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NFPA 59 LP-Gases at Utility Gas Plants 1992 Edition

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 59

Standard for the Storage and Handling of

Liquefied Petroleum Gases at Utility Gas Plants

1992 Edition

This edition of NFPA 59, *Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants*, was prepared by the Technical Committee on Liquefied Petroleum Gases and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 18-20, 1991 in Montréal, Québec, Canada. It was issued by the Standards Council on January 17, 1992, with an effective date of February 10, 1992, and supersedes all previous editions.

The 1992 edition of this document has been approved by the American National Standards Institute.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 59

The *Standard on Liquefied Petroleum Gases* (NFPA 58) was used as a general guide until this standard was adopted in 1949. Subsequent editions were adopted in 1954, 1956, 1958, 1962, 1963, 1968, 1974, 1976, 1979, 1984, and 1989.

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

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

The 1992 edition contains several revisions that bring it into agreement with similar requirements of NFPA 58. It has also been modified to provide a clear boundary between the utility gas plant and pipelines. Also included are editorial revisions to make the standard easier to use, understand, and enforce.

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

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.

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Standard for the Storage and Handling of

Liquefied Petroleum Gases at Utility Gas Plants

1992 Edition

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

Information on referenced publications can be found in Chapter 11 and Appendix F.

Foreword

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

In the case of pure product at atmospheric pressure and below 31°F (-0.6°C), normal butane is a liquid. Propane is a liquid at atmospheric pressure at temperatures below -44°F (-42°C) and normally does not present a flammable liquid hazard except when stored at or below its boiling point.

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

Rapid vaporization takes place at temperatures above the boiling points [normal butane about 31°F (-0.6°C); propane about -44°F (-42°C)]. Normally these gases are stored as a liquid under pressure; however, in refrigerated storage these gases are frequently stored at or below the boiling point at practically atmospheric pressure.

Chapter 1 General Provisions

1-1 General.

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

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

1-1.3 Persons engaged in operating and emergency procedures and the handling of liquefied petroleum gases shall be trained in th properties and safe handling of these gases, and emergency procedures. This training shall be repeated at least annually.

1-1.4 Metric units in this standard are provided for the convenience of the user. Alternate usage of English and metric units shall not be used to lessen the requirements of the standard.

1-2 Scope.

1-2.1 This standard applies to utility gas plants for the design, construction, location, installation, operation, and maintenance of refrigerated and nonrefrigerated liquefied petroleum gas systems to the point where LP-Gas or a mixture of LP-Gas and air is introduced into the utility distribution system.

NOTE: Those portions of LP-Gas systems downstream of the point where LP-Gas or a mixture of LP-Gas and air is introduced into the utility distribution system are covered in the United States by DOT, CFR 49, Part 192.

1-2.2 The provisions of this standard are not intended to prevent the use of any material, method of construction, or installation procedure not specifically prescribed by this standard, provided any such alternate is acceptable to the authority having jurisdiction (see definition). The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claim made regarding the safety of such alternatives.

1-2.3 When operations involving the liquid transfer of LP-Gas from the utility gas plant storage into cylinders or portable tanks (as defined by NFPA 58) are carried out in the utility gas plant, these operations shall conform to NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases.*

1-2.4 Installations having an aggregate water capacity of 4,000 gal (15.14 m^3) or less shall conform to NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases.*

1-3 Retroactivity.

1-3.1 The provisions of this document are considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosion. They reflect situations and the state of the art at the time the standard was issued.

1-3.2 Unless otherwise noted it is not intended that the provisions of this document be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the document, except in those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or adjacent property.

1-4 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: 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 or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Barrel. A unit of volume. One barrel equals 42 U.S. gal (0.159 kL) or 5.615 cu ft (0.159 m^3).

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

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

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

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

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

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

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

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

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

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

Psig and Psia. Pounds per sq in. gauge and pounds per sq in. absolute, respectively.

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

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.

When required in this standard, special protection consists of any of the following: applied insulating coatings, mounding, burial, water spray fixed systems or fixed monitor nozzles, meeting the criteria specified in this standard (*see 10-5.4*), or by any means listed (*see definition of Listed*) for this purpose.

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

Utility Gas Plant. A fuel gas distribution facility owned or operated by a utility, as designated by the appropriate governing jurisdiction.

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.

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

Vaporizer, Electric. A unit using electricity as a source of heat.

1. *Direct immersion electric vaporizer.* A vaporizer wherein an electric element is immersed directly in the LP-Gas liquid and vapor.

2. *Indirect electric vaporizer.* An immersion type wherein the electric element heats an interface solution in which the LP-Gas heat exchanger is immersed or heats an intermediate heat sink.

Vaporizer, Indirect (also called Indirect-Fired). 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 being at a point remote from the vaporizer.

Vaporizer, Waterbath (also called Immersion Type). 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, which is heated by an immersion heater not in contact with the LP-Gas heat exchange surface.

1-5 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, provided, however, that odorization is not required if harmful in the use or further processing of the liquefied petroleum gas or if odorization will serve no useful purpose as a warning agent in such use or further processing.

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

1-6 Acceptance of Equipment. In systems containers of over 2,000-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 Section 1-4, Approved*).

1-7 Damage from Vehicles. Where damage to liquefied petroleum gas systems from vehicular traffic is a possibility, precautions against such damage (such as warning signs or devices, or barricades) shall be taken (*see 2-9.2*).

1-8 Electrical Equipment and Lighting.

1-8.1 Electrical equipment and wiring shall be of the type specified by and shall be installed in accordance with NFPA 70, *National Electrical Code,*® for ordinary locations except that fixed electrical equipment in classified areas shall comply with Section 1-9.

1-8.2 Adequate lighting shall be provided to illuminate operating facilities, such as walkways and essential control valves, and particularly loading and unloading facilities.

1-9 Fixed Electrical Equipment in Classified Areas.

1-9.1 Fixed electrical equipment and wiring installed within classified areas specified in Table 1-8 shall comply with Table 1-8 and shall be installed in accordance with NFPA 70, *National Electrical Code*, for hazardous locations.

1-9.2 Fixed electrical equipment on LP-Gas cargo vehicles shall comply with the provisions of Chapter 6 of NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases.*

1-10 Source of Ignition.

1-10.1 Smoking and nonprocess ignition sources within the protective enclosure (*see 10-9.2*) shall be prohibited except in accordance with 1-10.2 through 1-10.4.

1-10.2 Smoking shall be permitted only in designated and properly signposted areas.

1-10.3 Welding, cutting, hot work, use of portable electric tools and extension lights, and similar operations shall be conducted only at times and places specifically authorized. Welding and cutting shall be conducted in accordance with the provisions of NFPA 51B, *Fire Prevention in Use of Cutting and Welding Processes*. Portable electric tools and extension lights capable of igniting LP-Gas shall not be permitted within classified areas specified in Table 1-8 unless the LP-Gas facilities have been freed of all liquid and vapor or special precautions observed under carefully controlled conditions.

1-10.4 Vehicles and other mobile equipment that constitute potential ignition sources shall be prohibited within diked areas or within 50 ft (15 m) of containers containing LP-Gas, flammable liquids, or flammable refrigerants except when specifically authorized and under constant supervision or when loading or unloading at facilities specifically for the purpose.

1-10.5 Electrical grounding and bonding shall be provided as required by NFPA 70, *National Electrical Code.*

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

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

1-10.6 If stray currents may be present or if impressed currents are used on loading and unloading systems (such as for cathodic protection), protective measures to prevent ignition shall be taken.

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

1-10.7 Metallic storage containers for LP-Gas generally do not require lightning protection. Grounding systems shall be provided for LP-Gas storage containers in accordance with Chapter 3, Section 4-4, and 6-3.2 of NFPA 78, *Lightning Protection Code.*

Table 1-8

Part	Location	Extent of Classified Area[1]	Equipment Shall Be Suitable for *NEC*,® Class 1, Group D[4]
A	Nonrefrigerated container.	Within 15 ft (4.6 m) in all directions from connections, except for connections otherwise covered in this table.	Division 2
B	Refrigerated.	Within 15 ft (4.6 m) in all directions from connections, except for connections otherwise covered in this table.	Division 2
		Area inside dike to a level of the top of the dike.	Division 2
C	Tank Vehicle and Tank Car Unloading.[2]	Within 5 ft (1.5 m) in all directions from connections regularly made or disconnected for product transfer.	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from a point where connections are regularly made or disconnected and with the cylindrical volume between the horizontal equator of the sphere and grade. (*See Figure 1-8.*)	Division 2
D	Gauge Vent Openings.	Within 5 ft (1.5 m) in all directions from point of discharge.	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of discharge.	Division 2
E	Relief Valve Discharge.	Within direct path of discharge.	Division 1 Note: Fixed electrical equipment should preferably not be installed.
		Within 5 ft (1.5 m) in all directions from point of discharge.	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of discharge except within path of discharge.	Division 2
F	Pumps, compressors, gas-air mixers, meter areas, calorimeters other than open flame types, and vaporizers other than direct fired.		
	Indoors without ventilation.	Entire room and any adjacent room not separated by a gastight partition.[1]	Division 1
		Within 15 ft (4.6 m) of the exterior side of any exterior wall or roof that is not vapor-tight or within 15 ft (4.6 m) of any exterior opening.	Division 2

Table 1-8 (Continued)

Part	Location	Extent of Classified Area[1]	Equipment Shall Be Suitable for *NEC*,® Class 1, Group D[4]
	Indoors with adequate ventilation.[3]	Entire room and any adjacent room not separated by a gastight partition.[1]	Division 2
	Outdoors, at or above grade.	Within 15 ft (4.6 m) in all directions from equipment and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure 1-8.)	Division 2
G	Pits or trenches containing equipment such as pumps, compressors, other than direct-fired vaporizers, and similar equipment. (Also pits or trenches located beneath classified areas.)		
	Without mechanical ventilation.[3]	Entire pit or trench.	Division 1
		Entire room and any adjacent room not separated by a gastight partition when located indoors.	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors.	Division 2
	Without adequate mechanical ventilation.[3]	Entire pit or trench.	Division 2
		Entire room and any adjacent room not separated by a gastight partition when located indoors.	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors.	Division 2
H	Pipelines and connections containing operational bleeds, drips, vents, or drains.	Within 5 ft (1.5 m) in all directions from point of discharge.	Division 1
		Beyond 5 ft (1.5 m) from point of discharge, same as Part F of this table.	

NOTES:

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

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

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

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

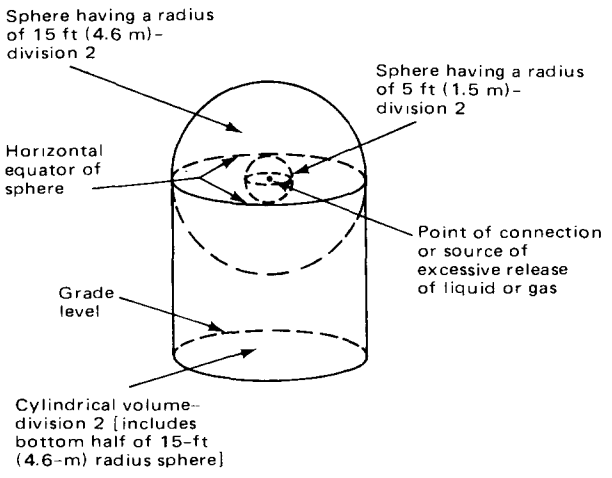

Figure 1-8.
(*See Table 1-8.*)

Chapter 2 Nonrefrigerated Containers

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

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

2-1.2 The provisions of 2-1.1 shall not be construed as prohibiting the continued use or reinstallation of containers constructed and maintained in accordance with the *ASME Code* in effect at the time of fabrication. (*See 1-3.*)

2-2 Design Pressure and Classification of Nonrefrigerated Containers.

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

Table 2-2.1

For gases with vapor pressure in psig at 100°F (37.8°C) not to exceed	Minimum design pressure in psig *ASME Code* Section VIII, 1986 Edition (Note 1)
80	100 (Note 2)
100	125
125	156
150	187
175	219
215	250

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

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

2-2.2 Field-erected nonrefrigerated containers shall be built in accordance with applicable provisions of the 1986 edition of the *ASME Boiler and Pressure Vessel Code*, except that construction using joint efficiencies in Table UW 12, Column C, Division 1 is not permitted.

