb/ft^2 (kPa)] — from ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*
(10) Wind loading — in accordance with the projected area at various height zones above ground in accordance with ASCE/SEI 7 and based on a mean occurrence interval of 100 years.
(11) Seismic loading
    (a) Design seismic loading on refrigerated LP-Gas containers is in accordance with API STD 625, API STD 620, and ASCE/SEI 7
    (b) A seismic analysis of the proposed installation is performed, as required by Section 6.6 of API STD 625, that meets the approval of the AHJ

6.2.4 All new construction shall incorporate any bottom or side penetrations that communicate with the liquid space of the container's in-tank valves.

6.2.4.1* Emergency shutoff valves shall be incorporated into the facility emergency shutdown system and shall be capable of being operated remotely.

6.2.5 Foundations.

6.2.5.1 In addition to requirements in this code, foundations for refrigerated aboveground containers shall be designed and constructed per API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, which requires foundations be designed, constructed, and inspected based on ACI 376-11, *Code Requirements for Design and Construction of Concrete Structures for the Containment of Refrigerated Liquefied Gases*.

6.2.5.1.1 The under-container temperature shall be observed and logged at least weekly.

6.2.5.2 Refrigerated LP-Gas container foundations shall be periodically monitored for settlement during the life of a facility.

6.2.5.2.1 Foundations shall be monitored in accordance with ACI 376-11, *Code Requirements for Design and Construction of Concrete Structures for the Containment of Refrigerated Liquefied Gases*.

6.2.5.2.2 Any settlement in excess of that predicted in the design shall be investigated and, if appropriate, corrective action shall be taken.

6.2.5.3 For a container having a double wall design, the bottom of the outer wall and the refrigerated LP-Gas container under-container insulation shall be above the groundwater table or protected from contact with groundwater at all times.

6.2.5.3.1 For a container having a double wall design, the bottom of the outer wall and the refrigerated LP-Gas container under-container insulation shall be protected from floodwaters.

6.2.5.4 Where two or more containers are sited in a common dike, the container foundations shall be constructed of material resistant to the effects of refrigerated LP-Gas and the temperatures to which they will be exposed.

6.2.5.5 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.

6.2.6 Marking on Refrigerated LP-Gas Containers.

6.2.6.1 Each refrigerated LP-Gas container shall be identified by the attachment of a nameplate directly on the container in a visible location in accordance with the requirements in Chapter 11 of API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*.

6.2.6.2 The nameplate shall be in accordance with Chapter 11 of API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*.

6.2.7 Piping.

6.2.7.1 All refrigerated LP-Gas container piping shall be in accordance with ASME B31.3, *Process Piping*.

6.2.7.2 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

6.2.7.3 Inert gas purge systems wholly within the insulation spaces shall be exempt from the provision in 6.2.7.1.

6.2.8 Relief valve, both pressure and vacuum, requirements shall be in accordance with Section 7.4 of API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, in addition to requirements in this standard in Section 10.3 through Section 10.6.

6.2.9 Provisions shall be made for purging and removal of the storage tank system from service.

6.2.10 Container Siting.

6.2.10.1 Spacing of refrigerated LP-Gas containers that operate 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 6.2.10.1. [**58:**Table 13.7.2]

6.2.10.2 The edge of a dike, impoundment, or drainage system that is intended for a refrigerated LP-Gas container shall be 100 ft (31 m) or more from a property line that can be built upon, a public way, or a navigable waterway. [**58:**13.7.3]

6.2.10.3 Nonrefrigerated LP-Gas containers or flammable liquid tanks shall not be located within dikes or impoundments enclosing refrigerated LP-Gas containers. [**58:**13.7.4]

6.2.10.4 The minimum distance between aboveground refrigerated LP-Gas containers shall be one-half the diameter of the larger container. [**58:**13.7.6]

6.2.10.5 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:**13.7.7]

6.2.11 Instruments and Controls.

6.2.11.1 Gauging Devices.

(A) Each refrigerated LP-Gas container shall be equipped with at least two independent liquid level gauging devices as required by 7.5.1 of API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage.*

(B) Liquid level gauging devices shall be designed and installed so that they can be maintained or replaced without taking the container out of service as required by 7.5.1.4 of API STD 625.

(C) The refrigerated LP-Gas container shall be provided with an audible and visual high–liquid level alarm. [**58:**13.4.1.3]

(D) 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:**13.4.1.4]

(E) The alarm shall be located so that it is visible and audible to the personnel who control the filling. [**58:**13.4.1.5]

(F) A high–liquid level flow cutoff device shall not be a substitute for the alarm. [**58:**13.4.1.6]

Table 6.2.10.1 Minimum Distances for Refrigerated LP-Gas Containers That Operate Below 15 psi (103 kPa)

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

6.2.11.2 High–Liquid Level Device.

(A) The refrigerated LP-Gas container shall be equipped with a high-high–liquid level flow cutoff device that is independent from all gauges. [**58:**13.4.1.7]

(B) Where refrigerated LP-Gas containers of 70,000 gal (265 m^3) or less are attended during the filling operation, they shall be equipped with either liquid try cocks or a high–liquid level alarm, and manual flow cutoff shall be permitted. [**58:**13.4.1.8]

(C) Each refrigerated LP-Gas container shall be provided with temperature-indicating devices that assist in controlling cool-down rates when placing the tank in service and monitoring product temperatures during operations. [**58:**13.4.1.9]

6.2.11.3 Pressure and Vacuum Control.

(A) Each refrigerated LP-Gas container shall be equipped with at least two independent pressure-indicating instruments as required by 7.5.5 of API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage.*

(B) Provisions shall be made to maintain the container pressure within the limits set by the design specifications by releasing or admitting gas as needed. [**58:**13.4.2.1]

(C) Provision for admission and release of gas shall be by any means compatible with the gas-handling facilities in the plant. [**58:**13.4.2.2]

(D) The option of gas admission, or other gas or vapor, if so designed, through the vacuum relief valves in accordance with 7.2.3 of API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* shall not be permitted.

6.2.12 Impoundment.

6.2.12.1 Each refrigerated LP-Gas container shall be located within an impoundment that complies with 6.3.8.

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

6.2.12.3 Impoundment for refrigerated LP-Gas containers shall have a volumetric holding capacity with an allowance made for the displacement of snow accumulation, other containers, or equipment that is equal to the total liquid volume of the largest container served, assuming that container is filled to the high–liquid level flow cutoff device.

6.2.12.4 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.

6.2.12.5 Impoundment structures and any penetrations thereof shall be designed to withstand the full hydrostatic head of the impounded LP-Gas, the effects of the product composition, and the resulting auto refrigeration temperatures.

6.2.12.6 Impoundment structures shall also be nonporous and resistant to natural forces such as wind, rain, and fire.

6.2.12.7 Provisions shall be made to clear rain or other water from the impounding area.

(A) Where automatically controlled sump pumps are used, they shall be equipped with an automatic shutoff device that prevents their operation when either of the following occurs:

(1) They are exposed to the flash temperature of the liquid LP-Gas.
(2) Flammable vapors in excess of 25 percent of the lower flammable limit are detected within the impoundment area.

(B) Gravity drainage utilizing piping penetrations through or below impoundment dikes shall not be permitted.

6.2.12.8 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.

(A) The grading shall move the spilled liquid to the toe of the dike system and as far away from the container as possible.

(B) The grading shall move the spilled liquid to a sub-impoundment basin that is capable of holding the quantity of liquid spilled from a line rupture, a flange leak, or a source other than container failure.

(C) The duration of the incident shall be the amount of time that automatic systems or plant personnel could affect emergency procedures and stop the leak, and the sub-impoundment basin shall be located as far away from the container as possible.

6.2.13 Inspection and Testing of Refrigerated LP-Gas Containers and Systems.

6.2.13.1 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 API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*; API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*; ACI 376-11, *Code Requirements for Design and Construction of Concrete Structures for the Containment of Refrigerated Liquefied Gases*; and ASME B31.3, *Process Piping*.

6.2.13.2 The inspections or tests required shall be conducted by the operator or by a third-party engineering, scientific, recognized insurance, or inspection organization.

6.2.13.3 Each inspector shall be qualified in accordance with the code or standard that is applicable to the test or inspection being performed.

6.2.13.4 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.

6.2.13.5 Retesting shall be required only if it tests the element affected and is necessary to demonstrate the adequacy of the repair or modification.

6.3 Refrigerated Containers Designed to Operate Above 15 psi (103 kPa).

6.3.1 Containers designed to operate above 15 psi (103 kPa) shall be in accordance with the ASME *Boiler and Pressure Vessel Code*, Section VIII, and any additional provisions of this chapter.

6.3.1.1 Construction using joint efficiencies listed in Table UW 12, Column C, of the ASME *Boiler and Pressure Vessel Code* shall not be permitted.

6.3.2 Construction and Design of Refrigerated Containers.

6.3.2.1 Container Material and Construction Requirements.

6.3.2.2 Materials that maintain their integrity at the boiling temperature of the liquid stored and are used in refrigerated containers shall be selected from those included in the ASME *Boiler and Pressure Vessel Code*, Section VIII.

6.3.2.3 All new construction shall incorporate either an internal valve or a back check valve on any bottom or side penetrations that communicate with the liquid space of the container.

