NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

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

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Liquefied Petroleum Gas Code

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This edition of NFPA 58, *Liquefied Petroleum Gas Code*, was prepared by the Technical Committee on Liquefied Petroleum Gases and acted on by the National Fire Protection Association, Inc., at its November Meeting held November 12–15, 2000, in Orlando, FL. It was issued by the Standards Council on January 13, 2001, with an effective date of February 9, 2001, and supersedes all previous editions.

This edition of NFPA 58 was approved as an American National Standard on February 9, 2001.

Origin and Development of NFPA 58

This first NFPA standard on LP-Gas was adopted in 1932. In the next 8 years, separate standards covering various LP-Gas applications were adopted. In 1940, several standards were combined and adopted as NFPA 58.

Revisions of NFPA 58 were adopted in 1943, 1946, 1948, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1965, 1967, 1969, 1972, 1974, 1976, 1979, 1982, 1985, 1988, 1992, 1995, 1998, and 2001.

The 2001 edition is a complete revision of the code and includes extensive editorial modifications that make the code clearer and easier to use. Major changes include a new Chapter 11, Operations and Maintenance, new retroactive requirements for valves with remote closing capability on all containers of 4000 gallons to be completed within 10 years, and a requirement for a fire safety analysis for all installations of 4000 gallons or more within 3 years of the effective date.

Report of the Committee on Liquefied Petroleum Gases

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

Committee Scope: This Committee shall have primary responsibility for documents on the design, construction, installation, and operation of fixed and portable liquefied petroleum gas systems in bulk plants and commercial, industrial (with specified exceptions), institutional, and similar properties; truck transportation of liquefied petroleum gas; engine fuel systems on motor vehicles and other mobile equipment; storage of containers awaiting use or resale; installation on commercial vehicles; and liquefied petroleum gas service stations.

Contents

NFPA 58

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

Information on referenced publications can be found in Chapter 13 and Appendix J.

In this code, pressures are indicated as follows: gauge pressures in psig (kPag), pressures of vapor in equilibrium with the liquid in psia (kPa), and pressure differences in psi (kPa).

Chapter 1 General Provisions

1.1* Scope.

1.1.1 Application. This code shall apply to the operation of all LP-Gas systems including the following:

(1) Containers, piping, and associated equipment, when delivering LP-Gas to a building for use as a fuel gas
(2) Highway transportation of LP-Gas
(3) The design, construction, installation, and operation of marine terminals whose primary purpose is the receipt of LP-Gas for delivery to transporters, distributors, or users

Exception No. 1: Marine terminals associated with refineries, petrochemicals, and gas plants.

Exception No. 2: Marine terminals whose purpose is the delivery of LP-Gas to marine vessels.

(4)* The design, construction, installation, and operation of pipeline terminals that receive LP-Gas from pipelines under the jurisdiction of the U.S. Department of Transportation, whose primary purpose is the receipt of LP-Gas for delivery to transporters, distributors, or users. Coverage shall begin downstream of the last pipeline valve or tank manifold inlet.

Exception: Those systems designated by 1.1.2 are exempt from this code.

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

(1) Frozen ground containers and underground storage in caverns including associated piping and appurtenances used for the storage of LP-Gas
(2) Natural gas processing plants, refineries, and petrochemical plants
(3) LP-Gas (including refrigerated storage) at utility gas plants (NFPA 59, *Utility LP-Gas Plant Code*)
(4) Chemical plants where specific approval of construction and installation plans, based on substantially similar requirements, is obtained from the authority having jurisdiction
(5) LP-Gas used with oxygen (NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, and ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, shall apply.)
(6)* Those portions of LP-Gas systems covered by NFPA 54 (ANSI Z223.1), *National Fuel Gas Code,* where NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*, is adopted, used, or enforced
(7) Transportation by air (including use in hot air balloons), rail, or water under the jurisdiction of the U.S. Department of Transportation (DOT)
(8) Marine fire protection (NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, shall apply.)
(9) Refrigeration cycle equipment and LP-Gas used as a refrigerant in a closed cycle
(10) Those manufacturing requirements for recreational vehicle LP-gas systems that are addressed by NFPA 1192, *Standard on Recreational Vehicles*

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

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

Unless otherwise specified, the provisions of this code shall not apply to facilities, equipment, appliances, structures, or installations that existed or were approved for construction or installation prior to the effective date of the code. Equipment and appliances include stocks in manufacturers' storage, distribution warehouses, and dealers' storage and showrooms in compliance with the provisions of this code in effect at the time of manufacture. Where specified, the provisions of this code shall be retroactive.

In those cases where the authority having jurisdiction determines that the existing situation presents a distinct hazard to life and property, the authority having jurisdiction shall be permitted to apply retroactively any portions of this code that are deemed appropriate.

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

1.2 Acceptance of Equipment and Systems.

1.2.1 Systems or components assembled to make up systems shall be approved as specified in Table 1.2.1. Where necessary to alter or repair containers or container assemblies in the field such changes shall be made using approved components.

1.2.2 Acceptance applies to the complete system or to the individual components of which it is comprised as specified in Table 1.2.1.

1.3 LP-Gas Odorization.

1.3.1* All LP-Gases shall be odorized prior to delivery to a bulk plant by the addition of a warning agent of such character that the gases are detectable, by a distinct odor, to a concentration in air of not over one-fifth the lower limit of flammability.

Exception: Odorization, however, shall not be required if harmful in the use or further processing of the LP-Gas or if such odorization will serve no useful purpose as a warning agent in such further use or processing.

1.3.2* If odorization is required, the presence of the odorant shall be determined by sniff-testing or other means and the results shall be documented as follows:

(1) When LP-Gas is delivered to a bulk plant
(2) When shipments of LP-Gas bypass the bulk plant

Table 1.2.1 Containers

Containers Used	Capacity, Water gal	Capacity, Water m^3	Approval Applies to . . .
Cylinders	<120	0.445	Container valves and connectors
			Manifold valve assemblies
			Regulators and pressure relief devices
ASME containers	≤2000	≤7.6	Container system* including regulator, or container assembly* and regulator separately
ASME containers	>2000	>7.6	Container valves
			Container excess-flow valves, backflow check valves, or alternate means of providing this protection such as remotely controlled internal valves
			Container gauging devices
			Regulators and container pressure relief devices

*Where necessary to alter or repair such systems or assemblies in the field in order to provide for different operating pressures, change from vapor to liquid withdrawal, or the like, such changes shall be permitted to be made by the use of approved components.

1.4 Notification of Installations.

1.4.1 Stationary Installations. Plans for stationary installations utilizing storage containers of over 2000-gal (7.6-m^3) individual water capacity, or with aggregate water capacity exceeding 4000 gal (15.1 m^3), and all rooftop installations of ASME containers shall be submitted to the authority having jurisdiction by the person or company that either installs or contracts to have the containers installed before the installation is started. *[See also 3.4.9.1(e).]*

1.4.2 Temporary Installations. The authority having jurisdiction shall be notified of temporary (not to exceed six months) installations of the container sizes covered in 1.4.1 before the installation is started.

1.5* Qualification of Personnel. Persons who transfer liquid LP-Gas, who are employed to transport LP-Gas, or whose primary duties fall within the scope of this code shall be trained in proper handling procedures. Refresher training shall be provided at least every three years. The training shall be documented.

1.6* Ammonia Contamination. LP-Gas stored or used in systems within the scope of this code shall contain less ammonia than the quantity required to turn red litmus paper blue. When any equipment has been converted from ammonia service to propane service, the LP-Gas shall be tested.

1.7 Definitions, Glossary of Terms, and Abbreviations.

1.7.1 Actuated Liquid Withdrawal Excess-Flow Valve. An excess-flow valve for liquid withdrawal applications that remains in a closed position until actuated by a pipe nipple or adapter, as recommended by the manufacturer, and that is used with a shutoff valve attached to the actuator.

1.7.2 Anodeless Riser. A transition assembly where polyethylene pipe or tubing is permitted to be installed under ground and is terminated above ground outside of a building.

1.7.3 ANSI. American National Standards Institute.

1.7.4 API. American Petroleum Institute.

1.7.5 API-ASME Container (or Tank). A container constructed in accordance with the pressure vessel code jointly developed by the American Petroleum Institute and the American Society of Mechanical Engineers.

1.7.6* Approved. Acceptable to the authority having jurisdiction.

1.7.7 ASME. American Society of Mechanical Engineers.

1.7.8 ASME Code. Section VIII, "Rules for the Construction of Unfired Pressure Vessels" of the *Boiler and Pressure Vessel Code* of the American Society of Mechanical Engineers.

1.7.9 ASME Container. A container constructed in accordance with the ASME Code.

1.7.10 ASTM. American Society for Testing and Materials.

1.7.11* Authority Having Jurisdiction. The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

1.7.12* Bulk Plant. A facility, the primary purpose of which is the storage and distribution of LP-Gas, that receives LP-Gas by cargo tank vehicle, railroad tank car, or piping, distributing this gas by portable container (package) delivery, by cargo tank vehicle, or through gas piping.

1.7.13 Cargo Tank. A container that is used to transport LP-Gas over a highway as liquid cargo and either is mounted on a conventional truck chassis or is an integral part of a transporting vehicle in which the container constitutes in whole, or in part, the stress member used as a frame. Essentially, it is a permanent part of the transporting vehicle.

1.7.14 CGA. Compressed Gas Association.

1.7.15 Compressed Gas. Any material or mixture having, when in its container, an absolute pressure exceeding 40 psia (an absolute pressure of 276 kPa) at 70°F (21.1°C) or, regardless of the pressure at 70°F (21.1°C), having an absolute pressure exceeding 104 psia (an absolute pressure of 717 kPa) at 130°F (54.4°C).

1.7.16 Container. Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for the transporting or storing of LP-Gases.

1.7.17 Container Appurtenances. Items connected to container openings needed to make a container a gastight entity. These include, but are not limited to, pressure relief devices; shutoff, backflow check, excess-flow check, and internal valves; liquid level gauges; pressure gauges; and plugs.

1.7.18 Container Assembly. An assembly consisting of the container and fittings for all container openings such as shutoff valves, excess-flow valves, liquid level gauging devices, pressure relief devices, and protective housings.

1.7.19 Cylinder. A container constructed in accordance with U.S. Department of Transportation specifications (Title 49, *Code of Federal Regulations*).

1.7.20 Design Certification. The process by which a product is evaluated and tested by an independent laboratory to affirm that the product design complies with specific requirements.

1.7.21 Direct Gas-Fired Tank Heater. A gas-fired device that applies hot gas from the heater combustion chamber directly to a portion of the container surface in contact with LP-Gas liquid.

1.7.22 Dispenser, Vehicle Fuel. A device or system designed to transfer and measure LP-Gas into engine fuel and mobile containers on vehicles.

1.7.23 Dispensing Station. Fixed equipment in which LP-Gas is stored and dispensed into portable containers.

1.7.24 DOT. U.S. Department of Transportation.

1.7.25 Fixed Piping System. Piping, valves, and fittings permanently installed in a location to connect the source of the LP-Gas to the utilization equipment.

1.7.26* Flexible Connector. A short [not exceeding 36 in. (0.91 m) overall length] component of a piping system fabricated of flexible material (such as hose) and equipped with suitable connections on both ends.

1.7.27 Gauge.

1.7.27.1 Fixed Liquid Level Gauge. A type of liquid level gauge that uses a relatively small positive shutoff vent valve and that indicates when the liquid level in a container being filled reaches the point at which the gauge or its connecting tube communicates with the liquid level in the container.

1.7.27.2 Fixed Maximum Liquid Level Gauge. A fixed liquid level gauge that indicates the liquid level at which the container is filled to its maximum permitted filling limit.

1.7.27.3 Float Gauge. A gauge constructed with an element installed inside the container that floats on the liquid surface and transmits its position to a device outside the container to indicate the liquid level.

1.7.27.4 Magnetic Gauge. See 1.7.27.3, Float Gauge.

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

1.7.27.6 Slip Tube Gauge. A variable liquid level gauge in which a relatively small positive shutoff valve is located at the outside end of a straight tube, normally installed vertically, that communicates with the container interior.

1.7.27.7 Variable Liquid Level Gauge. A device that indicates the liquid level in a container throughout a range of levels.

1.7.28 Gallon. U.S. Standard. 1 U.S. gal = 0.833 Imperial gal = 231 $in.^3$ = 3.785 L.

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

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

1.7.31 GPA. Gas Processors Association.

1.7.32 ICC. U.S. Interstate Commerce Commission.

1.7.33 Ignition Source. See 1.7.65, Sources of Ignition.

1.7.34 Industrial Occupancy. Includes factories that manufacture products of all kinds and properties devoted to operations such as processing, assembling, mixing, packaging, finishing or decorating, and repairing.

1.7.35 kPa. Absolute pressure in kilo-Pascals.

1.7.36 kPag. Gauge pressure in kilo-Pascals.

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

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

1.7.38.1 LP-Gas System. An assembly consisting of one or more containers with a means for conveying LP-Gas from a container to dispensing or consuming devices that incorporates components that control the quantity, flow, pressure, and physical state (liquid or vapor) of the LP-Gas.

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

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

1.7.40* Low Emission Transfer. Establishes a maximum fugitive emissions standard for certain product transfer operations. Low emission transfer specifications might be employed to comply with environmental regulations or to determine certain minimum distance requirements.

1.7.41 Mobile Container. A container that is permanently mounted on a vehicle and connected for uses other than supplying engine fuel.

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

1.7.43* Movable Fuel Storage Tender. A container equipped with wheels (including a farm cart) not in excess of 1200-gal (4.5-m^3) water capacity that is moved from one location to another.

1.7.44 MPa. Absolute pressure in mega-Pascals.

1.7.45 MPag. Gauge pressure in mega-Pascals.

1.7.46 Multipurpose Passenger Vehicle. A motor vehicle with motive power, with the exception of a trailer, designed to carry 10 or fewer persons that is constructed on a truck chassis or with special features for occasional off-road operations.

1.7.47 NFPA. National Fire Protection Association.

1.7.48 NPGA. National Propane Gas Association.

1.7.49 Overfilling Prevention Device. A safety device that is designed to provide an automatic means to prevent the filling of a container in excess of the maximum permitted filling limit.

1.7.50 Overpressure Shutoff Device. A device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches a predetermined maximum allowable pressure.

1.7.51 Permanent Installation. See 1.7.67, Stationary Installation.

1.7.52 Piping, Piping Systems. Pipe, tubing, hose, and flexible rubber or metallic hose connectors with valves and fittings made into complete systems for conveying LP-Gas from one point to another in either the liquid or the vapor state at various pressures.

1.7.53 Point of Transfer. The location where connections and disconnections are made or where LP-Gas is vented to the atmosphere in the course of transfer operations.

1.7.54* Portable Container. A container designed to be moved readily, as opposed to a container designed for stationary installations.

1.7.55* Portable Storage Container. A container similar to but distinct from a container that is designed for stationary installation, and that is designed and constructed to be moved readily over a highway from one usage locations to another, substantially empty of liquid.

1.7.56 Portable Tank (or Skid Tank). A container of more than 1000-lb (454-kg) water capacity used to transport LP-Gas handled as a package — that is, filled to its maximum permitted filling limit. Such containers are mounted on skids or runners and have all container appurtenances protected in such a manner that they can be safely handled as a package.

1.7.57 Pressure Relief Device. A device designed to open to prevent a rise of internal fluid pressure in excess of a specified value due to emergency or abnormal conditions.

1.7.58 psi. Pounds per square inch.

1.7.59 psia. Pounds per square inch, absolute.

1.7.60 psig. Pounds per square inch gauge.

1.7.61 Quick Connectors. Fittings used to connect hose assemblies to piping and valves without the use of tools.

1.7.62 Regulator.

1.7.62.1* Automatic Changeover Regulator. An integral two-stage regulator that combines two high pressure regulators and a second-stage regulator into a single unit designed for use with multiple cylinder installations.

1.7.62.2 First-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce pressure from the container to 10.0 psig (69 kPag) or less.

1.7.62.3 High-Pressure Regulator. A pressure regulator for LP-Gas liquid or vapor service designed to reduce pressure from the container to a lower pressure in excess of 1.0 psig (6.9 kPag).

1.7.62.4 Integral 2-psi Service Regulator. A pressure regulator that combines a high pressure regulator and a 2-psi service regulator into a single unit.

1.7.62.5 Integral Two-Stage Regulator. A pressure regulator that combines a high pressure regulator and a second-stage regulator into a single unit.

1.7.62.6 Line Pressure Regulator. A pressure regulator in accordance with the *Standard for Line Pressure Regulators,* ANSI Z-21.80/CSA 6.22, with no integral overpressure protection device for LP-Gas vapor service designed for installation inside a building to reduce a nominal 2-psi inlet pressure to 14 in. w.c. (4.0 kPa) or less.

1.7.62.7 Second-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to 14 in. w.c. (4.0 kPag) or less.

1.7.62.8 Single-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce pressure from the container to 1.0 psig (6.9 kPag) or less.

1.7.62.9 2-psi Service Regulator. A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to a nominal 2 psi (13.8 kPa).

1.7.62.10 2-psi System Regulator. An LP-Gas vapor delivery system that combines a first-stage regulator, a 2-psi service regulator and a line pressure regulator(s).

1.7.63 Service Head Adapter. A transition fitting for use with polyethylene pipe or tubing that is recommended by the manufacturer for field assembly and installation at the aboveground termination end of an anodeless riser.

1.7.64 Skid Tank. See 1.7.56, Portable Tank.

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

1.7.66* 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.

1.7.67 Stationary Installation (Permanent Installation). An installation of LP-Gas containers, piping, and equipment for indefinite use at a particular location; an installation not normally expected to change in status, condition, or location.

1.7.68 Two-Stage Regulator System. An LP-Gas vapor delivery system that combines a first-stage regulator and a second-stage regulator(s), or an integral two-stage regulator.

1.7.69 UL. Underwriters Laboratories Inc.

1.7.70 Universal Cylinder. A cylinder that can be connected for service in either the vertical or the horizontal position, so that the fixed maximum liquid level gauge, pressure relief device, and withdrawal appurtenances function properly in either position.

1.7.71 Valve.

1.7.71.1 Emergency Shutoff Valve. A shutoff valve incorporating thermal and manual means of closing that also provides for remote means of closing.

1.7.71.2 Excess-Flow Valve (or Excess-Flow Check Valve). A valve designed to close when the liquid or vapor passing through it exceeds a prescribed flow rate.

1.7.71.3 Internal Excess-Flow Valve. An excess-flow valve constructed and installed so that damage to valve parts exterior to the container does not prevent closing of the valve.

1.7.71.4* Internal Valve. A container primary shutoff valve whose seat and seat disc remain inside the container so that damage to parts exterior to the container or mating flange does not prevent effective sealing of the valve and that has the following features: (1) provision for the addition of a means of remote closure, and (2) automatic shutoff when the flow through the valve exceeds its rated maximum flow capacity or when pump actuation differential pressure drops to a predetermined point.

1.7.71.5 Pressure Relief Valve. A type of pressure relief device designed to both open and close to maintain internal fluid pressure.

1.7.71.5.1* External Pressure Relief Valve. A pressure relief valve that is used on older domestic containers, on pressure relief valve manifolds, and for piping protection where all the working parts are located entirely outside the container or piping.

1.7.71.5.2* Flush-Type Full Internal Pressure Relief Valve. An internal pressure relief valve in which the wrenching section is also within the container connection, not including a small portion due to pipe thread tolerances on makeup.

1.7.71.5.3* Full Internal Pressure Relief Valve. A pressure relief valve, for engine fuel and mobile container use, in which all working parts are recessed within the container connections, and the spring and guiding mechanism are not exposed to the atmosphere.

1.7.71.5.4* Internal Spring-Type Pressure Relief Valve. A pressure relief valve, for use on ASME stationary containers that has a low profile and is similar to a full internal relief valve except the wrenching pads and seating section are above the container connection. The adjusting spring and the stem are below the seat and are not exposed to the atmosphere.

1.7.72 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.

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

1.7.72.2 Electric Vaporizer. A vaporizer that uses electricity as a source of heat.

1.7.72.2.1 Direct Immersion Electric Vaporizer. A vaporizer wherein an electric element is immersed directly in the LP-Gas liquid and vapor.

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

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

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

1.7.72.5 Burner Vaporizing (or Vaporizer Burner or Self-Vaporizing Liquid Burner). A burner that contains an integral vaporizer that receives LP-Gas in liquid form and that uses part of the heat generated by the burner to vaporize the liquid in the burner so that it is burned as a vapor.

1.7.73 Volumetric Filling. Filling a container by determination of the liquid volume of LP-Gas in the container.

1.7.74 Volumetric Loading. See 1.7.73, Volumetric Filling.

1.7.75 Water Capacity. The amount of water, in either pounds or gallons, at 60°F (15.6°C) required to fill a container full of water.

1.7.76 Weight Filling. Filling containers by weighing the LP-Gas in the container.

Chapter 2 LP-Gas Equipment and Appliances

2.1 Scope.

2.1.1 Individual components and components shop-fabricated into subassemblies, container assemblies, and complete container systems shall meet the requirements of this chapter.

2.1.2 The field assembly of components, subassemblies, container assemblies, or complete container systems into complete LP-Gas systems is covered by Chapter 3. *(See 1.7.38.1, LP-Gas System.)*

2.2 Containers.

2.2.1 General.

2.2.1.1 The design, fabrication, and marking provisions for containers and features normally associated with container fabrication, such as container openings, appurtenances required for these openings to make the containers gastight entities, physical damage protecting devices, and container supports attached to or furnished with the container by the manufacturer shall meet the requirements of this section.

2.2.1.2 Refrigerated containers shall comply with Chapter 9.

2.2.1.3* Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT), the ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for the Construction of Unfired Pressure Vessels," or the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, except for UG-125 through UG-136. The following shall also apply:

(a) Adherence to applicable ASME *Code Case Interpretations and Addenda* that have been adopted and published by ASME 180 calendar days prior to the effective date of this code shall be considered as compliant with the ASME Code.

(b) Containers fabricated to earlier editions of regulations, rules, or codes listed in 2.2.1.3 and of the ICC, *Rules for Construction of Unfired Pressure Vessels,* prior to April 1, 1967, shall be permitted to be continued to be used in accordance with 1.1.4.

2.2.1.4 A container shall not be filled if the container assembly is not suitable for continued service.

2.2.1.5* Cylinders shall be filled, continued in service, and transported in accordance with DOT regulations. Any cylinder that is out of qualification date shall not be refilled until requalified by methods prescribed in DOT regulations.

2.2.1.6 Containers that have been involved in a fire and show no distortion shall be requalified for continued service as follows before being used or reinstalled:

(1) Cylinders shall be requalified by a manufacturer of the type of cylinder to be requalified or by a repair facility approved by DOT.

Exception: DOT 4E specification (aluminum) cylinders shall be permanently removed from service.

(2) ASME or API-ASME containers shall be retested using the hydrostatic test procedure applicable at the time of original fabrication.
(3) All container appurtenances shall be replaced.