2-2.3 Field-erected containers for nonrefrigerated storage shall be designed for a pressure not less than 125 percent of the maximum vapor pressure of the product at 100°F (37.8°C) to be stored in the containers, but in no case shall the container be designed for a pressure of 25 psig (0.17 mPag) or less.

2-3 Markings on Nonrefrigerated Containers. Each container for nonrefrigerated storage shall be marked as specified in the following:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2-4 Location of Nonrefrigerated Containers.

2-4.1 Nonrefrigerated Aboveground Containers.

2-4.1.1 Containers shall be located outside of buildings.

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

Table 2-4.1.2

Water capacity of each container in gal	Minimum Distances	
	Between containers in ft	From container to nearest important building or groups of buildings not associated with the utility gas plant, or a line of adjoining property that may be built upon.
2,001 to 30,000	5	50
30,001 to 70,000	1/4 of sum of diameters of adjacent containers	75
70,001 to 90,000	"	100
90,001 to 120,000	"	125
120,001 to 200,000	"	200
200,001 to 1,000,000	"	300
1,000,001 or more	"	400

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

2-4.1.3 Multiple aboveground containers (or groups of containers) installed for use in a single location shall be limited to the number of containers in one group, with each group separated from the next group in accordance with the degree of fire protection provided in Table 2-4.1.3.

Table 2-4.1.3

Fire Protection Provided By	Maximum No. of Containers in One Group	Min. Separation Between Groups—Feet
Hose Streams Only. See 10-1.1	6	50 (15 m)
Fixed Monitor Nozzles per 10-5-4.5	6	25 (7.6 m)
Fixed Water Spray per 10-5.4.4	9	25 (7.6 m)
Insulation per 10-5.4.1	9	25 (7.6 m)

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

2-4.1.4 All aboveground LP-Gas containers shall be 100 ft (30.5 m) or more from flammable liquids containers.

2-4.1.5 Nonrefrigerated liquefied petroleum gas containers shall not be located within dikes enclosing flammable liquid tanks and shall not be located within dikes enclosing refrigerated liquefied petroleum gas tanks.

2-4.1.6 Loose or piled combustible material and weeds and long dry grass shall not be permitted within 25 ft (7.6 m) of any container.

2-4.2 Nonrefrigerated Underground Containers.

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

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

2-4.2.3 When containers are installed parallel with ends in line, any number of containers are permitted to be in one group. When more than one row is installed, the adjacent ends of the tanks in each row shall be separated by not less than 10 ft (3.0 m).

2-4.2.4 Containers shall be located not less than 50 ft (15 m) from the nearest important building or group of buildings or line of adjacent property that may be built upon.

2-4.2.5 Containers shall be located not less than 50 ft (15.4 m) from buildings associated with the utility gas plant. They shall be located not less than 50 ft (15.4 m) from flammable liquids storage containers.

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

2-4.4 The ground within 25 ft (7.6 m) of any aboveground nonrefrigerated container shall be kept clear of readily ignitible material such as weeds and long dry grass.

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

2-5 Installation of Nonrefrigerated Storage Containers.

2-5.1 Nonrefrigerated Aboveground Containers.

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

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

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

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

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

2-5.1.6 Vertical containers shall be designed to be self-supporting without the use of guy wires and shall satisfy proper design criteria taking into account wind, seismic (earthquake) forces, and hydrostatic test loads.

2-5.1.7 Design pressure (*see Table 2-2.1*) shall be interpreted as the pressure at the top head with allowance made for increased pressure on lower shell sections and bottom head due to the static pressure of the product.

2-5.1.8 Wind loading on containers of 10,000 gal or larger shall be based on wind pressures on the projected area at various height zones aboveground as recommended in *Building Code Requirements for Minimum Design Loads in Buildings and Other Structures*, ANSI A58.1. Wind speeds shall be based on a Mean Occurrence Interval of 100 years.

2-5.1.9 Seismic loading on containers of 10,000 gal or larger shall be based on forces recommended in the *Uniform Building Code (UBC)*. In those areas identified as zones 3 and 4 on the Seismic Risk Map of the United States, Figures 1, 2, and 3 of Chapter 23 of the *UBC*, a seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction.

2-5.1.10* If insulation is used, it shall be capable of limiting the container temperature to not over 800°F (427°C) for a minimum of 50 minutes as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate. The insulation system shall be inherently resistant to weathering and the action of hose streams. (*See Appendix D.*)

2-5.2 Nonrefrigerated Underground Containers.

2-5.2.1 Buried containers shall be placed so that the top of the container is not less than 6 in. (154 mm) below the grade of the surrounding area. Partially buried (or mounded) containers shall have not less than 12 in. (308 mm) of cover, sufficient to provide surface drainage without erosion or other deterioration.

2-5.2.2 The container manway shall not be covered with the backfill or mounding material. Under conditions where the container manway cover is below the ground level, a manway providing sufficient access shall be installed. No other part of the container shall be exposed.

2-5.2.3 Containers shall be set upon a firm foundation (firm earth is permitted to be used) and surrounded with earth or sand firmly tamped in place. Backfill shall be free of rocks or other abrasive materials. Provision shall be made to take care of settling and rotation.

2-5.2.4 Containers shall be adequately protected against corrosion.

2-5.2.5 Bottom connections to the container shall be prohibited. All connections shall be in the container manway or at openings along the top length of the container.

2-5.2.6 If the area above a container is to be used for purposes not prohibited by this standard, consideration shall be given to depth of cover and loads that may be imposed.

2-5.3 Field welding where necessary shall be made only on saddle plates or brackets that were applied by the manufacturer of the container, except as provided by the code under which the container was fabricated.

2-5.4 Secure anchorage or adequate pier height shall be provided to protect against container flotation wherever sufficiently high water might occur.

2-5.5 When flammable liquid storage tanks are in the same general area as liquefied petroleum gas containers, the flammable liquid storage tanks shall be diked or diversion curbs or grading used to prevent accidentally escaping flammable liquids from flowing into liquefied petroleum gas container areas.

2-6 Reinstallation of Nonrefrigerated Containers. Containers once installed underground or aboveground that have been out of service for more than one year shall not be reinstalled aboveground or underground unless they successfully withstand, without distortion, hydrostatic pressure retests at the pressure specified for the original hydrostatic test as required by the code under which they were constructed and show no evidence of serious corrosion. Reinstallation of containers in all other respects shall be in accordance with all the provisions listed in this standard. (*See Section 2-5. See also Chapter 6 for relief valve requirements.*)

2-7 Gaskets. Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. They shall be of metal or other suitable material confined in metal, including spiral wound metal gaskets, having a melting point over 1,500°F (816°C) or shall be protected against fire exposure. When a flange is opened, the gasket shall be replaced.

2-8 Filling Densities.

2-8.1 The "filling density" is defined as the percent ratio of the weight of the gas in a container to the weight of water at 60°F (15.6°C) that the container will hold. Except as noted in 2-8.3, nonrefrigerated containers shall be filled in accordance with Table 2-8.

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

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

Table 2-8 Maximum Permitted Filling Density

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

2-9 Loading and Unloading Facility Spacing.

2-9.1 Loading and unloading connections shall be at least 75 ft (23 m) from uncontrolled sources of ignition, process areas, control buildings, offices, shops, and other occupied or important plant structures. This shall not apply to structures or equipment directly associated with the transfer operation.

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

Chapter 3 Refrigerated Containers

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

3-1.1 Refrigerated LP-Gas containers shall be designed and constructed in accordance with the applicable provisions of the following codes as appropriate for the design loadings including design pressure and temperature.

3-1.1.1 For pressures of 15 psig (103 kPa gauge) or more, use the *ASME Code*, Section VIII, except that construction using joint efficiencies in Table UW 12, Column C, Division 1 shall not be permitted. Material shall be selected from those recognized by ASME, which meet the requirements of Appendix R of ANSI/API 620.

3-1.1.2 For pressures below 15 psig (103 kPa gauge) use ANSI/API 620, *Rules for the Design and Construction of Large, Welded, Low Pressure Storage Tanks*, including Appendix R.

3-1.1.3 When austenitic steels or nonferrous materials are used, ANSI/API 620, Appendix Q shall be used in the selection of materials.

3-1.2 The operator shall specify the maximum allowable working pressure, which includes a suitable margin above the operating pressure and the maximum allowable vacuum.

3-1.2.1 For ASME vessels the positive margin shall be at least 5 percent of the absolute vapor pressure of the LP-Gas at the design storage temperature. The margin (both positive and vacuum) for low pressure API vessels shall include the control range of the boil-off handling system, the effects of flash or vapor collapse during filling operations, the flash that may result from withdrawal pump recirculation, and the normal range of barometric pressure changes.

3-1.2.2 The minimum design temperature for those parts of a refrigerated LP-Gas container that are in contact with the refrigerated liquid or vapor shall be the boiling point at atmospheric pressure of the product to be stored.

3-1.3 The design wind loading on refrigerated LP-Gas containers shall be based on the projected area at various height zones above ground in accordance with ANSI A58.1, *Design Loads for Buildings and Other Structures*. Wind speeds shall be based on a Mean Occurrence Interval of 100 years.

3-1.4 The design seismic loading on refrigerated LP-Gas containers shall be based on forces recommended in the ICBO *Uniform Building Code*. In those areas identified as zones 3 and 4 on the Seismic Risk Map of the United States, Figures 1, 2, and 3 of Chapter 23 of the *UBC*, a seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction.

3-1.5 All piping that is part of a refrigerated LP-Gas container shall be in accordance with ANSI B31.3. This container piping shall include all piping internal to the container, within the insulation spaces, and external piping attached or connected to the container up to the first circumferential external joint of the piping. Inert gas purge systems wholly within the insulation spaces are exempt from this provision.

3-1.6 Refrigerated LP-Gas containers shall be installed on foundations designed by an engineer experienced in foundations and soils and constructed in accordance with recognized structural engineering practices. Prior to the start of design and construction of the foundation, a subsurface investigation shall be conducted by a soils engineer to determine the stratigraphy and physical properties of the soils underlying the site.

NOTE: See ASCE 56, *Sub-Surface Investigation for Design and Construction of Foundation for Buildings*, and Appendix C of API 620, for further information.

3-1.6.1 The refrigerated LP-Gas container foundation shall be periodically monitored for settlement during the life of the facility including construction, hydrostatic testing, commissioning, and operation. Any settlement in excess of that anticipated in the design shall be investigated and corrective action taken if appropriate.

3-1.6.2 The bottom of a refrigerated LP-Gas container, either the bottom of an outer tank or the bottom of the undertank insulation, shall be above the ground water table or otherwise protected from contact with ground water at all times, and the material in contact with the bottom of the container shall be selected to minimize corrosion.

3-1.6.3 If the bottom of the refrigerated LP-Gas container is in contact with the soil, a heating system shall be provided to prevent the 32°F (0°C) isotherm from extending into the soil. The heating system shall be designed to permit both functional and performance monitoring. As a minimum, the undertank temperature shall be observed and logged on a weekly basis. Where there is a discontinuity in the foundation, such as bottom piping, careful attention and separate treatment shall be given to the heating system in that zone. Heating systems shall be installed so that any heating elements or temperature sensors used for control can be replaced while the tank is in service. Provisions shall be incorporated to protect against the detrimental effects of moisture accumulation in the conduit, which could result in galvanic corrosion or other forms of deterioration within the conduit or heating element.

3-1.6.4 If the foundation of a refrigerated LP-Gas container is installed to provide adequate air circulation in lieu of a heating system, the bottom of the container shall be of materials that are suitable for the temperatures to which they will be exposed.

3-1.7 Refrigerated LP-Gas Container Instruments and Controls.

3-1.7.1 Each refrigerated LP-Gas container shall be equipped with at least two independent liquid level gauging devices. These devices shall be replaceable without taking the container out of service.

3-1.7.2 The refrigerated LP-Gas container shall be provided with a high liquid level alarm. The alarm shall be set so that the operator will have sufficient time to stop the flow without exceeding the maximum permissible filling height and shall be located so that it is audible to personnel controlling the filling. A high-liquid level flow cutoff device shall not be considered as a substitute for the alarm.

3-1.7.3 The refrigerated LP-Gas container shall be equipped with a high-liquid level flow cutoff device, which shall be independent from all gauges.