6.3.2.4 Emergency shutoff valves shall be incorporated into facility emergency shutdown systems and be capable of being operated remotely.

6.3.3 Container Design Temperature and Pressure.

6.3.3.1 The maximum allowable working pressure shall include a margin above the operating pressure.

6.3.3.2 The design pressure of ASME containers shall include a minimum 5 percent of the absolute vapor pressure of the LP-Gas at the design storage temperature.

6.3.3.3 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.

6.3.3.4 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:**13.1.2.2(B)]

6.3.4 Marking on Refrigerated LP-Gas Containers.

6.3.4.1 Each refrigerated LP-Gas container shall be identified by the attachment of a nameplate located either on the container or in a visible location. [**58:**13.2.1]

6.3.5 Container Installation.

6.3.5.1 Wind Loading.

(A) 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/SEI 7–10, *Minimum Design Loads for Buildings and Other Structures*. [**58:**13.3.1.1]

(B) Design wind speeds shall be based on a mean occurrence interval of 100 years. [**58:**13.3.1.2]

6.3.5.2 Seismic Loading.

(A) The design seismic loading on refrigerated LP-Gas containers shall be in accordance with ASCE/SEI 7–10, *Minimum Design Loads for Buildings and Other Structures*. [**58:**13.3.2.1]

(B) A seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction. [**58:**13.3.2.2]

6.3.5.3 Piping.

6.3.5.3.1 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 B31.3, *Process Piping*. [**58:**13.3.3.1]

6.3.5.3.2 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:**13.3.3.2]

6.3.5.3.3 Inert gas purge systems wholly within the insulation spaces shall be exempt from the provision in 6.3.5.3.1. [**58:**13.3.3.3]

6.3.6 Foundations.

6.3.6.1 Foundations for refrigerated aboveground containers shall be designed and installed on foundations that have been engineered for site soil conditions and loadings.

6.3.6.2 Prior to the start of design and construction of the foundation, a subsurface investigation shall be conducted by a soils engineer.

6.3.6.3 Foundations shall be designed by an engineer who is experienced in foundations and soils. [**58:**13.3.4.2(B)]

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

(1) The foundation design and the container bottom insulation shall prevent damage to the container from frost heave.
(2) If the refrigerated LP-Gas container 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 falling below 32°F (0°C).
(3) The under-container heating system shall be designed to allow both functional and performance monitoring.
(4) The under-container temperature shall be observed and logged at least weekly.
(5) Where the foundation has a discontinuity, such as bottom piping, the heating system in that zone shall be designed for the discontinuity.
(6) The under-container heating system shall be installed so that any heating elements or temperature sensors used for control can be replaced while the container 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:**13.3.4.3]

6.3.6.5 The refrigerated LP-Gas container foundation shall be periodically monitored for settlement during the life of the facility. [**58:**13.3.4.4]

6.3.6.6 The monitoring shall include construction, hydrostatic testing, commissioning, and operation. [**58:**13.3.4.5]

6.3.6.7 Any settlement in excess of that anticipated in the design shall be investigated, and corrective action shall be taken if appropriate. [**58:**13.3.4.6]

6.3.6.8 For a container having a double wall design, the bottom of the outer wall and the refrigerated LP-Gas container under-container insulation shall be above the groundwater table or protected from contact with groundwater at all times, and it shall also be protected from floodwaters. [**58:**13.3.4.7]

6.3.6.9 Where two or more containers are sited in a common dike, the container foundations shall be constructed of material resistant to the effects of refrigerated LP-Gas and the temperatures to which they will be exposed. [**58:**13.3.4.8]

6.3.6.10 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:**13.3.4.9]

6.3.6.11 The material in contact with the bottom of the container shall be selected to minimize corrosion. [**58:**13.3.4.10]

6.3.7 Instruments and Controls.

6.3.7.1 Gauging Devices.

(A) Each refrigerated LP-Gas container shall be equipped with at least two independent liquid level gauging devices. [**58:**13.4.1.1]

(B) Liquid level gauging devices shall be installed so that they can be replaced without taking the container out of service. [**58:**13.4.1.2]

(C) The refrigerated LP-Gas container shall be provided with an audible and visual high–liquid level alarm. [**58:**13.4.1.3]

(D) 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:**13.4.1.4]

(E) The alarm shall be located so that it is visible and audible to the personnel who control the filling. [**58:**13.4.1.5]

(F) A high–liquid level flow cutoff device shall not be a substitute for the alarm. [**58:**13.4.1.6]

6.3.7.2 High–Liquid Level Device.

(A) The refrigerated LP-Gas container shall be equipped with a high-high–liquid level flow cutoff device that is independent from all gauges. [**58:**13.4.1.7]

(B) Where refrigerated LP-Gas containers of 70,000 gal (265 m^3) or less are attended during the filling operation, they shall be equipped with either liquid trycocks or a high–liquid level alarm, and manual flow cutoff shall be permitted. [**58:**13.4.1.8]

(C) 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:**13.4.1.9]

6.3.7.3 Pressure and Vacuum Control.

(A) Provisions shall be made to maintain the container pressure within the limits set by the design specifications by releasing or admitting gas as needed. [**58:**13.4.2.1]

(B) Provision for admission and release of gas shall be by any means compatible with the gas-handling facilities in the plant. [**58:**13.4.2.2]

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

6.3.8 Refrigerated LP-Gas Container Impoundment.

6.3.8.1 Each refrigerated LP-Gas container shall be located within an impoundment that complies with 6.3.8. [**58:**13.5.1]

6.3.8.2 Enclosed drainage channels for LP-Gas shall be prohibited. [**58:**13.5.2]

6.3.8.3 Impoundment for refrigerated LP-Gas containers shall have a volumetric holding capacity, with an allowance made for the displacement of snow accumulation, other containers, or equipment that is equal to the total liquid volume of the largest container served, assuming that container is full to the high–liquid level flow cutoff device. [**58:**13.5.4]

6.3.8.4 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:**13.5.5]

6.3.8.5 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:**13.5.6]

6.3.8.6 Impoundment structures shall also be nonporous and resistant to natural forces such as wind, rain, and fire. [**58:**13.5.7]

6.3.8.7 Provisions shall be made to clear rain or other water from the impounding area. [**58:**13.5.8]

(A) Where automatically controlled sump pumps are used, they shall be equipped with an automatic shutoff device that prevents their operation when either of the following occurs:

(1) They are exposed to the flash temperature of the liquid LP-Gas.
(2) Flammable vapors in excess of 25 percent of the lower flammable limit are detected within the impoundment area.

6.3.8.8 Gravity drainage utilizing piping penetrations through or below impoundment dikes shall not be permitted. [**58:**13.5.8.3]

6.3.8.9 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:**13.5.9]

(A) The grading shall move the spilled liquid to the toe of the dike system and as far away from the container as possible. [**58:**13.5.9.1]

(B) The grading shall move the spilled liquid to a sub-impoundment basin that is capable of holding the quantity of liquid spilled from a line rupture, a flange leak, or a source other than container failure. [**58:**13.5.9.2]

6.3.9 Inspection and Testing of Refrigerated LP-Gas Containers and Systems.

6.3.9.1 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:**13.6.1]

6.3.9.2 The inspections or tests required shall be conducted by the operator or a third-party engineering, scientific, recognized insurance, or inspection organization.

6.3.9.3 Each inspector shall be qualified in accordance with the code or standard that is applicable to the test or inspection being performed. [**58:**13.6.3]

6.3.9.4 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:**13.6.4]

6.3.9.5 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:**13.6.5]

6.3.10 Container Siting.

6.3.10.1 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 6.3.10.1. [**58:**13.7.1]

6.3.10.2 The edge of a dike, impoundment, or drainage system that is intended for a refrigerated LP-Gas container shall be 100 ft (31 m) or more from a property line that can be built upon, a public way, or a navigable waterway. [**58:**13.7.2]

6.3.10.3 Nonrefrigerated LP-Gas containers or flammable liquid tanks shall not be located within dikes or impoundments enclosing refrigerated LP-Gas containers. [**58:**13.7.4]

6.3.10.4 Refrigerated LP-Gas containers shall not be installed one above the other. [**58:**13.7.5]

6.3.10.5 The minimum distance between aboveground refrigerated LP-Gas containers shall be one-half the diameter of the larger container. [**58:**13.7.6]

6.3.10.6 The ground within 25 ft (7.6 m) of any aboveground refrigerated LP-Gas container, and all ground within a dike, impoundment, or drainage area, shall be kept clear of readily ignitable materials such as weeds and long, dry grass. [**58:**13.7.7]

Table 6.3.10.1 Minimum Distances for Refrigerated LP-Gas Containers That Operate at 15 psi (103 kPa) and Higher

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

Chapter 7 Piping, Valves, Process Pressure Vessels, 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 design pressure.

7.1.1.1 The design and fabrication of process 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 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 A395/A395M, *Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or malleable iron in accordance with ASTM A536, *Specifications for Ductile Iron Castings*, Grade 60-40-18 or 65-45-12
(3) Malleable iron in accordance with ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings*; brass; bronze; or equivalent copper alloys

7.1.1.3 Piping that can contain liquid LP-Gas, that can be isolated by valving, and that requires hydrostatic relief valves, as specified in Section 10.8, 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.