2.2.1.7 ASME paragraph U-68 or U-69 containers shall be permitted to be continued in use, installed, reinstalled, or placed back into service. Installation of containers shall be in accordance with all provisions listed in this code. *(See Section 2.2, Tables 2.2.2.2 and 2.3.2.3, and Appendix D.)*

2.2.1.8 Containers that show serious denting, bulging, gouging, or excessive corrosion shall be removed from service.

2.2.1.9 Repair or alteration of a container shall comply with the regulations, rules, or code under which the container was fabricated. Other welding shall be permitted only on saddle plates, lugs, or brackets attached to the container by the container manufacturer.

2.2.1.10 Containers for general use shall not have individual water capacities greater than 120,000 gal (454 m^3). Containers in dispensing stations shall have an aggregate water capacity not greater than 30,000 gal (114 m^3). This capacity restriction shall not apply to LP-Gas bulk plants, industrial plants, or industrial applications.

2.2.1.11 Heating or cooling coils shall not be installed inside storage containers.

2.2.2 Container Design or Service Pressure.

2.2.2.1 The minimum design or service pressure of cylinders shall be in accordance with the appropriate regulations published under Title 49, *Code of Federal Regulations,* "Transportation."

2.2.2.2 The minimum design pressure for ASME containers shall be in accordance with Table 2.2.2.2.

Table 2.2.2.2 Maximum Vapor Pressures and Design Pressures

Maximum Vapor Pressure in psig (MPag)		Design Pressure in psig (MPag)		
			Earlier Codes	
at 100°F	at 37.8°C	Current ASME Code[1]	API-ASME	ASME[2]
80	0.6	100 (0.7)	100 (0.7)	80 (0.6)
100	0.7	125 (0.9)	125 (0.9)	100 (0.7)
125	0.9	156 (1.1)	156 (1.1)	125 (0.9)
150	1.0	187 (1.3)	187 (1.3)	150 (1.0)
175	1.2	219 (1.5)	219 (1.5)	175 (1.2)
215	1.5	250 (1.7)[3]	250 (1.7)[3]	200 (1.4)
215	1.5	312.5 (2.2)[3]	312.5 (2.2)[3]	—

Note: See Appendix D for information on earlier ASME or API-ASME codes.
[1]ASME Code, 1949 edition, paragraphs U-200 and U-201 and all later editions *(see D.2.1.5)*.
[2]All ASME codes up to the 1946 edition and paragraphs U-68 and U-69 of the 1949 edition *(see D.2.1.5)*.
[3]See 3.8.2.1(a), 3.8.2.1(b)(2) and 8.2.2.1(e) for required minimum design pressure for ASME engine fuel and mobile containers.

2.2.2.3 In addition to the applicable provisions for horizontal ASME containers, vertical ASME containers over 125-gal (0.5-m^3) water capacity shall comply with the following:

(a) 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.

(b) Design pressure *(see Table 2.2.2.2)* shall be 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.

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

(d) Seismic loading on 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.

(e) Shop-fabricated containers shall be fabricated with lifting lugs or some other suitable means to facilitate erection in the field.

2.2.3 ASME Container Openings.

2.2.3.1 Containers shall be equipped with openings suitable for the service for which the container is to be used. Such openings shall be permitted to be either in the container proper or in the manhole cover, or partially in each location.

2.2.3.2 ASME containers of more than 30-gal (0.1-m^3) through 2000-gal (7.6-m^3) water capacity and designed to be filled volumetrically and manufactured after December 1, 1963, shall be equipped for filling into the vapor space.

2.2.3.3 ASME containers of 125-gal (0.5-m^3) through 2000-gal (7.6-m^3) water capacity and manufactured after July 1, 1961 shall be provided with an opening for an actuated liquid withdrawal excess-flow valve with a connection not smaller than $^3/_4$-in. national pipe thread.

2.2.3.4 ASME containers of more than 2000-gal (7.6-m^3) water capacity shall be provided with an opening for a pressure gauge.

2.2.3.5 Connections for pressure relief valves shall be located as follows and installed in such a way as to have direct communication with the vapor space, whether the ASME container is in storage or in use:

(a) If located in a well inside the ASME container with piping to the vapor space, then the design of the well and piping shall allow sufficient pressure relief valve relieving capacity.

(b) If located in a protecting enclosure, the enclosure shall be designed to protect against corrosion and to allow inspection.

(c) If located in any position other than the uppermost point of the ASME container, the connection shall be internally piped to the uppermost point practical in the vapor space of the container.

2.2.3.6 ASME containers to be filled on a volumetric basis and manufactured after December 31, 1965, shall be fabricated so that they can be equipped with a fixed maximum liquid level gauge(s) that is capable of indicating the maximum permitted filling level(s) in accordance with 4.4.2.2.

2.2.4 Portable Container Appurtenance Physical Damage Protection.

2.2.4.1 Cylinders of 1000-lb (454-kg) water capacity [nominal 420-lb (191-kg) LP-Gas capacity] or less shall incorporate protection against physical damage to cylinder appurtenances and immediate connections to such appurtenances when in transit, storage, being moved into position for use, and when in use, except in residential and commercial installations, by the following means:

(a) A ventilated cap or collar designed to permit pressure relief valve discharge and capable of withstanding a blow from any direction equivalent to that of a 30-lb (14-kg) weight dropped 4 ft (1.2 m). Construction shall be such that the force of the blow will not be transmitted to the valve.

(b) Collars shall be designed so that they do not interfere with the free operation of the cylinder valve.

2.2.4.2 Portable containers, skid tanks, and tanks for use as cargo containers of more than 1000-lb (454-kg) water capacity [nominal 420-lb (191-kg) LP-Gas capacity], shall incorporate protection against physical damage to container appurtenances by recessing, by protective housings, or by location on the vehicle. Such protection shall comply with the provisions under which the containers are fabricated and shall be designed to withstand static loadings in any direction equal to twice the weight of the container and attachments when filled with LP-Gas, using a minimum safety factor of four, based on the ultimate strength of the material to be used.

2.2.5 Containers with Attached Supports.

2.2.5.1 Horizontal ASME containers with attached supports and designed for permanent installation in stationary service shall be installed in accordance with Table 2.2.5.1. For installation of horizontal containers without attached supports, see 3.2.6.

Table 2.2.5.1 Installation of Permanently Installed Horizontal ASME Containers with Attached Supports

Container Size gal (m^3)	Attached Support	Height of Bottom of the Container
>2000 (≥7.6)	Nonfireproofed steel on flat topped concrete foundations	6 in. (150 mm) maximum above concrete foundations
≤2000 (≤7.6)	Nonfireproofed steel on firm foundations or concrete foundations more than 12 in. (300 mm) above the ground	2 in.–12 in. (51–305 mm) above concrete foundation
≤2000 (≤7.6)	Nonfireproofed steel on paved surfaces or concrete pads within 4 in. (100 mm) of the ground	24 in. (610 mm) maximum above paved surface or top of concrete pads

2.2.5.2 Vertical ASME containers of over 125-gal (0.5-m^3) water capacity and designed for permanent installation in stationary service shall be designed with steel supports that are designed to allow the container to be mounted on and fastened to concrete foundations or supports. Such steel supports shall be designed to make the container self-supporting without guy wires and to withstand the wind and seismic (earthquake) forces anticipated at the site. The provisions of 2.2.2.3 shall apply.

The steel supports shall be protected against fire exposure with a material having a fire resistance rating of at least 2 hours.

Exception: Continuous steel skirts having only one opening of 18 in. (457 m) or less in diameter shall have 2-hour fire protection applied to the outside of the skirt.

2.2.5.3 ASME containers to be used as portable storage containers including movable fuel storage tenders and farm carts for temporary stationary service (normally not more than 12 months duration at any location) and to be moved only with 5 percent or less of their liquid capacity shall comply with the following:

(a) If mounted on legs or supports, then such supports shall be of steel and either shall be welded to the container by the manufacturer at the time of fabrication or shall be attached to lugs that have been so welded to the container. The legs or supports or the lugs for the attachment of these legs or supports shall be secured to the container in accordance with the code or rule under which the container was designed and built, using a minimum safety factor of four, to withstand loading in any direction equal to twice the weight of the empty container and attachments.

(b) If the container is mounted on a trailer or semi-trailer running gear so that the unit can be moved by a conventional over-the-road tractor, attachment to the vehicle, or attachments to the container to make it a vehicle, shall comply with the appropriate DOT requirements for cargo tank service, except that stress calculations shall be based on twice the weight of the empty container. The unit also shall comply with applicable local, state, and federal laws and shall be approved by the authority having jurisdiction.

2.2.5.4 Portable tank design and construction, securing of skids or lugs for the attachment of skids, and protection of fittings shall be in accordance with DOT portable tank specifications. The bottom of the skids shall be between 2 in. (50 mm) or more than 12 in. (300 mm) below the outside bottom of the tank shell.

2.2.5.5 Movable fuel storage tenders, including farm carts, shall be secured to the trailer support structure for the service involved.

2.2.6 Container Marking.

2.2.6.1 Cylinders shall be marked as provided in the regulations, rules, or code under which they are fabricated and shall be in accordance with the following:

(1) Where LP-Gas and one or more other compressed gases are to be stored or used in the same area, the cylinders shall be marked "Flammable" and either "LP-Gas," "LP-GAS," "Propane," or "Butane." Compliance with marking requirements of Title 49, *Code of Federal Regulations,* "Transportation," shall meet this provision.
(2) When being transported, cylinders shall be marked and labeled in accordance with Title 49, *Code of Federal Regulations*, "Transportation."

2.2.6.2 Cylinders shall be marked with the following information:

(1) The water capacity of the cylinder in pounds
(2) The tare weight of the cylinder in pounds, fitted for service. The tare weight is the cylinder weight plus the weight of all permanently attached valves and other fittings but does not include the weight of protecting devices that are removed in order to load the cylinder.

2.2.6.3* The markings specified for ASME containers shall be on a stainless steel metal nameplate attached to the container, located to remain visible after the container is installed. The nameplate shall be attached in such a way as to minimize corrosion of the nameplate or its fastening means and not contribute to corrosion of the container.

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

ASME containers shall be marked with the following information:

(1) Service for which the container is designed (for example, underground, aboveground, or both)
(2) Name and address of container supplier or trade name of container
(3) Water capacity of container in pounds or U.S. gallons
(4) Design pressure in pounds per square inch
(5) The wording "This container shall not contain a product that has a vapor pressure in excess of ___ psig at 100°F" *(See Table 2.2.2.2.)*
(6) Outside surface area in square feet
(7) Year of manufacture
(8) Shell thickness and head thickness
(9) OL (overall length), OD (outside diameter), HD (head design)
(10) Manufacturer's serial number
(11) ASME Code symbol

2.2.6.4 A warning label shall be applied to all cylinders of 100 lb (45.4 kg) LP-Gas capacity or less and not filled on site. The label shall include information on the potential hazards of LP-Gas.

2.2.6.5 Effective January 1, 1996, all ASME containers that contain unodorized LP-Gas products shall be marked NOT ODORIZED in letters 4 in. (10 cm) in height with a contrasting background surrounded by a $^1/_2$-in. (1.3-cm) rectangular border. The markings shall be located on either both sides or both ends of the container.

2.3 Container Appurtenances.

2.3.1 General.

2.3.1.1 This section includes fabrication and performance provisions for container appurtenances, such as pressure relief devices, container shutoff valves, backflow check valves, internal valves, excess-flow check valves, plugs, liquid level gauges, and pressure gauges connected directly into the container openings described in 2.2.3. Shop installation of such appurtenances in containers listed as container assemblies or container systems in accordance with Section 1.2 is a responsibility of the fabricator under the listing. Field installation of such appurtenances is covered in Chapters 3 and 8.

2.3.1.2 Container appurtenances shall be fabricated of materials that are suitable for LP-Gas service and shall be resistant to the action of LP-Gas under service conditions. The following shall also apply:

(a) Pressure-containing metal parts of appurtenances, such as those listed in 2.3.1.1, except fusible elements, shall have a minimum melting point of 1500°F (816°C) such as steel, ductile (nodular) iron, malleable iron, or brass. Ductile iron shall meet the requirements of ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or equivalent and malleable iron shall meet the requirements of ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings*, or equivalent.

Exception: Approved or listed variable liquid level gauges used in containers of 3500-gal (13.2-m^3) water capacity or less are exempt from this provision.

(b) Cast iron shall not be used.

(c) Nonmetallic materials shall not be used for bonnets or bodies of valves or regulators.

2.3.1.3 Container appurtenances shall have a rated working pressure of at least 250 psig (1.7 MPag).

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

Exception: Aluminum O-rings and spiral wound metal gaskets shall be permitted. Gaskets for use with approved or listed liquid level gauges for installation on a container of 3500-gal (13.2-m^3) water capacity or less shall be exempted from this provision.

2.3.1.5 Cylinders with 4-lb (1.8-kg) through 40-lb (18-kg) propane capacity for vapor service shall comply with the following:

(a)*Cylinders fabricated after September 30, 1998, shall be equipped or fitted with a listed overfilling prevention device and a fixed maximum liquid level gauge. These devices shall be part of the container assembly. The length of the fixed maximum liquid level gauge dip tube shall be in accordance with 4.4.3.3(a).

(b) Cylinders requalified after September 30, 1998, shall be equipped with a listed overfilling prevention device and a fixed maximum liquid level gauge prior to being filled.

(c) Effective April 1, 2002, no cylinder shall be filled unless it is equipped with an overfilling prevention device and a fixed maximum liquid level gauge. The length of the fixed maximum liquid level gauge dip tube shall be in accordance with 4.4.3.3(a).

(d) Cylinders required to have an overfilling prevention device installed shall be equipped with either a CGA connection number 791 or a CGA connection number 810 as described in CGA Publication V-1.

Exception No. 1: All cylinders used in industrial truck service, including forklift truck cylinders and cylinders identified and used for industrial welding and cutting gases.

Exception No. 2: Cylinders manufactured prior to October 1, 1998, and designed for use in the horizontal orientation for which an overfilling prevention device is not available. Such cylinders shall have a label to indicate that they are not equipped with an overfilling prevention device.

2.3.1.6 Container appurtenances shall be maintained in operating condition.

2.3.2 Pressure Relief Devices. See 2.4.7 for hydrostatic relief valves.

2.3.2.1 ASME containers shall be equipped with one or more pressure relief valves that are designed to relieve vapor.

2.3.2.2 Cylinders shall be equipped with pressure relief valves as required by DOT regulations.

(a) If a spring-loaded pressure relief valve(s) is the only relief device, the valve shall comply with the flow capacity requirements of CGA S-1.1, *Pressure Relief Device Standards, Part 1 — Cylinders for Compressed Gases*, with the start-to-discharge pressure not less than 75 percent or more than 100 percent of the minimum required test pressure of the cylinder.

(b) DOT nonrefillable metal containers shall be equipped with a pressure relief device(s) or system(s) that will prevent failure or propulsion of the container when the container is exposed to fire.

2.3.2.3 ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with applicable requirements of UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, or other equivalent pressure relief valve standards. The start-to-leak setting of such pressure relief valves, with relation to the design pressure of the container, shall be in accordance with Table 2.3.2.3.

Exception: On containers of 40,000-gal (151-m³) water capacity or more, a pilot-operated pressure relief valve in which the relief device is combined with and is controlled by a self-actuated, direct, spring-loaded pilot valve shall be permitted to be used provided it complies with Table 2.3.2.3, is approved, is inspected and maintained by persons with appropriate training and experience, and is tested for proper operation at intervals not exceeding 5 years.

Table 2.3.2.3 Start-to-Leak Pressure Settings of Pressure Relief Valves in Relation to Container Design Pressure

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

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

2.3.2.4 Pressure relief valves for ASME containers shall also comply with the following:

(a) The minimum rate of discharge of pressure relief valves shall be in accordance with Table 2.3.2.4(a) or shall be calculated using the formula

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

where:

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

(b) Relief valves for aboveground containers shall relieve at not less than the flow rate specified in 2.3.2.4(a) before the pressure exceeds 120 percent of the minimum permitted start-to-leak pressure setting of the device. This does not include the 10 percent tolerance in Table 2.3.2.3.

(c) The flow capacity of pressure relief valves installed on underground or mounded containers shall be permitted to be reduced to 30 percent of the flow specified in Table 2.3.2.4(a).

(d) Each pressure relief valve shall be plainly and permanently marked with the following:

(1) The pressure in psig at which the valve is set to start-to-leak

(2) Rated relieving capacity in cubic feet per minute of air at 60°F (16°C) and 14.7 psia (101 kPa)

(3) The manufacturer's name and catalog number

Table 2.3.2.4(a) Pressure Relief Valve Flow Capacity as a Function of Container Surface Area

Surface Area, ft²	Flow Rate, ft³/min air	Surface Area, ft²	Flow Rate, ft³/min air	Surface Area, ft²	Flow Rate, ft³/min air
≤20	626	170	3620	600	10,170
25	751	175	3700	650	10,860
30	872	180	3790	700	11,550
35	990	185	3880	750	12,220
40	1100	190	3960	800	12,880
45	1220	195	4050	850	13,540
50	1330	200	4130	900	14,190
55	1430	210	4300	950	14,830
60	1540	220	4470	1000	15,470
65	1640	230	4630	1050	16,100
70	1750	240	4800	1100	16,720
75	1850	250	4960	1150	17,350
80	1950	260	5130	1200	17,960
85	2050	270	5290	1250	18,570
90	2150	280	5450	1300	19,180
95	2240	290	5610	1350	19,780
100	2340	300	5760	1400	20,380
105	2440	310	5920	1450	20,980
110	2530	320	6080	1500	21,570
115	2630	330	6230	1550	22,160
120	2720	340	6390	1600	22,740
125	2810	350	6540	1650	23,320
130	2900	360	6690	1700	23,900
135	2990	370	6840	1750	24,470
140	3080	380	7000	1800	25,050
145	3170	390	7150	1850	25,620
150	3260	400	7300	1900	26,180
155	3350	450	8040	1950	26,750
160	3440	500	8760	2000	27,310
165	3530	550	9470	—	—

(e) A shutoff valve shall not be located between a pressure relief device and the container.

Exception No. 1: An LPG container equipped with a listed multiple port relief valve unit.

Exception No. 2: Relief valves in accordance with the exceptions to 3.2.11.9.

(f) Pressure relief valves shall be designed to minimize the possibility of tampering. Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment.

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

(1) Have a yield point between 208°F and 220°F (98°C and 104°C)
(2) Have a total discharge area not exceeding 0.25 $in.^2$ (1.6 cm^2)
(3) Communicate directly with the vapor space of the container

2.3.2.5 All cylinders used in industrial truck service (including forklift truck cylinders) shall have the cylinder's pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the cylinders and every 10 years thereafter.

2.3.3 Container Connections and Appurtenances.

2.3.3.1 Pressure relief devices, container shutoff valves, backflow check valves, internal valves, excess-flow check valves, plugs, liquid level gauges, and overfilling prevention devices that are used individually or in suitable combinations shall comply with 2.3.1.2, 2.3.1.3, and 2.3.1.5, and with 2.3.3.2 and 2.3.3.3.

2.3.3.2 Container appurtenances shall be required as follows:

(a) Containers of 4000 gal (15.2 m^3) water capacity or less, shall comply with Table 2.3.3.2(a). Containers of 4000 gal water capacity or less and used in bulk plant or industrial plant service shall comply with 3.3.3.6.

(1) The requirement for internal spring-type pressure relief valves that are shown in Table 2.3.3.2(a) for stationary ASME containers up to and including 4000 gal (15.2 m^3) water capacity shall not apply to underground containers where external pressure relief valves are permitted or to containers that were originally equipped with external pressure relief valves.
(2) Containers of 125 gal through 4000 gal (0.5 m^3 through 15.2 m^3) water capacity shall be provided with an actuated liquid withdrawal excess-flow valve with a connection not smaller than $^3/_4$-in. national pipe thread. This valve shall not be connected for continuous service unless the valve is recommended by the manufacturer for such service.

Exception: An actuated liquid withdrawal excess-flow valve shall not be required on containers equipped for liquid withdrawal with both a liquid outlet shutoff valve and an excess-flow valve.

(3) An overfilling prevention device shall not be required for engine fuel cylinders used on industrial (and forklift) trucks powered by LP-Gas or for engine fuel cylinders used on vehicles having LP-Gas-powered engines mounted on them (including floor maintenance machines.
(4) Excess-flow protection shall not be required for manual shutoff valves for vapor service where an approved regulator is directly attached or attached with a flexible connector to the outlet of the manual shutoff valve for vapor service and the controlling orifice between the container contents and the shutoff valve outlet does not exceed $^5/_{16}$ in. (8 mm) in diameter.
(5) Overfilling prevention devices shall be required on cylinders having 4 lb through 40 lb (1.8 kg through 18 kg) propane capacity for vapor service. *(See 2.3.1.5.)*

(b) Containers over 4000 gal (15.2 m^3) water capacity shall be equipped as follows:

(1) For vapor withdrawal openings, either of the following:
   a. A positive shutoff valve that is located as close to the container as practical in combination with an excess-flow valve installed in the container
   b. An internal valve with an integral excess-flow valve or excess-flow protection
(2) For liquid withdrawal openings, any of the following:
   a. An internal valve equipped for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is located within 5 ft (1.5 m) of the internal valve
   b. Internal valves installed in containers equipped for remote closure and automatic shutoff using thermal (fire) actuation as described in 2.3.3.2(b)(2)(a) by July 1, 2003
   c. Containers equipped with a positive shutoff valve that is located as close to the container as is practical in combination with an excess flow valve and retrofitted by July 1, 2011, with one of the following:
      1. An internal valve equipped for remote closure and automatic shutoff using thermal (fire) actuation
      2. An emergency shutoff valve equipped for remote closure and automatic shutoff using thermal (fire) actuation installed in the line downstream as close as practical to the existing positive shutoff valve
(3) For vapor inlet openings, either of the following:
   a. A positive shutoff valve that is located as close to the container as practical in combination with either a backflow check valve or excess-flow valve installed in the container
   b. An internal valve with an integral excess-flow valve or excess flow protection
(4) For liquid inlet openings, any of the following:
   a. An internal valve equipped for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is located within 5 ft (1.5 m) of the internal valve
   b. A positive shutoff valve that is located as close to the container as practical in combination with a backflow check valve installed in the container that is designed for the intended application
   c. Internal valves shall be equipped for remote closure and automatic shutoff using thermal (fire) actuation as described in 2.3.3.2(b)(4)(a) by July 1, 2003
   d. Containers equipped with a positive shutoff valve that is located as close to the container as is practical in combination with an excess flow valve and retrofitted by July 1, 2011, with one of the following:
      1. An internal valve equipped for remote closure and automatic shutoff using thermal (fire) actuation
      2. An emergency shutoff valve equipped for remote closure and automatic shutoff using thermal (fire) actuation, installed in the line upstream and as close as practical to the existing positive shutoff valve
      3. A positive shutoff valve that is located as close to the container as practical in combination with a backflow check valve, designed for the intended application and installed in the container
      4. A backflow check valve designed for the intended application and installed in the line upstream as close as practical to the existing positive shutoff valve

e. The container shall also be equipped with the following appurtenances:

1. An internal spring-type, flush-type full internal, or external pressure relief valve *(see Appendix E)*
2. A fixed maximum liquid level gauge
3. A float gauge, rotary gauge, slip tube gauge, or a combination of these gauges
4. A pressure gauge
5. A temperature gauge

2.3.3.3 The appurtenances specified in Table 2.3.3.2(a) and paragraph 2.3.3.2(b) shall comply with the following:

(a) Manual shutoff valves shall be designed to provide positive closure under service conditions.