Exception: Refrigerated LP-Gas containers of 70,000 gal (264.98 m³) or less, if attended during the filling operation, shall be permitted to be equipped with liquid trycocks in lieu of the high-liquid level alarm, and manual flow cutoff is permitted.

3-1.7.4 Each refrigerated LP-Gas container shall be provided with temperature indicating devices to assist in controlling cool-down rates when placing the container in service.

3-1.8 Inspection of Refrigerated LP-Gas Containers.

3-1.8.1 During construction and prior to the initial operation or commissioning, each refrigerated LP-Gas container shall be inspected or tested in accordance with the provisions of this standard and other applicable referenced codes and standards. Such inspections or tests shall be adequate to assure compliance with the design, material specifications, fabrication methods, and quality required by this and the referenced standards.

3-1.8.2 The inspections or tests required by 3-1.8.1 are the responsibility of the operator who is permitted to delegate any part of those inspections to employees, a third party engineering or scientific organization, or a recognized insurance or inspection company. Each inspector shall be qualified in accordance with the code or standard that is applicable to the test or inspection being performed.

3-1.9 Marking on Refrigerated LP-Gas Containers. Each refrigerated LP-Gas container shall be identified by the attachment of a nameplate on the outer covering in an accessible and visible place marked as specified in the following:

(a) Manufacturer's name and date built.

(b) Liquid volume of the container in gal (U.S. standard) or barrels.

(c) Maximum allowable working pressure in lb per sq in.

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

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

(f) Density of the product to be stored in lb per cu ft, or specific gravity, for which the container was designed.

(g) Maximum level to which the container is permitted to be filled with the LP-Gas for which it was designed.

3-2 Refrigerated LP-Gas Container Impoundment.

3-2.1 Each refrigerated LP-Gas container shall be located within an impoundment that complies with this section, in order to minimize the possibility that the accidental discharge of liquid LP-Gas from the container would endanger adjoining property or lives, process equipment or structures, or reach waterways.

3-2.2 Enclosed drainage channels for LP-Gas are prohibited.

Exception: Container downcomers used to rapidly conduct spilled LP-Gas away from critical areas shall be permitted to be enclosed provided that an adequate drainage rate is achieved.

3-2.3 Dikes, impounding walls, and drainage for refrigerated LP-Gas and flammable refrigerant containment shall have a minimum volumetric holding capacity, including any useful holding capacity of the drainage area and with allowance made for the displacement of snow accumulation, other containers, or equipment, equal to the total liquid volume of the largest container served assuming that container is full.

3-2.4 Dikes, impounding walls, and drainage for refrigerated LP-Gas and flammable refrigerant containment shall be of compacted earth, concrete, metal, or other suitable materials. It shall be permitted to construct such structures

independent of the container, mounted integral to, or constructed against the container. They, and any penetrations thereof, shall be designed to withstand the full hydrostatic head of impounded LP-Gas or flammable refrigerant, the effect of rapid cooling to the temperature of the liquid to be confined, any anticipated fire exposure, and natural forces such as earthquake, wind, or rain.

3-2.5 To assure that any accidentally discharged liquid stays within an area enclosed by a dike or impounding wall and yet to provide a reasonably wide margin for area configuration design, the dike or impounding wall height and distance shall be determined in accordance with Figure 3-2.5

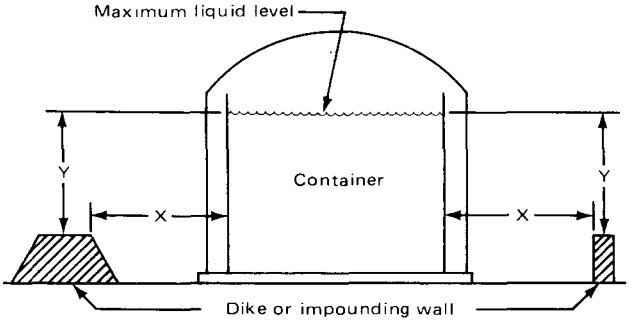

Figure 3-2.5.

NOTES:

Dimension "X" must equal or exceed the sum of dimension "Y" plus the equivalent head in LP-Gas of the pressure in the vapor space above the liquid.

Exception: When the height of the dike or impounding wall is equal to or greater than the maximum liquid level, "X" may have any value.

Dimension "X" is the distance from the inner wall of the container to the closest face of the dike or impounding wall.

Dimension "Y" is the distance from the maximum liquid level in the container to the top of the dike or impounding wall.

3-2.6 Provision shall be made to clear rain or other water from the impounding area. Automatically controlled sump pumps shall be permitted if equipped with an automatic cutoff device, which shall prevent their operation when exposed to LP-Gas temperatures. Piping, valves, and fittings whose failure could permit liquid to escape from the impounding area shall be suitable for continuous exposure to LP-Gas temperatures. If gravity drainage is employed for water removal, provision shall be made to prevent the escape of LP-Gas by way of the drainage system.

3-2.7 Insulation systems used for impounding surfaces shall be, in the installed condition, noncombustible and suitable for the intended service considering the anticipated thermal and mechanical stresses and loadings. If flotation is a problem, mitigation measures shall be provided. Such insulation systems shall be inspected as appropriate for their intended service.

3-3 Locating Aboveground Refrigerated LP-Gas Containers.

3-3.1 Containers shall be located outside of buildings.

3-3.2 A refrigerated LP-Gas container having a capacity of 70,000 gal (265 m^3) or less shall be installed in accordance with Table 3-3.2. Refrigerated LP-Gas containers of 70,001 gal (264.98 m^3) or more shall be located 100 ft (31 m) or more from any occupied building, storage containers for flammable or combustible liquids, and from a property line that may be built upon.

3-3.3 The edge of a dike, impoundment, or drainage system intended for a refrigerated LP-Gas container shall be 100 ft (31 m) or more from a property line that may be built upon, a public way, or a navigable waterway.

3-3.4 Refrigerated LP-Gas containers shall not be located within dikes enclosing flammable liquid tanks or within dikes or empoundments enclosing nonrefrigerated pressurized LP-Gas containers.

3-3.5 Refrigerated LP-Gas containers shall not be installed one above the other.

3-3.6 The minimum distance between aboveground refrigerated LP-Gas containers of 70,001 gal (264.98 m^3) or larger shall be one-half the diameter of the larger container.

3-3.7 The ground within 25 ft (7.6 m) of any aboveground refrigerated LP-Gas containers and all ground within a diked, impoundment, or drainage area shall be kept clear of readily ignitible materials such as weeds and long dry grass.

3-4 Installation of Refrigerated Containers.

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

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

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

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

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

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

Table 3-3.2

Water Capacity Per Container Gallons (m^3)	Minimum Distances: Mounded or Underground Containers [Note (d)]	Minimum Distances: Aboveground Containers [Note (f)]	Minimum Distances: Between Containers [Note (e)]
Less than 125 (0.5) [Note (a)]	10 ft (3 m)	None [Note (b)]	None
125 to 250 (0.5 to 1.0)	10 ft (3 m)	10 ft (3 m)	None
251 to 500 (1.0+ to 1.9)	10 ft (3 m)	10 ft (3 m)	3 ft (1 m)
501 to 2,000 (1.9+ to 7.6)	10 ft (3 m)	25 ft (7.6 m) [Note (c)]	3 ft (1 m)
2,001 to 30,000 (7.6+ to 114)	50 ft (15 m)	50 ft (15 m)	5 ft (1.5 m)
30,001 to 70,000 (114+ to 265)	50 ft (15 m)	75 ft (23 m)	(1/4 of sum of diameters of adjacent containers)

Notes to Table 3-3.2

Note (a): At a consumer site, if the aggregate water capacity of a multicontainer installation comprised of individual containers having a water capacity of less than 125 gal (0.5 m^3) is 501 gal (1.9 m^3) or more, the minimum distance shall comply with the appropriate portion of this table, applying the aggregate capacity rather than the capacity per container. If more than one such installation is made, each installation shall be separated from any other installation by at least 25 ft (7.6 m). Do not apply the MINIMUM DISTANCES BETWEEN CONTAINERS to such installations.

Note (b): The following shall apply to aboveground containers installed alongside of buildings:

(1) DOT specification container shall be located and installed so that the discharge from the container pressure relief device is at least 3 ft (1 m) horizontally away from any building opening below the level of such discharge and shall not be beneath any building unless this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter. The discharge from container pressure relief devices shall be located not less than 5 ft (1.5 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

(2) ASME containers of less than 125 gal (0.5 m^3) water capacity shall be located and installed so that the discharge from pressure relief devices shall not terminate in or beneath any building and shall be located at least 5 ft (1.5 m) horizontally away from any building opening below the level of such discharge, and not less than 5 ft (1.5 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

(3) The filling connection and the vent from liquid level gauges on either DOT or ASME containers filled at the point of installation shall be not less than 10 ft (3 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

Note (c): This distance may be reduced to not less than 10 ft (3 m) for a single container of 1,200 gal (4.5 m^3) water capacity or less provided such container is at least 25 ft (7.6 m) from any other LP-Gas container of more than 125 gal (0.5 m^3) water capacity.

Note (d): Minimum distances for underground containers shall be measured from the pressure relief device and filling or liquid level gauge vent connection at the container, except that no part of an underground container shall be less than 10 ft (3 m) from a building or line of adjoining property that may be built upon.

Note (e): When underground multicontainer installations are made of individual containers having a water capacity of 125 gal (0.5 m^3) or more, such containers shall be installed so as to permit access at their ends or side to facilitate working with cranes or hoists.

Note (f): In applying the distance between buildings and ASME containers of 125 gal (0.5 m^3) or more water capacity, a minimum of 50 percent of this horizontal distance shall also apply to all portions of the building that project more than 5 ft (1.5 m) from the building wall and that are higher than the relief valve discharge outlet. This horizontal distance shall be measured from a point determined by projecting the outside edge of such overhanging structure vertically downward to grade or other level upon which the container is installed. Under no conditions shall distances to the building wall be less than those specified in Table 3-3.2.

Exception to Note (f): Not applicable to installations in which overhanging structure is 50 ft (15 m) or more above the relief valve discharge outlet.

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

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

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

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

2. If liquid can reach the outside container wall, the material that can be wetted by spilled liquid shall be suitable for use at minus 44°F (–42°C).

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

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

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

3-4.4.5 Provision shall be made to drain rainwater from the diked area, and drains shall be equipped with a positive closure that shall be closed except when manually opened for draining. The valve and other parts of the drain system that may be subject to LP-Gas temperature shall be of suitable material to withstand low temperatures.

Such drains shall not permit drainage of tank contents to enter natural water courses, public sewers, or public drains. When pumps control drainage from the diked area, they shall be manually controlled and provided with an open sight discharge.

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

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

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

3-5 Reinstallation of Refrigerated Containers. Once installed, containers that have been out of service for more than one year shall not be put back in service unless they successfully withstand, without distortion, hydrostatic pressure retests at the pressure specified for the original hydrostatic test as required by the code under which they were constructed and show no evidence of serious corrosion. Reinstallation of containers in all other respects shall be in accordance with all the provisions listed in this standard. (*See Section 3-4. See also Chapter 6 for relief valve requirements.*)

3-6 Gaskets. Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. They shall be of metal or other suitable material confined in metal, including spiral wound metal gaskets, having a melting point over 1,500°F (816°C) or shall be protected against fire exposure. When a flange is opened, the gasket shall be replaced.

3-7 Filling Densities. The filling limits for refrigerated storage containers shall be based upon sound engineering practice for the individual design and operating conditions involved. Since negligible expansion of the liquid can take place within the possible range of operating pressure and temperature of a refrigerated container, the maximum liquid volume in percent of the total container capacity is greater for a refrigerated container than normally employed for a non-refrigerated container.

3-8 Loading and Unloading Facility Spacing.

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

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

Chapter 4 Piping, Valves, and Equipment

4-1 General.

4-1.1 Piping, valves, and equipment shall be suitable for their intended use at the temperatures of the application and shall be designed for not less than the maximum pressure and for the minimum temperature to which they may be subjected.

4-1.1.1 The design and fabrication of piping systems shall be in accordance with ANSI/ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*, except as modified by the provisions of this chapter and any applicable federal pipeline regulations. Special consideration shall be given to the behavior of the piping material upon possible fire exposure.