7.1.1.4 The piping specified in 7.1.1.3 shall be subjected to a pressure test, in accordance with 7.1.1.1, of no less than 150 percent of the design pressure.

7.1.1.5* Buried Piping Cover.

7.1.1.5.1 New or replaced buried flammable liquid or gas piping with a design pressure below 20 percent of the pipe's specified minimum yield strength (SMYS) within the scope of this standard shall be installed with a minimum of 24 in. (610 mm) of cover in normal soil and a minimum of 18 in. (460 mm) of cover in consolidated rock condition.

7.1.1.5.2 New or replaced buried flammable liquid or gas piping with design pressure above 20 percent of the pipe's specified minimum yield strength (SMYS) within the scope of this standard shall be installed with a minimum of 30 in. (760 mm) of cover in normal soil and a minimum of 18 in. (460 mm) of cover in consolidated rock condition.

7.1.1.6 Buried Piping Separation Clearance.

7.1.1.6.1 New or replaced buried flammable liquid or gas piping design pressure above 20 percent of the pipe's specified minimum yield strength (SMYS) within the scope of this standard shall be installed with a minimum of 12 in. (300 mm) clearance from any other structure not associated with the piping.

7.1.1.6.2 New or replaced buried flammable liquid or gas piping design pressure below 20 percent of the pipe's specified minimum yield strength (SMYS) within the scope of this standard shall be installed with enough clearance from any other underground structure to allow proper maintenance and to protect against damage that might result from the pipe's proximity to the other structures.

7.1.2 Piping connections to the container for sizes over 2 in. (5 cm) 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 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 meet the following requirements:

(1) The melting point shall not exceed 250°F (121°C).
(2) The element shall be connected to actuate the valve.
(3) The element shall not be more than 5 ft (1.5 m) from the nearest end of the hose or swivel-type piping connected to the line in which the valve is installed.

7.1.6 Gaskets used to retain LP-Gas in flanged connections shall be resistant to the action of LP-Gas.

7.1.7 Gaskets used to retain LP-Gas in flanged connections shall be either:

(1) Made of metal or other material that is confined in metal that has a melting point over 1500°F (816°C) or protected against fire exposure, or
(2) Nonmetallic or electrically insulating where electrical insulating fittings are required

7.1.8 Gaskets used to retain LP-Gas in flanged connections shall be replaced when a flange is opened.

7.1.9 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.

7.1.10* Piping systems including interconnecting of permanently installed containers shall compensate for expansion, contraction, jarring, vibration, and settling.

7.1.10.1 The use of metallic flexible connectors shall be permitted.

7.1.10.2 The use of nonmetallic pipe, tubing, or hose for permanently interconnecting containers shall be prohibited.

7.1.11 Piping shall be supported and protected against physical damage and corrosion.

7.1.12 Underground and submerged piping shall be protected and maintained as required in Section 12.3.

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.

7.2.1.1 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).

7.2.1.2 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 ductile iron.

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

7.2.2.1 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.

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

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

7.2.2.4 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 and shall be selected and installed for rated closing flows based on process requirements.

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 [0.055 in. (1.4 mm)], 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 STD 607, *Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats*; API SPEC 6FA, *Standard for Fire Tests for Valves*; or the equivalent, equipped for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is installed in compliance with 7.1.5
(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 a No. 54 drill size [0.055 in. (1.4 mm)].

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 [0.040 in. (1.02 mm)] 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 Liquid manifold connections shall be located at nonadjacent ends of parallel rows of containers.

7.3.2* 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.

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

7.3.2.2 The mechanism for such valves shall be provided with a secondary control equipped with a fusible release in accordance with 7.1.5(1) that will cause the valve to close automatically in case of fire.

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

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

7.3.2.5 Fail-safe valves shall be located to limit the volume between valves in aboveground piping systems to a maximum of 500 gal (1.89 m^3) of liquid where the piping system is within 300 ft (91.4 m) of another container, important building, or line of adjoining property that can be built upon.

7.4 Liquid Level Gauging Device.

7.4.1 Each nonrefrigerated storage container 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 gauge or a pressure differential gauge, the container also shall be provided with an auxiliary gauging device, such as a fixed liquid level gauge, 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 liquid level gauge, and slip tube, shall be designed so that the bleed valve maximum opening is not larger than a No. 54 drill size [0.055 in. (1.4 mm)], 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 liquid level gauge 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 permit-

ted 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.

Δ 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.

7.8 Pumps and Compressors in Refrigerated LP-Gas Systems.

7.8.1 Refrigeration facilities shall be provided with sufficient capacity to maintain containers at a pressure not in excess of the operating pressure under design ambient conditions where the tank is sited and shall be provided with additional capacity for filling or standby service.

7.8.2 Unless facilities are provided for the safe disposal of vented vapors while the refrigeration system is inoperative, at least two compressors shall be installed where compressors and condensers are used.

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

7.8.4 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.

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

7.9 Process Pressure Vessels. Process pressure vessels shall be designed, fabricated, and code-stamped in accordance with the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1 or Division 2, or with CSA B51, *Boiler, Pressure Vessel, and Pressure Piping Code*.

7.10 Protection of Container Accessories.

7.10.1 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.

7.10.2 All connections on underground containers shall be protected against vehicular damage or located so as not to be subject to vehicular damage.

7.11 Transfer Equipment.

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

7.11.2 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.

7.11.3 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.

7.11.4 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 7.11.4.1 through 7.11.4.4, 11.3.2, and Section 12.4.

7.11.4.1 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 for vapor transfer, the following requirements shall be met:

(1) An emergency shutoff valve complying with 7.1.4 or a check valve with a metal-to-metal seat or a primary resilient seat with a secondary metal seat not hinged with combustible metal 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.
(2) Where either a liquid or vapor line has two or more hose or swivel-type piping connectors of the sizes designated, an emergency shutoff valve or a backflow check valve shall be installed in each leg of the piping.

7.11.4.2 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.

Δ 7.11.4.3* The emergency shutoff valve(s) or backflow check valve(s) specified in 7.11.4.1 shall be installed in the facility 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 facility side of the connection.

7.11.4.4 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.

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

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

7.11.7 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.

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.

8.2.2.1 The structure shall be ventilated.

8.2.2.2 Where mechanical ventilation is used, the air exchange rate shall be at least 1 $ft^3/min \times ft^2$ (0.3 $m^3/min \times m^2$) of floor area and operated either continuously or automatically activated upon detection of a flammable gas at the gas detection setting in 13.2.3.

8.2.2.2.1 Where mechanical ventilation is used, outlets shall discharge outdoors at least 5 ft (1.5 m) from any opening into the structure or any other structure.

8.2.2.3 Where natural ventilation is used, each exterior wall shall be provided with one opening for each 20 ft (6.1 m) of length.

8.2.2.3.1 Where natural ventilation is used, the bottom of air openings shall be not more than 6 in. (150 mm) above the floor.

8.2.2.3.2 Where natural ventilation is used, 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 $in.^2/ft^2$ (6900 mm^2/m^2) of floor area.

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, or by appliances listed for Class I, Group D, Division 2 locations, in accordance with *NFPA 70*.

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 (Class 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) 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 (Class B) fire doors
(3) 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]

8.4 Rooms Housing Vaporizers or Mixers. Rooms housing vaporizers or gas–air mixers shall not have drains to sewers or sump pits.

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

9.1 General.

9.1.1 LP-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 Vaporizers or heating devices used to raise storage container pressure 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 9.1.3, which corresponds with the design pressure of the container (or its ASME *Boiler and Pressure Vessel Code* equivalent).

9.1.4 Pressure relief valve discharge piping in buildings shall be in accordance with 10.7.3.

Table 9.1.3 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	
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

9.2 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 General Requirements.

9.3.1.1 All vaporizers, including atmospheric-type vaporizers that use heat from 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 10.7.1. Fusible plug devices shall not be used.

9.3.1.2 Vaporizer heat exchangers for LP-Gas shall be constructed in accordance with the ASME *Boiler and Pressure Vessel Code* for not less than an MAWP of 250 psi (1.7 MPa) 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
(4) The rated vaporizing capacity
(5) The rated heat input in British thermal units per hour (Btu/hr) (mJ/hr)

9.3.1.2.1 Heat exchangers for 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.

9.3.1.3 All vaporizers shall be provided with a suitable automatic means to prevent LP-Gas 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.

9.3.2 Gas-fired Vaporizers.

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

9.3.2.2 An automatic safety device(s) shall be provided to shut off the flow of gas to the pilot and the main burner if the pilot is extinguished.

9.3.2.3 An automatic safety device shall be provided to shut off the flow of gas to the main burner and pilot in the event of flame failure.

9.3.2.4 An electronic flame safeguard shall be provided on units having input of 400,000 Btu/hr (422 MJ/hr) or greater that performs the following functions:

(1) Allows the combustion chamber to purge with air prior to ignition
(2) Proves the presence of a pilot prior to opening the main burner valve
(3) Shuts down the main gas valve and pilot upon failure of the burner flame

9.3.3 Waterbath Vaporizers.

9.3.3.1 Waterbath sections of waterbath vaporizers shall be protected from overpressure conditions and shall be designed to withstand the pressures to which they will be subjected.