(b) Excess-flow check valves shall be designed to close automatically at the rated flows of vapor or liquid specified by the manufacturer. Excess-flow valves shall be designed with a bypass that shall not exceed a No. 60 drill size opening to allow equalization of pressure.

Exception: Excess-flow valves of less than $^1/_2$ in. (1.3 cm) NPT shall have a bypass that limits propane vapor flow to 10 scf/hr at 100 psig (690 kPag).

(c) Backflow check valves shall be of the spring-loaded or weight-loaded type with in-line or swing operation. They shall close when the flow is either stopped or reversed.

(d) Internal valves *(see 1.7.71.4, Internal Valve),* either manually or remotely operated and designed to remain closed except during operating periods, shall be considered positive shutoff valves.

2.3.4 Liquid Level Gauging Devices.

2.3.4.1 Liquid level gauging devices shall be installed on all containers filled by volume. They shall be either fixed maximum liquid level gauges or variable gauges of the slip tube, rotary tube, or float types (or combinations of such gauges).

2.3.4.2 Every container constructed after December 31, 1965, and designed to be filled on a volumetric basis shall be equipped with a fixed maximum liquid level gauge(s) to indicate the maximum filling level(s) for the service(s) in which the container is to be used *(see 4.4.3.3)*. This shall be permitted to be accomplished either by using a dip tube of appropriate length or by the position of the gauging device in the container. The following shall also apply to fixed maximum liquid level gauges:

(a) ASME containers shall have permanently attached to the container adjacent to the fixed maximum liquid level gauge, or on the container nameplate, markings showing the percentage of capacity that is indicated by that gauge.

(b) Cylinders shall have the letters DT stamped on them followed by the vertical distance (to the nearest tenth inch) measured from the top of the boss or coupling into which the gauge, or the cylinder valve of which it is a part, is installed to the end of the dip tube.

(c) Cylinders equipped with a fixed maximum liquid level gauge for which the tube is not welded in place shall be permanently marked adjacent to such a gauge as follows:

(1) Cylinders designed to be filled in one position shall be marked with the letters DT followed by the vertical distance (to the nearest tenth inch) measured from the top center of the cylinder boss or coupling into which the gauge is installed to the maximum permitted filling level.

(2) Universal-type cylinders shall be marked as follows:

a. *Vertical Filling*: With the letters VDT followed by the vertical distance (to the nearest tenth inch) measured from the top center of the cylinder boss or coupling into which the gauge is installed to the maximum permitted filling level.

b. *Horizontal Filling*: With the letters HDT followed by the vertical distance (to the nearest tenth inch) measured from the top centerline of the cylinder boss or coupling opening into which the gauge is installed to the inside top of the cylinder when the cylinder is in the horizontal position.

(d) Cargo tanks having multiple fixed level gauges shall have the loading percentage (to the nearest $^2/_{10}$ percent) stamped adjacent to each gauge.

2.3.4.3 Variable liquid level gauges shall comply with the following:

(a) Variable liquid level gauges installed on containers over 2000-gal (7.6-m^3) water capacity shall be so marked that the maximum liquid level, in inches, metric units, or percent of capacity of the container in which they are to be installed, is readily determinable. These markings shall indicate the maximum liquid level for propane, for 50/50 butane–propane mixtures, and for butane at liquid temperatures from 20°F to 130°F (–6.7°C to 54.4°C) and in increments not greater than 20°F (11°C).

(b) The markings indicating the various liquid levels from empty to full shall be directly on the system nameplate, on the gauging device, or on both.

(c) Dials of magnetic float or rotary gauges shall indicate whether they are for cylindrical or spherical containers and whether for aboveground or underground service.

(d) The dials of gauges for use only on aboveground containers of over 1200 gal (4.5 m^3) water capacity shall be so marked.

2.3.4.4 Variable liquid level gauges shall comply with the provisions of 4.4.3.3(b) if they are used for filling containers.

2.3.4.5 Gauging devices requiring bleeding of product to the atmosphere, such as fixed liquid level, rotary tube, and slip tube gauges, shall be designed so that the bleed valve maximum opening to the atmosphere is not larger than a No. 54 drill size.

2.3.5 Pressure Gauges.

2.3.5.1 Pressure gauges shall comply with 2.3.1.2 and 2.3.1.3.

2.3.5.2 Pressure gauges shall be attached directly to the container opening or to a valve or fitting that is directly attached to the container opening. If the cross sectional area of the opening into the container is greater than that of a No. 54 drill size, an excess-flow check valve shall be provided.

Table 2.3.3.2(a) Container Connection and Appurtenance Requirements for Containers Used on Domestic, Commercial, Industrial, Engine Fuel, and Over-the-Road Mobile Applications

Part	Appurtenances	1 Cylinders, 2-lb to 100-lb (0.9-kg to 45.4-kg) Propane Capacity for Vapor Service	2 Cylinders, 2-lb to 100-lb (0.9-kg to 45.4-kg) Propane Capacity for Liquid Service	3 Cylinders, 2-lb to 100-lb (0.9-kg to 45.4-kg) Propane Capacity for Liquid and Vapor Service	4 Cylinders, 100-lb to 420-lb (45.4-kg to 190-kg) Propane Capacity Filled on Site	5 Stationary ASME Containers Through 4000-gal (15.2-m^3) Water Capacity	6 DOT and ASME Engine Fuel or Mobile Containers
A	Manual shutoff valve with an integral external pressure relief valve	R 2.3.1.5(d) 2.3.3.2(a)5					
B	Manual shutoff valve (CGA 555 outlet) with integral external pressure relief valve and excess-flow valve attached to the internal liquid line inside the cylinder		R√ 2.3.2.2				
C	Manual shutoff valve (CGA 555 outlet) with excess-flow valve for liquid service attached to the internal liquid line inside the cylinder; manual shutoff valve (CGA 510 outlet) with integral external pressure relief valve for vapor service			R√ 2.3.2.2			
D	Double backflow check filler valve		O√		R√	R√	O-DOT R-ASME
E	Manual shutoff valve for vapor service *[see 2.3.3.2(a)(4) and 3.4.2.1(f)]*				R√	R√	
F	Fixed maximum liquid level gauge	R√	O√	O√	R√	R√	R
G	External pressure relief valve *(see 2.3.2)*				R√		
H	Internal spring-type pressure relief valve *(see 2.3.2)*					R 2.3.3.2(a)(1)	
I	Float gauge	O√	O√	O√	O	R√	O
J	Backflow check and excess-flow vapor return valve					O√	
K	Actuated liquid withdrawal excess-flow valve *[see 2.3.3.2(a)(2)]*					R	
L	Manual shutoff liquid or vapor valve with internal excess-flow check valve						R
M	Full internal or flush-type full internal pressure relief valve						R
N	Overfilling prevention device	R√ (4 to 40 lb only) 2.3.3.2(a)(5)					R 2.3.3.2(a)(3)

R = Required as a separate appurtenance
O = Optional
R√= Required as a separate appurtenance or as part of a multipurpose valve
O√= Optional as a separate appurtenance or as part of a multipurpose valve

2.3.6 Other Container Connections. Container openings shall be equipped with one of the following:

(1) A positive shutoff valve in combination with either an excess-flow check valve or a backflow check valve, plugged
(2) An internal valve, plugged
(3) A backflow check valve, plugged
(4) An actuated liquid withdrawal excess-flow valve, normally closed and plugged, with provision to allow for external actuation
(5) A plug, blind flange, or plugged companion flange

Exception No. 1: Pressure relief valves in accordance with 2.3.2.

Exception No. 2: Connections for flow controls in accordance with 2.3.3.

Exception No. 3: Liquid level gauging devices in accordance with 2.3.4.

Exception No. 4: Pressure gauges in accordance with 2.3.5.

2.3.7 Container Appurtenance Protection. Container appurtenances other than pressure relief devices shall be installed and protected as follows:

2.3.7.1 All container openings except those used for pressure relief devices, liquid level gauging devices, pressure gauges, those equipped with double check filler valves and backflow check and excess-flow vapor return valves, and plugged openings shall be equipped with internal valves or with positive shutoff valves and either excess-flow or backflow check valves as follows:

(a) ASME containers shall have excess-flow or backflow check valves located between the LP-Gas in the container and the shutoff valves, either inside the container or at a point immediately outside where the line enters or leaves the container. If outside, installation shall be made so that any strain beyond the excess-flow or backflow check valve will not cause breakage between the container and the valve. All connections that are listed in the ASME Manufacturers' Data Report for the container shall be considered part of the container.

(b) If an excess-flow valve is required for cylinders other than for mobile or engine fuel service, it shall be permitted to be located at the outlet of the cylinder shutoff valve.

(c) Shutoff valves shall be located as close to the container as practical. The valves shall be readily accessible for operation and maintenance under normal and emergency conditions. Valves either shall be located in a readily accessible position less than 6 ft (1.8 m) above ground level or shall have extension handles, stairs, ladders, or platforms, or shall be equipped for remote operation.

(d) The connections, or line, leading to or from any individual opening shall have greater flow capacity than the rated flow of the excess-flow valve protecting the opening.

2.3.7.2 Valves, regulators, gauges, and other container appurtenances shall be protected against physical damage.

2.3.7.3 Valves that are part of the assembly of portable multicontainer systems shall be arranged so that replacement of containers can be made without shutting off the flow of gas in the system. This provision shall not be construed as requiring an automatic changeover device.

2.3.7.4 Connections to ASME containers installed underground shall be located within a substantial dome, housing, or manhole and shall have a cover. Underground containers shall be installed so that all connections for hose and any opening through which there can be a flow from pressure relief devices or pressure regulator vents are located above the normal maximum water table. Such manholes or housings shall be ventilated. The area of ventilation openings shall equal or exceed the combined discharge areas of the pressure relief devices and other vent lines that discharge into the manhole or housing.

2.3.7.5 Container inlet and outlet connections on ASME containers of more than 2000-gal (7.6-m^3) water capacity shall be labeled to designate whether they communicate with the vapor or liquid space. Labels shall be permitted to be on valves.

Exception: Connections for pressure relief devices, liquid level gauging devices, and pressure gauges shall not be required to be labeled.

2.3.7.6 Every ASME storage container of more than 2000-gal (7.6-m^3) water capacity shall be provided with a pressure gauge.

2.4 Piping (Including Hose), Fittings, and Valves.

2.4.1 General.

2.4.1.1 Material specifications for pipe, tubing, pipe and tubing fittings, valves (including hydrostatic relief valves), hose, hose connections, and flexible connectors shall be in accordance with this section.

2.4.1.2 Piping, pipe and tubing fittings, and valves used to supply utilization equipment within the scope of NFPA 54, *National Fuel Gas Code*, shall comply with that code.

2.4.1.3 Pipe and tubing shall comply with one of the following requirements:

(1) Pipe and tubing shall comply with 2.4.2 and 2.4.3.
(2) Pipe and tubing shall be recommended for that service by the manufacturer and shall be approved.

2.4.1.4 Piping that can contain liquid LP-Gas and that can be isolated by valving and that requires hydrostatic relief valves, as specified under 3.2.21, shall have a minimum design pressure of 350 psig (2.4 MPag) or a design pressure that is equivalent to the maximum discharge pressure of any pump or other source feeding the piping system if it is greater than 350 psig (2.4 MPag).

2.4.2 Pipe. Pipe shall be wrought iron or steel (black or galvanized), brass, copper, or polyethylene and shall comply with the following:

(1) Wrought-iron pipe — ASME B 36.10M, *Welded and Seamless Wrought Steel Pipe*
(2) Steel pipe — ASTM A 53, *Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
(3) Steel pipe — ASTM A 106, *Specification for Seamless Carbon Steel Pipe for High-Temperature Service*
(4) Brass pipe — ASTM B 43, *Specification for Seamless Red Brass Pipe, Standard Sizes*
(5) Copper pipe — ASTM B 42, *Specification for Seamless Copper Pipe, Standard Sizes*
(6) Polyethylene pipe — ASTM D 2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings,* and shall be recommended by the manufacturer for use with LP-Gas.

2.4.3 Tubing. Tubing shall be steel, brass, copper, or polyethylene *(see 3.2.16)* and shall comply with the following:

(1) Steel tubing — ASTM A 539, *Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines*
(2) Brass tubing *[see 3.2.13(c), Exception No. 3]* — ASTM B 135, *Specification for Seamless Brass Tube*
(3) Copper tubing *[see 3.2.13(c), Exception No. 3]*
    a. Type K or L — ASTM B 88, *Specification for Seamless Copper Water Tube*
    b. ASTM B 280, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*

(4) Polyethylene tubing — ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fitting*, and shall be recommended by the manufacturer for use with LP-Gas.

(5) Corrugated stainless steel tubing — ANSI/AGA LC1, *Interior Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*.

2.4.4 Fittings for Pipe and Tubing. Fittings shall be steel, brass, copper, malleable iron, ductile (nodular) iron, or polyethylene.

2.4.4.1 Pipe fitting shall have a minimum pressure rating as specified in Table 2.4.4.1 and shall comply with the following:

(a) Cast-iron pipe fittings shall not be used.

(b) Thermoplastic fittings fabricated from materials listed in ASTM D 2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, shall comply with ASTM D 2513, and shall be recommended for LP-Gas use by the manufacturer.

(c) Brazing filler material shall have a melting point that exceeds 1000°F (538°C).

Table 2.4.4.1 Minimum Pressure Rating of Pipe, Tubing Fittings, and Valves

Service	Minimum Working Pressure
Higher than container pressure	350 psig (2.4 MPag), or the design pressure, whichever is higher, or 400 psig (2.8 MPag) WOG rating
LP-Gas liquid, or vapor at operating pressure over 125 psig and at or below container pressure	250 psig (1.7 MPag)
LP-Gas vapor at operating pressure of 125 psig (0.9 MPag) or less	125 psig (0.9 MPag)

2.4.4.2 Metal tube fitting shall have a minimum pressure rating as specified in Table 2.4.4.1.

2.4.4.3* Joints in polyethylene pipe and polyethylene tubing shall be made by heat fusion, by compression-type mechanical fittings, or by factory-assembled transition fittings and shall comply with the following:

(a) Polyethylene pipe shall not be joined by a threaded or miter joint.

(b) Polyethylene fusion fittings shall conform to ASTM D 2683, *Standard Specification for Socket-type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe*, or ASTM D 3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*, or ASTM F 1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing*, and shall be recommended by the manufacturer for use with LP-Gas. Installation instructions specific to the type and grade of polyethylene being joined shall be provided with heat fusion fittings.

(c)*Mechanical fittings shall comply with Category 1 of ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and the following:

(1) Mechanical joints shall be tested and recommended by the manufacturer for use with polyethylene pipe and tubing.

(2) Compression-type mechanical fittings shall include a rigid internal tubular stiffener, other than a split tubular stiffener, to support the pipe. Gasket material in the fitting shall be resistant to the action of LP-Gas and shall be compatible with the polyethylene pipe material.

(3) Compression-type mechanical fittings shall not be used on any polyethylene pipe above 2 in. IPS size.

(d) Anodeless risers shall comply with the following:

(1) The metal gas carrying portion of the anodeless riser after the transition shall have a wall thickness equal to Schedule 40 pipe.

(2) Factory-assembled anodeless risers shall be recommended for LP-Gas use and shall be leak tested by the manufacturer in accordance with written procedures.

(3) Field-assembled anodeless risers with service head adapters shall be equipped with moisture seals and shall be recommended for LP-Gas use by the manufacturer and shall be design certified to meet the requirements of Category 1 of ASTM D 2513, and U.S. Department of Transportation, *Code of Federal Regulations*, Title 49, 192.281(e) "Transportation," and the requirements of 3.2.16.1 through 3.2.16.8. The manufacturer shall provide the user qualified installation instructions as prescribed by U.S. Department of Transportation, *Code of Federal Regulations*, Title 49, Part 192.283(b).

2.4.5 Valves Other Than Container Valves.

2.4.5.1 Pressure-containing metal parts of valves shall be of steel, ductile (nodular) iron, malleable iron, or brass.

(1) Ductile iron shall meet the requirements of ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Related Castings for Use at Elevated Temperatures*, or equivalent.

(2) Malleable iron shall meet the requirements of ASTM A 47, *Specification for Ferritic Malleable Iron Castings*, or equivalent.

(3) All materials used, including valve seat discs, packing, seals, and diaphragms, shall be resistant to the action of LP-Gas under service conditions.

2.4.5.2 Valves shall have a minimum pressure rating as specified in Table 2.4.4.1.

2.4.5.3 Manual shutoff valves, emergency shutoff valves, excess-flow check valves, and backflow check valves used in piping systems shall comply with the provisions for container valves. *[See 2.3.3.3(a), (b), (c) and (d).]*

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

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

(2) Manual shutoff from a remote location.

(3) Manual shutoff at the installed location.

2.4.5.5 Valves in polyethylene piping systems shall be manufactured from thermoplastic materials fabricated from materials listed in ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, that have been shown to be resistant to the action of LP-Gas and comply with ASTM D 2513, or from metals protected to minimize corrosion in accordance with 3.2.24. Valves shall be recommended for LP-Gas service by the manufacturer.

2.4.6 Hose, Quick Connectors, Hose Connections, and Flexible Connectors.

2.4.6.1 Hose, hose connections, and flexible connectors *(see 1.7.26, Flexible Connector)* shall be fabricated of materials that are resistant to the action of LP-Gas both as liquid and vapor. If wire braid is used for reinforcement, it shall be of corrosion-resistant material such as stainless steel.

2.4.6.2 Hose and quick connectors shall be approved.

2.4.6.3 Hose, hose connections, and flexible connectors used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psig (34 kPag), and as provided in Section 3.4 regardless of the pressure, shall comply with the following:

Exception: Hoses at a pressure of 5 psig (34 kPag) or less used in agricultural buildings not normally occupied by the public.

(a) Hose shall be designed for a working pressure of 350 psig (2.4 MPag) with a safety factor of 5 to 1 and shall be continuously marked with LP-GAS, PROPANE, 350 PSI WORKING PRESSURE, and with the manufacturer's name or trademark.

Exception: Hoses at a pressure of 5 psig (34 kPag) or less in agricultural buildings not normally occupied by the public shall be designed for the working pressure of the system and shall be constructed of material resistant to the action of LP-Gas.

(b) Hose assemblies, after the application of connections, shall have a design capability of not less than 700 psig (4.8 MPag). If a test is performed, such assemblies shall be leak tested at 120 percent of the pressures between the operating pressure and the maximum working pressure [350 psig (24 MPag) minimum] of the hose.

Exception: Hose at a pressure of 5 psig (34 kPag) or less used in agricultural buildings not normally occupied by the public.

2.4.6.4 Hoses or flexible connectors used to supply LP-Gas to utilization equipment or appliances shall be installed in accordance with the provisions of 3.2.17 and 3.2.20.

2.4.7 Hydrostatic Relief Valves. Hydrostatic relief valves designed to relieve the hydrostatic pressure that might develop in sections of liquid piping between closed shutoff valves shall have pressure settings not less than 400 psig (2.8 MPag) or more than 500 psig (3.5 MPag) unless installed in systems designed to operate above 350 psig (2.4 MPag). Hydrostatic relief valves for use in systems designed to operate above 350 psig (2.4 MPag) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

2.4.8* Pipe for Regulator Venting. Pipe used to vent regulators shall meet the requirements of 2.4.2, 2.4.3 or shall meet the requirements of UL 651, *Schedule 40 and 80 Rigid PVC Conduit*, for aboveground service. Other PVC piping materials shall not be permitted.

2.5 Equipment.

2.5.1 General.

2.5.1.1 This section shall apply to pressure-containing metal parts of LP-Gas equipment including the following:

(1) Pumps
(2) Compressors
(3) Vaporizers
(4) Strainers
(5) Meters
(6) Sight flow glasses
(7) Regulators

2.5.1.2 The design pressure of equipment shall be in accordance with Table 2.5.1.2.

Table 2.5.1.2 Equipment Design Pressure

Fluid	Pressure	Equipment Design Pressure
LP-Gas vapor	≤20 psig (≤138 kPag)	Maximum anticipated pressure
	20–125 psig (138 kPag–0.9 MPag)	125 psig (0.9 MPag)
	> 125 psig (>0.9 MPag)	250 psig (1.7 MPag) or the anticipated pressure, whichever is higher
LP-Gas liquid	≤250 psig (≤1.7 MPag)	250 psig (1.7 MPag)
	> 250 psig (>1.7 MPag)	350 psig (2.4 MPag) or the anticipated pressure, whichever is higher

2.5.1.3 Equipment shall be fabricated of materials resistant to deterioration by LP-Gas under service conditions. The following shall also apply:

(a) Pressure-containing metal parts shall be of the following:

(1) Steel
(2) Ductile (nodular) iron (ASTM A 395, *Standard Specification for Ferretic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or ASTM A 536, *Standard Specification for Ductile Iron Castings*, Grade 60-40-18 or 65-45-12)
(3) Malleable iron (ASTM A 47, *Standard Specification for Ferretic Malleable Iron Castings*)
(4) Higher strength gray iron (ASTM A 48, *Standard Specification for Gray Iron Castings*, Class 40B)
(5) Brass
(6) Materials equivalent to 2.5.1.3(1) through 2.5.1.3(5) in melting point, corrosion resistance, toughness and strength

(b) Cast iron shall not be used as a material of construction for strainers or flow indicators.

(c) Aluminum shall be permitted to be used for approved meters.

(d) Aluminum or zinc shall be permitted to be used for approved regulators. Zinc used for regulators shall comply with ASTM B 86, *Standard Specification for Zinc-Alloy Die Casting*.

(e) Nonmetallic materials shall not be used for upper or lower casings of regulators.

2.5.2 Engines. Engines used to drive portable pumps and compressors shall be equipped with exhaust system spark arresters and shielded ignition systems.

2.5.3 Pumps. Pumps shall be designed for LP-Gas service.

2.5.4 Compressors.

2.5.4.1 Compressors shall be designed for LP-Gas service.

2.5.4.2 Compressors shall be constructed or shall be equipped with auxiliary devices to limit the suction pressure to the maximum for which the compressor is designed.

2.5.4.3 Compressors shall be constructed or shall be equipped with auxiliary devices to prevent the entrance of LP-Gas liquid into the compressor suction.

Exception: Portable compressors used with temporary connections shall not require means to prevent liquid entrance into the compressor suction.

2.5.5 Vaporizers, Tank Heaters, Vaporizing Burners, and Gas–Air Mixers.

2.5.5.1 Indirect vaporizers shall comply with the following.

(a) Indirect vaporizers shall be constructed in accordance with the applicable provision of the ASME Code for a design pressure of 250 psig (1.7 MPag) and shall be permanently and legibly marked with the following:

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

Exception: Indirect vaporizers that have an inside diameter of 6 in. (152 mm) or less are exempt from the ASME Code and shall not be required to be marked. They shall be constructed for a minimum design pressure of 250 psig (1.7 MPag).