4-1.1.2 Pressure-containing metal parts of equipment for application temperatures of -20°F (-29°C) or above shall be fabricated of materials suitable for LP-Gas service and resistant to the action of LP-Gas under service conditions. They shall be of steel, ductile (nodular) iron (ASTM A395-80 or A 536-80 Grade 60-40-18 or 65-45-12), malleable iron (ASTM A47-77), higher strength gray iron (ASTM A48-76, Class 40B), brass, or the equivalent. Cast iron shall not be used for strainers or flow indicators.

4-1.2 Piping connections to the container for sizes over 2 in. nominal pipe diameter shall be made by welding or with welded flanges with the possible exception of piping connections for excess flow valves.

4-1.3 The use of cast-iron valves, pipe, and fittings shall be prohibited in piping carrying LP-Gas. This shall not prohibit the use of container valves or fittings made of malleable or ductile iron if used within the limitations set forth in paragraph 323.4.2 of ANSI B31.3.

4-1.4 Emergency shutoff valves shall be approved and incorporate all of the following means of closing (*see 4-3.6*):

(a) Automatic shutoff through thermal (fire) actuation. When fusible elements are used, they shall have a melting point not exceeding 250°F (121°C).

(b) Manual shutoff from two or more remote locations.

(c) Manual shutoff at the installed location.

4-1.5 Gaskets used to retain LP-Gas in flanged connections in piping shall be resistant to the action of LP-Gas. They shall be of metal or other suitable material confined in metal having a melting point over 1500°F (816°C) or shall be protected against fire exposure. When a flange is opened, the gasket shall be replaced.

4-1.6 All piping, tubing, fittings, and the valves shall be leak tested after assembly and proved free of leaks at not less than normal operating pressures. Test shall not be made with a flame.

4-1.7 Provision shall be made for expansion, contraction, jarring, and vibration, and for settling.

NOTE: It must be recognized that the temperature of liquid propane will drop to about -40°F (-40°C) when released to the atmosphere.

4-1.8 Piping outside buildings is permitted to be buried, above ground, or both, but shall be well supported and protected against physical damage and corrosion. Underground and submerged piping shall be protected and maintained to minimize corrosion.

NOTE: For information on corrosion protection see National Association of Corrosion Engineers Standard RP-01-69, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems.*

4-1.9 Equipment selection for application temperatures below –20°F (–29°C) shall be based upon sound engineering practices for the individual design and operating conditions involved. Special consideration shall be given to the behavior of material upon possible fire exposure.

4-2 Container Valves and Accessories.

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

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

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

4-2.4 All liquid and vapor connections on containers shall be equipped with a back pressure check valve, an excess flow valve, and an emergency shutoff valve as specified in 4-1.4 or a quick-acting internal valve incorporating the means of closing as specified in 4-1.4.

Exception: Openings not larger than a No. 54 drill size as covered in 4-2.5 and 4-4.4.

4-2.5 Openings from a container or through fittings attached directly on the container to which pressure gauge connection is made need not be equipped with an excess flow valve if such openings are not larger than No. 54 drill size.

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

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

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

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

4-3 Filler and Discharge Pipes, Manifolds.

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

4-3.2 Liquid manifold connections shall be located at nonadjacent ends of parallel rows of containers.

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

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

4-3.5 In the design of the liquid piping system, shutoff or block valves shall be installed to limit the volume of liquid that could be discharged in the vicinity of containers or important structures in the event of a liquid line failure. Automatically or remotely controlled valves, or both, of the fail-safe type shall be used. The mechanism for such valves shall be provided with a secondary control equipped with a fusible release [not over 250°F (121°C) melting point] that will cause the valve to close automatically in case of fire. Such valves shall also be capable of being manually operated at the installed location. A remote closing control shall be located so as to be accessible during a fire or other emergency. On aboveground piping systems, such valves shall be arranged to limit the quantity that could be discharged within 300 ft (91.4 m) of a container, important building, or line of adjoining property that may be built upon to a maximum of 500 gal (1.89 m^3) of liquid.

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

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

(a) A backflow check valve, or

(b) An emergency shutoff valve complying with 4-1.4.

4-3.6.2 The connection, or connecting piping, from which the liquid or vapor is being drawn shall be equipped with an emergency shutoff valve complying with 4-1.4.

4-3.6.3 When used in conjunction with hose or swivel type piping, the valve specified in 4-3.5 shall be:

(a) Supplemented with a thermal sensor mounted along the entire length of the hose or swivel piping. This requirement shall be considered to be met by the use of hydraulically or pneumatically operated valves with plastic tubing attached along the entire length of the hose or swivel piping such that the melting of the plastic tubing will cause the valve to close, or approved alternate equipment providing equal protection, and

(b) Installed in the plant piping so that any break resulting from a pull will occur on the hose or swivel piping side of the connection. This provision shall apply to backflow check valves installed in accordance with 4-3.6.1.

NOTE: This may be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fittings or other means.

4-3.7 When the liquid line manifold connecting containers in a group has a volumetric capacity of more than 100 gal (0.4 m^3), such container manifolds shall be located not less than 100 ft (31 m) from the nearest adjacent property, owned by others, that may be built upon. The manifold piping terminates at the first line valve, which is used to isolate the manifolded containers from any other part of the liquid line system.

4-4 Liquid Level Gauging Device.

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

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

4-4.2 Refrigerated containers shall be equipped with a liquid level gauging device of approved design. An auxiliary gauging device shall not be required for refrigerated containers. However, in lieu of an auxiliary gauge, refrigerated containers, if subject to overfilling, shall be equipped with an automatic device to interrupt filling of the tank when the maximum filling level is reached.

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

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

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

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

4-5 Hose Specifications for Nonrefrigerated LP-Gas.

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

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

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

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

4-6 Drips, Pits, and Drains.

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

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

4-7 Pumps and Compressors.

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

4-7.2 Refrigerated storage systems shall be provided with sufficient capacity to maintain all containers at a pressure not in excess of the operating pressure under summer weather conditions and shall be provided with additional capacity for filling or standby service. Unless facilities are provided to safely dispose of vented vapors while the refrigeration system is inoperative, at least two compressors shall be installed where compressors and condensers

are used. Compressor capacity provided for standby service shall be capable of handling the volume of vapors necessary to be evolved to maintain operating pressure. Auxiliary equipment, such as fans, circulating water pumps, and instrument air compressors, shall be provided with spare or standby facilities sufficient to ensure that prolonged failure of refrigeration may be prevented.

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

4-8 Protection of Container Accessories.

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

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

Chapter 5 Vaporizers, Heat Exchangers, and Gas-Air Mixing

5-1 General.

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

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

5-1.3 Vaporizer houses shall not have drains to sewers or sump pits.

5-1.4 Building or structural enclosures in which vaporizers or gas-air mixers are installed shall be of lightweight noncombustible construction with non-load-bearing walls. If rooms containing such equipment are located within or attached to buildings in which LP-Gases are not handled, i.e., control rooms, shops, boiler rooms, etc., the common walls shall be limited to no more than two in number, shall be designed to withstand a static pressure of at least 100 psf (4.8 kPa), have no doors or other communicating openings, and shall have a fire resistance rating of at least one hour. Such buildings or structural enclosures shall be ventilated to minimize the possibility of hazardous accumulations of flammable vapors by a gravity system composed of a combination of wall openings near the floor line and roof ventilators. The ventilation rate shall be at least 1 cfm (0.47 L/s) of air per sq ft (0.09 m^2) of floor area.

5-2 Vaporizers, Heat Exchangers, and Gas-Air Mixers.

5-2.1 Vaporizers shall be of the indirect type (utilizing steam, hot water, or other heating medium) or direct fired. This subsection does not apply to engine fuel vaporizers or to integral vaporizer-burners such as those used with weed burners or tar kettles.

5-2.2 Indirect vaporizers and heat exchangers shall comply with the following:

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

(1) The markings required by the code.

(2) The outside surface area in sq ft.

(3) The area of the heat exchange surface in sq ft.

(4) The maximum vaporizing capacity in gal per hr.

(5) The rated heat input in Btuh.

(6) The name or symbol of the manufacturer.

(b) Indirect vaporizers shall be provided with a suitable automatic means to prevent liquid passing through the vaporizer to the vapor discharge piping. This means shall be permitted to be integral with the vaporizer or otherwise provided in the external piping (*see 5-3.2.6*).

(c) Indirect vaporizers, including atmospheric-type vaporizers using heat from the surrounding air or the ground, shall be equipped, at or near the discharge, with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 5-2.5. Fusible plug devices shall not be used.

5-2.3 Direct-fired vaporizers shall comply with the following.

(a) Design and construction shall be in accordance with the applicable requirements of the *ASME Code* for the working conditions to which the vaporizer will be subjected, and it shall be permanently and legibly marked with:

(1) The markings required by the code.

(2) The outside surface area in sq ft.

(3) The area of the heat exchange surface in sq ft.

(4) The maximum vaporizing capacity in gal per hr.

(5) The rated heat input in Btuh.

(6) The name or symbol of the manufacturer.

(b) Direct-fired vaporizers shall be equipped, at or near the discharge, with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 5-2.5. The relief valve shall be located so as not to be subject to temperatures in excess of 140°F (60°C). Fusible plug devices shall not be used.

(c) Direct-fired vaporizers shall be provided with suitable automatic means to prevent liquid passing from the vaporizer to its vapor discharge piping.

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

(e) Direct-fired vaporizers shall be equipped with an automatic safety device to shut off the flow of gas to the main burner if the pilot light is extinguished. If the pilot flow exceeds 2,000 Btuh (2 MJ/h), the safety device shall shut off the flow of gas to the pilot also.

(f) Direct-fired vaporizers shall be equipped with a limit control to prevent the heater from raising the product

pressure above the design pressure of the vaporizer equipment, and to prevent raising the pressure within the storage container above the pressure shown in the first column of Table 5-2.3(f) corresponding with the design pressure of the container [or its *ASME Code* equivalent—see Note 1 of Table 5-2.3(f)].

Table 5-2.3(f)

For Gases with Vapor Pressure in psig (MPa gauge) at 100°F (37.8°C) Not to Exceed	Minimum Design Pressure in psig (MPa gauge) *ASME Code*, Section VIII, Division 1, 1986 Edition (Note 1)
80 (0.6)	100 (0.7) (Note 2)
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)

Note 1: See Appendix D for information on earlier ASME or API-ASME Code.
Note 2: New containers for 100 psig (0.7 MPa gauge) design pressure (or equivalent under earlier codes) not authorized after December 31, 1947.

5-2.4 Waterbath vaporizers shall comply with the following.

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

(1) The markings required by the code.

(2) The outside surface area in sq ft.

(3) The area of the heat exchange surface in sq ft.

(4) The maximum vaporizing capacity in gal per hr.

(5) The rated heat input in Btuh.

(6) The name or symbol of the manufacturer.

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

(c) Heat exchangers for waterbath vaporizers shall be equipped at or near the discharge with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 5-2.5. Fusible plug devices shall not be used.

(d) Waterbath sections of waterbath vaporizers shall be designed to eliminate a pressure buildup above the design pressure.

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

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

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

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

(i) A means shall be provided to shut off the source of heat in case the level of the heat transfer medium falls below the top of the heat exchanger.

5-2.5 The minimum rate of discharge in cubic feet of air per minute for pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct fired, shall be determined as follows:

(a) The surface area of that part of the vaporizer shell directly in contact with LP-Gas shall be added to the heat exchange surface area directly in contact with LP-Gas to obtain the total surface area in sq ft.

(b) Refer to Appendix E to obtain the rate of discharge in cu ft of air per minute (Flow Rate CFM Air) for the total surface area in sq ft for the vaporizer computed in accordance with 5-2.5(a).

5-2.6 Gas-air mixers shall comply with the following.

(a) Gas-air mixers shall be designed for the air, vapor, and mixture pressures to which they are subjected. Piping materials shall comply with applicable portions of this standard.

(b) Gas-air mixers shall be designed so as to prevent the formation of a combustible mixture. Gas-air mixers that are capable of producing combustible mixtures shall be equipped with safety interlocks on both the LP-Gas and air supply lines to shut down the system if combustible limits are approached.

(c) In addition to the interlocks provided for in 5-2.6(b), a method shall be provided to prevent air from accidentally entering gas distribution lines without LP-Gas being present. Check valves shall be installed in the air and LP-Gas supply lines close to the mixer to minimize the possibility of backflow of gas into the air supply lines, or of air into the LP-Gas system. Gas mixing control valves in the LP-Gas and air supply lines that are arranged to fail closed when actuated by safety interlock trip devices shall be considered as acceptable shutdown devices.