9.3.3.2 The immersion heater that provides heat to the waterbath shall be installed so as not to contact the LP-Gas heat exchanger.

9.3.3.3 A control to limit the temperature of the waterbath shall be provided. [**58:**5.24.6.7]

9.3.3.4 The heat source shall be shut off if the level of the heat transfer medium falls below the top of the fire tube or the electric heating coil or element unless the vaporizer is designed for such an occurrence.

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 facility is not in operation.

9.4.3.1 Check valves shall not be the sole method relied upon to prevent backflow.

9.4.3.2 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 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.

9.4.5.1 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.

9.4.5.2 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 and attached structures or rooms in which indirect-fired vaporizers are installed shall comply with Chapter 8.

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

9.5.1.3 If the heat-supplying device serving an indirect vaporizer is installed outdoors and utilizes a noncombustible heat transfer fluid, such as steam, water, or a water–glycol mixture, the 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 or shall comply with one of the following:

(1) If installed within a structure, the structure shall comply with Chapter 8.
(2) 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.
(3) 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* and Section 9.3 of NFPA 54 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.
(4) 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.

9.5.1.4 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.

9.5.1.5 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.

9.5.1.6 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 fails.

9.5.1.7 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.

9.5.2 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.

9.5.3 Installation of Waterbath Vaporizers. Waterbath vaporizers suitable for Class I, Division 1 or 2, Group D locations shall be installed in accordance with 9.5.1. All other waterbath vaporizers shall be installed in accordance with 9.5.2.

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 9.5)*]	50	15
Building or room housing gas–air mixer	10	3
Cabinet housing gas–air mixer outdoors	0	0

9.5.4 Installation of Electric Vaporizers. Electric vaporizers suitable for Class I, Division 1 or 2, Group D locations shall be installed in accordance with 9.5.1. All other electric vaporizers shall be installed in accordance with 9.5.2.

9.5.5 Installation of Gas–Air Mixers.

9.5.5.1 Where a gas–air mixer is installed in a building without a vaporizer, the building shall comply with Section 8.2.

9.5.5.2 Where a gas–air mixer is installed in a building with an indirect heated vaporizer, the building shall comply with Section 8.2.

9.5.5.3 Where a gas–air mixer is installed in a building remote from a vaporizer, the building shall comply with Chapter 8.

9.5.5.4 Where used with a direct-fired vaporizer, the mixer shall be installed to comply with one of the following:

(1) Where the mixer is listed or approved, outdoors in a common cabinet with the vaporizer, in accordance with 9.5.2.4
(2) Outdoors on a common skid with the vaporizer, in accordance with 9.5.2.4
(3) Adjacent to the vaporizer to which it is connected, in accordance with 9.5.2.4
(4) In a building complying with Chapter 8, with no direct-fired vaporizer in the same room

9.5.5.5 Where a listed vaporizer-mixer is not in a common cabinet having an indirect-fired vaporizer and is installed in a building with no sources of ignition, the structure shall comply with Chapter 8.

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. All relief devices required by this code, other than hydrostatic relief valves, shall be tested for proper operation at intervals not exceeding 5 calendar years.

10.2 Nonrefrigerated Container Relief Devices.

10.2.1 ASME containers shall be equipped with one or more pressure relief valves that are designed to relieve vapor. [**58:**5.9.2.1]

10.2.2 ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with the applicable requirements of UL 132, *Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas,* or other equivalent pressure relief valve standards. [**58:**5.9.2.5]

10.2.2.1 The start-to-leak setting of the pressure relief valves specified in 10.2.2, in relation to the pressure rating of the container, shall be in accordance with Table 10.2.2.1. [**58:**5.9.2.5(A)]

Table 10.2.2.1 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 5.9.2.5(A)]

10.2.2.2 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) Pilot-operated relief valves shall be combined with, and controlled by, self-actuated, direct, spring-loaded pilot valves that comply with Table 10.2.2.1.
(2) Pilot-operated pressure relief valves shall be inspected and maintained by persons with training and experience.
(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:**5.9.2.5(B)]

10.2.3 For relief valve discharge pressure settings up to a maximum of 300 psig (2.1 MPag) for propane and 250 psig (1.7 MPag) for butane, the minimum rate of discharge of pressure relief valves installed in ASME containers shall be in accordance with Table 10.2.3 or shall be calculated using the following formula:

[10.2.3]

$$F = 53.632 \times A^{0.82}$$

where:
F = minimum flow rate (SCFM air)
A = total outside surface area of container (ft^2)

Table 10.2.3 Minimum Required Rate of Discharge in Cubic Feet per Minute of Air at 120 Percent of the Maximum Permitted Start-to-Discharge Pressure for Safety Relief Devices to Be Used on Nonrefrigerated Containers as a Function of Container Surface Area*

Surface Area (ft^2)	Flow Rate (SCFM)	Surface Area (ft^2)	Flow Rate (SCFM)	Surface Area (ft^2)	Flow Rate (SCFM)
≤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	—	—

*This table is only applicable to containers holding propane with a maximum pressure of 300 psi or less or butane with a maximum pressure of 250 psi or less.
For SI units: 1 SCFM = 0.0283 m^3/min, 1 psi (gauge) = 6.9 kPa (gauge).
Note: Flow rate in SCFM air.

10.2.4 For ASME containers not covered by 10.2.3, the minimum rate of discharge of pressure relief valves installed in ASME containers shall be determined in accordance with one of the following:

(1) Computing the minimum discharge rate with the following formula utilizing established and source-documented formula values approved by the AHJ heat input:

[10.2.4a]

$$Q = 34{,}500 A^{0.82}$$

where:
Q = heat input (Btu/hr)
A = total outside surface area of the container (ft^2)

The rate of vaporization:

[10.2.4b]

$$W_{vap} = \frac{Q}{L}$$

where:
W_{vap} = rate of vaporization (lb/hr)
Q = heat input (Btu/hr)
L = latent heat of vaporization of the fluid (Btu/lb)

The minimum rate of discharge of the pressure relief valve:

[10.2.4c]

$$F = W_{vap} \frac{13.1 \text{ SCF air}}{1 \text{ lb air}} \frac{1 \text{ hr}}{60 \text{ min}} \frac{520\sqrt{k_a\left(\frac{2}{k_a+1}\right)^{\frac{k_a+1}{k_a-1}}}}{520\sqrt{k_v\left(\frac{2}{k_v+1}\right)^{\frac{k_v+1}{k_v-1}}}} \sqrt{\frac{M_a T_v Z_v}{M_v T_a}}$$

where:
F = minimum flow rate (SCFM air)
W_{vap} = rate of vaporization (lb/hr)
k_a = ratio of specific heats, air = 1.4
k_v = ratio of specific heats, vapor
M_a = molecular weight of air = 28.97
M_v = molecular weight of vapor
Z_v = compressibility factor of vapor
T_a = absolute temperature, air = 520°R
T_v = absolute temperature, vapor (at set-to-discharge pressure)

(2) By the use of a model approved by the AHJ that takes into account the same physical factors and has been validated by experimental test data

10.2.5 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, excluding the 10 percent tolerance in Table 10.2.2.1. [**58:**5.9.2.7]

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

10.2.7 The flow capacity of pressure relief valves installed on underground or mounded containers shall be a minimum of 30 percent of the flow specified in Table 10.2.3. [**58:**5.9.2.8]

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

(1) Pressure in psig (MPag) at which the valve is set to start-to-leak
(2) Rated relieving capacity in SCFM (m^3/min) air
(3) Manufacturer's name and catalog number

[**58:**5.9.2.9]

10.2.9 Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold meeting the requirements of 10.2.10 is used. [**58:**5.9.2.10]

10.2.10 Listed pressure relief valve manifolds shall be exempt from the requirements of 10.2.9 when the following conditions are met:

(1) Two or more pressure relief devices are installed in the manifold.
(2) Only one pressure relief device in the manifold is designed to shut off at any one time.
(3) The remaining pressure relief device(s) remains open and provides the rated relieving capacity required for the container.

[**58:**6.9.2.9]

10.2.11 Pressure relief valves shall be designed to minimize the possibility of tampering. [**58:**5.9.2.11]

10.2.12 Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment. [**58:**5.9.2.12]

10.3 Refrigerated Container Relief Devices.

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 STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, for containers designed to operate at 15 psi (103 kPa) and below
(2) ASME *Boiler and Pressure Vessel Code*, Section VIII, for containers designed to operate at above 15 psi (103 kPa)

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 Pressure losses in inlet and outlet piping connections to relief devices shall be included in the selection and sizing of relief devices.

10.3.5 A manually operated full opening stop valve shall be installed between each pressure and vacuum relief valve and the LP-Gas container.

10.3.5.1 A sufficient number of pressure and vacuum relief valves shall be installed on the refrigerated LP-Gas container to allow each relief valve to be isolated individually while maintaining the full relieving capacities required.

10.3.5.2 All stop valves installed between a relief valve and a container shall be lockable or sealable in the fully open position.

10.3.5.3 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.

10.3.5.4 Where only one relief device is required, a second, redundant relief device shall be installed with either a full port opening three-way valve between the container and the two redundant relief devices or separate stop valves installed beneath each redundant relief device.