(b) Indirect vaporizers shall be provided with an automatic means to prevent the passage of liquid through the vaporizer to the vapor discharge piping.

(c) Indirect vaporizers, including atmospheric-type vaporizers using heat from the surrounding air or the ground, and of more than 1-qt (0.9-L) capacity shall be equipped with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 2.5.5.4. Fusible plug devices shall not be used.

(d) Indirect atmospheric-type vaporizers of less than 1-qt (0.9-L) capacity shall not be required to be equipped with pressure relief valves but shall be installed in accordance with 3.6.2.7.

2.5.5.2 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 the vaporizer shall be permanently and legibly marked with the following:

(1) The markings required by the ASME Code
(2) The maximum vaporizing capacity in gallons per hour
(3) The rated heat input in British thermal units per hour (Btu/hr)
(4) The name or symbol of the manufacturer

(b) Direct-fired vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 2.5.5.4. 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 automatic means to prevent the passage of liquid 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 2000 Btu/hr (2 MJ/h), the safety device shall also shut off the flow of gas to the pilot.

(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 specified in the first column of Table 2.2.2.2 that corresponds with the design pressure of the container (or its ASME Code equivalent). *(See notes to Table 2.2.2.2.)*

2.5.5.3 Waterbath vaporizers shall comply with the following.

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

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

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

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

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

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

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

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

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

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

(i) The heat source shall be shut off if the level of the heat transfer medium falls below the top of the heat exchanger.

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

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

(b) If the vaporizer is direct fired or if a substantial exterior surface is in contact with the LP-Gas, the sum of the vaporizer surface and the LP-Gas wetted exterior surface shall be used in conjunction with Table 2.3.2.4(a) to determine the required relief valve capacity.

2.5.5.5 Direct gas-fired tank heaters shall be designed exclusively for outdoor aboveground use and so that there is no

direct flame impingement upon the container and shall comply with the following:

(a) Tank heaters shall be approved and shall be permanently and legibly marked with the following:

(1) The rated input to the burner in British thermal units per hour
(2) The maximum vaporizing capacity in gallons per hour
(3) The name or symbol of the manufacturer

(b) The heater shall be designed so that it can be removed for inspection of the entire container.

(c) The fuel gas supply connection to the tank heater shall originate in the vapor space of the container being heated and shall be provided with a manually operated shutoff valve at the heater.

(d) The heater control system shall be equipped with an automatic safety shutoff valve of the manual-reset type arranged to shut off the flow of gas to both the main and pilot burners if the pilot flame is extinguished.

(e) Where installed on a container exceeding 1000-gal (3.8-m^3) water capacity, the heater control system shall include a valve to automatically shut off the flow of gas to both the main and pilot burners if the container becomes empty of liquid.

(f) Direct gas-fired tank heaters shall be equipped with a limit control to prevent the heater from raising the pressure in the storage container to more than 75 percent of the pressure shown in the first column of Table 2.2.2.2 that corresponds with the design pressure of the container (or its ASME *Boiler and Pressure Vessel Code* equivalent).

2.5.5.6 Vaporizing burners shall be constructed with a minimum design pressure of 250 psig (1.7 MPag) with a safety factor of 5 to 1 and shall comply with the following.

(a) The vaporizing burner or the appliance in which it is installed shall be permanently and legibly marked with the following.

(1) The maximum burner input in British thermal units per hour
(2) The name or symbol of the manufacturer

(b) Vaporizing coils or jackets shall be made of ferrous metals or high-temperature alloys.

(c) The vaporizing section shall be protected by a relief valve, located where it will not be subject to temperatures in excess of 140°F (60°C), and with a pressure setting sufficient to protect the components involved but not lower than 250 psig (1.7 MPag). The relief valve discharge shall be directed upward and away from the component parts of the vaporizing burner. Fusible plug devices shall not be used.

(d) A valve shall be provided to turn off the gas supply to the main burner and the pilot.

(e) Vaporizing burners shall be provided with an automatic safety device to shut off the flow of gas to the main burner and pilot in the event the pilot is extinguished.

(f)* Dehydrators and dryers utilizing vaporizing burners shall be equipped with automatic devices both upstream and downstream of the vaporizing section. These devices shall be installed and connected to shut off in the event of excessive temperature, flame failure, and, if applicable, insufficient air flow.

(g) Pressure-regulating and control equipment shall be so located or so protected to prevent its exposure to temperatures above 140°F (60°C), unless designed and recommended for use at a higher temperature by the manufacturer.

(h) Pressure-regulating and control equipment located downstream of the vaporizing section shall be designed to withstand the maximum discharge temperature of hot vapor.

2.5.5.7 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.

(b) 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 required in 2.5.5.7(b), a method shall be provided to prevent air from accidentally entering gas distribution lines without LP-Gas being present. Gas mixing control valves installed in the air and LP-Gas supply lines that fail closed when actuated by safety trip devices shall meet this requirement.

(d) 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 installed in the air and LP-Gas supply lines that fail closed when actuated by safety trip devices shall meet this requirement.

(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, shall comply with the following:

(1) Be exempt from the interlock provisions in 2.5.5.7(b), (c), and (d)
(2) Be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down

(f) Gas–air mixers of this type receiving air from a blower, compressor, or any source of air other than directly from the atmosphere shall prevent air without LP-Gas, or mixtures of air and LP-Gas within the flammable range, from entering the gas distribution system accidentally.

2.5.6 Meters.

2.5.6.1 Vapor meters of the tin or brass case type of soldered construction shall not be used at pressures in excess of 1 psig (7 kPag).

2.5.6.2 Vapor meters of the die cast or iron case type shall be permitted to be used at any pressure equal to or less than the working pressure for which they are designed and marked.

2.5.7 Regulators.

2.5.7.1 Single-stage regulators shall have a maximum outlet pressure setting of 1.0 psig (7 kPag) and shall be equipped with one of the following *[see 3.2.12.4 for required protection from the elements]*:

(1) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in UL 144, *Standard for LP-Gas Regulators.*
(2) An integral overpressure shutoff device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches the overpressure limits specified in UL 144. Such a device shall not open to permit flow of gas until it has been manually reset.

2.5.7.2 Second-stage regulators and integral two-stage regulators shall have a maximum outlet pressure setting of 14 in. (4.0 kPag) w.c. and shall be equipped with one of the following *(see 3.2.12.4 for required protection from the elements):*

(a) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*. This relief device shall limit the outlet pressure of the second-stage regulator to 2.0 psig (14 kPag) when the regulator seat disc is removed and the inlet pressure to the regulator is 10.0 psig (69 kPag) or less as specified in UL 144.

(b) An integral overpressure shutoff device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches the overpressure limits specified in UL 144. Such a device shall not open to permit flow of gas until it has been manually reset.

Exception: Regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) shall be permitted to have a separate overpressure protection device complying with 2.9.2 through 2.9.8 of NFPA 54, National Fuel Gas Code (ANSI Z223.1). The overpressure protection device shall limit the outlet pressure of the regulator to 2.0 psig (14 kPag) when the regulator seat disc is removed and the inlet pressure to the regulator is 10 psig (69 kPag) or less.

2.5.7.3 Integral two-stage regulators shall be provided with a means to determine the outlet pressure of the high-pressure regulator portion of the integral two-stage regulator.

Exception: Automatic changeover regulators shall be exempt from this requirement.

2.5.7.4 Integral two-stage regulators shall not incorporate an integral pressure relief valve in the high-pressure regulator portion of the unit.

2.5.7.5 First-stage regulators shall incorporate an integral pressure relief valve having a start-to-discharge setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*.

Exception: First-stage regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) shall be permitted to have a separate pressure relief valve

2.5.7.6 High-pressure regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) where permitted to be used in two-stage systems shall incorporate an integral relief valve or shall have a separate relief valve.

2.5.7.7 First-stage regulators shall have an outlet pressure setting up to 10.0 psig (69 kPag) in accordance with UL 144, *Standard for LP-Gas Regulators*.

2.5.7.8 Regulators shall be designed so as to drain all condensate from the regulator spring case when the vent is directed down vertically.

2.5.7.9 Two-psi service regulators shall be equipped with one of the following:

(a) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*. This relief device shall limit the outlet pressure of the 2-psi (14-kPa) service regulator to 5.0 psi (34.5 kPa) when the regulator seat disc is removed and inlet pressure to the regulator is 10.0 psi (69 kPa) or as specified in UL 144.

(b) An integral overpressure shutoff device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches the overpressure limits specified in UL 144. Such a device shall not open to permit flow of gas until it has been manually reset.

2.5.8 Sight Flow Indicators. Where installed, sight flow indicators shall either be the simple observation type or be combined with a backflow check valve.

2.6 Appliances. This section shall apply to the basic construction and performance of LP-Gas consuming appliances.

2.6.1 Approved Appliances. New residential, commercial, and industrial LP-Gas consuming appliances shall be approved.

2.6.2 Appliance Requirements.

2.6.2.1 Any appliance originally manufactured for operation with a gaseous fuel other than LP-Gas shall not be used with LP-Gas unless it is converted to use LP-Gas, and is tested for performance with LP-Gas before being placed into use.

2.6.2.2 Unattended heaters used inside buildings for animal or poultry production or care shall be equipped with approved automatic devices to shut off the flow of gas to the main burners and to pilots, if used, in the event of flame extinguishment or combustion failure.

Exception: Approved automatic devices to shut off the flow of gas to the main burners, and pilots shall not be required in structures without enclosing walls with the approval of the authority having jurisdiction.

2.6.2.3 Appliances using vaporizing burners shall comply with 2.5.5.6.

2.6.2.4 Appliances used in mobile homes and recreational vehicles shall be approved for such service.

2.6.2.5* LP-Gas appliances used on commercial vehicles shall be approved for the service and shall comply with the following:

(a) Gas-fired heating appliances and water heaters shall be equipped with automatic devices designed to shut off the flow of gas to the main burner and the pilot in the event the pilot flame is extinguished.

(b) Catalytic heating appliances shall be equipped with an approved automatic device to shut off the flow of gas in the event of combustion failure.

(c) Gas-fired heating appliances and water heaters to be used in vehicles intended for human occupancy shall be designed for complete separation of the combustion system and the living space.

Exception: If this separation is not integral with the appliance, it shall be provided in accordance with installation requirements in 3.8.4.2.

Chapter 3 Installation of LP-Gas Systems

3.1 Scope.

3.1.1* Application.

3.1.1.1 This chapter shall apply to the following:

(1) The location and field installation of LP-Gas systems that use components, subassemblies, container assemblies, and container systems that are fabricated in accordance with Chapter 2
(2) The location of containers and liquid transfer systems
(3) The installation of container appurtenances and regulators
(4) The installation of piping (including flexible connectors and hose), hydrostatic relief valves, and piping service limitations
(5) The installation of equipment (other than vaporizers) *(see Section 3.6)*
(6) The testing of piping systems

3.1.1.2 LP-Gas systems shall be installed in accordance with this code and other national standards or regulations that apply, which include the following:

(1) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
(2) NFPA 54, *National Fuel Gas Code* (ANSI Z223.1)
(3) NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*
(4) NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*
(5) NFPA 86, *Standard for Ovens and Furnaces*
(6) NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*
(7) NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*
(8) NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*
(9) NFPA 1192, *Standard on Recreational Vehicles*
(10) U.S. DOT Regulations, Title 49, *Code of Federal Regulations*, "Transportation," 191, and 192, "Transportation of Natural and Other Gas by Pipeline," for LP-Gas pipeline systems subject to DOT

3.1.2 Nonapplication. This chapter shall not apply to the following:

3.1.2.1 Refrigerated containers shall be installed in accordance with Chapter 9.

3.1.2.2 Installation of systems used in the highway transportation of LP-Gas shall be in accordance with Chapter 6.

3.2 General Provisions.

3.2.1 Installation of Containers. The installation of LP-Gas containers shall be in accordance with this section.

3.2.2 Location of Containers.

3.2.2.1 LP-Gas containers shall be located outside of buildings.

Exception No. 1: Cylinders as specifically provided for in Section 3.4.

Exception No. 2: Containers of less than 125 gal (0.5 m^3) water capacity for the purposes of being filled in buildings or structures complying with Chapter 7.

Exception No. 3: Containers on LP-Gas vehicles complying with, and parked or garaged in accordance with, Chapter 6.

Exception No. 4: Containers used with LP-Gas stationary or portable engine fuel systems complying with Chapter 8.

Exception No. 5: Containers used with LP-Gas fueled industrial trucks complying with 8.3.6.

Exception No. 6: Containers on LP-Gas fueled vehicles garaged in accordance with Section 8.6.

Exception No. 7: Cylinders awaiting use, resale, or exchange when stored in accordance with Chapter 5.

3.2.2.2 Containers installed outside of buildings, whether of the portable type replaced on a cylinder exchange basis or permanently installed and refilled at the installation, shall be located with respect to the adjacent containers, important building, group of buildings, or line of adjoining property that can be built upon, in accordance with Tables 3.2.2.2, 3.2.2.4, and 3.2.2.6(f) and the following:

Exception No. 1: When the provisions of 3.11.2 are met, the minimum distance from a container to a building shall be reduced by one-half for ASME containers of 2001 gal through 30,000 gal (7.6 m^3 through 114 m^3) water capacity used in systems complying with Section 3.11.

Exception No. 2: The 25-ft (7.6-m) distance from aboveground containers of 501 gal to 2000 gal (1.9 m^3 to 7.6 m^3) water capacity to buildings, a group of buildings, or the line of adjoining property that can be built upon shall be reduced to 10 ft (3 m) for a single container of 1200 gal (4.5 m^3) or less water capacity where 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.

Exception No. 3: Minimum distances for underground or mounded ASME containers of 2001 gal through 30,000 gal (7.6 m^3 through 114 m^3) water capacity incorporating all the provisions of Section 3.11 shall be reduced to 10 ft (3 m). Distances for all underground and mounded ASME containers shall be measured from the relief valve and the filing connection. No part of an underground ASME container shall be less than 10 ft (3 m) from a building or line of adjoining property that can be built upon, and no part of a mounded ASME container that is installed above grade shall be less than 5 ft (1.5 m) from a building or line of adjoining property that can be built upon.

Exception No. 4: The separation distances specified in Table 3.2.2.2 between containers and of buildings of other than wood-frame construction devoted exclusively to gas manufacturing and distribution operations shall be reduced to 10 ft.

(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 Table 3.2.2.2, 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).

Exception: The minimum distances between containers shall not be applied to such installations.

(b) Cylinders installed alongside of buildings shall be located and installed so that the discharge from the cylinder pressure relief device is at least 3 ft (1 m) horizontally away from any building opening that is below the level of such discharge. The discharge from cylinder 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.

(c) Cylinders shall not be located and installed underneath any building unless the space is open to the atmosphere for 50 percent of its perimeter or more.

(d) The distance measured horizontally from the point of discharge of a container pressure relief valve to any building opening below the level of such discharge shall be in accordance with Table 3.2.2.2(d).

(e) The distance from any of the following, measured in any direction, shall be in accordance with Table 3.2.2.2(d):

(1) From the point of discharge of a container pressure relief valve
(2) The vent of a fixed maximum liquid level gauge on a container
(3) The installed location of the filling connection of a container to any of the following:
    a. Exterior source of ignition
    b. Openings into direct-vent (sealed combustion system) appliances
    c. Mechanical ventilation air intakes

Table 3.2.2.2 Separation Distances Between Containers, Important Buildings, and Other Properties

Water Capacity per Container		Minimum Distances					
		Mounded or Underground Containers[a]		Aboveground Containers[b]		Between Containers[c]	
gal	m^3	ft	m	ft	m	ft	m
<125[d]	<0.5[d]	10	3	0[e]	0[e]	0	0
125–250	0.5–1.0	10	3	10	3	0	0
251–500	1.0+–1.9	10	3	10	3	3	1
501–2000	1.9+–7.6	10	3	25	7.6	3	1
2001–30,000	7.6+–114	50	15	50	15	5	1.5
30,001–70,000	114+–265	50	15	75	23		
70,001–90,000	265+–341	50	15	100	30		
90,001–120,000	341+–454	50	15	125	38	$^1/_4$ of sum of diameters of adjacent containers	
120,001–200,000	454+–757	50	15	200	61		
200,001–1,000,000	757+–3785	50	15	300	91		
>1,000,000	>3785	50	15	400	122		

[a]See 3.2.2.2 Exception No. 2.
[b]See 3.2.2.2(g).
[c]See 3.2.2.2(f).
[d]See 3.2.2.2(a).
[e]See 3.2.2.2(b), (c), and (d).

Table 3.2.2.2(d) Separation Distance Between Container Pressure Relief Valve and Building Openings

Container Type	Exchange or Filled on Site	Distance Horizontally from Relief Valve Discharge to Opening Below Discharge		Discharge from Relief Valve, Vent Discharge, and Filling Connection to Exterior Source of Ignition, Openings into Direct-Vent Appliances, Mechanical Ventilation Air Intakes	
		ft	m	ft	m
Cylinder	Exchange	3	0.9	5	1.5
Cylinder	Filled on site	3	0.9	10	3.0
ASME	Filled on site	5	1.5	10	3.0

(f) Where 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 allow access at their ends or sides to facilitate working with cranes or hoists.

(g) 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.

Exception No. 1: Not applicable to installations in which overhanging structure is 50 ft (15 m) or more above the relief valve discharge outlet.

Exception No. 2: Where the distance from a 2001 to 30,000 gal container to a building are in accordance with 3.11.2 and 3.11.4.

3.2.2.3 Where storage containers having an aggregate water capacity of more than 4000 gal (15.1 m^3) are located in heavily populated or congested areas, the siting provisions of 3.2.2.2 and Table 3.2.2.2 shall be permitted to be modified as indicated by the fire safety analysis described in 3.10.2.2.

3.2.2.4 Aboveground multicontainer installations comprised of containers having an individual water capacity of 12,000 gal (45 m^3) or more and 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 3.2.2.4.

Exception: Where the provisions of 3.11.3 and 3.11.4 are met the minimum separation distance between groups of ASME containers protected by hose stream only shall be one-half the distances in Table 3.2.2.4.

3.2.2.5 Underground or mounded containers shall be located outside of any buildings. Buildings shall not be constructed over any underground or mounded containers. Sides of adjacent containers shall be separated in accordance with Table 3.2.2.2 but shall not be separated less than 3 ft (1 m).

Where underground or mounded containers are installed parallel with ends in line, the number of containers in one group shall not be limited. Where more than one row is installed, the adjacent ends of the tanks in each row shall be separated by not less than 10 ft (3 m).

Table 3.2.2.4 Maximum Number of Containers in a Group and their Separation Distances

Fire Protection Provided by	Maximum Number of Containers in One Group	Minimum Separation Between Groups	
		ft	m
Hose streams only *(see 3.2.2.4 and 3.10.2.2)*	6	50	15
Fixed monitor nozzles per 3.10.3.5	6	25	7.6
Fixed water spray per 3.10.3.4	9	25	7.6
Insulation per 3.10.3.1	9	25	7.6

3.2.2.6 The following provisions shall also apply to container locations.

(a) Containers shall not be stacked one above the other.

(b) Loose or piled combustible material and weeds and long dry grass shall be separated from containers by a minimum of 10 ft (3.0 m).

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

(d) LP-Gas containers shall be located at least 10 ft (3.0 m) from the centerline of the wall of diked areas containing flammable or combustible liquids.

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

Exception: This provision shall not apply where LP-Gas containers of 125-gal (0.5-m^3) or less water capacity are installed adjacent to fuel oil supply tanks of 660-gal (2.5-m^3) or less capacity.

(f)* The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with Table 3.2.2.6(f).

Exception: Where protective structures having a minimum fire resistance rating of 2 hours interrupt the line of sight between uninsulated portions of the oxygen or hydrogen containers and the LP-Gas containers, no minimum distance shall apply.

(g) The minimum separation between LP-Gas containers and liquefied hydrogen containers shall be in accordance with NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites*.

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

(i) Where LP-Gas containers are to be stored or used in the same area with other compressed gases, the containers shall be marked to identify their content in accordance with ANSI/CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*.

(j) An aboveground LP-Gas container, and any of its parts, shall not be located within 6 ft (1.8 m) of a vertical plane beneath overhead electric power lines that are over 600 volts, nominal.

3.2.2.7* Impoundment in accordance with Section 9.2 shall be installed around refrigerated LP-Gas containers.

3.2.2.8* Structures such as fire walls, fences, earth or concrete barriers, and other similar structures shall be avoided around or over installed nonrefrigerated containers.

Exception No. 1: Such structures partially enclosing containers shall be permitted if designed in accordance with a sound fire protection analysis.

Exception No. 2: Structures used to prevent flammable or combustible liquid accumulation or flow shall be permitted in accordance with 3.2.2.6(c).

Exception No. 3: Structures between LP-Gas containers and gaseous hydrogen containers shall be permitted in accordance with 3.2.2.6(f).

Exception No. 4: Fences shall be permitted in accordance with 3.3.6.

Table 3.2.2.6(f) Separation Distances of LP-Gas Containers and Oxygen and Hydrogen Containers

LP-Gas Containers Aggregate Water Capacity		Separation from Oxygen Containers Aggregate Capacity					Separation from Gaseous Hydrogen Containers Aggregate Capacity				
		400 ft^3 (11 m^3)* or Less	More Than 400 ft^3 (11 m^3)* to 20,000 ft^3 (566 m^3)* Including Unconnected Reserves		More Than 20,000 ft^3 (566 m^3)* Including Unconnected Reserves		Less Than 400 ft^3 (11 m^3)*	400 ft^3 (11 m^3)* to 3000 ft^3 (85 m^3)*		More Than 3000 ft^3 (85 m^3)*	
gal	m^3		ft	m	ft	m		ft	m	ft	m
≤1200	≤4.5	None	20	6	25	7.6	—	—	—	—	—
>1200	>4.5	None	20	6	50	15	—	—	—	—	—
≤500	≤1.9	—	—	—	—	—	None	10	3	25	7.6
>500	>1.9	—	—	—	—	—	None	25	7.6	50	15

*Cubic feet (m^3) measured at 70°F (21°C) and atmospheric pressure.

3.2.3 Location of Transfer Operations.

3.2.3.1* Liquid shall be transferred into containers, including containers mounted on vehicles, only outdoors or in structures specially designed for the purpose.

(a) The transfer of liquid into containers mounted on vehicles shall not take place within a building but shall be permitted to take place under a weather shelter or canopy *(see 3.9.3.2)*

(b) Structures housing transfer operations or converted for such use after December 31, 1972, shall comply with Chapter 7

(c) The transfer of liquid into containers on the roofs of structures shall be permitted, provided that the installation conforms to the requirements contained in 3.2.10 and 3.4.9

(d) The transfer hose shall not be routed in or through any building except those specified in 3.2.3.1(b)

3.2.3.2 Containers located outdoors in stationary installations *(see 1.7.67)* in accordance with 3.2.2 and with the point of transfer located at the container shall be permitted to be filled at that location. If the point of transfer *(see 1.7.53)* is not located at the container, it shall be located in accordance with 3.2.3.3.