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

(e) Gas-air mixers that utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere, and are so designed that maximum air entrained is less than 85 percent of the mixture, need not include the interlocks specified in 5-2.6(b), (c), and (d) but shall be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down. Gas-air mixers of this type receiving air from a blower, compressor, or any source of

air other than directly from the atmosphere shall include a method of preventing air without LP-Gas, or mixtures of air and LP-Gas within the flammable range, from entering the gas distribution system accidentally.

5-3 Vaporizer Installation.

5-3.1 Application. This section applies to the installation of vaporizing devices covered in Section 5-2.

5-3.2 Installation of Indirect-Fired Vaporizers.

5-3.2.1 Indirect-fired vaporizers shall comply with 5-2.2 and shall be installed as follows:

5-3.2.2 Indirect vaporizers shall be permitted to be installed outdoors, in buildings used exclusively for gas manufacturing or distribution, or in separate structures constructed in accordance with 5-1.4. Any such buildings shall be well ventilated near the floor line and roof.

5-3.2.3 Indirect vaporizers shall also be permitted to be installed in structures attached to, or rooms within, buildings not used for gas manufacturing or distribution, provided such attached structures or rooms comply with Section 7-3 of NFPA 58 and that there are no openings of any sort from the vaporizer room into the building or structure of which it is a part.

5-3.2.4 The housing for the vaporizer covered by 5-3.2.2 or 5-3.2.3 shall not have any unprotected drains to sewers or sump pits. Pressure relief valves on vaporizers within buildings shall be piped to a point outside the building and shall discharge vertically upward.

5-3.2.5 The device supplying the heat necessary for producing steam, hot water, or other heating medium shall be permitted to be installed outdoors, in a separate building, or in a structure attached to, or in rooms within, another gas manufacturing or distributing building (but not buildings used for other purposes), provided:

(a) The housing provided shall comply with 5-1.4 and shall be well ventilated near the floor line and roof.

(b) The heat supplying device, if outdoors, or the housing in which it is installed, shall be located with respect to other LP-Gas facilities and operations as required by Section 3-8. If the heat supplying device is gas-fired and is packaged with the vaporizer, or installed within 15 ft (5 m) of the vaporizer, it shall be subject to the provisions of 5-3.3 covering installation of direct gas-fired vaporizers.

5-3.2.6 The heating medium piping into and from the vaporizer shall be provided with a suitable means for preventing the flow of gas into a heating system that is supplying heat to areas other than the LP-Gas facility in the event of a tube rupture in the vaporizer. If the device supplying the heat to the vaporizer is for that purpose only, the device, or the piping to and from the device, shall contain a relief valve, vented to the outside, to relieve excessive pressure in the event of a tube rupture in the vaporizer.

5-3.2.7 Gas-fired heating systems supplying heat for vaporization purposes shall be equipped with automatic safety devices to shut off gas to the main burners if the pilot light should fail.

5-3.2.8 Vaporizers shall be permitted to be an integral part of a fuel storage container, directly connected to either the liquid or vapor space, or to both. A limit control shall be provided to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, or the pressure within the storage container above the pressure shown in the first column of Table 3-3.2(f) corresponding with the design pressure of the container [or its 1980 code equivalent—see Note 1 of Table 3-3.2(f)].

5-3.3 Installation of Direct Gas-Fired Vaporizers.

5-3.3.1 Direct gas-fired vaporizers shall comply with 5-2.3 and shall be installed as follows:

5-3.3.2 Direct gas-fired vaporizers shall be permitted to be installed outdoors or in separate structures constructed in accordance with 5-1.4. Any such buildings shall be well ventilated near the floor line and roof.

5-3.3.3 Direct gas-fired vaporizers shall also be permitted to be installed in structures attached to, or in rooms within, a gas manufacturing or distributing structure (but not buildings used for other purposes), provided:

(a) The housing provided shall comply with 5-1.4 and shall be well ventilated near the floor line and roof.

(b) The wall separating it from all other compartments or rooms containing LP-Gas vaporizers, pumps, and central gas mixing devices shall have no openings.

5-3.3.4 The housing for the vaporizer covered in 5-3.3.2 and 5-3.3.3 shall not have unprotected drains or sump pits. Pressure relief valves on vaporizers within buildings shall be piped to a point outside the building and shall discharge vertically upward.

5-3.3.5 Direct gas-fired vaporizers shall be permitted to be connected to the liquid space or to both the liquid and the vapor space of the container, but in any case there shall be a manually operated shutoff valve in each connection at the container to permit completely shutting off all flow of vapor or liquid.

5-3.3.6 Direct gas-fired vaporizers of any capacity shall be located in accordance with Table 5-3.3.6.

5-3.4 Installation of Waterbath Vaporizers.

5-3.4.1 Waterbath vaporizers shall comply with 5-2.4 and shall be installed as follows:

(a) If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class 1, Group D locations, the unit shall be treated as indirect-fired and installed in accordance with 5-3.2.

(b) All others shall be treated as direct-fired vaporizers and installed in accordance with 5-3.3.

5-3.5 Installation of Electric Vaporizers.

5-3.5.1 Electric vaporizers, whether direct immersion or indirect immersion, shall be treated as indirect-fired and installed in accordance with 5-3.2.

Table 5-3.3.6

Exposure	Minimum Distance Required
Container	50 ft (15 m)
Container shutoff valves	50 ft (15 m)
Point of transfer	50 ft (15 m)
Nearest important building or group of buildings or line of adjoining property that may be built upon (except buildings in which vaporizer is installed; *see 3-7.3.2 and 3-7.3.3).*	50 ft (15 m)
Building or room housing gas-air mixer	10 ft (3 m)
Cabinet housing gas-air mixer outdoors	0 ft (0 m)

5-3.6 Installation of Gas-Air Mixers.

5-3.6.1 Gas-air mixing equipment shall comply with 5-2.6 and shall be installed as follows:

(a) When used without the vaporizer(s), the mixer(s) shall be permitted to be installed outdoors or in buildings complying with 5-1.4.

(b) When used with the indirect heated vaporizer(s), the mixer(s) shall be permitted to be installed outdoors, or in the same compartment or room with the vaporizer(s), in a building(s) complying with 5-1.4, or shall be permitted to be installed remotely from the vaporizer(s) and shall be located in accordance with 5-3.2.

(c) When used with the direct-fired vaporizer(s), the mixer(s) shall be installed as follows:

1. Listed or approved in a common cabinet with the vaporizer(s) outdoors in accordance with 5-3.3.6.

2. Outdoors on a common skid with the vaporizer(s) in accordance with 5-3.3.

3. Installed adjacent to the vaporizer(s) to which it is connected in accordance with 5-3.3.

4. In a building complying with 5-1.4 with no direct-fired vaporizer in the same room.

5-3.6.2 Listed vaporizer-mixers in a common cabinet having a direct-fired type vaporizer shall be installed outdoors in accordance with the distance provisions in 5-3.3. Listed vaporizer-mixers not in a common cabinet having an indirect-fired type vaporizer shall be permitted to be installed in a building or structure complying with 5-1.4 provided there is no source of ignition in such building or structure.

Chapter 6 Relief Devices

6-1 General.

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

6-1.2 Each container relief device shall be plainly and permanently marked with the pressure in lb per sq in. gauge at which the device is set to start to discharge, with the actual rate of discharge in cu ft per min of air at 60°F (16°C) and 14.7 psia (0.101 MPa), and with the manufacturer's name and catalog number. For example, a safety relief valve marked "250-15,000 AIR" indicates that it is set to start to discharge at 250 psig (1.7 MPa gauge) and that its rate of discharge is 15,000 cu ft (424.50 m^3) per min of air.

6-1.3 Connections to which relief devices are attached, such as couplings, flanges, nozzles, and discharge lines for venting, shall have internal dimensions that will not restrict the net relief area.

6-1.4 The size of the relief device outlet connection shall not be smaller in diameter than the nominal size of the relief outlet connection and shall not appreciably restrict flow through the relief.

6-1.5 All container relief devices shall be located on the containers and shall be connected with the vapor space of the container.

6-1.6 No shutoff valve shall be installed between the relief device and the container, equipment, or piping to which the relief device is connected.

Exception: A shutoff valve shall be permitted to be used where the arrangement of this valve is such that full required capacity flow through the relief device is always afforded.*

6-1.7 Any outlet piping shall be directed horizontally or upward so as not to cause flame impingement or endanger personnel. It shall have at least the area of the valve outlet and shall be so arranged as not to unduly restrict the flow.

6-1.7.1 Return bends and restrictive pipe fittings shall not be permitted in relief device discharge vents.

6-1.8 Discharge lines from two or more relief devices located on the same unit or similar lines from two or more different units, except those located on storage containers, are permitted to be run into a common discharge header provided the header is designed with a flow capacity sufficient to limit the maximum back pressure to (a) not exceeding 10 percent of the lowest start-to-discharge pressure setting for conventional relief valves, and (b) not exceeding 50 percent of the lowest start-to-discharge pressure setting for balanced valves. Header design shall assume that all valves connected to the header are discharging at the same time.

6-1.8.1 Relief valve piping shall be designed so that liquid that may be trapped will not create dangerous back pressure when the relief valve operates.

6-1.9 All discharge vents from the safety relief valves or common discharge headers shall be installed in such a manner as to:

(a) Lead to the open air.

(b) Be protected against mechanical damage.

(c) Exclude or remove moisture and condensate. This may be done by the use of loose-fitting rain caps and

drains. Drains shall be so installed as to prevent possible flame impingement on the containers, piping, equipment, and structures.

6-1.9.1 All discharge vents from the safety relief valves or common discharge headers shall be installed in such a manner as to discharge in an area that:

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

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

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

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

6-1.9.2 All discharge vents from the safety relief valves or common discharge headers shall be installed in such a manner as to prevent malfunction due to freezing or icing.

6-2 Testing Relief Devices. Relief devices shall be tested for proper operation at intervals not exceeding five years.

6-3 On Aboveground Containers.

6-3.1 The discharge from the relief devices shall be vented away from the container and unobstructed to the open air in a manner to prevent any impingement of escaping gas upon the container, adjacent containers, piping, and other equipment. The vents shall be fitted with loose-fitting rain caps. Suitable provision shall be made to prevent any liquid or condensate that may accumulate inside the relief device or its vent from rendering the relief device inoperative. If a bottom drain is used, a means shall be provided to protect the container, adjacent containers, and piping of equipment against impingement of flame resulting from ignition of product escaping from the drain. The vent piping shall extend upward at least 7 ft (2.2 m) above the top of the container.

Table 6-3

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

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

6-3.2 Relief devices on containers shall be constructed to discharge at not less than the rates shown in Appendix F before the pressure is in excess of 120 percent of the maximum (not including the 10 percent referred to in the asterisked note of Table 6-3) permitted start to discharge pressure setting of the devices.

6-3.3 For refrigerated storage, consideration shall be given to making proper provisions for vacuum conditions.

6-4 On Underground Containers.

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

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

6-5 On Vaporizers.

6-5.1 Each vaporizer shall be provided with a relief device providing an effective rate of discharge in accordance with F-3.1.

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

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

Chapter 7 Handling

7-1 Transfer of Liquids within a Utility Plant.

7-1.1 Pumps and compressors used for transferring liquefied petroleum gas shall be suitable for the product handled.

7-1.2 Transfer of liquefied petroleum 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:

(a) 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.

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

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

7-1.3 Transfer operations shall be conducted by employees familiar with the properties of the material and instructed in transfer and emergency procedures. At least one competent person shall remain in attendance during the entire period of transfer from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

7-1.4 Written procedures shall be available to cover all transfer operations and shall cover emergency as well as normal operating procedures. They shall be reviewed and updated at least annually and shall be available to all personnel engaged in transfer operations.

7-1.5 The maximum vapor pressure of nonrefrigerated product at 100°F (37.8°C) that can be transferred into a container shall be in accordance with 2-2.1 or 2-2-2 and 2-2.3.

7-1.6 Isolation valving and bleed connections shall be provided at the loading or unloading manifold for both liquid and vapor return lines so that hoses and arms can be blocked off, drained of liquid, and depressured before disconnecting. Bleeds or vents shall discharge to a safe area.