10.3.5.5 No more than one stop valve shall be closed at one time.

10.4 Relief Device Sizing for Refrigerated Containers.

10.4.1 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 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 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 with a subcooled liquid

10.4.3.1 Reduction in the vacuum relief capacity to allow for the rate of vaporization that results from minimum normal heat gain to the contents of the container shall be allowed.

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

10.5 Refrigerated Container Relief Device Sizing for Fire Exposure.

10.5.1 The pressure relieving capacity required for fire exposure shall be computed using the following formula in conjunction with Table 10.5.1:

[10.5.1]

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

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)

10.5.2 Insulated Containers.

10.5.2.1 When credit for insulation is taken in sizing of a relief valve for fire exposure, the insulation shall meet the criteria listed in 10.5.2.1(1) through 10.5.2.1(3), or the criteria in 10.5.2.1(4) as follows:

(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 (538°C).
(4) The credit for insulation shall be permitted if the material meets the acceptance criteria listed in NFPA 290.

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

[10.5.2.2]

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

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

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).

where:

SCFM (air) = equivalent airflow 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

10.6 Pressure Relief Valve Discharge Vents.

10.6.1 General.

10.6.1.1 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.

10.6.1.2 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.

10.6.1.3 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.

10.6.2 Nonrefrigerated Aboveground Containers.

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

10.6.2.1.1 Where installed, vent stacks shall be fitted with loose-fitting rain caps.

10.6.2.1.2 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.

10.6.3 Nonrefrigerated Underground and Mounded Containers.

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

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

10.7 Vaporizers.

10.7.1 Vaporizer Pressure Relief Valve. The minimum rate of discharge in cubic feet (cubic meters) of air per minute for

pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct-fired, shall comply with one of the following:

(1) Assuming that the vaporizing chamber is liquid full, the maximum vapor generating capacity (rate) shall be determined when maximum heat is available. That vapor rate shall be converted to an equivalent air rate.
(2) If the vaporizer is direct fired or if a substantial exterior surface is in contact with the LP-Gas, the sum of the vaporizer surface and the LP-Gas wetted exterior surface shall be used in conjunction with Table 10.2.3 to determine the required relief valve capacity.
(3) The minimum rate of discharge in cubic feet (cubic meters) of air per minute for pressure relief valves for LP-Gas vaporizers, of either the indirect type or direct fire type, shall be at least 150 percent of the rated vaporizing capacity.

10.7.2 Where portions of the vaporizer containing LP-Gas can be exposed to external fire, the vaporization rate from the exposed surface area under fire exposure conditions shall be added to the discharge rate determined in 10.7.1.

10.7.3 Pressure relief valves on vaporizers within buildings or structures shall be piped to a point outside the building or structure and shall discharge vertically upward.

10.8 Hydrostatic Relief Valves. A hydrostatic relief valve shall be installed between each pair of shutoff valves on LP-Gas liquid piping so as to relieve the pressure that could develop from the trapped liquid.

10.8.1 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).

10.8.2 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 General. The requirements of Chapter 11 shall be applied to new and existing facilities.

11.2 Operating Procedures Manuals. Each facility shall prepare and maintain written operating procedures manuals that cover facility start-up, operation, and shutdown.

11.2.1 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) Human senses

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

11.2.3* Operating procedures shall include procedures for purging systems containing flammable or hazardous materials in accordance with the *Purging Manual* and are developed prior to the purging activity being performed.

11.2.4 Operating procedures for vaporizers shall provide instructions on the following:

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

11.2.5 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.

11.3 Handling.

11.3.1 Loading and Unloading Operations.

11.3.1.1 Transfer operations shall be conducted by individuals familiar with the properties of the material and instructed in transfer and emergency procedures.

11.3.1.2 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.

11.3.1.3 Written procedures shall be available to cover all transfer operations, and they shall cover emergency as well as normal operating procedures.

11.3.1.4 Written procedures shall be reviewed and updated at least annually and shall be available to all personnel engaged in transfer operations.

11.3.1.5 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.

11.3.1.6 Only those gases or liquids for which the system is designed shall be utilized in its operation.

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

11.3.1.8 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) 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.
(2) 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.

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

11.3.3 Railroad Tank Car Loading and Unloading Point.

11.3.3.1* 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.

11.3.3.2 When cars are on a side track for unloading, the wheels at both ends shall be blocked on the rail.

11.3.4 Cargo Tank Vehicle Loading and Unloading.

11.3.4.1 When cargo tank vehicles are loading or unloading, the wheels shall be blocked.

11.4 Operating Records.

11.4.1 Each facility shall maintain a record of all operating log sheets and recorded data. These records shall be made available to the authority having jurisdiction upon request during normal office hours.

11.4.2 Operating log sheets required under 11.4.1 shall be retained for at least 5 years.

Chapter 12 Maintenance

12.1 Retroactivity. The requirements of Chapter 12 shall be applied to new and existing facilities. Corrosion protection shall be implemented retroactively in accordance with 12.3.3.

12.2 Maintenance Manuals.

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

12.2.2 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.

12.2.3 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

12.3 Corrosion Protection.

12.3.1 Monitoring Corrosion Control. Corrosion protection shall be monitored to provide early recognition of ineffective corrosion protection, in accordance with 12.3.1.1 through 12.3.1.3.

12.3.1.1 Cathodic protection of buried or submerged components shall comply with the following:

(1) Components meeting the requirements of 4.10.3.1 shall be tested 6 months after initial burial, including tests for component-to-soil potential measurements with respect to either a continuous reference cell electrode or an electrode using close spacing, not to exceed 20 ft (6 m), and soil resistivity measurements at potential profile peak locations to evaluate the potential profile at the component or along the pipeline. If tests indicate that a corrosive condition exists, the affected components shall be cathodically protected in accordance with Section 4.10.
(2) After the initial tests required by 12.3.1.1(1), additional tests shall be conducted every 3 years and not exceeding 39 months to reevaluate the condition of the unprotected components. If tests indicate that an active corrosion exists by either electrical survey of leak repair or exposed pipe inspection records, the affected components shall be cathodically protected in accordance with Section 4.10.
(3) Cathodic protection systems installed in accordance with Section 4.10 shall be monitored by testing and the results documented and retained per 12.10.2(3).
(4)* Cathodic protection system tests shall be described by one of the following:
    (a) Producing a voltage of –0.85 volts or more negative, with reference to a saturated copper–copper sulfate half cell
    (b) Producing a voltage of –0.78 volts or more negative, with reference to saturated KCl calomel half cell
    (c) Producing a voltage of –0.80 volts or more negative, with reference to a silver–silver chloride half cell
(5) Each buried or submerged component under cathodic protection shall be tested by personnel qualified to perform corrosion control monitoring at least once each calendar year, with intervals not exceeding 15 months, to determine whether the cathodic protection is performing as designed.
(6) Each cathodic protection rectifier or other impressed current power source shall be inspected by personnel qualified to perform corrosion control monitoring at least six times each calendar year, with intervals not exceeding 2½ months, to ensure that it is performing as designed.
(7) Each reverse current switch, each diode, and each interference bond whose failure would jeopardize component protection shall be electrically checked for proper performance at least six times each calendar year, with intervals not exceeding 2½ months, by personnel qualified to perform corrosion control monitoring. Each other interference bond shall be checked at least once each calendar year, with intervals not exceeding 15 months.
(8) Whenever any portion of a buried pipe is exposed, the exposed portion of the pipe shall be examined for evidence of external corrosion in either of the following instances:
    (a) If general external or localized external pitting corrosion is identified, additional examination in the exposed area is necessary to identify the extent of the corrosion.
    (b) If damage to the component coating is observed, the coating shall be repaired in accordance with 4.10.1.1.2.

12.3.1.2 Each component that is protected from atmospheric corrosion shall be inspected at intervals not exceeding 3 years.

12.3.1.2.1 Components located at soil-to-air interfaces, under disbonded coatings, at pipe supports, in splash zones, and deck penetrations shall be inspected.

12.3.1.2.2* Components covered by insulation that are subject to atmospheric corrosion shall be periodically monitored based on a written program for inspection of components under insulation.

12.3.1.3 Components that are protected from internal corrosion shall have monitoring devices designed to detect internal corrosion. Monitoring devices shall be located where corrosion is most likely to occur. Internal corrosion control monitoring devices shall be monitored at least two times each calendar year, with intervals not exceeding 7½ months.

12.3.1.3.1 Monitoring shall not be required for corrosion-resistant materials if it is demonstrated that the component is not adversely affected by internal corrosion during its service life.

12.3.1.3.2 Whenever a pipe is opened, the internal surface shall be examined for evidence of corrosion.

12.3.2 Remedial Measures. Corrective action shall be taken when inspection determines that atmospheric, external, or internal corrosion is not controlled in accordance with Section 12.3.

12.3.2.1* Components observed during monitoring required per 12.3.1.1, 12.3.1.2, and 12.3.1.3 shall be replaced where uniform or localized corrosion, or localized corrosion pitting has resulted in a remaining wall thickness less than that required for the maximum allowable operating pressure of the pipeline, or a remaining wall thickness less than 50 percent of the nominal wall thickness.