3.2.3.3 Containers not located in stationary installations *(see 1.7.67)* shall be filled at a location determined by the point of transfer *(see 1.7.53)* in accordance with Table 3.2.3.3.

(a) If the point of transfer is a component of a system covered by Section 3.8 or Chapter 8, the requirements of parts A, B, and C of Table 3.2.3.3 shall not apply to the structure containing the point of transfer.

(b) If LP-Gas is vented to the atmosphere under the conditions stipulated in 4.3.1, Exception No. 4, the distances in Table 3.2.3.3 shall be doubled.

(c) If the point of transfer is housed in a structure complying with Chapter 7, the distances in Table 3.2.3.3 shall be permitted to be reduced provided either the exposing wall(s) or the exposed wall(s) complies with 7.3.1.2.

(d) The distances in Table 3.2.3.3, parts B, C, D, E, F(b), and J shall be reduced by one-half where the system incorporates the provisions of low emission transfer as provided in 3.11.5.

3.2.4 Installation of Containers.

3.2.4.1 Containers shall be positioned so that the pressure relief valve is in direct communication with the vapor space of the container.

3.2.4.2 LP-Gas containers or systems of which they are a part shall be protected from damage from vehicles.

3.2.4.3 Field welding on containers shall be limited to nonpressure parts such as saddle plates, wear plates, or brackets applied by the container manufacturer. Welding to the container shall comply with 2.2.1.9.

3.2.4.4* Aboveground containers shall be painted.

3.2.4.5 ASME containers shall be installed so that all container operating appurtenances are accessible.

3.2.5 Installation of Cylinders. Cylinders shall be installed only above ground and shall be set upon a firm foundation or be otherwise firmly secured. Flexibility shall be provided in the connecting piping. The requirements of 3.2.17 shall apply.

Table 3.2.3.3 Distance Between Point of Transfer and Exposures

Part	Exposure	Minimum Horizontal Distance ft	m
A	Buildings,[1] mobile homes, recreational vehicles, and modular homes with fire-resistive walls[2]	10*	3.1
B	Buildings[1] with other than fire-resistive walls[2]	25*	7.6*
C	Building wall openings or pits at or below the level of the point of transfer	25*	7.6*
D	Line of adjoining property that can be built upon	25*	7.6*
E	Outdoor places of public assembly including schoolyards, athletic fields, and playgrounds	50*	15*
F	Public ways including public streets, highways, thoroughfares, and sidewalks		
	(a) From points of transfer in LP-Gas dispensing stations and at vehicle fuel dispensers	10	(3.1)
	(b) From other points of transfer	25*	(7.6)*
G	Driveways[3]	5	(1.5)
H	Mainline railroad track centerlines	25	(7.6)
I	Containers[4] other than those being filled	10	(3.1)
J	Flammable and Class II combustible liquid[5] dispensers and the fill connections of containers	10*	(3.1)*
K	Flammable and Class II combustible liquid containers, aboveground containers, and containers underground	20	(6.1)

*See 3.2.3.3(d).

[1]Buildings, for the purpose of the table, also include structures such as tents and box trailers at construction sites.

[2]Walls constructed of noncombustible materials having, as erected, a fire resistance rating of at least 1 hour as determined by NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*.

[3]Not applicable to driveways and points of transfer at vehicle fuel dispensers.

[4]Not applicable to filling connections at the storage container or to dispensing vehicle fuel dispenser units of 2000 gal (7.6 m^3) water capacity or less when used for filling containers not mounted on vehicles.

[5]NFPA 30, *Flammable and Combustible Liquids Code,* defines these as follows: Flammable liquids include those having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia (an absolute pressure of 2068 mm Hg) at 100°F (37.8°C). Class II combustible liquids include those having a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

3.2.6 Installation of Horizontal ASME Containers.

3.2.6.1 Horizontal ASME containers designed for permanent installation in stationary service above ground shall be placed on masonry or other noncombustible structural supports located on concrete or masonry foundations with the containers supported as follows:

(a) Where saddles are used, they shall allow for expansion and contraction and prevent an excessive concentration of stresses.

(b) Where structural steel supports are used, they shall comply with 3.2.6.3.

(c) Containers of more than 2000-gal (7.6-m^3) water capacity shall be provided with concrete or masonry foundations formed to fit the container contour or, if furnished with saddles in compliance with Table 2.2.5.1, shall be placed on flat-topped foundations.

(d) Containers of 2000-gal (7.6-m^3) water capacity or less either shall be installed on concrete or masonry foundations formed to fit the container contour or, if equipped with attached supports complying with Table 2.2.5.1, shall be installed as follows: If the bottoms of the horizontal members of the container saddles, runners, or skids are to be more than 12 in. (300 mm) above grade, fire-resistive foundations shall be provided. A container shall not be mounted with the outside bottom of the container shell more than 5 ft (1.5 m) above the surface of the ground.

(e) Containers or container-pump assemblies mounted on a common base complying with Table 2.2.5.1 shall be placed either on paved surfaces or on concrete pads at ground level within 4 in. (102 mm) of ground level.

3.2.6.2 ASME containers that have liquid interconnections shall be installed so that the maximum permitted filling level of each container is at the same elevation.

3.2.6.3 Where single containers complying with Table 2.2.5.1 are installed in isolated locations with nonfireproofed steel supports resting on concrete pads or footings and the outside bottom of the container shell is not more than 5 ft (1.5 m) above the ground level, the approval of the authority having jurisdiction shall be obtained.

3.2.6.4 The part of the container in contact with saddles or foundations or masonry shall be coated or protected to minimize corrosion.

3.2.6.5 In locations where heavy snow can be expected to cover the container, the following additional requirements shall apply:

(a) A stake or other marking shall be installed higher than the highest anticipated snow cover up to a height of 15 ft (4.6 m).

(b) The installation shall prevent moving of the container by the forces anticipated as a result of snow accumulation.

3.2.6.6 If the container is mounted on or is part of a vehicle in accordance with 2.2.5.3(b), the unit shall be located in accordance with 3.2.2.2 and shall be in accordance with the following:

(a) The surface on which the vehicle is parked shall be level and, if not paved, shall be able to support heavy vehicular traffic and shall be clear of dry grass and weeds and other combustible material within 10 ft (3 m) of the container.

(b) Flexibility shall be provided in the connecting piping.

3.2.6.7 Portable tanks *(see 1.7.56, Portable Tank)* of 2000 gal (7.6 m^3) water capacity or less that comply with 2.2.5.4 shall be installed in accordance with 3.2.6.1(d).

3.2.7 Installation of Vertical ASME Containers.

3.2.7.1 Vertical ASME containers over 125-gal (0.5-m^3) water capacity designed for permanent installation in stationary service above ground shall be installed on reinforced concrete or steel structural supports on reinforced concrete foundations that are designed to meet the coding provisions established in 2.2.2.3. The requirements in 3.2.7.2 and 3.2.7.3 shall also apply.

3.2.7.2 Steel supports shall be protected against fire exposure with a material that has a fire resistance rating of at least 2 hours.

Exception: Continuous steel skirts that have only one opening that is 18 in. (457 mm) or less in diameter shall have fire protection applied to the outside of the skirts.

3.2.7.3 Vertical ASME containers used in liquid service shall not be manifolded to horizontal ASME containers. Vertical ASME containers of different dimensions shall not be manifolded together.

3.2.8 Temporary Container Installations.

3.2.8.1 Single containers constructed as portable storage containers *(see 1.7.55)* for temporary stationary service in accordance with 2.2.5.3(a) shall be placed on concrete pads, paved surfaces, or firm earth for such temporary service (not more than 12 months at a given location).

3.2.8.2 The surface on which the containers are placed shall be level and, if not paved, shall be clear of dry grass and weeds and other combustible material within 10 ft (3 m) of the container.

3.2.8.3 Flexibility shall be provided in the connecting piping.

3.2.8.4 Where portable containers are installed at isolated locations with the bottoms of the skids or runners above the ground, nonfireproofed structural supports shall be permitted with the approval of the authority having jurisdiction provided the height of the outside bottom of the container does not exceed 5 ft (1.5 m) above the ground. Otherwise, fire-resistive supports shall be provided.

3.2.9 Installation of Underground and Mounded Containers.

3.2.9.1 ASME container assemblies listed for underground installation, including interchangeable aboveground-underground container assemblies, shall be installed underground as follows:

(a) Containers installed in areas with no vehicle traffic shall be installed at least 6 in. (15 cm) below grade.

(b) In areas where vehicle traffic is expected, a noninterchangeable underground container shall be installed at least 18 in. (46 cm.) below grade, or the container shall be protected from damage from vehicles. Protection shall be provided for the fitting housing, housing cover, tank connections, and piping against vehicular damage.

(c) Where containers are installed underground within 10 ft (3 m) of where vehicular traffic can be expected, protection against vehicular damage shall be provided for the fitting housing, housing cover, tank connections, and piping.

(d) Approved interchangeable aboveground-underground container assemblies installed underground shall not be placed with the container shell more than 12 in. (0.30 m) below grade.

(e) Any party involved in construction or excavation in the vicinity of a buried container shall be responsible for determining the location of, and providing protection for,

the container and piping against their physical damage from vehicular traffic.

(f) Where a container is to be abandoned underground, the following procedure shall be followed:

(1) As much liquid LP-Gas as practical shall be removed through the container liquid withdrawal connection.

(2)* As much of the remaining LP-Gas vapor as practical shall be removed through a vapor connection. The vapor shall either be recovered, burned, or vented to the atmosphere.

(3) Where only vapor LP-Gas at atmospheric pressure remains in the container, the container shall be filled with water, sand, or foamed plastic or shall be purged with an inert gas. If purged, the displaced vapor shall be either recovered, burned or vented to the atmosphere.

(g) The discharge of the regulator vent shall be above the highest probable water level.

(h) Containers shall be coated or protected to minimize corrosion. Any damage to the coating shall be repaired before backfilling.

(i)* Containers shall be set level and shall be surrounded by earth or sand firmly tamped in place. Backfill shall be free of rocks and abrasives.

3.2.9.2 Partially underground, unmounded ASME containers shall be installed as follows:

(a) The portion of the container below the surface, and for a vertical distance of at least 3 in. (75 mm) above the surface, shall be coated or protected to minimize corrosion. Any damage to the coating shall be repaired before backfilling.

(b) Containers shall be set level and shall be surrounded by earth or sand firmly tamped in place. Backfill shall be free of rocks and abrasives.

(c) Spacing provisions shall be as specified for aboveground containers in 3.2.2.2 and Table 3.2.2.2.

(d) The container shall be located so as not to be subject to vehicular damage or shall be adequately protected against such damage.

3.2.9.3 Mounded containers shall be installed as follows:

(a)*Mounding material shall be earth, sand, or other noncombustible, noncorrosive materials and shall cover the container for at least 1 ft (0.3 m).

(b) A protective cover shall be provided on top of mounding materials subject to erosion.

(c) Container valves and appurtenances shall be accessible for operation or repair, without disturbing mounding material.

(1) Where containers are mounded and the bottom of the container is 30 in. (0.76 m) or more above the surrounding grade, access to bottom connections shall be provided by an opening or tunnel with a 4-ft (1.2-m) minimum diameter and a 3-ft (0.9-m) minimum clear area.

(2) Bottom connections that extend beyond the mound shall be part of the ASME container or shall be installed in compliance with the ASME Code, and shall be designed for the forces that can act on the connections.

(d)*Mounded containers shall be coated or protected to minimize corrosion.

3.2.10 Installation of Containers on Roofs of Buildings.

3.2.10.1 Installation of containers on roofs of buildings shall be prohibited, unless approved by the authority having jurisdiction and the fire department.

3.2.10.2 Where the authority having jurisdiction and the fire department have approved an installation of a container, it shall comply with the following:

(a) The building shall be of Type I, 443 or 332, or Type II, 222 construction as specified in NFPA 220, *Standard on Types of Building Construction.*

(b) LP-Gas containers installed on roofs shall be 2000 gal water capacity or less. The aggregate water capacity of LP-Gas containers installed on the roof or terrace of one building shall not exceed 4000 gal.

Exception: Additional installations shall be located at least 50 ft (15.2 m) apart.

(c) An ASME container installed on the roof of a building shall always be filled by two operators, one at the controls of the vehicle supplying LP-Gas and another at the controls of the container.

(d) Containers shall be installed in external locations only. Where a fill line to the container is required, it shall be located entirely outside the building. The fill connection shall be located entirely outside the building. The fill connection shall be located at least 8 ft (2.4 m) above ground level.

(e) Containers shall be installed on a level location.

(f) The container shall be secured to the building structure. The support of the container shall be designed to the same seismic criteria as the building.

(g) The roof on which the container is located shall be able to support the weight of the container filled with water, with the safety margins required by local codes.

(h) Containers shall be located in areas where there is free air circulation, at least 10 ft (3.0 m) from building openings (such as windows and doors), and at least 20 ft (6.1 m) from air intakes of air-conditioning and ventilating systems.

(i) Location shall permit access to all valves and controls and shall have enough area to permit the required maintenance.

(j)* The location of the container shall have fixed stairs or another safe method to reach it.

(k) If the installation requires the use of more than one container, the distances between containers of Table 3.2.2.2 shall apply.

(l) If the container location is higher than 23 ft (7 m) from the ground, or the filling hose cannot be observed by the operators in its entire length, the container shall have a filling line constructed to withstand liquid transfer, and it shall have the following appurtenances: filling valve with back check valve, cap, two control valves, hydrostatic relief, venting line. The liquid and vapor fill connections shall be conspicuously marked or labeled.

(m) A fire safety analysis shall be conducted in accordance with 3.10.2.2.

3.2.11 Installation of Container Appurtenances.

3.2.11.1 Pressure relief devices shall be installed on containers in accordance with this section and positioned so that the relief device is in direct communication with the vapor space of the container.

3.2.11.2 Pressure relief devices on cylinders shall be installed to minimize the possibility of relief device discharge impingement on the cylinder.

3.2.11.3 Pressure relief devices on the following ASME containers shall be installed so that any gas released is vented away from the container upward and unobstructed to the open air.

(1) Containers of 125-gal (0.5-m^3) water capacity or more installed in stationary service
(2) Portable storage containers *(see 1.7.55)*,
(3) Portable tanks of nominal 120-gal (0.5-m^3) water capacity or more
(4) Cargo tanks

3.2.11.4 Rain caps or other means shall be provided to minimize the possibility of the entrance of water or other extraneous matter into the relief device or any discharge piping. Provision shall be made for drainage where the accumulation of water is anticipated. The rain cap or other protector shall be designed to remain in place, except during relief device operation, and shall not restrict relief device flow.

3.2.11.5 The relief valve discharge on each aboveground container of more than 2000 gal (7.6 m^3) water capacity shall be piped vertically upward and shall be unobstructed to the open air at a point at least 7 ft (2 m) above the top of the container. The following also shall apply:

(a) Relief valve discharge piping shall comply with 3.2.11.9.

(b) The design of the relief valve drain opening shall provide the following:

(1) Protection of the container against flame impingement that might result from ignited product escaping from the drain opening.
(2) Direction of the relief valve drain opening so that a container(s), piping, or equipment that might be installed adjacent to the container on which the relief device is installed is not subjected to flame impingement.

3.2.11.6 The relief valve discharge from underground containers of 2000 gal (7.6 m^3) or less water capacity, shall extend beyond the manhole or housing and shall discharge into the manhole or housing, where the manhole or housing is equipped with ventilated louvers, or their equivalent, in accordance with 2.3.7(d).

Exception: Pressure relief devices installed in dispensing stations shall be piped vertically upward to a point at least 10 ft (3.0 m) above the ground. Discharge piping shall be supported and protected against physical damage. Valves in discharge piping shall be in accordance with 3.2.11.9.

3.2.11.7 The discharge from relief valves on underground containers of more than 2000-gal (7.6-m^3) water capacity shall be piped vertically and directly upward to a point at least 7 ft (2 m) above the ground. Valves in discharge piping shall be in accordance with 3.2.11.9.

Exception: The relief valve discharge on underground containers in dispensing stations shall be piped vertically and directly upward to a point at least 10 ft (3.0 m) above the ground. Discharge piping shall comply with 3.2.11.9 and shall be adequately supported and protected against physical damage by vehicles.

3.2.11.8 The discharge piping shall be sized to provide the rate of flow specified in 2.3.2.4(a). Such piping shall be metallic and have a melting point over 1500°F (816°C). Discharge piping shall be designed so that excessive force applied to the discharge piping will result in breakage on the discharge side of the valve rather than on the inlet side without impairing the function of the valve. Return bends and restrictive pipe or tubing fittings shall not be used.

3.2.11.9 Shutoff valves shall not be installed between relief devices and the container or between the relief devices and the discharge piping.

Exception: Listed relief valve manifolds shall be exempt from the requirements pertaining to shutoff valves in 3.2.11.9, when the following conditions are met: (1) Two or more relief devices are installed in a manifold, (2) only one relief device in the manifold is designed to shutoff at any one time, and (3) the remaining relief device(s) remain open and provide the rated relieving capacity required for the container.

3.2.12 Regulator Installation.

3.2.12.1 A two-stage regulator system, an integral two-stage regulator, or a two-psi regulator system shall be required on all fixed piping systems that serve $^1/_2$-psig (3.4-kPag) appliance systems [normally operated at 11 in. w.c. (2.7 kPag) pressure]. The regulators utilized in these systems shall meet the requirements of 2.5.7. This requirement includes fixed piping systems for appliances on RVs (recreational vehicles), mobile home installations, manufactured home installations, catering vehicles, and food service vehicle installations. Single-stage regulators shall not be installed in fixed piping systems after June 30, 1997.

Exception No. 1: This requirement does not include small portable appliances and outdoor cooking appliances with input ratings of 100,000 Btu/hr (29 kW) or less.

Exception No. 2: Gas distribution systems utilizing multiple second-stage regulators shall be permitted to use a high-pressure regulator installed at the container provided a first-stage regulator is installed downstream of the high-pressure regulator and ahead of the second-stage regulators.

Exception No. 3: High-pressure regulators with an overpressure protection device and a rated capacity of more than 500,000 Btu/hr (147 kW) shall be permitted to be used in two-stage systems where the second-stage regulator incorporates an integral or separate overpressure protection device. This overpressure protection device shall limit the outlet pressure of the second-stage regulator to 2.0 psig (14 kPag) when the regulator seat disc is removed and with an inlet pressure equivalent to the maximum outlet pressure setting of the high-pressure regulator

Exception No. 4: Systems consisting of listed components that provide an equivalent level of overpressure protection.

3.2.12.2 First-stage or high-pressure regulators shall be directly attached or attached by flexible connectors to the vapor service valve of a container or to a vaporizer outlet. The regulators also shall be permitted to be installed with flexibility in the interconnecting piping of manifolded containers or vaporizers

Exception: First-stage regulators installed downstream of high-pressure regulators

3.2.12.3 First-stage and high-pressure regulators shall be installed outside of buildings.

Exception No. 1: Regulators on portable containers installed indoors in accordance with Section 3.4.

Exception No. 2: Regulators on containers of less than 125-gal (0.5- m^3) water capacity for the purpose of being filled or in structures complying with Chapter 7.

Exception No. 3: Regulators on containers on LP-Gas vehicles complying with, and parked or garaged in accordance with, Chapter 8.

Exception No. 4: Regulators on containers used with LP-Gas stationary or portable engine fuel systems complying with Chapter 8.

Exception No. 5: Regulators on containers used with LP-Gas fueled industrial trucks complying with 8.3.6

Exception No. 6: Regulators on containers on LP-Gas fueled vehicles garaged in accordance with Section 8.6.

Exception No. 7: Regulators on cylinders awaiting use, resale, or exchange when stored in accordance with Chapter 5.

3.2.12.4 All regulators for outdoor installations shall be designed, installed, or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud, or debris). This protection shall be permitted to be integral with the regulator.

Exception: Regulators used for portable industrial applications.

3.2.12.5 The point of discharge from the required pressure relief device on regulating equipment installed outside of buildings in fixed piping systems shall be located not less than 3 ft (1 m) horizontally away from any building opening below the level of such discharge, and not 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 point of discharge shall also be located not less than 5 ft (1.5 m) in any direction away from any source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes. Where a vent line is used to comply with the point of discharge requirements, it shall comply with 3.2.12.6(a) and (c).

3.2.12.6 The discharge from the required pressure relief device on second-stage regulating equipment other than line pressure regulators, installed inside of buildings in fixed piping systems shall comply with the following:

(a) The discharge shall be directly vented with supported piping to the outside air. The vent line shall be at least the same nominal pipe size as the regulator vent connection pipe size. Where there is more than one regulator at a location, each regulator either shall have a separate vent to the outside or the vent lines shall be manifolded in accordance with accepted engineering practices to minimize back pressure in the event of high vent discharge. The material of the vent line shall comply with 2.4.2, 2.4.3, or 2.4.8.

(b) The discharge outlet shall be located not less than 3 ft (1 m) horizontally away from any building opening below the level of such discharge. The discharge outlet shall also be located not less than 5 ft (1.5 m) in any direction away from any source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes.

(c) The discharge outlet shall be designed, installed, or protected from blockage so it will not be affected by the elements (freezing rain, sleet, snow, ice, mud or debris) or insects.

Exception No. 1: This provision shall not apply to appliance regulators otherwise protected, line pressure regulators listed as complying with ANSI Z21.80/CSA 6.22, Standard for Line Pressure Regulators, or to regulators used in connection with containers in buildings as provided for in 3.2.2.1, Exceptions Nos. 1, 2, 4, 5, and 6.

Exception No. 2: This requirement shall not apply to vaporizers.

3.2.12.7 Single-stage regulators shall be permitted to be used only on portable appliances and outdoor cooking appliances with input ratings of 100,000 Btu/hr (29 kW) maximum.

3.2.12.8* A two-psi regulator system shall consist of a first-stage regulator and a 2-psi service regulator in compliance with the requirements of 2.5.7 in conjunction with a line pressure regulator in compliance with ANSI Z21.80/CSA 6.22, *Standard for Line Pressure Regulators*. The line pressure regulator shall be installed in accordance with the requirements of NFPA 54, *National Fuel Gas Code*.

3.2.13 Piping System Service Limitations. The physical state (vapor or liquid) and pressure at which LP-Gas shall be transmitted through piping systems shall be as follows:

(a) Outdoor LP-Gas liquid or vapor metallic piping systems shall have no pressure limitations.

(b) Polyethylene piping systems shall be limited to the following:

(1) Vapor service not exceeding 30 psig (208 kPag)
(2) Installation outdoors and underground *(see 3.2.16)*

(c)*LP-Gas vapor at pressures exceeding 20 psig (138 kPag) or LP-Gas liquid shall not be piped into any building.