7-1.7 Precaution shall be exercised to assure that only those gases for which the system is designed, examined, and listed are employed in its operation, particularly with regard to pressures.

7-1.8 Transfer of refrigerated product shall be made only into systems designed to accept refrigerated product.

7-2 Tank Car Loading and Unloading Point.

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

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

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

7-3 Tank Truck Loading and Unloading.

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

7-3.2 A tank truck loading and unloading area shall be of sufficient size to accommodate the vehicles without excessive movement or turning. Tank trucks or transports unloading into storage containers shall be at least 25 ft (7.6 m) from the container and so positioned that the shutoff valves on both the truck and the container are readily accessible.

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

Chapter 8 Operations

8-1 Operating Procedures Manuals.

8-1.1 Each facility shall prepare and maintain written operating procedures manuals covering facility startup, operation, and shutdown. These manuals shall include procedures to provide for safe operation of the facility during normal and abnormal operation.

8-1.2 Operating procedures manuals shall include operator actions to be taken if flammable concentrations of flammable liquids or gases are detected in the facility using fixed detectors, portable detectors, operating malfunctions, and human senses. When human senses are relied on, a schedule of tours of the facility shall be included in the operating procedures.

8-1.3 Operating procedures shall include procedures for purging and inerting equipment.

NOTE: For information on purging and inerting equipment see NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*, 1987 edition and *AGA Purging Principles and Practice*.

8-1.4 Operating procedures for vaporizers shall include maintenance of vaporization rate, pressure control, and temperature. Procedures shall include specific actions to be taken when parameters exceed normal operating limits and criteria for emergency shutdown.

8-1.5 In facilities where propane is stored as a refrigerated liquid, operating procedures shall include monitoring of liquid temperature and pressure and procedures to be taken if these exceed operating limits. These procedures shall minimize the release of flammable gases to the atmosphere.

8-2 Emergency Procedures.

8-2.1 Nonfire Emergencies. Each facility shall prepare a comprehensive list of incidents that could occur as a result of reasonably anticipated abnormal conditions. This list shall be updated annually and when new equipment is added. Emergency procedures shall be prepared for each emergency condition.

8-2.2 Fire Emergencies. For each emergency condition identified in 8-2.1 that could result in fire, a plan for fire fighting shall be developed. This plan shall be reviewed with local emergency response personnel at least annually.

8-3 Personnel Safety.

8-3.1 Employees assigned and trained to perform emergency actions shall be assigned personal protective equipment for use when responding to emergencies that have progressed beyond the incipient stage. Employees assigned personal protective equipment shall be trained in its proper use.

8-3.2 Each utility gas plant shall have first-aid materials on hand in sufficient quantity to handle a reasonably anticipated emergency.

8-4 Transfer Procedures.

8-4.1 The procedures required in Section 8-1 shall include all aspects of LP-Gas transfer, including:

(a) Verification of connections to ensure proper delivery of LP-Gas

(b) Verification of gas tightness of connections

(c) Inspection of hoses and fittings

(d) Valve sequencing

(e) Disconnection procedures

(f) Purging procedures, if used.

8-4.2 All LP-Gas transfers shall be attended by plant personnel in accordance with 7-1.3.

8-4.3 Provisions shall be implemented to prevent moving of tank vehicles during transfer.

8-5 Operating Records.

8-5.1 Each facility shall maintain a record of all operating log sheets and recorded data. These records shall be made available to the authority having jurisdiction upon reasonable request.

8-5.2 Operating log sheets required under 8-5.1 shall be retained for at least 5 years.

Chapter 9 Maintenance

9-1 Maintenance Manuals.

9-1.1 Maintenance manuals for all equipment at the facility shall be kept at the facility and shall be available to maintenance personnel.

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

9-1.2 Maintenance manuals shall include:

(a) Drawings, procedures, and parts lists, provided by the manufacturer or installer

(b) Routine and preventative maintenance procedures and schedules

(c) Routine inspections to be performed

(d) Corrosion inspection and control procedures where applicable.

9-2 Maintenance of Fire Protection Equipment. Maintenance activities on fire control equipment shall be scheduled so that a minimum of equipment is taken out of service at any time and is returned to service in a reasonable period of time.

9-3 Auxiliary Power Sources. Each auxiliary power source shall be tested at least monthly to verify its operational capability.

9-4 Purging Prior to Maintenance. All equipment containing flammable or hazardous materials shall be purged in accordance with 8-1.3 prior to beginning maintenance procedures.

9-5 Maintenance Records.

9-5.1 Each facility shall maintain a record of all maintenance log sheets of process equipment. These records shall be made available to the authority having jurisdiction upon reasonable request.

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

9-5.2 Records required under 9-5.1 shall be retained for the life of the equipment, while in use, and for 3 years thereafter.

Chapter 10 Fire Protection, Safety, and Security

10-1 General.

10-1.1* Fire protection shall be provided for all utility gas plants. The extent of such protection shall be determined by an evaluation based upon the type (refrigerated or nonrefrigerated), quantity, and size of storage containers; an analysis of local conditions; hazards within the facility; and exposure to and from other property. The evaluation shall consider, as a minimum:

(a) The time of response and effectiveness of local emergency response agencies.

(b) The type, quantity, and location of equipment necessary for the detection and control of potential nonprocess and electrical fires.

(c) The methods necessary for protection of the equipment and structures from the effects of fire exposure.

(d) Fire protection water systems.

(e) Fire extinguishing and other fire control equipment.

(f) Automatic shutdown equipment, including the type and location of sensors to initiate manual or automatic operation.

(g) The availability and duties of individual plant personnel and the availability of external response personnel during an emergency.

(h) The protective equipment and special training needed by the individual plant personnel for their respective emergency duties.

NOTE: In heavily populated or congested areas where serious mutual exposures between container(s) and adjacent properties prevail, it is recommended that greater distances or special protection in accordance with good fire

protection engineering practices be provided. Special protection may consist of mounding or burying containers or providing fixed water spray or monitor nozzle protection.

10-1.2 The wide range in size, design, and location of facilities covered by this standard precludes the inclusion of detailed fire protection provisions completely applicable to all facilities.

10-1.3 A detailed emergency procedure manual shall be prepared to cover the potential emergency conditions that may develop whether or not a fire has occurred. Such procedures shall include but not necessarily be limited to the following:

(a) 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,

(b) Use of fire protection facilities,

(c) Notification of public authorities,

(d) First aid, and

(e) Duties of personnel.

10-1.3.1 The emergency procedure manual shall be kept readily available in the operating control room or at a constantly attended location if the plant site is not continually manned. It shall be reviewed and updated annually and as required by changes in equipment or procedures.

10-1.4 All personnel shall be trained in their respective duties contained in the emergency manual. Those personnel responsible for the use of fire protection or other plant emergency equipment shall be trained annually in the use of that equipment.

10-1.5 The planning of effective fire control measures shall be coordinated with the authority having jurisdiction and local emergency handling agencies, such as fire and police departments, who are expected to respond to such emergencies.

10-1.6 Gas fires shall normally not be extinguished until the source of the burning gas has been shut off.

10-2 Ignition Source Control. Control of ignition sources shall comply with Section 1-10.

10-3 Fire and Leak Detection.

10-3.1 Those areas, including enclosed buildings, that have a potential for flammable gas concentrations and fire shall be monitored as determined by the study required in 10-1.1.

10-3.2 Continuously monitored flammable gas detection systems shall alarm at the plant site and at a constantly attended location if the plant site is not continuously manned. Flammable gas detection systems shall alarm at not more than 25 percent of the lower flammable limit of the gas or vapor being monitored.

10-3.3 Fire detectors shall alarm at the plant site and at a constantly attended location if the plant site is not continually manned.

10-3.4 Detection systems, when used, shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable:

(a) NFPA 72, *Protective Signaling Systems*

(b) NFPA 72E, *Automatic Fire Detectors*

(c) NFPA 1221, *Public Fire Service Communication Systems.*

10-4 Container Protection. Nonrefrigerated storage containers shall be considered adequately protected against fire exposure if they are buried or mounded in accordance with 2-5.3 or insulated. (*See Appendix D.*)

10-5 Fire Protection Water Systems.

10-5.1 A water supply and a system for distributing and applying water shall be provided for protection of exposures; cooling containers, equipment, and piping; and controlling unignited leaks and spills unless an evaluation in accordance with 10-1.1 indicates the use of water is unnecessary or impractical.

10-5.2 The design of fire water supply and distribution systems, if provided, shall provide for the simultaneous supply of those fixed fire protection systems, including monitor nozzles, at their design flow and pressure, involved in the maximum single incident expected in the plant. An additional supply of 1000 gpm (63 L/s) shall be available for hand hose streams for a period of not less than 2 hours. Manually actuated monitors shall be permitted to be used to augment hand hose streams.

10-5.3 Nonrefrigerated storage containers that are not adequately protected per 10-4.1 shall be analyzed based on availability of water supply, the probable effectiveness of the plant fire brigades, and the time of response and probable effectiveness of the fire department. The first consideration in such an analysis shall consist of the use of water applied by the fire brigade or fire department for effective control of hazardous leakage or fire exposing storage tanks, cargo vehicles, or railroad tank cars that may be present. If the analysis indicates additional water protection is needed, it shall comply with 10-5.4.

10-5.4 Special Protection.

10-5.4.1 If insulation is used, it shall be capable of limiting the container temperature to not over 800°F (427°C) for a minimum of 50 minutes as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate. The insulation system shall be inherently resistant to weathering and the action of hose streams.

NOTE: It is recommended that insulation systems be evaluated on the basis of experience or listings by an approved testing laboratory. (*See also Appendix D.*)

10-5.4.2 If mounding is utilized, the provisions of 3-2.4.7 of NFPA 58 shall constitute adequate protection.

10-5.4.3 If burial is utilized, the provisions of 2-4.2 shall constitute adequate protection.

10-5.4.4 If water spray fixed systems are used, they shall comply with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*. Such systems shall be automatically actuated by fire responsive devices and also have a capability for manual actuation.

10-5.4.5 If monitor nozzles are used, they shall be located and arranged so that container surfaces likely to be exposed to fire will be wetted. Such systems shall otherwise comply with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and shall be automatically actuated by fire responsive devices and also have a capability for manual actuation.

10-5.5 Fire protection water systems, when used, shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable, considering the fire control problems in facilities covered by this standard:

(a) NFPA 13, *Installation of Sprinkler Systems*

(b) NFPA 14, *Standpipe and Hose Systems*

(c) NFPA 15, *Water Spray Fixed Systems*

(d) NFPA 20, *Centrifugal Fire Pumps*

(e) NFPA 22, *Water Tanks for Private Fire Protection*

(f) NFPA 24, *Private Fire Service Mains and Their Appurtenances*

(g) NFPA 1961, *Fire Hose*

(h) NFPA 1962, *Care, Use, and Maintenance of Fire Hose*

(i) NFPA 1963, *Screw Threads and Gaskets for Fire Hose Connections*.

NOTE: See also NFPA 13A, *Recommended Practice for the Inspection, Testing, and Maintenance of Sprinkler Systems*, and NFPA 26, *Recommended Practice for the Supervision of Valves Controlling Water Supplies*.

10-6 Fire Extinguishing and Other Fire Control Equipment.

10-6.1 Portable or wheeled fire extinguishers suitable for gas fires, preferably of the dry chemical type, shall be available at strategic locations, as determined in accordance with 10-1.1, within the facility. The minimum size portable dry chemical extinguisher shall be 18 lb with a B:C rating. These extinguishers shall be provided and maintained in accordance with NFPA 10, *Portable Fire Extinguishers*.

10-6.2 Fixed fire-extinguishing and other fire control systems may be appropriate for the protection of specific hazards as determined in accordance with 10-1.1. If provided, such systems shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable:

(a) NFPA 11, *Foam Extinguishing Systems and Combined Agent Systems*

(b) NFPA 11A, *Medium- and High-Expansion Foam Systems*

(c) NFPA 12, *Carbon Dioxide Extinguishing Systems*

(d) NFPA 12A, *Halon 1301 Fire Extinguishing Systems*

(e) NFPA 12B, *Halon 1211 Fire Extinguishing Systems*

(f) NFPA 16, *Deluge Foam-Water Sprinkler and Spray Systems*

(g) NFPA 17, *Dry Chemical Extinguishing Systems*.