12.3.2.2 Where components are observed with atmospheric corrosion not exceeding values in 12.3.2.1, the coating shall be repaired in accordance with 4.10.1.1.2.

12.3.3 Retroactivity.

12.3.3.1 All new facilities shall meet all the requirements for corrosion control in Section 12.3 and 12.10.2(3).

12.3.3.2 All expanded, significantly modified facilities, or facilities replacing components containing LP-Gas (liquid or vapor state) shall meet the requirements for corrosion control in Section 12.3 and 12.10.2(3) for expanded, modified, or replaced portions of the facility.

12.3.3.3 Corrosion control requirements shall be applied retroactively to existing facilities in accordance with 12.3.3.3.1 through 12.3.3.3.3.

12.3.3.3.1 Atmospheric corrosion control requirements shall be applied to existing facilities in accordance with 12.3.3.3.1.1 and 12.3.3.3.1.2.

12.3.3.3.1.1 The following atmospheric corrosion control requirements shall be met by July 14, 2015:

(1) Coating of exposed components in accordance with 4.9.1(2)
(2) Monitoring in accordance with 12.3.1.2
(3) Remedial measures in accordance with 12.3.2
(4) Recordkeeping in accordance with 12.10.2(3)

12.3.3.3.1.2 The following requirements for components covered by thermal insulation or fireproofing materials shall be met by July 14, 2017:

(1) Coating in accordance with 4.9.1(2)
(2) Monitoring in accordance with 12.3.1.2.2
(3) Remedial measures in accordance with 12.3.2
(4) Recordkeeping in accordance with 12.10.2(3)

12.3.3.3.2 The following requirements for internal corrosion control shall be met by July 14, 2015:

(1) Component monitoring in accordance with 12.3.1.3
(2) Remedial measures in accordance with 12.3.2
(3) Recordkeeping in accordance with 12.10.2(3)

12.3.3.3.3 The following requirements for external corrosion control of buried or submerged components shall be met by July 14, 2019:

(1) Installing a cathodic protection system in accordance with 4.8.2, 4.10.3, 4.10.4, 4.10.5, and Section 4.12
(2) Monitoring in accordance with 12.3.1.1
(3) Remedial measures in accordance with 12.3.2
(4) Recordkeeping in accordance with 12.10.2(3)

12.4 Maintenance of Emergency Shutoff and Check Valves.

12.4.1 Emergency shutoff valves shall be maintained in working order.

12.4.2 Emergency shutoff valves and check valves required by 7.11.4.1 shall be tested annually for proper operation. The results of the tests shall be documented.

12.5 Maintenance of Foundations and Supports. Each operating company shall perform inspections of foundations and supports of equipment and piping containing flammable liquids/gases to visually evaluate their structural integrity.

12.5.1 Inspections shall be conducted at intervals identified in the maintenance manual.

12.5.2 Where structural integrity appears compromised, the support/foundation shall be further evaluated and repaired as required.

12.6 Maintenance of Fire Protection Equipment.

12.6.1 Maintenance of fire protection systems shall be in accordance with fire protection standards identified in Chapter 13.

12.6.2 Maintenance activities on fire protection systems 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.

12.7 Leakage Surveys.

12.7.1 Leakage surveys with leak-detection equipment shall be conducted of all buried or submerged components carrying LP-Gas (liquid or vapor state) every 5 years, not to exceed 63 months.

12.7.2 Where a buried or submerged component is not protected by a corrosion control system in accordance with Section 4.10 and 12.3.1, the leakage surveys of components carrying LP-Gas (liquid or vapor state) shall be conducted every 3 years, not to exceed 39 months.

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

12.9 Purging Prior to Maintenance. All systems that contain flammable or hazardous materials shall be purged in accordance with the *Purging Manual* and 11.2.3 prior to beginning maintenance and returning to service.

12.10 Maintenance Records.

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

12.10.1.1 The records shall be made available to the AHJ upon reasonable request.

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

12.10.2 Retention of records that are required under Section 12.10 shall be as follows:

(1) Records of the inspection, testing, and maintenance of propane pressure relief valves shall be retained for the following minimum amounts of time:
   (a) 10 years while the valve is in service
   (b) 5 years after the valve is removed from service
(2) Records of the inspection, testing, and maintenance for all other process equipment shall be kept for 5 years.
(3) Corrosion control records shall be kept for the following amounts of time:
   (a) Records or maps of corrosion control system installation locations shall be retained for the life the facility remains in service
   (b) Records associated with each test, survey, or inspection shall be retained for 5 years in sufficient detail to demonstrate adequacy of corrosion control measures.

Chapter 13 Fire Protection, Safety, and Security

13.1 General.

13.1.1 Fire protection shall be provided for all utility LP-Gas facilities.

13.1.1.1* 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

13.1.1.2* 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 protection 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

13.1.1.3 A primary consideration when conducting the evaluation in 13.1.1.1 and 13.1.1.2 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 pull-away protection.

13.1.1.4 If it is determined in the preparation of the fire protection evaluation identified in 13.1.1.1 and 13.1.1.2 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 Section 13.6.

13.1.1.5 The evaluation required by 13.1.1.1 shall be conducted for all new and existing facilities within 1 year of adoption of this code, shall be reviewed every 3 years, and shall be revised when necessary.

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.

13.1.3.1 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
(6) Analyzing accidents or failures for the purpose of determining the cause of the failure and minimizing the possibility of recurrence

13.1.3.2 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.

13.1.3.3 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 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 and shall include the safety of emergency personnel, workers, and the public.

13.2 Gas, 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 and low temperature sensors used for leak detection purposes 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.

13.2.5* Where installed as determined by the evaluation required in 13.1.1, the following fire alarm components shall be designed, installed, documented, tested, and maintained in accordance with *NFPA 72*:

(1) Initiating devices (detectors — smoke, flame, heat, etc.)
(2) Fire system monitor panels
(3) Notification appliances (strobes, sirens, etc.)
(4) Fire system activation devices on installed extinguishment/suppression systems (water deluge, fixed dry chemical systems)
(5) Field wiring between initiating, notification components, activation/suppression system, and control panels
(6) Power supply and backup power equipment for fire alarm system

13.3 Container Protection. Nonrefrigerated storage containers shall be protected against fire exposure by one of the means in Section 13.6, unless an evaluation in accordance with 13.1.1 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.

13.4.2.1 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.

13.4.2.2 Manually actuated monitors shall be permitted to be used to augment hand hose streams.

Δ **13.4.3** Fire protection water systems, where used, shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable, considering the fire protection problems in facilities covered by this standard:

(1) NFPA 13
(2) NFPA 14
(3) NFPA 15
(4) NFPA 20
(5) NFPA 22
(6) NFPA 24
(7) NFPA 25
(8) NFPA 1961
(9) NFPA 1962
(10) NFPA 1963

13.5 Fire-Extinguishing and Other Fire Protection Equipment.

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

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

13.5.2 Where required, extinguishers for use in nonprocess locations shall be rated, sized, and located as determined in accordance with 13.1.1, within the facility.

Δ **13.5.3** Where fixed fire-extinguishing and other fire protection systems are provided, such systems shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable:

(1) NFPA 10
(2) NFPA 11
(3) NFPA 12
(4) NFPA 12A
(5) NFPA 17
(6) NFPA 2001

13.6 Special Protection.

13.6.1* If insulation is used, it shall comply with NFPA 290.

13.6.2 If mounding or burial is used, the provisions of 5.5.2 shall constitute adequate protection.

13.6.3 If water spray fixed systems are used, they shall comply with NFPA 15 and shall be automatically actuated by fire-responsive devices and also shall have a capability for manual actuation.

13.6.4 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 and shall be automatically actuated by fire-responsive devices and also shall have a capability for manual actuation.

13.6.5* 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 it shall be resistant to weathering and the action of hose streams.

13.7 Maintenance of Fire Protection Equipment. Operators shall prepare and implement a maintenance program for all plant fire protection equipment.

13.8 Personnel Safety.

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

13.8.2 Each utility gas plant shall have first-aid materials readily available.

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

13.8.3.1 Protective clothing and equipment shall be available to protect employees from the hazard of frostbite.

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

13.8.4.1 If employees' emergency activities include fire fighting, the protective clothing, including helmets, face shields, gloves, and boots, shall comply with NFPA 1971 and protective clothing shall have an impermeable outer shell.

13.8.5 Self-contained breathing apparatus (SCBA) shall be provided for those employees who are required to enter an atmosphere that could be injurious to health during an emergency.

13.8.5.1 Such apparatus shall comply with NFPA 1981 and shall be maintained in accordance with the manufacturer's instructions.

13.8.6 A portable flammable gas detector shall be readily available.

13.8.7* Personnel shall be advised of the dangers of working on or near exposed electrical components that are or can become energized.

13.9 Security.

13.9.1 Each utility gas plant shall have a security system with controlled access, which shall be designed to minimize entry by unauthorized persons.

13.9.2 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

13.9.2.1 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

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

13.9.2.3 Such devices, when in place, shall prevent unauthorized operation of any of the container appurtenances, facility valves, or equipment.

13.9.3 The provisions of 13.9.2 shall be met by either one continuous enclosure or several independent enclosures or other approved means.