Exception No. 1: Buildings or separate areas of buildings constructed in accordance with Chapter 7 and used exclusively to house the following:

(a) Equipment for vaporization, pressure reduction, gas mixing, gas manufacturing, or distribution

(b) Internal combustion engines, industrial processes, research and experimental laboratories, or equipment or processing having a similar hazard

Exception No. 2: Piping systems in buildings or structures under construction or undergoing major renovation, where the temporary piping is in accordance with 3.4.2 and 3.4.10.2.

Exception No. 3: Liquid piping systems in buildings or structures feeding a vaporizer, other than those covered by 3.2.13(c) Exception Nos. 1 and 2, where heavy walled seamless brass or copper tubing not exceeding $^{3}/_{32}$-in. (2.4-mm) internal diameter and with a wall thickness not less than $^{3}/_{64}$ in. (1.2 mm) is used.

(d) Corrugated stainless steel piping systems shall be limited to vapor service not exceeding 5 psig (34 kPag).

3.2.14 Sizing of LP-Gas Vapor Piping Systems.

3.2.14.1 LP-Gas vapor piping systems downstream of the first-stage pressure regulator shall be sized so that all appliances operate within their manufacturer's specifications.

3.2.14.2 LP-Gas vapor piping systems shall be sized and installed to provide a supply of gas sufficient to meet the maximum demand of all gas utilization equipment. This shall be accomplished by using the tables in Chapter 12 or engineering methods.

3.2.15 Installation of Metallic Pipe, Tubing, and Fittings.

3.2.15.1 All metallic LP-Gas piping shall be designed and installed in accordance with ASME B 31.3, *Chemical Plant and Petroleum Refinery Piping*. All welding and brazing of metallic piping shall be in accordance with ASME *Boiler and Pressure Vessel Code*, Section IX.

3.2.15.2 Metallic piping shall comply with the following:

(a) Piping used at pressures higher than container pressure, such as on the discharge side of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psi (2.4 MPa).

(b) Vapor LP-Gas piping with operating pressures in excess of 125 psig (0.9 MPag) and liquid piping not covered by 3.2.15.2(a) shall be suitable for a working pressure of at least 250 psig (1.7 MPag).

(c) Vapor LP-Gas piping subject to pressures of not more than 125 psig (0.9 MPag) shall be suitable for a working pressure of at least 125 psig (0.9 MPag)

Exception: Safety relief discharge piping (see 3.2.11.3).

3.2.15.3 Metallic pipe joints shall be permitted to be threaded, flanged, welded, or brazed using pipe and fittings that comply with 2.4.2 and 2.4.4 as follows.

(a) Metallic threaded and welded pipe joints shall be in accordance with Table 3.2.15.3(a).

Table 3.2.15.3(a) Types of Metallic Pipe Joints in LP-Gas Service

Service	Schedule 40	Schedule 80
Liquid	Welded	Threaded or welded
Vapor, ≤125 psig (≤0.9 MPag)	Threaded or welded	Threaded or welded
Vapor, >125 psig (>0.9 MPag)	Welded	Threaded or welded

(b) Fittings and flanges shall be designed for a working pressure equal to or greater than the required working pressure of the service for which they are used.

(c) Brazed joints shall be made with a brazing material having a melting point exceeding 1000°F (538°C).

(d) Gaskets used to retain LP-Gas in flanged connections in piping shall be resistant to the action of LP-Gas. They shall be made of metal or 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.

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

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

3.2.15.4 Metallic tubing joints shall be flared or brazed using tubing and fittings in accordance with 2.4.3 and 2.4.4.

3.2.15.5 Piping in systems shall be run as directly as is practical from one point to another, with as few fittings as practical.

Where condensation of vapor can occur, piping shall be sloped back to the container or means shall be provided for revaporizing the condensate.

3.2.15.6 Piping systems including interconnecting of permanently installed containers shall compensate for expansion, contraction, jarring and vibration, and for settling. Using flexible connectors complying with 2.4.6 shall be permitted. The use of nonmetallic pipe, tubing, or hose for permanently interconnecting such containers shall be prohibited.

3.2.15.7 Aboveground piping shall be supported and protected against physical damage by vehicles. The portion of aboveground piping in contact with a support or a corrosion-causing substance shall be protected against corrosion.

3.2.15.8 Buried metallic pipe and tubing shall be installed underground with a minimum 18 in. (460 mm) of cover. The cover shall be permitted to be reduced to 12 in. (300 mm) if external damage to the pipe or tubing is not likely to result. If a minimum 12 in. (300 mm) of cover cannot be maintained, the piping shall be installed in conduit or shall be bridged (shielded). Where underground piping is beneath driveways, roads, or streets, possible damage by vehicles shall be taken into account.

3.2.15.9 Underground metallic piping shall be protected against corrosion as warranted by soil conditions *(see 3.2.24)*.

3.2.15.10 LP-Gas piping shall not be used as a grounding electrode.

3.2.16 Polyethylene Pipe, Tubing, and Fittings.

3.2.16.1 Polyethylene pipe, tubing and fittings shall be installed outdoors underground only.

3.2.16.2 Polyethylene pipe and tubing shall be buried as follows:

(1) With a minimum 18 in. (460 mm) of cover
(2) With a minimum of 12 in. (300 mm) of cover if external damage to the pipe or tubing is not likely to result
(3) If a minimum 12 in. (300 mm) of cover cannot be provided, with piping installed in conduit or bridged (shielded).

3.2.16.3 Assembled anodeless risers shall be used to terminate underground polyethylene piping systems above ground. The horizontal portion of risers shall be buried at least 12 in. (300 mm) below grade and the casing material used for the risers shall be protected against corrosion in accordance with 3.2.24.

3.2.16.4 Either the aboveground portion of the riser casing shall be provided with a plastic sleeve inside the riser casing or the pipe or tubing shall be centered in the riser casing.

3.2.16.5 Factory-assembled risers shall be sealed and leak tested by the manufacturer.

3.2.16.6 Field-assembled risers shall be supplied only in kit form with all necessary hardware for installation. Field-assembled risers shall comply with the following:

(1) Be design certified
(2) Be sealed and pressure tested by the installer
(3) Be assembled and installed in accordance with the riser manufacturer's instructions

3.2.16.7 The casing of the riser shall be constructed of one of the following materials:

(1) ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless,* Schedule 40 steel pipe
(2) ASTM A 513, *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing,* mechanical steel tubing with a minimum wall thickness of 0.073 in. (1.9 mm)
(3) A flexible metal tubing with a minimum crush strength of 1000 lb (453.6 kg) and a tensile strength of 300 lb (136 kg) including the transition connection as tested by the manufacturer

3.2.16.8* Polyethylene piping shall be installed so as to minimize thrust forces caused by contraction or expansion of the piping or by anticipated external or internal loading. The pipeline shall be designed and installed so that each joint will sustain these forces.

3.2.16.9 An electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape shall be buried with the polyethylene pipe to facilitate locating. One end shall be brought aboveground at a building wall or riser. The wire or tape shall not be in direct contact with the polyethylene pipe.

3.2.16.10 Polyethylene piping that is installed in a vault or any other belowground enclosure shall be completely encased in gastight metal pipe and fittings that are protected from corrosion.

3.2.16.11 Polyethylene piping shall be installed in accordance with the manufacturer's installation instructions.

3.2.16.12 Where polyethylene pipe or tubing is inserted into an existing steel pipe, the polyethylene pipe or tubing shall be protected from being damaged during the insertion process. The leading end of the polyethylene being inserted shall also be closed prior to insertion.

3.2.16.13 Polyethylene pipe that is not encased shall have a minimum wall thickness of 0.090 in. (2.3 mm).

Exception: Pipe with an outside diameter of 0.875 in. (22.2 mm) or less shall be permitted to have a minimum wall thickness of 0.062 in. (1.6 mm).

3.2.16.14 Valves in polyethylene piping shall comply with following:

(a) Valves shall protect the pipe from excessive torsional or shearing loads when the valve is operated.

(b) Valve boxes shall be installed so as to avoid transmitting external loads to the valve or pipe.

3.2.16.15 Valves shall be recommended for LP-Gas service by the manufacturer. Valves shall be manufactured from thermoplastic materials fabricated from materials listed in ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, that have been shown to be resistant to the action of LP-Gas, or from metals protected to minimize corrosion in accordance with 3.2.24.

3.2.16.16 Each imperfection or damaged piece of polyethylene pipe shall be replaced by fusion or mechanical fittings. Repair clamps shall not be used to cover damaged or leaking sections.

3.2.17 Flexible Connectors. Flexible components used in piping systems shall comply with the following:

(a) They shall be installed in accordance with the manufacturer's instructions.

(b) *Flexible connectors and hose used as flexible connectors shall not exceed 36 in. (1 m) in length where used with liquid or vapor piping on portable or stationary tanks.

(c) Hose shall be permitted to be installed if flexibility is required for liquid or vapor transfer.

3.2.18 Internal Valves.

3.2.18.1 All of the following shall be required for internal valves in liquid service installed on containers over 4000-gal (15.2-m^3) water capacity by July 1, 2003.

3.2.18.2 Automatic shutdown of internal valves in liquid service shall be provided using thermal (fire) actuation. The thermal element shall be within 5 ft (1.5 m) of the internal valve.

3.2.18.3 At least one remote shutdown station for internal valves in liquid service shall be installed not less than 25 ft (7.6 m) or more than 100 ft (30 m) from the liquid transfer point.

3.2.18.4 Emergency remote shutdown stations shall be identified by a sign incorporating the words "Propane — Container Liquid Valve Emergency Shutoff" in block letters of not less than 2 in. (51 mm) in height on a background of contrasting colors to the letters. The sign shall be visible from the point of transfer.

3.2.19 Emergency Shutoff Valves.

3.2.19.1 On new installations and, by December 31, 1980, on existing installations, stationary container storage systems with an aggregate water capacity of more than 4000 gal (15.1 m^3) utilizing a common or manifolded liquid transfer line that is larger than $1^1/_2$ in. (39 mm) and a pressure equalizing vapor line that is larger than $1^1/_4$ in. (32 mm) shall comply with the following subsections.

3.2.19.2 An emergency shutoff valve complying with 2.4.5.4 shall be installed in the liquid or vapor transfer lines of the fixed piping transfer system within 20 ft (6 m) of lineal pipe from the nearest end of the hose or swivel-type piping connections.

Exception: When the flow is only into the container, a backflow check valve shall be permitted to be used in lieu of an emergency shutoff valve if installed in the fixed piping transfer system downstream of the hose or swivel-type piping connections. The backflow check valve shall have a metal-to-metal seat or a primary resilient seat with metal back-up, not hinged with combustible material, and shall be designed for this specific application.

3.2.19.3 Where there are two or more liquid or vapor lines with hoses or swivel-type piping connected of the sizes designated, an emergency shutoff valve or a backflow check valve where allowed shall be installed in each leg of the piping.

3.2.19.4 Emergency shutoff valves shall be installed so that the temperature-sensitive element in the valve, or a supplemental temperature-sensitive element [250°F (121°C) maximum] connected to actuate the valve, is not more than 5 ft (1.5 m) from the nearest end of the hose or swivel-type piping connected to the line in which the valve is installed.

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

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

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

3.2.19.8 All new installations and existing installations of emergency shutoff valves shall have at least one clearly identified and easily accessible manually operated remote emergency shutoff device. The device shall be located not less than 25 ft (7.6 mm) or more than 100 ft (30.5 m) in the path of egress from the emergency shutoff valve.

3.2.19.9 Emergency shutoff valve requirements and other requirements for railroad tank car transfer systems are located in 3.3.3.3, 3.3.3.8, 3.11.4, 4.2.3.5, 4.2.3.6, and 4.2.3.8.

3.2.20 Hose for Portable Appliances. Where hose is to be used on the low-pressure side of regulators to connect to other than domestic and commercial appliances, the following subsections shall apply.

3.2.20.1 The appliance connected shall be of a portable type.

3.2.20.2 Where used inside buildings, the following shall apply:

(a) The hose shall be the minimum practical length not exceeding 6 ft (1.8 m).

(b) The hose shall not extend from one room to another or pass through any partitions, walls, ceilings, or floors except as provided by 3.4.3.7.

(c) The hose shall not be concealed from view or used in concealed locations.

3.2.20.3 Where installed outside of buildings, the hose length shall be permitted to exceed 6 ft (1.8 m) but shall be as short as practical.

3.2.20.4 Hose shall be securely connected to the appliance. The use of rubber slip ends shall not be permitted.

3.2.20.5 A shutoff valve shall be provided in the piping immediately upstream of the inlet connection of the hose. Where more than one such appliance shutoff is located near another, the valves shall be marked to indicate which appliance is connected to each valve.

3.2.20.6 Hose shall be protected against physical damage.

3.2.21 Hydrostatic Relief Valve Installation. A hydrostatic relief valve that complies with 2.4.7 or a device providing pressure-relieving protection shall be installed in each section of piping (including hose) in which liquid LP-Gas can be isolated between shutoff valves so as to relieve the pressure that could develop from the trapped liquid to a safe atmosphere or product-retaining section.

3.2.22 Testing Piping Systems. After assembly, piping systems (including hose) shall be tested and proven free of leaks at not less than the normal operating pressure. Piping within the scope of NFPA 54, *National Fuel Gas Code [see 1.1.2(6)]*, shall be pressure tested in accordance with that code. Tests shall not be made with a flame.

3.2.23 Areas of Heavy Snowfall. In areas where heavy snowfall is anticipated, piping, regulators, meters, and other equipment installed in the piping system shall be protected from the forces anticipated as a result of accumulated snow.

3.2.24* Corrosion Protection. All metallic equipment and components that are buried or mounded shall be coated or protected and maintained to minimize corrosion. Corrosion protection of all other materials shall be in accordance with accepted engineering practice.

3.2.25 Equipment Installation.

3.2.25.1 Pumps shall be installed as recommended by the manufacturer and in accordance with the following:

(a) Installation shall be made so that the pump casing is not subjected to excessive strains transmitted to it by the suction and discharge piping. Such protection shall be accomplished by piping design, the use of flexible connectors or expansion loops, or by other means.

(b) Positive displacement pumps shall be installed in accordance with the following:

(1) The bypass valve or recirculating device to limit the normal operating discharge pressure shall discharge either into a storage container or into the pump inlet.
(2) If the bypass valve or recirculating device is equipped with a shutoff valve, a secondary device shall be required and designed to operate at not more than 400 psi (2.8 MPa) or, for systems with a design pressure above 350 psi (2.4 MPa), 50 psi (345 kPa) above the operating pressure. The secondary device shall be incorporated, if not integral with the pump, in the pump piping and shall be designed or installed so that it cannot be rendered inoperative and shall discharge either into a storage container or into the pump inlet.

(c) A pump operating control or disconnect switch shall be located near the pump. Remote control points shall be provided for other plant operations such as container filling, loading or unloading of cargo tank vehicles and railroad tank cars, or operation of the engine fuel dispenser.

3.2.25.2 Compressors shall be installed as recommended by the manufacturer and shall be in accordance with the following:

(a) Installation shall be made so that the compressor housing is not be subjected to excessive strains transmitted to it by the suction and discharge piping. The use of flexible connectors to isolate the piping shall not be prohibited.

(b) Where the compressor is not equipped with an integral means to prevent the LP-Gas liquid from entering the suction, a liquid trap shall be installed in the suction piping as close to the compressor as practical.

Exception: Portable compressors used with temporary connections shall be excluded from this requirement unless used to unload railroad tank cars.

(c) Engines used to drive portable compressors shall be equipped with exhaust system spark arresters and shielded ignition systems.

3.2.25.3 Strainers shall be installed so that the strainer element can be removed without removing equipment or piping.

3.2.25.4 Liquid or vapor meters shall be installed as recommended by the manufacturer and shall be in compliance with the following:

(a) Liquid meters shall be installed so that the meter housing is not subject to excessive strains from the connecting piping. If not provided in the piping design, the use of flexible connectors shall not be prohibited.

(b) Vapor meters shall be installed so as to minimize the possibility of physical damage.

3.3 Bulk Plant and Industrial LP-Gas Systems.

3.3.1 Application. This section includes provisions for LP-Gas systems installed at bulk plants and industrial plants. It also includes provisions for operations, maintenance, and fire safety analyses, to augment the other leak control, ignition source control, and fire protection provisions in this code. The provisions of Chapter 11 shall apply to all new LP-gas installations at bulk plants, industrial occupancies, and industrial plants and by 3 years after effective date to existing installations at bulk plants and industrial plants.

3.3.2 General. The location and installation of storage containers and the installation of container appurtenances, piping, and equipment shall comply with Section 3.2.

3.3.3 Installation of Liquid Transfer Facilities.

3.3.3.1 Points of transfer *(see 1.7.53)* or the nearest part of a structure housing transfer operations shall be located in accordance with 3.2.3.2 and 3.2.3.3.

3.3.3.2 Buildings used exclusively for housing pumps or vapor compressors shall be located in accordance with 3.2.3.3, considering the building as one that houses a point of transfer.

3.3.3.3 The track of the railroad siding or the roadway surface at the transfer points shall be relatively level. Adequate clearances from buildings, structures, or stationary containers shall be provided for the siding or roadway approaches to the unloading or loading points to prevent the railroad tank car or cargo tank vehicle from contacting buildings, structures, or stationary containers. Barriers shall be provided at the ends of railroad sidings.

3.3.3.4 Compressors used for liquid transfer normally shall withdraw vapor from the vapor space of the container being filled and discharge into the vapor space of the container from which the withdrawal is being made.

3.3.3.5 Pumps and compressors shall be provided with an operating control or disconnect switch located nearby. Remote shutoff controls shall be provided as necessary in other liquid transfer systems.

3.3.3.6 Safeguards shall be provided to prevent the uncontrolled discharge of LP-Gas in the event of failure of the hose or swivel-type piping. The provisions of 3.2.19 shall apply. For containers at bulk plants and industrial plants that have connections or connecting piping up to $^1/_2$-in. internal diameter, see 2.3.3.2.

For containers at bulk plants and industrial plants that exceed 2000-gal (7.6-m^3) water capacity and have connections or connecting piping larger than $^1/_2$-in. internal diameter, the following shall apply:

(a) The connection or connecting piping through which vapor is being transferred into a container shall be equipped with one of the following:

(1) For containers exceeding 2000-gal (7.6-m^3) water capacity, one of the following shall apply:
   a. A positive shutoff valve that is installed as close to the container as practical in combination with either a backflow check valve or an excess flow valve properly sized in accordance with 2.3.7.1(d) installed in the container
   b. An internal valve with an excess-flow feature properly sized in accordance with 2.3.7.1(d).

(b) The connection or connecting piping through which liquid is being transferred into a container shall be equipped with at least one of the following:

(1) For containers that have a water capacity greater than 2001 (7.6 m^3) and up to and including 4000 gal (15.2 m^3), one of the following shall apply:
   a. A positive shutoff valve that is installed as close to the container as practical in combination with either a backflow check valve or an excess flow valve properly sized in accordance with 2.3.7.1(d) installed in the container.
   b. An internal valve with an excess flow feature properly sized in accordance with 2.3.7.1(d).

(2) For containers over 4000-gal (15.2-m^3) water capacity, one of the following shall apply:
   a. An internal valve equipped for remote closure and automatic shutoff using thermal (fire) actuation
   b. For liquid inlet connections only, a positive shutoff valve that is located as close to the container as practical in combination with a backflow check valve designed for the intended application and installed in the container.
   c. Existing containers are required to be retrofitted in accordance with 2.3.3.2(b)(4)(d) by July 1, 2011.

(c) The connection or connecting piping through which vapor is being withdrawn from a container shall be equipped with at least one of the following:

(1) For containers over 2000 gal (7.6 m^3), one of the following shall apply:
   a. A positive shutoff valve that is installed as close to the container as practical in combination with an excess flow valve properly sized in accordance with 2.3.7.1(d) installed in the container.
   b. An internal valve with an excess-flow feature properly sized in accordance with 2.3.7.1(d).

(d) The connection or connecting piping from which liquid is withdrawn from a container shall be equipped with the following:

(1) For containers that have a water capacity greater than 2001 gal and up to and including 4000-gal (15.2-m^2) water capacity, one of the following shall apply:
   a. A positive shutoff valve that is installed as close to the container as practical in combination with an excess-flow valve properly sized in accordance with 2.3.7.1(d) installed in the container
   b. An internal valve with an excess flow feature in accordance with 2.3.7.1(d)

(2) For containers over 4000-gal (15.2-m^3) water capacity, one of the following shall apply:
   a. An internal valve equipped for remote closure and automatic shutoff using thermal (fire) actuation. See retrofit requirements in 2.3.3.2(b)(2)(c).
   b. Existing containers are required to be retrofitted in accordance with 2.3.3.2(b)(2)(c) by July 1, 2011.

3.3.3.7 System piping shall be designed to prevent debris from impeding the action of valves and other components of the piping system.

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

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

(b) An emergency shutoff valve or a backflow check valve shall be installed on the tank car end of the hose or swivel piping where flow is only into the railroad type tank car.

3.3.3.9 Transfer hose larger than $^1/_2$-in. (12-mm) internal diameter shall not be used for making connections to individual containers being filled indoors.

3.3.3.10 If gas is to be discharged from containers inside a building, the provisions of 4.3.2.1 shall apply.

3.3.4 Installation of Gas Distribution Facilities.

3.3.4.1 This subsection shall apply to the following:

(1) Gas manufacturing facilities
(2) Gas storage facilities
(3) Gas–air mixing and vaporization facilities
(4) Compressors not associated with liquid transfer

3.3.4.2 Separate buildings and attachments to such buildings or rooms within other buildings housing gas distribution facilities shall comply with Chapter 7.

Exception No. 1: Facilities for vaporizing LP-Gas and gas-air mixing shall be designed, located, and installed in accordance with Section 3.6.

Exception No. 2: Facilities for storing LP-Gas in cylinders at industrial plants and distributing points shall comply with Chapter 5.

3.3.4.3 Separate buildings used for housing vapor compressors shall be located in accordance with 3.2.3.3, considering the building as one that houses a point of transfer.

3.3.4.4 Where pits are used to house gas distribution facilities, automatic flammable vapor detecting systems shall be installed in the pit. Drains or blow-off lines shall not be directed into or in proximity of sewer systems.

3.3.4.5 If gas is to be discharged from containers inside a building, the installation provisions of 4.3.2.1 shall apply.

3.3.5 Installation of Electrical Equipment. Installation of electrical equipment shall comply with 3.7.2.

3.3.6 Protection Against Tampering for Section 3.3 and Section 3.9 Systems. The area that includes container appurtenances, pumping equipment, loading and unloading facilities, and container filling facilities shall be protected by one of the methods in the following subsections.

3.3.6.1 Enclosure with at least a 6-ft (1.8-m) high industrial-type fence, chain link fence, or equivalent protection. There shall be at least two means of emergency access from the enclosure. Clearance of at least 3 ft (1.0 m) shall be provided to allow emergency access to the required means of egress. If guard service is provided, it shall be extended to the LP-Gas installation. The requirements of Section 1.5 shall apply to guard personnel.

Exception No. 1: A second gate shall not be required where

(a) The fenced or otherwise enclosed area is not over 100 ft² (9 m²)

(b) The point of transfer is within 3 ft (1 m) of the gate

(c) Containers are not filled within the enclosure

Exception No. 2: Fencing shall not be required where devices that prevent unauthorized operation of valves, equipment, and appurtenances that can be locked in place are provided.