10-7 Maintenance of Fire Protection Equipment. Facility operators shall prepare and implement a maintenance program for all plant fire protection equipment.

10-8 Personnel Safety.

10-8.1 Personnel shall be advised of the danger of frostbite, which can result upon contact with LP-Gas liquid or cold refrigerants. Suitable protective clothing and equipment shall be available.

10-8.2 Those employees who will be involved in emergency activities, as determined in accordance with 10-1.1, shall be equipped with the necessary clothing and equipment. Protective clothing shall comply with NFPA 1971, *Protective Equipment for Structural Fire Fighting*, and have an impermeable outer shell. Those employees requiring such protective clothing shall also be equipped with helmets, face shields, gloves, and boots suitable for the intended exposure.

10-8.3 Self-contained breathing apparatus shall be provided for those employees who may be required to enter an atmosphere that could be injurious to health during an emergency. Such apparatus shall comply with NFPA 1981, *Self-Contained Breathing Apparatus for Fire Fighters*, and be maintained in accordance with the manufacturer's instructions.

10-8.4 A portable flammable gas detector shall be readily available.

10-9 Security.

10-9.1 The facility operator shall provide a security system with controlled access, which shall be designed to minimize entry by unauthorized persons.

10-9.2 A protective enclosure including a peripheral fence, building wall, or natural barrier shall be provided enclosing major facility components, such as:

(a) LP-Gas storage containers.

(b) Flammable refrigerant storage tanks.

(c) Flammable liquid storage tanks.

(d) Other hazardous materials storage areas.

(e) Outdoor process equipment areas.

(f) Buildings housing process or control equipment.

(g) Onshore loading and unloading facilities.

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

Exception: As an alternate to fencing the operating area, suitable devices that can be locked in place shall be provided. Such devices, when in place, shall effectively prevent unauthorized operation of any of the container appurtenances, system valves, or equipment.

10-9.3 The provisions of 10-9.2 shall be permitted to be met by either one continuous enclosure or several independent enclosures. At least two exit gates or doors shall be provided for rapid escape of personnel in the event of an emergency.

10-9.4 Provisions shall be made for the ready access to the facility by emergency personnel or services.

10-9.5 Illumination shall be provided as necessary in the vicinity of protective enclosures and in other areas to promote security of the facility.

Chapter 11 Referenced Publications

11-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

11-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1990 edition

NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*, 1988 edition

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1988 edition

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 1989 edition

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 1989 edition

NFPA 12B, *Standard on Halon 1211 Fire Extinguishing Systems*, 1990 edition

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1991 edition

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 1990 edition

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 1990 edition

NFPA 16, *Standard on the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*, 1991 edition

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 1990 edition

NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, 1990 edition

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 1987 edition

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1992 edition

NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, 1989 edition

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1992 edition

NFPA 70, *National Electrical Code*, 1990 edition

NFPA 72, *Standard for the Installation, Maintenance, and Use of Protective Signaling Systems*, 1990 edition

NFPA 72E, *Standard on Automatic Fire Detectors*, 1990 edition

NFPA 78, *Lightning Protection Code*, 1989 edition

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Public Fire Service Communication Systems*, 1991 edition

NFPA 1961, *Standard for Fire Hose*, 1992 edition

NFPA 1962, *Standard for the Care, Use, and Maintenance of Fire Hose Including Couplings and Nozzles*, 1992 edition

NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*, 1985 edition

NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*, 1991 edition

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire Fighters*, 1987 edition

11-1.2 Other Publications.

11-1.2.1 ANSI Publications. American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI B31.3-1990, *Chemical Plant and Petroleum Refinery Piping*

11-1.2.2 API Publication. American Petroleum Institute, 2101 L St., NW, Washington, DC 20037.

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

11-1.2.3 ASCE Publication. American Society of Civil Engineers, 345 East 47th St., New York, NY 10017.

ASCE 7-1988, *Minimum Design Loads in Buildings and Other Structures*

11-1.2.4 ASME Publication. American Society for Mechanical Engineers, 345 East 47th St., New York, NY 10017.

"Rules for the Construction of Unfired Pressured Vessels," Section VIII, *ASME Boiler and Pressure Vessel Code*-1989

11-1.2.5 ASTM Publications. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM A47M-1990, *Standard Specification for Ferritic Malleable Iron Castings*

ASTM A48-1990, *Specification for Gray Iron Castings*

ASTM A395-1988, *Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*

ASTM A536-1984, *Specifications for Ductile Iron Castings*

11-1.2.6 ICBO Publication. International Conference of Building Officials, 5360 South Workman Rd., Whittier, CA 90601.

Uniform Building Code (UBC), 1988

11-1.2.7 UL Publication. Underwriters Laboratories, Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

UL 132-1984, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*

11-1.2.8 U.S. Government Publication. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20401.

Code of Federal Regulations, Title 49, Parts 171-192

Appendix A

A-1-2.1 See Figure A-1-2.1.

A-1-5.1 It is recognized that no odorant will be completely effective as a warning agent in all circumstances.

It is recommended that odorants be qualified as to compliance with Section 1-5 by tests or experience. Where qualifying is by tests, such tests should be certified to by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb (0.45 kg) per 10,000 gal (37.8 kL) of liquid LP-Gas has been recognized as an effective odorant. Other odorants and quantities meeting the provisions of Section 1-5 may be used. Research on odorants has shown that thiophane (tetrahydrothiophene) in a ratio of at least 6.4 lb (2.9 kg) per 10,000 gal (37.8 kL) of liquid LP-Gas may satisfy the requirements of Section 1-5.

NOTE: *A New Look at Odorization Levels for Propane Gas*, BERC/RI-77/1, United States Energy Research & Development Administration, Technical Information Center, September, 1977.

A-2-5.2.6 For LP-Gas fixed storage facilities of 60,000 gal (227 m^3) water capacity or less, a competent firesafety analysis (see 10-1.1) could indicate that applied insulating coatings are quite often the most practical solution for special protection.

A-6-1.6 This exception is made to cover such arrangements as a three-way valve installed under two relief devices, each of which has the required rate of discharge. The installation shall allow either of the relief valves to be closed but shall not allow both to be closed at the same time. In another arrangement, two separate relief valves are permitted to be installed with individual shutoff valves if the shutoff valve stems are mechanically interconnected in a manner that will allow full required flow from one relief valve at all times.

A-7-2.2 Formerly ICC (Interstate Commerce Commission). Published in *Federal Code of Regulations*—Title 49—Parts 171-190. In Canada, the regulations of the Canadian Transport Commission for Canada apply.

A-10-1.1 The first consideration in such an analysis should consist of the use of water applied by hose streams by the fire brigade or fire department for the effective control of hazardous leakage or fire exposing storage tanks, cargo vehicles, or railroad tank cars that may be present.

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

Appendix B

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

Method of calculating maximum liquid volume that can be placed in a container at any liquid temperature.

The quantity of gas that may be placed in a container is dependent upon the temperature of the liquid in the container and the maximum permitted filling density in addition to the size of the container.

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 2-8.1. Since the temperature of the liquid in the container is seldom exactly 60°F (15.6°C), it is necessary to measure the actual liquid temperature and then obtain a correction factor from the attached table and insert this in the following formula. The average liquid temperature may be obtained by one of two ways. One procedure is to measure the liquid temperature in the container after the container is almost filled to its permissible liquid content. This is secured by inserting a

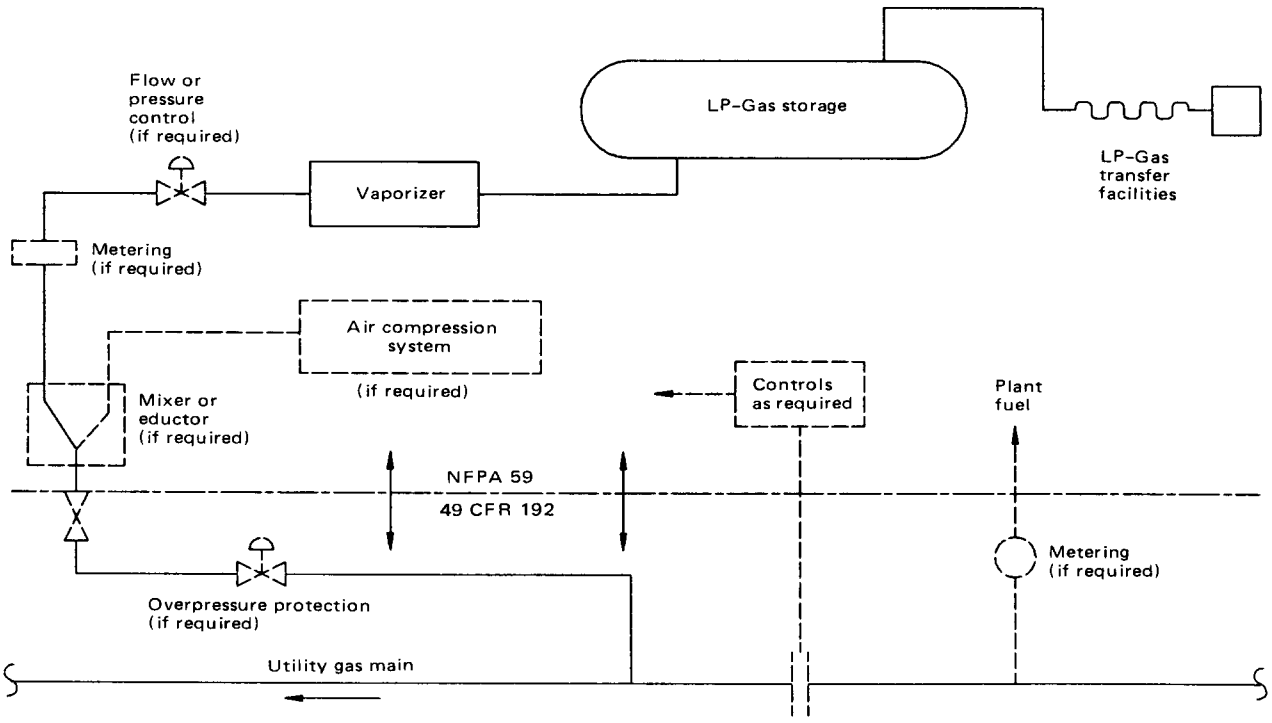

Figure A-1-2.1 Typical installation LP-Gas air base or peaking facility LP-Vapor base load or enrichment facility.

thermometer into a thermometer well, installed in the container so as to be in the liquid. The other procedure can only be used if the container is essentially empty prior to filling. In this case, the liquid temperature is measured by a thermometer placed in a thermometer well or other device installed in the filling line at a place near the container. The temperature should be read at intervals and averaged.

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

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

Where

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

D = filling density from 2-8.1 in percent.

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

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

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

After obtaining V from the above formula the actual maximum gal, Q_T, of LP-Gas that may be placed in a container is obtained by multiplying the water capacity of the container by $\frac{V}{100}$

Where

Q_T = actual gal at liquid temperature T.

Example:

Assume an aboveground container with 10,000-gal water capacity.

Propane with a specific gravity of 0.508 at 60°F (15.6°C) to be placed in container.

Filling density from 2-8.1 for aboveground container having a capacity greater than 1,200 gal in which a product having a specific gravity at 60°F (15.6°C) of 0.508 is to be placed is 45 percent.