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

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

13.9.6 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 See Figure A.1.1.1 for a graphical representation of the scope of coverage of NFPA 59.

• N **A.1.4.1** Some portions of this code are retroactive and are to be implemented at all new and existing installations. Table A.1.4.1 is provided as a reference to retroactive requirements that appear in the code. Note that the effective date of a section might be altered by the local jurisdiction.

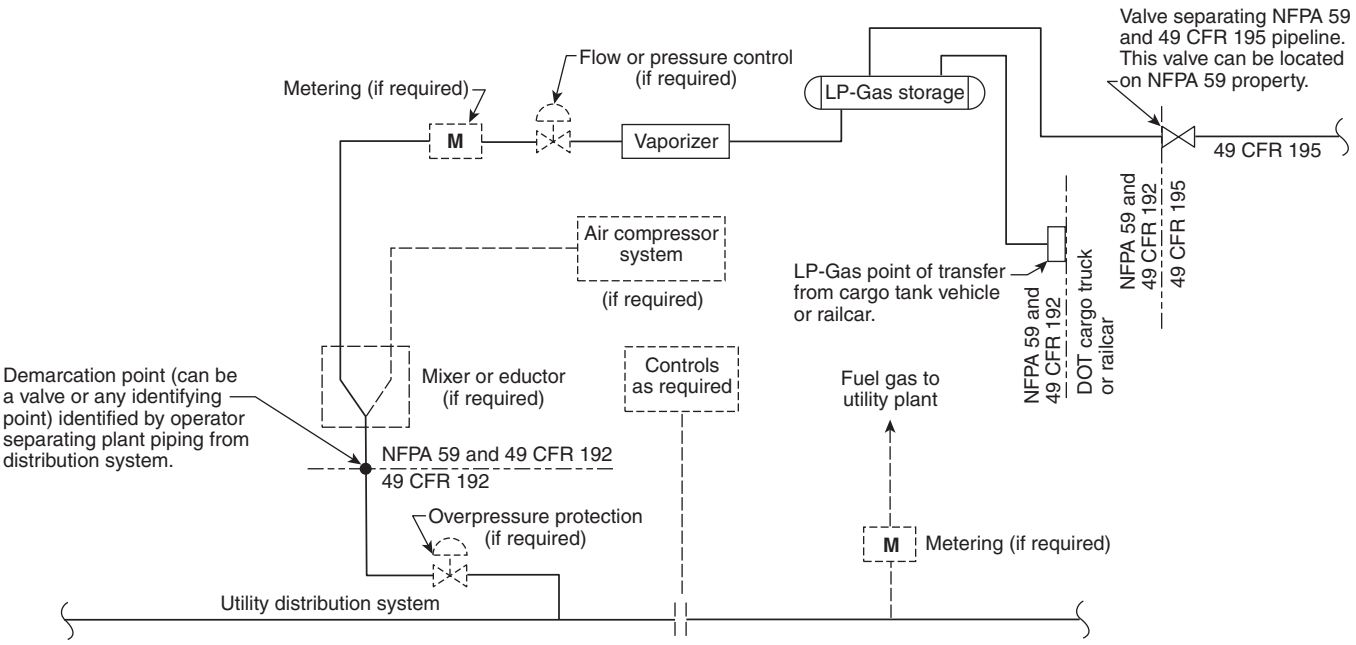


FIGURE A.1.1.1 Typical Installation of an LP-Gas or an LP-Gas Air Facility.

N **Table A.1.4.1 Reference to Retroactivity Requirements**

Section in Current Edition	Heading	Effective Date	Original Edition
4.8.2	Design and Installation (For buried or submerged components)	July 14, 2019	2015
4.9.1(2)	Atmospheric Corrosion Control (For components subject to atmospheric corrosion)	July 14, 2015	2015
4.9.1(2)	Atmospheric Corrosion Control (For components covered by insulation or fireproofing materials)	July 14, 2017	2015
4.10.3	External Corrosion Control: Buried or Submerged Components	July 14, 2019	2015
4.10.4	External Corrosion Control: Buried or Submerged Components	July 14, 2019	2015
4.10.5	External Corrosion Control: Buried or Submerged Components	July 14, 2019	2015
4.12	Interference Currents (For buried or submerged components)	July 14, 2019	2015
7.11.4.1	Railroad Tank Car and Cargo Tank Vehicle Transfer Areas	December 31, 2005	2001
7.11.4.2	Railroad Tank Car and Cargo Tank Vehicle Transfer Areas	December 31, 2005	2001
7.11.4.3	Railroad Tank Car and Cargo Tank Vehicle Transfer Areas	December 31, 2005	2001
7.11.4.4	Railroad Tank Car and Cargo Tank Vehicle Transfer Areas	December 31, 2005	2001
Chapter 11	Chapter 11	June 20, 2011. See below for sections with other effective dates.	2012
11.3.2	Loading and Unloading Operations	December 31, 2005	2001
Chapter 12	Chapter 12	June 20, 2012. See below for sections with other effective dates.	2012
12.3.1.1	Monitoring Corrosion Control (For buried or submerged components)	July 14, 2019	2015
12.3.1.2	Monitoring Corrosion Control (For components subject to atmospheric corrosion)	July 14, 2015	2015
12.3.1.2.2	Monitoring Corrosion Control (For components covered by insulation or fireproofing materials)	July 14, 2017	2015
12.3.1.3	Monitoring Corrosion Control (For components subject to internal corrosion)	July 14, 2015	2015
12.3.2	Remedial Measures (For components subject to atmospheric corrosion)	July 14, 2015	2015
12.3.2	Remedial Measures (For components subject to internal corrosion)	July 14, 2015	2015
12.3.2	Remedial Measures (For components covered by insulation of fireproofing materials)	July 14, 2017	2015
12.3.2	Remedial Measures (For buried or submerged components)	July 14, 2019	2015
12.4.1	Maintenance of Emergency Shutoff and Check Valves	December 31, 2005	2001
12.4.2	Maintenance of Emergency Shutoff and Check Valves	December 31, 2005	2001
12.10.2(3)	Maintenance Records (For components subject to atmospheric corrosion)	July 14, 2015	2015
12.10.2(3)	Maintenance Records (For components subject to internal corrosion)	July 14, 2015	2015
12.10.2(3)	Maintenance Records (For components covered by insulation or fireproofing materials)	July 14, 2017	2015
12.10.2(3)	Maintenance Records (For buried or submerged components)	July 14, 2019	2015

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.

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.3.3.9 Component. Components are usually removable in one piece and are considered indivisible for a particular purpose or use.

A.3.3.16 Fire Protection. The term *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.

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

The term *fire suppression* covers means of supplying water or other agents providing for fire control, exposure protection, or fire extinguishment. The term *fire control* is defined in NFPA 13 as a means of limiting the size of a fire by distribution of water so as to decrease the heat release rate and pre-wet adjacent combustibles while controlling ceiling gas temperatures to avoid structural damage.

A.3.3.18 Gas (for the purposes of this code). The more specific terms *liquid LP-Gas* or *vapor LP-Gas* are used for clarity.

A.3.3.19 Gas–Air Mixer. A gas–air mixture normally is used in industrial or commercial facilities as a substitute for another fuel gas. [**58,** 2017]

A.3.3.37 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 monitor nozzles that meet the criteria specified in this code
(6) Any means listed for this purpose

See Section 6.29 [of NFPA 58] for more information on fire protection and special protection. [**58,** 2017]

Δ **A.3.3.40 Utility Gas Plant.** In the United States, utility gas plants, as defined within this standard, and gas distribution systems are subject to, but not limited to, the following regulatory requirements:

(1) 49 CFR 191, "Transportation of Natural and Other Gas by Pipeline; Annual Reports, Incident Reports, and Safety-Related Condition Reports" (latest revision)
(2) 49 CFR 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards" (latest revision):
    (a) 49 CFR 192.11, "Petroleum Gas Systems," incorporates by reference the 2004 edition of NFPA 59 at the time of publication of this NFPA 59 edition.
    (b) NFPA 59 has been aligned to include applicable regulatory requirements listed in 49 CFR 192 into this code.
    (c) As such, the scope of 49 CFR 192 within an NFPA 59 utility gas plant begins at the gas–air mixer with respect to 49 CFR 192, Subpart N, "Qualification of Pipeline Personnel," as the operation and maintenance of the gas–air mixer can affect the integrity of the distribution system piping downstream of the utility gas plant. NFPA 59 requirements for the gas–air mixer is jointly applicable with 49 CFR 192 requirements as stated previously.
    (d) Portions of the NFPA 59 utility gas plant prior to the gas-air mixer must meet the requirements listed in the version of NFPA 59 as described in the NFPA 59 applicability in A.3.3.40(4).
(3) 49 CFR 199, "Drug and Alcohol Testing" (latest revision)
(4) NFPA 59:
    (a) Original facility design, construction, modifications, operations, maintenance, and fire/safety and security prior to August 1970 when the 49 CFR 192 regulations were promulgated are to have complied with the edition of NFPA 59 published at the time of the design/construction.
    (b) Original facility design, construction, post original design and construction modifications, operations, maintenance, and fire safety and security after August 1970 and the promulgation of 49 CFR 192 regulations are to have complied with the edition of NFPA 59 incorporated by reference by 49 CFR 192 at the time of the facility design, construction, post original design and construction modifications,

operations, maintenance, and fire safety and security.