3.3.6.2 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.

3.3.7 Lighting. If operations are normally conducted during other than daylight hours, lighting shall be provided to illuminate storage containers, containers being loaded, control valves, and other equipment.

3.3.8 Ignition Source Control. Ignition source control shall comply with Section 3.7.

3.4 LP-Gas Systems in Buildings or on Building Roofs or Exterior Balconies.

3.4.1 Application.

3.4.1.1 This section shall apply to the installation of LP-Gas systems in buildings or structures. These systems include those utilizing cylinders inside of or on the roofs or exterior balconies of buildings and those in which the liquid is piped from outside containers into buildings or onto the roof. Cylinders in use shall mean connected for use. These systems shall be permitted in accordance with 3.4.1 and 3.4.2.

(a) The use of cylinders indoors shall be only for the purposes specified in 3.4.3 through 3.4.8. Such use shall be limited to those conditions where operational requirements make use of cylinders necessary and location outside is impractical.

(b) Installations using cylinders on roofs shall be as specified in 3.4.9.1. Such use shall be limited to those conditions where operational requirements make use of cylinders necessary and location other than on roofs of buildings or structures is impractical.

(c) Installations using cylinders on exterior balconies shall be as specified in 3.4.9.2.

(d) Liquid LP-Gas shall be piped into buildings or structures only for the purposes specified in 3.2.13(c).

3.4.1.2 Storage of cylinders awaiting use shall be in accordance with Chapter 5.

3.4.1.3 Transportation of cylinders within a building shall be in accordance with 3.4.2.7.

3.4.1.4 The following provisions shall be required in addition to those specified in Section 3.2.

(a) Liquid transfer systems shall be in accordance with Chapter 4.

(b) Engine fuel systems used inside buildings shall be in accordance with Chapter 8.

(c) LP-Gas transport or cargo tank vehicles stored, serviced, or repaired in buildings shall be in accordance with Chapter 6.

3.4.2 General Provisions for Cylinders, Equipment, Piping, and Appliances.

3.4.2.1 Cylinders shall be in accordance with the following requirements:

(a) They shall comply with DOT cylinder specifications.

(b) They shall not exceed 245 lb (111 kg) water capacity [nominal 100 lb (45 kg) LP-Gas capacity] each.

(c) They shall comply with other applicable provisions of Section 2.2, and they shall be equipped as provided in Section 2.3.

(d) Cylinders shall be marked in accordance with 2.2.6.1 and 2.2.6.2.

(e) Cylinders with propane capacities greater than 2 lb (0.9 kg) shall be equipped as provided in Table 2.3.3.2(a), and an excess-flow valve shall be provided for vapor service.

(f) Cylinder valves shall be protected in accordance with 2.2.4.1.

(g) Cylinders having water capacities greater than 2.7 lb (1.2 kg) and connected for use shall stand on a firm and substantially level surface. If necessary, they shall be secured in an upright position.

(h) Cylinders and the valve-protecting devices used with them shall be oriented to minimize the possibility of impingement of the pressure relief device discharge on the cylinder and adjacent cylinders.

3.4.2.2 Regulators shall be recommended by the manufacturer for use with LP-Gas. Manifolds and fittings connecting cylinders to pressure regulator inlets shall be designed for at least 250-psig (1.7-MPag) service pressure.

3.4.2.3 Piping shall comply with Section 2.4 and shall have a minimum working pressure of 250 psig (1.7 MPag). The following also shall apply:

(a) Liquid piping and vapor piping at pressures above 125 psig (0.9 MPag) shall be installed in accordance with 3.2.15.

(b) Hose, hose connections, and flexible connectors shall comply with the following:

(1) Hose used at pressures above 5 psi (34 kPa) shall be designed for a working pressure of at least 350 psig (2.4 MPag). Hose used at a pressure of 5 psi (34 kPa) or less and used in agricultural buildings not normally

occupied by the public shall be designed for the operating pressure of the hose.
(2) Hose shall comply with 2.4.6.
(3) Hose shall be installed in accordance with 3.2.20.
(4) Hose length requirements of 3.2.20.2(a) shall be applicable.
(5) Hose shall be as short as practical, without kinking or straining hose or causing it to be close enough to a burner to be damaged by heat.

3.4.2.4 Cylinders, regulating equipment, manifolds, pipe, tubing, and hose shall be located to minimize exposure to the following:

(1) Abnormally high temperatures (such as might result from exposure to convection and radiation from heating equipment or installation in confined spaces)
(2) Physical damage
(3) Tampering by unauthorized persons

3.4.2.5 Heat-producing equipment shall be installed with clearance to combustibles in accordance with the manufacturer's installation instructions. It shall be located and used to minimize the possibility of the ignition of combustibles.

3.4.2.6 Where cylinders are located on a floor, roof, or balcony, cylinders shall be secured to prevent falling over the edge.

3.4.2.7 Transportation (movement) of cylinders having water capacities greater than 2.7 lb (1.2 kg) within a building shall be restricted to movement directly associated with the uses covered by this section and in accordance with the following:

(a) Valve outlets on cylinders having water capacities greater than 2.7 lb (1.2 kg) shall be tightly plugged, capped, or sealed with a listed quick-closing coupling or a listed quick-connect coupling.

(b) Only emergency stairways not normally used by the public shall be used, and precautions shall be taken to prevent the cylinder from falling down the stairs where freight or passenger elevators are used. They shall be occupied only by those engaged in moving the cylinder.

3.4.2.8 Portable heaters, including salamanders, shall comply with the following:

(a) They shall be equipped with an approved automatic device to shut off the flow of gas to the main burner and to the pilot, if used, in the event of flame extinguishment or combustion failure.

(b) Portable heaters shall be self-supporting unless designed for cylinder mounting *(see 3.4.3.3 Exception)*.

(c) Cylinder valves, connectors, regulators, manifolds, piping, or tubing shall not be used as structural supports.

(d) Portable heaters manufactured on or after May 17, 1967, having an input of more than 50,000 Btu/hr (53 MJ/hr), and those manufactured prior to May 17, 1967, with inputs of more than 100,000 Btu/hr (105 MJ/hr), shall be equipped with either of the following:

(1) A pilot that must be lighted and proved before the main burner can be turned on
(2) An approved electric ignition system

Exception: The provisions of 3.4.2.8 shall not be applicable to the following:

(a) Tar kettle burners, hand torches, or melting pots

(b) Portable heaters with less than 7500-Btu/hr (8-MJ/hr) input if used with cylinders having a maximum water capacity of 2.7 lb (1.2 kg) and filled with no more than 16.8 oz (0.522 kg) of LP-Gas.

3.4.3 Buildings Under Construction or Undergoing Major Renovation.

3.4.3.1 Cylinders shall be permitted to be used and transported in buildings or structures under construction or undergoing major renovation where such buildings are not occupied by the public. In such buildings or structures partially occupied by the public, cylinders shall be permitted to be used and transported in the unoccupied portions with the prior approval of the authority having jurisdiction.

3.4.3.2 Cylinders, equipment, piping, and appliances shall comply with 3.4.2.

3.4.3.3 Heaters used for temporary heating shall be located at least 6 ft (1.8 m) from any cylinder.

Exception: Integral heater-cylinder units specifically designed for the attachment of the heater to the cylinder, or to a supporting standard attached to the cylinder, where they are designed and installed to prevent direct or radiant heat application to the cylinder shall be exempt from this spacing requirement.

3.4.3.4 Blower-type and radiant-type units shall not be directed toward any cylinder within 20 ft (6.1 m).

3.4.3.5 If two or more heater-cylinder units of either the integral or nonintegral type are located in an unpartitioned area on the same floor, the cylinder(s) of each such unit shall be separated from the cylinder(s) of any other such unit by at least 20 ft (6.1 m).

3.4.3.6 If heaters are connected to cylinders manifolded together for use in an unpartitioned area on the same floor, the total water capacity of cylinders manifolded together serving any one heater shall not be greater than 735 lb (333 kg) [nominal 300 lb (136 kg) LP-Gas capacity], and, if there is more than one such manifold, it shall be separated from any other by at least 20 ft (6.1 m).

3.4.3.7 Where cylinders are manifolded together for connection to a heater or heaters on another floor, the following shall apply:

(a) Heaters shall not be installed on the same floors as manifolded cylinders.

(b) The total water capacity of the cylinders connected to any one manifold is not greater than 2450 lb (1111 kg) [nominal 1000 lb (454 kg) LP-Gas capacity].

(c) Manifolds of more than 735 lb (333 kg) water capacity [nominal 300 lb (136 kg) LP-Gas capacity], if located in the same unpartitioned area, shall be separated from each other by at least 50 ft (15 m).

3.4.3.8 Where compliance with the provisions 3.4.3.4, 3.4.3.5, 3.4.3.6, and 3.4.3.7 is impractical, alternate installation provisions shall be allowed with the approval of the authority having jurisdiction.

3.4.4 Buildings Undergoing Minor Renovation When Frequented by the Public. Cylinders used and transported for repair or minor renovation in buildings frequented by the public shall comply with the following:

3.4.4.1 During the hours the public normally occupies the building, the following shall apply:

(a) The maximum water capacity of individual cylinders shall be 50 lb (23 kg) [nominal 20 lb (9.1 kg) LP-Gas capacity], and the number of cylinders in the building shall not exceed the number of workers assigned to the use of the LP-Gas.

(b) Cylinders having a water capacity greater than 2.7 lb (1.2 kg) shall not be left unattended.

3.4.4.2 During the hours the building is not open to the public, cylinders shall be permitted to be used and transported within the building for repair or minor renovation in accordance with 3.4.2 and 3.4.3, provided that cylinders with a water capacity greater than 2.7 lb (1.2 kg) shall not be left unattended.

3.4.5 Buildings Housing Industrial Occupancies.

3.4.5.1 Cylinders used in buildings housing industrial occupancies for processing, research, or experimental purposes shall comply with the following:

(a) Cylinders, equipment, and piping used shall comply with 3.4.2.

(b) If cylinders are manifolded together, the total water capacity of the connected cylinders shall be not more than 735 lb (333 kg) [nominal 300 lb (136 kg) LP-Gas capacity]. If there is more than one such manifold in a room, it shall be separated from any other by at least 20 ft (6.1 m).

(c) The amount of LP-Gas in cylinders for research and experimental use in the building shall be limited to the smallest practical quantity.

3.4.5.2 The use of cylinders to be used to supply fuel for temporary heating in buildings housing industrial occupancies with essentially noncombustible contents shall comply with 3.4.3. This use shall be allowed only where portable equipment for space heating is essential and a permanent heating installation is not practical.

3.4.6 Buildings Housing Educational and Institutional Occupancies. The use of cylinders in classrooms shall be prohibited. Where cylinders are used in buildings housing educational and institutional laboratory occupancies for research and experimental purposes, the following shall apply:

3.4.6.1 The maximum water capacity of individual cylinders used shall be 50 lb (23 kg) [nominal 20 lb (9.1 kg) LP-Gas capacity] if used in educational occupancies and 12 lb (5.4 kg) [nominal 5 lb (2 kg) LP-Gas capacity] if used in institutional occupancies.

3.4.6.2 If more than one such cylinder is located in the same room, the cylinders shall be separated by at least 20 ft (6.1 m).

3.4.6.3 Cylinders not connected for use shall be stored in accordance with Chapter 5.

Exception: Cylinders shall not be stored in a laboratory room.

3.4.7 Temporary Heating and Food Service Appliances in Buildings in Emergencies.

3.4.7.1 Cylinders shall not be used in buildings for temporary emergency heating purposes except when all of the following conditions are met:

(1) The permanent heating system is temporarily out of service.
(2) Heat is necessary to prevent damage to the buildings or contents.
(3) The cylinders and heaters comply with and are used and transported in accordance with 3.4.2 and 3.4.3.
(4) The temporary heating equipment is not left unattended.

3.4.7.2 When a public emergency has been declared and gas, fuel, or electrical service has been interrupted, portable listed LP-Gas commercial food service appliances meeting the requirements of 3.4.8.4 shall be permitted to be temporarily used inside affected buildings. The portable appliances used shall be discontinued and removed from the building at the time the permanently installed appliances are placed back in operation.

3.4.8 Use in Buildings for Demonstrations or Training, or Use in Small Cylinders.

3.4.8.1 Cylinders used temporarily inside buildings for public exhibitions or demonstrations, including use in classroom demonstrations, shall be in accordance with the following:

(a) The maximum water capacity of a cylinder shall be 12 lb (5.4 kg) [nominal 5 lb (2 kg) LP-Gas].

(b) If more than one such cylinder is located in a room, the cylinders shall be separated by at least 20 ft (6.1 m).

3.4.8.2 Cylinders used temporarily in buildings for training purposes related to the installation and use of LP-Gas systems shall be in accordance with the following:

(a) The maximum water capacity of individual cylinders shall be 245 lb (111 kg) [nominal 100 lb (45 kg) LP-Gas capacity], but not more than 20 lb (9.1 kg) of LP-Gas shall be placed in a single cylinder.

(b) If more than one such cylinder is located in the same room, the cylinders shall be separated by at least 20 ft (6.1 m).

(c) The training location shall be acceptable to the authority having jurisdiction.

(d) Cylinders shall be promptly removed from the building when the training class has terminated.

3.4.8.3* Cylinders used in buildings as part of approved self-contained torch assemblies or similar appliances shall be in accordance with the following:

(a) Cylinders used in buildings shall comply with UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*

(b) Cylinders shall have a maximum water capacity of 2.7 lb (1.2 kg).

3.4.8.4 Cylinders used with commercial food service appliances shall be used inside restaurants and in attended commercial food catering operations in accordance with the following:

(a) Cylinders and appliances shall be listed.

(b) Commercial food service appliances shall not have more than two 10-oz (296-ml) nonrefillable butane gas cylinders, each having a maximum capacity of 1.08 lb (0.490 Kg).

(c) Cylinders shall comply with UL 147B, *Standard for Nonrefillable (Disposal) Type Metal Container Assemblies for Butane.*

(d) Cylinders shall be connected directly to the appliance and shall not be manifolded.

(e) Cylinders shall be an integral part of the listed, approved, commercial food service device and shall be connected without the use of a rubber hose.

(f) Storage of cylinders shall be in accordance with 5.3.1.

3.4.9 Cylinders on Roofs or Exterior Balconies.

3.4.9.1 Cylinders installed permanently on roofs of buildings of fire-resistant construction or noncombustible construction having essentially noncombustible contents, or of other construction or contents that are protected with automatic sprinklers *(see NFPA 220, Standard on Types of Building Construction)* shall be in accordance with the following:

(a) The total water capacity of cylinders connected to any one manifold shall be not greater than 980 lb (445 kg) [nominal 400 lb (181 kg) LP-Gas capacity]. If more than one manifold

is located on the roof, it shall be separated from any other by at least 50 ft (15 m).

(b) Cylinders shall be located in areas where there is free air circulation, at least 10 ft (3.0 m) from building openings (such as windows and doors), and at least 20 ft (6.1 m) from air intakes of air conditioning and ventilating systems.

(c) Cylinders shall not be located on roofs that are entirely enclosed by parapets more than 18 in. (457 mm) high unless the parapets are breached with low-level ventilation openings no more than 20 ft (6.1 m) apart or all openings communicating with the interior of the building are at or above the top of the parapets.

(d) Piping shall be in accordance with 3.4.2.3. Hose shall not be used for connection to cylinders.

(e) The fire department shall be advised of each such installation.

3.4.9.2 Cylinders having water capacities greater than 2.7 lb (1 kg) [nominal 1 lb (0.5 kg)] LP-Gas capacity shall not be located on balconies above the first floor that are attached to a multiple family dwelling of three or more living units located one above the other.

Exception: Cylinders located on balconies served by outside stairways, where only such stairways are used to transport the cylinder shall not be prohibited.

3.4.10 Liquid LP-Gas Piped into Buildings or Structures.

3.4.10.1 Liquid LP-Gas piped into buildings in accordance with 3.2.13(c), Exception No. 1, shall comply with 3.2.15.

3.4.10.2 Liquid LP-Gas piped into buildings in accordance with 3.2.13(c), Exception No. 2, from containers located and installed outside the building or structure in accordance with 3.2.2 and 3.2.3 shall comply with the following:

(a) Liquid piping shall not exceed $^3/_4$ in. and shall comply with 3.2.13 and 3.2.15. Copper tubing with a maximum outside diameter of $^3/_4$ in. shall be used where approved by the authority having jurisdiction. Liquid piping in buildings shall be kept to a minimum length and shall be protected against construction hazards by the following methods:

(1) Fastening it to walls or other surfaces to provide protection against breakage
(2) Locating it so as to avoid exposure to high ambient temperatures

(b) A readily accessible shutoff valve shall be located at each intermediate branch line where it leaves the main line. A second shutoff valve shall be located at the appliance end of the branch and upstream of any flexible appliance connector.

(c) Excess-flow valves complying with 2.3.3.3(b) shall be installed in the container outlet supply line as follows:

(1) They shall be downstream of each branch line shutoff valve, and
(2) They shall be at any point in the piping system where the pipe size is reduced
(3) They shall be sized for the reduced size piping.

(d) Hose shall not be used to carry liquid between the container and building and shall not be used at any point in the liquid line.

Exception: Hose used as the appliance connector shall be as short as practical and shall comply with 2.4.6, 3.2.17, and 3.2.20.

(e) Hydrostatic relief valves shall be installed in accordance with 3.2.21.

(f) The release of fuel when any section of piping or appliances is disconnected shall be minimized by one of the following methods:

(1) Using an approved automatic quick-closing coupling that shuts off the gas on both sides when uncoupled
(2) Closing the shutoff valve closest to the point to be disconnected and allowing the appliance or appliances on that line to operate until the fuel in the line is consumed

3.5 Installation of Appliances.

3.5.1 Application.

3.5.1.1 This section shall apply to the installation of LP-Gas appliances fabricated in accordance with Section 2.6.

3.5.1.2 Installation of appliances on commercial vehicles shall be in accordance with Section 3.8.

3.5.2 Referenced Standards. LP-Gas appliances shall be installed in accordance with this code and the following standards:

(1) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
(2) NFPA 54, *National Fuel Gas Code* (ANSI Z223.1)
(3) NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*
(4) NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*
(5) NFPA 86, *Standard for Ovens and Furnaces*
(6) NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*
(7) NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*
(8) NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*
(9) NFPA 1192, *Standard on Recreational Vehicles* (ANSI A119.2)

3.6 Vaporizer Installation.

3.6.1 Application. This section shall apply to the installation of vaporizing devices covered in 2.5.5.

Exception: It shall not apply to engine fuel vaporizers or to integral vaporizing burners such as those used for weed burners or tar kettles.

3.6.2 Installation of Indirect-Fired Vaporizers. Indirect-fired vaporizers shall comply with 2.5.5.1, and shall be installed as according to the following subsections.

3.6.2.1 Indirect fired vaporizers shall comply with 2.5.5.1.

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

(a) Separate buildings or structures shall comply with Section 7.2.

(b) Attached structures or rooms shall comply with Section 7.3.

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

3.6.2.3 If the heat source of an indirect vaporizer is gas fired and is located within 15 ft (4.6 m) of the vaporizer, the vaporizer and its heat source shall be installed as a direct-fired vaporizer and shall be subject to the requirements of 3.6.3.

3.6.2.4 The installation of a heat source serving an indirect vaporizer that utilizes a flammable or combustible heat transfer fluid shall comply with one of the following:

(a) It shall be located outdoors.

(b) If installed within a structure, the structure shall comply with Section 7.2.

(c) If installed in structures attached to, or in rooms within, buildings, the structures or rooms shall comply with Section 7.3.

3.6.2.5 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 ignition fails to occur.

3.6.2.6 The installation of a heat source serving an indirect vaporizer that utilizes a noncombustible heat transfer fluid, such as steam, water, or a water-glycol mixture, shall be installed outdoors or shall comply with the following:

(a) Where a source of heat for an indirect vaporizer is installed in an industrial occupancy *(see 1.7.34, Industrial Occupancy)* complying with Chapter 28 of NFPA *101®, Life Safety Code®*, and Section 6.3 of NFPA 54, *National Fuel Gas Code* (ANSI Z223.1), the following shall apply:

(1) The heat transfer fluid shall be steam or hot water.

(2) The heat transfer fluid shall not be recirculated.

(3) A backflow preventer shall be installed between the vaporizer and the heat source.

(b) If the heat transfer fluid is recirculated after leaving the vaporizer, the heat source shall be installed in accordance with 3.6.2.4 and a phase separator shall be installed with the gas vented.

3.6.2.7 Indirect-fired vaporizers employing heat from the atmosphere shall be installed outdoors and shall be located in accordance with Table 3.6.3.5.

Exception: Where atmospheric vaporizers of less than 1-qt (0.9-L) capacity are installed inside an industrial building, they shall be installed as close as practical to the point of entry of the supply line in the building.

3.6.3 Installation of Direct-Fired Vaporizers.

3.6.3.1 Direct-fired vaporizers shall comply with 2.5.5.2 and shall be installed as follows.

3.6.3.2 Where a direct-fired vaporizer is installed in a separate structure, the separate structure shall be constructed in accordance with Chapter 7.

3.6.3.3 The housing for direct-fired vaporizers shall not have any drains to a sewer or a sump pit that is shared with any other structure or to a sewer. Pressure relief valve discharges on direct-fired vaporizers shall be piped to a point outside the structure or building.

3.6.3.4 Direct-fired vaporizers shall be connected to the liquid space or to the liquid or vapor space of the container. A manually operated shutoff valve shall be installed in each connection of the container supplying the vaporizer.

3.6.3.5 Direct-fired vaporizers of any capacity shall be located in accordance with Table 3.6.3.5.

Table 3.6.3.5 Minimum Separation Distances Between Direct-Fired Vaporizers and Exposures

Exposure	Minimum Distance Required	
	ft	m
Container	10	3.0
Container shutoff valves	15	4.6
Point of transfer	15	4.6
Nearest important buildings or group of buildings or line of adjoining property that can be built	25	7.6
Nearest Chapter 7 building or room housing gas–air mixer	10	3.0
Cabinet housing gas–air mixer outdoors	0	0

Note: Do not apply distances to the building in which a direct-fired vaporizer is installed.

3.6.4 Installation of Tank Heaters.

3.6.4.1 Gas-fired tank heaters shall comply with 2.5.5.5 and shall be installed as follows.

3.6.4.2 Tank heaters shall be installed only on aboveground containers and shall be located in accordance with Table 3.6.4.2 with respect to the nearest important building, group of buildings, or line of adjoining property that can be built upon.

Table 3.6.4.2 Minimum Separation Between Tank Heaters and Exposures

Container Water Capacity		Minimum Distance Required	
gal	m^3	ft	m
≤500	≤1.9	10	3.0
501–2000	1.9–7.6	25	7.6
2001–30,000	7.6–114	50	15
30,001–70,000	114–265	75	23
70,001–90,000	265–341	100	30.5
90,001–120,000	341–454	125	38.1

3.6.4.3 If the tank heater is gas fired, an automatic shutoff shall be provided on the fuel supply (including the pilot) that will operate if the container pressure exceeds 75 percent of the maximum design pressure specified in Table 2.2.2.2 or if the liquid level in the container falls below the top of the tank heater.