To determine maximum quantity that may be placed in container when the liquid temperature is 60°F (15.6°C).

$$Q_{60^F} = \frac{45 \times 10{,}000}{0.508 \times 100} = 8{,}860 \text{ gal}$$

When liquid temperature is 82°F (27.8°C) find correction factor in the table on next page for specific gravity at 60°F (15.6°C) of 0.508 and a liquid temperature of 82°F (27.8°C), which is 0.963.

$$Q_{82^F} = \frac{45 \times 10{,}000}{0.508 \times 0.963 \times 100} = 9{,}200 \text{ gal}$$

Liquid Volume Correction Factors

Observed Temperature Degrees Fahrenheit	0.500	Propane 0.5079	0.510	0.520	0.530	0.540	0.550	0.560	iso-Butane 0.5631	0.570	0.580	n-Butane 0.5844	0.590
	SPECIFIC GRAVITIES AT 60°F/60°F												
	VOLUME CORRECTION FACTORS												
-50	1.160	1 155	1.153	1.146	1 140	1.133	1.127	1 122	1.120	1.116	1.111	1 108	1.106
-45	1.153	1.148	1 146	1.140	1.134	1 128	1.122	1.117	1 115	1.111	1.106	1.103	1.101
-40	1.147	1 142	1.140	1.134	1.128	1 122	1.117	1.111	1 110	1.106	1.101	1 099	1 097
-35	1.140	1.135	1 134	1 128	1.122	1.116	1.112	1.106	1.105	1.101	1 096	1.094	1 092
-30	1.134	1.129	1.128	1.122	1.116	1.111	1 106	1.101	1.100	1.096	1 092	1.090	1 088
-25	1.127	1.122	1.121	1.115	1.110	1.105	1.100	1.095	1 094	1.091	1.087	1.085	1 083
-20	1.120	1.115	1.114	1.109	1 104	1 099	1 095	1.090	1.089	1 086	1.082	1.080	1 079
-15	1 112	1.109	1 107	1.102	1.097	1.093	1.089	1.084	1.083	1 080	1.077	1.075	1.074
-10	1.105	1.102	1.100	1.095	1.091	1.087	1.083	1.079	1.078	1.075	1.072	1.071	1.069
-5	1.098	1 094	1.094	1.089	1 085	1.081	1.077	1.074	1.073	1.070	1.067	1.066	1.065
0	1.092	1.088	1.088	1.084	1.080	1.076	1.073	1.069	1.068	1.066	1 063	1.062	1.061
2	1.089	1.086	1.085	1.081	1.077	1.074	1.070	1.067	1.066	1.064	1.061	1 060	1.059
4	1.086	1.083	1.082	1.079	1.075	1.071	1.068	1.065	1.064	1.062	1.059	1 058	1.057
6	1.084	1.080	1.080	1.076	1.072	1.069	1.065	1.062	1.061	1.059	1.057	1.055	1.054
8	1.081	1.078	1.077	1.074	1.070	1.066	1.063	1.060	1.059	1.057	1.055	1.053	1.052
10	1.078	1.075	1.074	1.071	1 067	1.064	1.061	1 058	1.057	1.055	1.053	1.051	1.050
12	1.075	1.072	1.071	1.068	1 064	1.061	1.059	1 056	1 055	1.053	1.051	1.049	1 048
14	1.072	1.070	1.069	1.066	1 062	1.059	1.056	1 053	1.053	1.051	1.049	1.047	1 046
16	1 070	1.067	1.066	1 063	1.060	1.056	1 054	1 051	1.050	1 048	1 046	1.045	1.044
18	1.067	1 065	1.064	1.061	1.057	1 054	1.051	1.049	1 048	1.046	1.044	1 043	1.042
20	1.064	1 062	1 061	1.058	1.054	1.051	1.049	1.046	1 046	1.044	1.042	1 041	1.040
22	1.061	1 059	1.058	1.055	1.052	1.049	1.046	1.044	1.044	1.042	1 040	1 039	1.038
24	1 058	1.056	1 055	1.052	1.049	1 046	1.044	1.042	1.042	1.040	1.038	1.037	1.036
26	1.055	1.053	1.052	1.049	1.047	1.044	1 042	1.039	1.039	1 037	1 036	1 036	1.034
28	1.052	1 050	1.049	1.047	1.044	1.041	1.039	1.037	1.037	1 035	1 034	1 034	1.032
30	1 049	1.047	1.046	1.044	1.041	1 039	1.037	1.035	1.035	1 033	1.032	1.032	1 030
32	1 046	1.044	1 043	1.041	1.038	1.036	1 035	1.033	1 033	1 031	1.030	1.030	1.028
34	1.043	1 041	1.040	1.038	1 036	1.034	1 032	1 031	1.030	1 029	1.028	1.028	1.026
36	1.039	1 038	1.037	1.035	1.033	1.031	1 030	1.028	1.028	1.027	1.025	1.025	1.024
38	1.036	1 035	1.034	1.032	1.031	1.029	1 027	1 026	1.025	1.025	1.023	1 023	1.022
40	1.033	1 032	1.031	1 029	1.028	1 026	1 025	1.024	1.023	1.023	1.021	1.021	1.020
42	1.030	1.029	1.028	1.027	1.025	1.024	1.023	1.022	1 021	1.021	1.019	1 019	1.018
44	1.027	1.026	1.025	1.023	1.022	1.021	1.020	1.019	1.019	1.018	1.017	1 017	1 016
46	1 023	1.022	1.022	1.021	1.020	1.018	1.018	1.017	1.016	1.016	1.015	1.015	1 014
48	1 020	1.019	1.019	1.018	1.017	1.016	1.015	1.014	1.014	1.013	1.013	1.013	1 012
50	1 017	1.016	1.016	1.015	1.014	1.013	1 013	1.012	1.012	1.011	1 011	1.011	1.010
52	1 014	1.013	1.012	1.012	1.011	1 010	1.010	1.009	1 009	1 009	1.009	1.009	1 008
54	1.010	1.010	1 009	1.009	1 008	1 008	1.007	1.007	1 007	1.007	1.006	1.006	1 006
56	1.007	1.007	1.006	1.006	1 005	1.005	1.005	1 005	1 005	1.005	1.004	1.004	1.004
58	1.003	1.003	1.003	1 003	1.003	1 003	1.002	1.002	1 002	1 002	1 002	1.002	1.002
60	1.000	1.000	1 000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
62	0 997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.998	0.998	0.998	0.998
64	0.993	0.993	0.994	0.994	0 994	0.994	0.995	0 995	0.995	0.995	0.996	0 996	0.996
66	0 990	0.990	0.990	0.990	0.991	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.993
68	0 986	0.986	0.987	0.987	0 988	0.989	0.990	0.990	0.990	0.990	0.991	0.991	0.991
70	0.983	0 983	0.984	0.984	0 985	0.986	0.987	0 988	0 988	0.988	0.989	0 989	0 989
72	0.979	0.980	0.981	0 981	0.982	0.983	0 984	0.985	0.986	0 986	0.987	0.987	0.987
74	0 976	0.976	0 977	0 978	0.980	0 980	0 982	0.983	0.983	0 984	0.985	0.985	0.985
76	0 972	0.973	0.974	0 975	0.977	0.978	0.979	0.980	0.981	0.981	0.982	0.982	0.983
78	0 969	0.970	0 970	0 972	0.974	0 975	0 977	0.978	0.978	0 979	0.980	0.980	0.981
80	0.965	0.967	0.967	0.969	0.971	0.972	0.974	0.975	0 976	0 977	0.978	0.978	0.979
82	0 961	0.963	0.963	0.966	0.968	0 969	0.971	0.972	0 973	0 974	0.976	0.976	0.977
84	0.957	0.959	0 960	0.962	0.965	0 966	0.968	0.970	0.971	0.972	0 974	0.974	0.975
86	0.954	0.956	0.956	0.959	0.961	0.964	0.966	0.967	0.968	0.969	0 971	0 971	0.972
88	0.950	0.952	0.953	0.955	0.958	0.961	0.963	0.965	0.966	0.967	0 969	0 969	0.970
90	0.946	0.949	0 949	0 952	0 955	0.958	0.960	0 962	0.963	0 964	0.967	0 967	0.968
92	0.942	0.945	0 946	0.949	0.952	0 955	0.957	0.959	0.960	0 962	0.964	0 965	0.966
94	0 938	0.941	0.942	0 946	0.949	0 952	0 954	0.957	0 958	0 959	0.962	0.962	0.964
96	0 935	0.938	0.939	0 942	0.946	0 949	0 952	0.954	0 955	0 957	0.959	0.960	0 961
98	0 931	0.934	0.935	0 939	0.943	0.946	0 949	0.952	0.953	0 954	0.957	0.957	0.959
100	0.927	0 930	0.932	0.936	0.940	0.943	0.946	0 949	0 950	0.952	0.954	0.955	0.957
105	0.917	0.920	0 923	0.927	0.931	0.935	0 939	0.943	0.943	0.946	0.949	0.949	0.951
110	0.907	0.911	0 913	0.918	0.923	0.927	0 932	0.936	0 937	0.939	0.943	0.944	0 946
115	0.897	0 902	0.904	0 909	0 915	0.920	0 925	0.930	0.930	0.933	0.937	0.938	0.940
120	0.887	0 892	0.894	0 900	0 907	0.912	0 918	0.923	0.924	0.927	0.931	0 932	0.934
125	0.876	0.881	0.884	0 890	0 898	0.903	0 909	0.916	0.916	0.920	0 925	0.927	0.928
130	0 865	0.871	0.873	0 880	0.888	0.895	0 901	0.908	0.909	0.913	0 918	0.921	0.923
135	0 854	0.861	0.863	0 871	0 879	0.887	0 894	0 901	0 902	0.907	0 912	0 914	0.916
140	0 842	0.850	0.852	0.861	0.870	0 879	0 886	0 893	0.895	0 900	0 905	0.907	0 910

Appendix C

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

Method of calculating maximum volume of liquefied petroleum gas that can be placed in a container for which length of fixed dip tube is set.

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

2. Formula for determining maximum volume of liquefied petroleum gas for which a fixed length of dip tube shall be set.

$$\frac{\text{Water Cap. (Gal) of Container* } \times \text{ Filling Density**}}{\text{Sp. Gr. of liquefied petroleum gas* x Volume Correction Factor † } \times 100} = \text{Maximum Volume of liquefied petroleum gas}$$

Example: Assume a 30,000-gal total water capacity container for aboveground storage of propane having a specific gravity of 0.510 at 60°F (15.6°C).

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

$\frac{1{,}350{,}000}{52.58}$ = 25,675 gal propane, the maximum amount permitted to be placed in a 30,000-gal total water capacity aboveground container equipped with a fixed dip tub.

Volume Correction Factors

Specific Gravity	Aboveground	Underground
0.500	1.033	1.017
0.510	1.031	1.016
0.520	1.029	1.015
0.530	1.028	1.014
0.540	1.026	1.013
0.550	1.025	1.013
0.560	1.024	1.012
0.570	1.023	1.011
0.580	1.021	1.011
0.590	1.020	1.010

*Measured at 60°F (15.6°C)

**From 2-8.1, "Filling Densities."

†For aboveground containers the liquid temperature is assumed to be 40°F (4.4°C) and for underground containers the liquid temperature is assumed to be 50°F (10°C). To correct the liquid volumes at these temperatures to 60°F (15.6°C) the factors in paragraph 4-4.6 should be used.

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

$$\frac{\text{Maximum Vol. of liquefied petroleum gas (From Formula in Par. 2 preceding)} \times 100}{\text{Total water content of container in gal}} = \text{Maximum Volume of liquefied petroleum gas}$$

4. The maximum weight of liquefied petroleum gas that may be placed in a container *for determining the length of a fixed dip tube* is determined by multiplying the maximum volume of liquefied petroleum gas obtained by the formula in paragraph 2 preceding by the lb of liquefied petroleum gas in a gal of 40°F (4.4°C) for aboveground and at 50°F (10°C) for underground containers. For example, typical lb per gal are specified below:

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

Appendix D Procedure for Torch Fire and Hose Stream Testing of Thermal Insulating Systems for LP-Gas Containers

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

(This Appendix contains non-NFPA mandated provisions.)

A. *Performance Standard.* Thermal protection insulating systems, proposed for use on LP-Gas containers as a means of "Special Protection" under paragraph 3-10.3.1 of NFPA 58, are required to undergo thermal performance testing as a precondition for acceptance. The intent of this testing procedure is to identify insulation systems that retard or prevent the release of the container's contents in a fire environment of a 50-minute duration; and which will resist a concurrent hose stream of a 10-minute duration.

B. *Reference Test Standards.* The testing procedure described herein was taken with some modification from segments of the two following test standards:

1. *Code of Federal Regulations* — Title 49, Part 179.105-4, "Thermal Protection."

2. *National Fire Code* — NFPA Standard No. 252, Chapter 4, Section 4-3, "Hose Stream Test."

C. *Thermal Insulation Test.*

1. A torch fire environment shall be created in the following manner:

(i) The source of the simulated torch shall be a hydrocarbon fuel. The flame temperature from the simulated torch shall be 2,200°F ± 100°F throughout the duration of the test. Torch velocities shall be 40 miles per hour ± 10 miles per hour throughout the duration of the test.