A.3.3.42.1 Direct-Fired Vaporizer. This classification includes submerged-combustion vaporizers.

A.4.1.1 NFPA 59 operator qualifications as stated in Section 4.1 include safe handling of propane and responding to emergencies per established procedures. Additionally, 4.1.1 addresses the qualification requirements intended by 49 CFR 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards," in the United States. 49 CFR 192 Operator Qualifications (OQ) requirements are applicable to NFPA 59 facilities but limited to those operating and maintenance personnel who operate and maintain the propane–air mixing equipment.

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.

A.4.5.1.2 Static grounding or bonding protection is not required where tank cars, tank vehicles, or marine equipment is 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 information on grounding and bonding for protection against static electricity, see NFPA 77.

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.

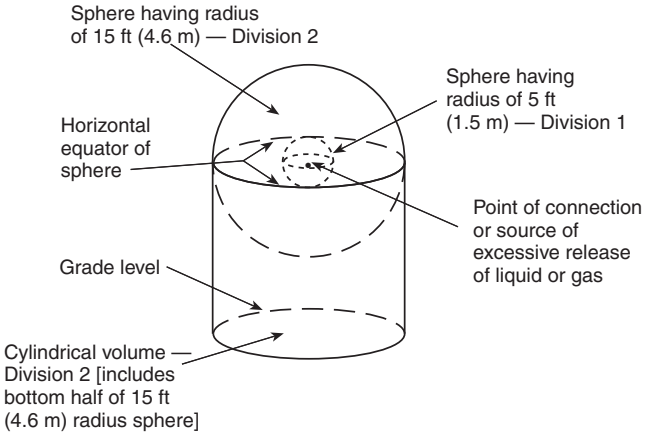
Where specified for the prevention of fire or explosion during normal operation, ventilation is considered adequate where provided in accordance with the provisions of this code.

See Figure A.4.5.2.2.

When classifying the extent of an entire facility or a specific portion of the facility, consideration should be given to increasing the extent of the hazardous area location above those stated in *NFPA 70* (*NEC*) and Table 4.5.2.2 in NFPA 59 based on higher flow rates and pressures utilized within larger facilities. Additional guidance for extending electrical area classifications can be found in NFPA 497.

A.4.5.3 The use of nonferrous tools in areas with the potential for flammable atmosphere should be considered.

A.4.5.5 For additional information, see API RP 2003, *Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents.*



Δ **FIGURE A.4.5.2.2 Extent of Electrically Classified Area.** ***(See Table 4.5.2.2.)*** **[58:Figure A.6.25.2.3]**

Δ **A.4.10** SP0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*, and SP0285, *Corrosion Control of Underground Storage Tank Systems by Cathodic Protection*, provide guidance for corrosion control systems for buried and submerged components.

A.4.10.1(2)(a) Facilities under U.S. federal regulations should comply with 49 CFR 192.461, "External Corrosion Control: Protective Coating."

A.4.10.1(2)(b) Facilities under U.S. federal regulations should comply with 49 CFR 192.463, "External Corrosion Control: Cathodic Protection."

A.5.2.1 See Annex D of NFPA 58 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 Table A.5.4 is a compilation of the spacing requirements in the code.

A.5.4.1.2 In heavily populated or congested areas where serious mutual exposures between container(s) and adjacent properties exist, 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.

The reference to an "important building or group of buildings" in Table 9.5.2.4 refers to buildings that are not a part of the utility LP-Gas plant process and that meet one of the following criteria:

(1) The building is intended for human occupancy.
(2) The building or its contents are of high value.
(3) The building is important to emergency responders in a fire situation.

Δ Table A.5.4 Spacing Chart

Exposure	Aboveground LP-Gas Container (ft)	Underground LP-Gas Container (ft)	Aboveground Flammable Liquids Tank (ft)	Point of Transfer (ft)	Dike/ Impoundment (ft)
Vehicles, ignition sources, mobile equipment	See 4.5.4	50	See 4.5.4	75*	
Aboveground LP-Gas containers	See 5.4.1.2			20	25
Underground LP-Gas containers		10		10	25
Buildable property line/Important buildings	See 5.4.1.2	50		75	100
Buildings associated with utility gas plant	See 5.4.1.3	50			75*
Groups of aboveground containers	See 5.4.1.4				
Ignitible material	25	25 from manway			
Barriers for vehicle protection				5 behind	
Additional shutdown station				25–100	
Navigable waterway					100

Note: For SI units, 1 ft = 0.3 m.
*Also process areas, other than equipment directly associated with the transfer operation.

A building that meets any of the above criteria is considered important.

A.5.4.1.8 For information on determination of flash points, see NFPA 30. [**58:** A.6.4.4.4]

Δ A.5.5.2.9 For information on corrosion protection, see SP0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*.

A.6.2.4.1 See API STD 625, *Tank Systems for Refrigerated Liquefied Gas Storage*, for specific design and installation of penetrations including in-tank valve and nozzle criteria.

A.7.1.1.5 Where piping was buried prior to the addition of the requirements in 7.1.1.5, consideration should be given to marking the buried piping.

A.7.1.10 It should be recognized that the temperature of liquid propane will drop to about –40°F (–40°C) when released to the atmosphere.

A.7.3.2 See A.5.4.1.2.

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

A.7.11.4.3 Anchorage can be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting.

A.8.3.2.6 See NFPA 80.

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, Interchangeability of Other Fuel Gases with Natural Gas*, and the AGA Gas Interchangeability Program.

A.9.5.2.4 See A.5.4.1.2.

Δ A.10.1 Dilution effects from relief valves releasing hydrocarbon gases can vary dramatically depending on whether the product released is vapor, mist, or liquid. Based on information provided in API STD 521, *Guide for Pressure-Relieving and Depressuring Systems*, safety relief valves that are in liquid service when relieving do not entrain sufficient volumes of air to dilute the mixture to below lower flammable limit levels.

In contrast, for safety relief valves in vapor service only and those safety relief valves that emit a mist, 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.

These additional factors should be considered when establishing the electrical area classification and classification distances near relief valves in liquid service.

Δ A.11.2.3 For additional information on purging tanks and containers, see NFPA 326.

A.11.3.3.1 The U.S. Department of Transportation (DOT) was formerly the Interstate Commerce Commission (ICC), and its rules are published in 49 CFR 171–180, "Hazardous Materials Regulations," and 49 CFR 190–199, "Pipeline Safety Regulations." In Canada, the regulations of the Canadian Transport Commission for Canada apply.

A.12.3.1.1(4) In addition to tests listed in 12.3.1.1(4)(a) through 12.3.1.1(4)(c), other methods described in Appendix D of 49 CFR 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards," are acceptable.

Δ A.12.3.1.2.2 SP0198, *Control of Corrosion Under Thermal Insulation and Fireproofing Materials — A Systems Approach*, provides guidance on which corrosion control monitoring program can be established.

A.12.3.2.1 Corroded pipe can be repaired by a method that reliable engineering tests and analyses show can permanently restore the serviceability of the pipe.

A.13.1.1.1 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.

Assistance in performing this analysis is available from a number of sources. Users should consult the AHJ (e.g., a federal, state, or local office) in which the installation is located. The department with jurisdiction over LP-Gas installations could offer guidance or a template for the analysis. The AHJ might also have specific requirements in how the analysis is performed or its content. The analysis is sometimes called a fire safety analysis.

Other sources for assistance include, but are not limited to:

(1) State propane gas associations
(2) The National Propane Gas Association
(3) The National Fire Protection Association through its web site: www.NFPA.org
(4) The Propane Education and Research Council has published a *Fire Safety Analysis Manual for LP-Gas Storage Facilities*, available from its web site: www.propanesafety.com

A.13.1.1.2 In addition to areas such as enclosed buildings that have a potential for flammable gas concentrations, operators conducting the evaluation required in 13.1.1.1 and 13.1.1.2 should also consider installation of fixed gas detection near the location of the combustion air intakes of fired process equipment. When installed, gas detection equipment at the fired equipment can be installed such that if the detector senses the presence of flammable gas at some determined safe level below the lower explosive limit (LEL) (25%–50%), it activates an interlock so that the fired equipment is immediately shut down minimizing the risk that the flammable gas finds an ignition source.

A.13.2.4 Information on detection systems can be found in *NFPA 72* and NFPA 1221.

A.13.2.5 Where fire protection systems are installed in accordance with *NFPA 72* and are planned for integration with other systems, NFPA 3 might be useful in the commissioning and testing of the integrated systems.

A.13.6.1 It is recommended that insulation systems be evaluated on the basis of experience or listings by an approved testing laboratory.

A.13.6.5 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.13.8.7 *NFPA 70E* can be used to identify personnel protection levels where electrical exposure and contact concerns are present within the facility. Protective clothing and equipment should be made available as listed by *NFPA 70E* based on the tasks performed.

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.

Δ **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:

[B.3a]

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

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 at liquid temperature T, Q_T, of LP-Gas that can be placed in a container is obtained by multiplying the water capacity of the container by $V/100$ where Q_T equals actual gallons at liquid temperature T.