3.6.4.4 If the tank heater is of the electric immersion type, the heater shall be automatically deenergized when the pressure or level conditions specified in 3.6.4.3 are reached.

3.6.4.5 If the tank heater is similar in operation to an indirect vaporizer, the flow of the heat transfer fluid shall be automatically interrupted under the pressure or temperature conditions specified in 3.6.4.3 and the heat source shall comply with 3.6.2.6 and 3.6.2.7.

3.6.4.6 If a point of transfer is located within 15 ft (4.6 m) of a direct-gas-fired tank heater, the heater burner and pilot shall be shut off during the product transfer and a caution notice shall be displayed immediately adjacent to the filling connections and shall read as follows:

A gas-fired device that contains a source of ignition is connected to this container. Burner and pilot must be shut off before filling tank.

3.6.5 Installation of Vaporizing Burners. Vaporizing burners shall comply with 2.5.5.6 and shall be installed as follows:

3.6.5.1 Vaporizing burners shall be installed outside of buildings. The minimum distance between any container and a vaporizing-burner shall be in accordance with Table 3.6.5.1.

Table 3.6.5.1 Minimum Separation Distance Between Containers and Vaporizing Burners

Container Water Capacity		Minimum Distance Required	
gal	m^3	ft	m
≤500	≤1.9	10	3.0
501–2000	1.9–7.6	25	7.6
>2000	>7.6	50	15.0

3.6.5.2 Manually operated positive shutoff valves shall be located at the containers to shut off all flow to the vaporizing burners.

3.6.6 Installation of Waterbath Vaporizers. Waterbath vaporizers shall comply with 2.5.5.3 and shall be installed as follows:

3.6.6.1 If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class 1, Group D locations, the unit shall be treated as indirect-fired and shall be installed in accordance with 3.6.2.

3.6.6.2 All other waterbath vaporizers shall be treated as direct-fired vaporizers and shall be installed in accordance with 3.6.3.

3.6.7 Installation of Electric Vaporizers. Electric vaporizers, whether direct immersion or indirect immersion, shall be treated as indirect-fired and shall be installed in accordance with 3.6.2.

3.6.8 Installation of Gas–Air Mixers. Gas–air mixing equipment shall comply with 2.5.5.7 and shall be installed as follows:

3.6.8.1 Piping and equipment installed with gas–air mixer shall comply with 3.2.13, 3.2.15, and 3.2.22.

3.6.8.2 Where used without a vaporizer, a mixer shall be installed outdoors or in a building complying with Chapter 7.

3.6.8.3 Where used with an indirect-heated vaporizer, a mixer shall be installed in accordance with one of the following:

(a) Outdoors

(b) In the same compartment or room with the vaporizer

(c) In a building complying with Chapter 7

(d) In a location that is both remote from the vaporizer and in accordance with 3.6.2

3.6.8.4 Where used with a direct-fired vaporizer, a mixer shall be installed as follows:

(a) With a listed or approved mixer in a common cabinet with the vaporizer outdoors in accordance with 3.6.3.5

(b) Outdoors on a common skid with the vaporizer in accordance with 3.6.3

(c) Adjacent to the vaporizer to which it is connected in accordance with 3.6.3

(d) In a building complying with Chapter 7 without a direct-fired vaporizer in the same room

3.7 Ignition Source Control.

3.7.1 Scope.

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

3.7.1.2* The installation of lightning protection equipment shall not be required on LP-Gas storage containers.

3.7.1.3* Grounding and bonding shall not be required on LP-Gas systems.

3.7.2 Electrical Equipment.

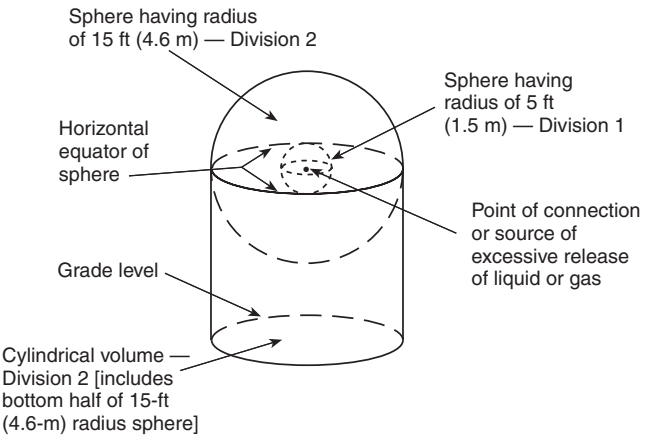
3.7.2.1 Electrical equipment and wiring shall be of a type specified by, and installed in accordance with, NFPA 70, *National Electrical Code®*, for ordinary locations.

Exception: Fixed electrical equipment in classified areas shall comply with 3.7.2.2.

3.7.2.2* Fixed electrical equipment and wiring installed within classified areas specified in Table 3.7.2.2 shall comply with Table 3.7.2.2 and shall be installed in accordance with NFPA 70, *National Electrical Code*. The provision shall apply to vehicle fuel operations. (*See Figure 3.7.2.2.*)

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

FIGURE 3.7.2.2 Extent of electrically classified area. ***(See Table 3.7.2.2.)***



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

3.7.2.4 Electrical equipment installed on LP-Gas cargo tank vehicles shall comply with 6.1.1.4.

Table 3.7.2.2 Electrical Area Classification

Part	Location	Extent of Classified Area[1]	Equipment Shall be Approved for *National Electrical Code*, Class I[1], Group D[2]
A	Unrefrigerated containers other than cylinders and ASME vertical containers of less than 1000-lb (454-kg) water capacity	Within 15 ft (4.6 m) in all directions from connections, except connections otherwise covered in Table 3.7.2.2	Division 2
B	Refrigerated storage containers	Within 15 ft (4.6 m) in all directions from connections otherwise covered in Table 3.7.2.2	Division 2
		Area inside dike to the level of the top of the dike	Division 2
C[3]	Tank vehicle and tank car loading and unloading	Within 5 ft (1.5 m) in all directions from connections regularly made or disconnected for product transfer	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 3.7.2.2)*	Division 2
D	Gauge vent openings other than those on cylinders and ASME vertical containers of less than 1000-lb (454 kg) water capacity	Within 5 ft (1.5 m) in all directions from point of discharge	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of discharge	Division 2
E	Relief device discharge other than those on cylinders and ASME vertical containers of less than 1000-lb (454 kg) water capacity and vaporizers	Within direct path of discharge	Note: Fixed electrical equipment should preferably not be installed.
F[3]	Pumps, vapor compressors, gas–air mixers and vaporizers (other than direct-fired or indirect-fired with an attached or adjacent gas-fired heat source)		
	Indoors without ventilation	Entire room and any adjacent room not separated by a gastight partition	Division 1
		Within 15 ft (4.6 m) of the exterior side of any exterior wall or roof that is not vaportight or within 15 ft (4.6 m) of any exterior opening	Division 2
	Indoors with ventilation	Entire room and any adjacent room not separated by a gastight partition	Division 2
	Outdoors in open air at or above grade	Within 15 ft (4.6 m) in all directions from this equipment and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 3.7.2.2)*	Division 2
G	Vehicle fuel dispenser	Entire space within dispenser enclosure, and 18 in. (256 mm) horizontally from enclosure exterior up to an elevation 4 ft (1.2 m) above dispenser base; entire pit or open space beneath dispenser	Division 1
		Up to 18 in. (256 mm) above ground within 20 ft (6.1 m) horizontally from any edge of enclosure (Note: For pits within this area, see part H of this table.)	Division 2
H	Pits or trenches containing or located beneath LP-Gas valves, pumps, vapor compressors, regulators, and similar equipment		

(Sheet 1 of 2)

Table 3.7.2.2 Electrical Area Classification ***(Continued)***

Part	Location	Extent of Classified Area[1]	Equipment Shall be Approved for *National Electrical Code*, Class I[1], Group D[2]
	Without mechanical ventilation	Entire pit or trench	Division 1
		Entire room and any adjacent room not separated by a gastight partition	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors	Division 2
	With mechanical ventilation	Entire pit or trench	Division 2
		Entire room and any adjacent room not separated by a gastight partition	Division 2
		Within 15 ft (4.6 m) in all directions from pit or trench when located outdoors	Division 2
I	Special buildings or rooms for storage of cylinders	Entire room	Division 2
J	Pipelines and connections containing operational bleeds, drips, vents, or drains	Within 5 ft (1.5 m) in all directions from point of discharge	Division 1
		Beyond 5 ft (1.5 m) from point of discharge, same as part F of this table	
K[3]	Cylinder filling		
	Indoors with ventilation	Within 5 ft (1.5 m) in all directions from a point of transfer	Division 1
		Beyond 5 ft (1.5 m) and entire room	Division 2
	Outdoors in open air	Within 5 ft (1.5 m) in all directions from a point of transfer	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of transfer and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 3.7.2.2)*	Division 2
L	Piers and Wharves	Within 5 ft (1.5 m) in all directions from connections regularly made or disconnected for product transfer	Division 1
		Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and the vessel deck *(see Figure 3.7.2.2)*	Division 2

(Sheet 2 of 2)

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

3.7.3 Other Sources of Ignition.

3.7.3.1 Open flames or other sources of ignition shall not be used or installed in pump houses, cylinder filling rooms, or other similar locations.

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

3.7.3.3 Open flames, cutting or welding, portable electric tools, and extension lights capable of igniting LP-Gas shall not be installed or used within classified areas specified in Table 3.7.2.2.

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

Exception No. 2: Vaporizers and vaporizing burners shall be installed in accordance with Section 3.6.

3.8 LP-Gas Systems on Vehicles (Other Than Engine Fuel Systems).

3.8.1 Application.

3.8.1.1 This section shall apply to the following:

(a) Nonengine fuel systems on commercial, industrial, construction, and public service vehicles such as trucks, semitrailers, trailers, portable tar kettles, road surface heating equipment, mobile laboratories, clinics, and mobile cooking units (such as catering and canteen vehicles).

(b) Installations served by exchangeable (removable) cylinder systems and by permanently mounted containers.

3.8.1.2 This section shall not apply to the following:

(1) Systems installed on mobile homes
(2) Systems installed on recreational vehicles *[see 3.1.1.2(9)]*
(3) Cargo tank vehicles, cargo tank vehicles (trailers and semitrailers), and similar units used to transport LP-Gas as cargo, which are covered by Chapter 6
(4) LP-Gas engine fuel systems on the vehicles covered by Section 3.8 and those cited in 3.8.1.2, which are covered by Chapter 8

3.8.2 Construction, Location, Mounting, and Protection of Containers and Systems.

3.8.2.1 Containers shall comply with Section 2.2, and appurtenances used to equip them for service shall comply with Section 2.3. In addition, the following shall apply:

(a) ASME mobile containers shall have a minimum design pressure as follows:

(1) 250 psig (1.7 MPag) or 312.5 psig (2.2 MPag) where required if constructed prior to April 1, 2001.
(2) 312.5 psi (2.2 MPa) if constructed on or after April 1, 2001.

(b) Containers installed on recreational vehicles or in enclosed spaces on other vehicles shall be constructed as follows:

(1) Cylinders shall be designed and constructed for at least a 240-psig (1.6-MPag) service pressure.
(2) ASME mobile containers shall be constructed for at least a 312.5-psig (2.2-MPag) design pressure.

(c) Cylinders shall comply with 2.2.4.

(d) Permanently mounted containers shall comply with 3.8.2.4.

(e) LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200-gal (0.8-m^3) aggregate water capacity.

(f) The capacity of individual LP-Gas containers on highway vehicles shall be in accordance with Table 3.8.2.1(f).

Table 3.8.2.1(f) Maximum Capacities of Individual LP-Gas Containers Installed on LP-Gas Highway Vehicles

Vehicle	Maximum Container Capacity	
	gal	m^3
Passenger vehicle	200	0.8
Nonpassenger vehicle	300	1.1
Road surfacing vehicle	1000	3.8
Cargo tank vehicle	Not limited by this code	

(g) Containers designed for stationary service only and not in compliance with the container appurtenance protection requirements of 2.2.4 shall not be used.

3.8.2.2 ASME containers and cylinders utilized for the purposes covered by this section shall not be installed, transported, or stored (even temporarily) inside any vehicle covered by Section 3.8.

Exception: ASME containers installed in accordance with 3.8.2.4(f), Chapter 6 or DOT regulations.

3.8.2.3 The LP-Gas supply system, including the containers, shall be permitted to be installed on the outside of the vehicle or in a recess or cabinet vaportight to the inside of the vehicle but accessible from and vented to the outside, with the vents located near the top and bottom of the enclosure and 3 ft (1 m) horizontally away from any opening into the vehicle below the level of the vents.

3.8.2.4 Containers shall be mounted securely on the vehicle or within the enclosing recess or cabinet and shall be located in accordance with the following:

(a) Containers shall be installed with road clearance in accordance with 8.2.6.5.

(b) Fuel containers shall be mounted to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand, without permanent visible deformation, static loading in any direction equal to four times the weight of the container filled with fuel.

(c) Where containers are mounted within a vehicle housing, the securing of the housing to the vehicle shall comply with this provision. Any removable portions of the housing or cabinet shall be secured while in transit.

(d) Field welding on containers shall be limited to attachments to nonpressure parts such as saddle plates, wear plates, or brackets applied by the container manufacturer.

(e) All container valves, appurtenances, and connections shall be protected to prevent damage from accidental contacts with stationary objects, from loose objects, stones, mud, or ice thrown up from the ground or floor, and from damage due to overturn or similar vehicular accident.

(1) Permanently mounted ASME containers shall be located on the vehicle to provide this protection.
(2) Cylinders shall have permanent protection for cylinder valves and connections.
(3) Where cylinders are located on the outside of a vehicle, weather protection shall be provided.

(f) Containers mounted on the interior of passenger-carrying vehicles shall be installed in compliance with 8.2.7. Pressure relief valve installations for such containers shall comply with 8.2.6.9.

3.8.2.5 Cylinders installed on portable tar kettles alongside the kettle, on the vehicle frame, or on road surface heating equipment shall be protected from radiant or convected heat from open flame or other burners by the use of a heat shield or by the location of the cylinder(s) on the vehicle. In addition, the following shall apply:

(a) Cylinder location, mounting, and protection shall comply with 3.8.2.4.

Exception: Protection for cylinder valves shall be in accordance with 2.2.4.1(a) and (b).

(b) Piping shall comply with 3.8.2.8(a), (b), (d), (e), (g), (h), and (i).

(c) Flexible connections shall comply with 2.4.6.1, 2.4.6.2, and 2.4.6.3.

(d) Cylinder valves shall be closed when burners are not in use.

(e) Cylinders shall not be refilled while burners are in use as provided in 4.2.3.2(b).

3.8.2.6 Container appurtenances shall be installed in accordance with the following.

(a) ASME container pressure relief devices shall be located and installed as follows:

(1) On ASME containers mounted in the interior of vehicles complying with 8.2.7, the pressure relief valve installation shall comply with 8.2.6.9
(2) Pressure relief valve installations on ASME containers installed on the outside of vehicles shall comply with 8.2.6.9 and 3.8.2.3.

(b) Connections and appurtenances on containers shall be in compliance with 2.3.3.1 through 2.3.3.3 and Table 2.3.3.2(a).

(c) Main shutoff valves on containers for liquid and vapor shall be readily accessible.

(d) Containers to be filled volumetrically shall be equipped with fixed maximum liquid level gauging devices as provided in 2.3.4. Cylinders shall be permitted to be designed, constructed, and fitted for filling in either the vertical or horizontal position or, if of the universal type *[see 2.3.4.2(c)2]*, in either position. The cylinder shall be in the appropriate position when filled or, if of the universal type, shall be permitted to be loaded in either position, provided the following conditions apply:

(1) The fixed maximum liquid level gauge indicates correctly the maximum permitted filling level in either position.
(2) The pressure relief devices are located in or connected to the vapor space in either position.

(e) All container inlets and outlets, except pressure relief devices and gauging devices, shall be labeled to designate whether they communicate with the vapor or liquid space. Labels shall be permitted to be affixed to valves.

(f) Containers from which only vapor is to be withdrawn shall be installed and equipped with connections to minimize the possibility of the accidental withdrawal of liquid.

3.8.2.7 Regulators shall be installed in accordance with 3.2.12 and the following:

(a) Where regulators are installed in an enclosed space, the discharge from the regulator pressure relief device shall be vented to the outside air in accordance with 3.8.2.2.

(b) A two-stage regulator system or an integral two-stage regulator in accordance with 3.2.12.1 shall be installed on all vapor withdrawal systems. Regulators shall be protected from the elements in accordance with 3.2.12.4.

(c) The regulator shall be installed with the pressure relief vent opening pointing vertically downward to allow for drainage of moisture collected on the diaphragm of the regulator.

(d) Regulators not installed in compartments shall be equipped with a durable cover designed to protect the regulator vent opening from sleet, snow, freezing rain, ice, mud, and wheel spray.

(e) If a vehicle-mounted regulator(s) is installed at or below the floor level, it shall be installed in a compartment that provides protection against the weather and wheel spray. The following shall also apply:

(1) The compartment shall be of sufficient size to allow tool operation for connection to and replacement of the regulators(s).
(2) The compartment shall be vaportight to the interior of the vehicle.
(3) The compartment shall have a 1-in.^{2} (650-mm^2) minimum vent opening to the exterior located within 1 in. (25 mm) of the bottom of the compartment.
(4) The compartment shall not contain flame or spark-producing equipment.

(f) A regulator vent outlet shall be at least 2 in. (51 mm) above the compartment vent opening.

3.8.2.8 Piping shall be installed in accordance with 3.2.15. The following shall also apply to piping systems on vehicles covered by Section 3.8.

(a) Steel tubing shall have a minimum wall thickness of 0.049 in. (1.2 mm).

(b) A flexible connector or a tubing loop shall be installed between the regulator outlet and the piping system to protect against expansion, contraction, jarring, and vibration strains.

(c) Flexibility shall be provided in the piping between a cylinder and the gas piping system or regulator.

(d) Flexible connectors shall be installed in accordance with 3.2.17. Flexible connectors of more than 36 in. (0.9 m) overall length, or fuel lines that incorporate hose, shall be used only with the approval of the authority having jurisdiction.

(e) The piping system shall be designed, installed, supported, and secured to minimize the possibility of damage due to vibration, strains, or wear and to preclude any loosening while in transit.

(f) Piping shall be installed in a protected location. Where installed outside the vehicle, it shall be installed as follows:

(1) Piping shall be under the vehicle and below any insulation or false bottom.
(2) If outside, piping shall be under the vehicle and below any insulation or false bottom.
(3) Fastening or other protection shall be installed to prevent damage due to vibration or abrasion.
(4) At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chafing.

(g) Gas piping shall be installed to enter the vehicle through the floor directly beneath or adjacent to the appliance served. If a branch line is installed, the tee connection shall be located in the main gas line under the floor and outside the vehicle.

(h) Exposed parts of the piping system either shall be of corrosion-resistant material or shall be coated or protected to minimize exterior corrosion.

(i) Hydrostatic relief valves complying with 2.4.7 shall be installed in isolated sections of liquid piping as provided in 3.2.21.

(j) Piping systems, including hose, shall be pressure tested and proven free of leaks in accordance with 3.2.22.

(k) There shall be no fuel connection between a tractor and trailer or other vehicle units.

3.8.3 Equipment Installation. Equipment shall be installed in accordance with 3.2.25 and the following:

3.8.3.1 Installation shall be made in accordance with the manufacturer's recommendations and, in the case of listed or approved equipment, as provided in the listing or approval.

3.8.3.2 Equipment installed on vehicles shall be considered as part of the LP-Gas system on the vehicle and shall be protected against vehicular damage as provided for container appurtenances and connections in 3.8.2.4(c).

3.8.4 Appliance Installation.

3.8.4.1 This subsection shall apply to the installation of all appliances on vehicles.

Exception: This subsection shall not cover engines.

3.8.4.2 All appliances covered by this subsection installed on vehicles shall be approved and shall be installed as follows.

(a) Wherever the device or appliance is of a type designed to be in operation while the vehicle is in transit, such as a cargo heater or cooler, suitable means to stop the flow of gas in the event of a line break, such as an excess-flow valve, shall be installed. Excess-flow valves shall comply with 2.3.3.3(b).

(b) All gas-fired heating appliances shall be equipped with safety shutoffs in accordance with 2.6.2.5(a) except those covered in 3.4.2.8 Exception.

(c) For installations on vehicles intended for human occupancy, all gas-fired heating appliances, except ranges and illuminating appliances, shall be designed or installed to provide for a complete separation of the combustion system from the atmosphere inside the vehicle. Combustion air inlets and flue gas outlets shall be listed as components of the appliance.

(d) For installations on vehicles not intended for human occupancy, unvented-type gas-fired heating appliances shall be permitted to be used to protect the cargo. Provision shall be made to provide air for combustion *[see 3.8.4.2(f)]* and to dispose of the products of combustion to the outside.

(e) Appliances installed within vehicles shall comply with the following:

(1) If in the cargo space, they shall be readily accessible whether the vehicle is loaded or empty.
(2) Appliances shall be constructed or otherwise protected to minimize possible damage or impaired operation due to cargo shifting or handling.
(3) Appliances shall be located so that a fire at any appliance will not block egress of persons from the vehicle.

(f) Provision shall be made in all appliance installations for a supply of outside air for complete combustion.

(g) A permanent caution plate shall be provided, affixed to either the appliance or the vehicle outside of any enclosure and adjacent to the container(s), and shall include the following items:

CAUTION

1. Be sure all appliance valves are closed before opening container valve.
2. Connections at the appliances, regulators, and containers shall be checked periodically for leaks with soapy water or its equivalent.
3. Never use a match or flame to check for leaks.
4. Container valves shall be closed when equipment is not in use.

3.8.5 General Precautions. Mobile units containing hotplates and other cooking equipment, including mobile kitchens and catering vehicles, shall be provided with at least one approved portable fire extinguisher rated in accordance with NFPA 10, *Standard for Portable Fire Extinguishers,* at not less than 10-B:C.

3.8.6 Parking, Servicing, and Repair.

3.8.6.1 Vehicles with LP-Gas fuel systems mounted on them for purposes other than propulsion shall be permitted to be parked, serviced, or repaired inside buildings.

(a) The fuel system shall be leak-free, and the container(s) shall not be filled beyond the limits specified in Chapter 4.

(b) The container shutoff valve shall be closed.

Exception: The container shutoff valve shall not be required to be closed when fuel is required for test or repair.

(c) The vehicle shall not be parked near sources of heat, open flames, or similar sources of ignition, or near unventilated pits.

3.8.6.2 Vehicles having containers with water capacities larger than 300 gal (1.1 m^3) shall comply with the requirements of Section 6.6.

3.9 Vehicle Fuel Dispenser and Dispensing Stations.

3.9.1 Application. This section shall include location, installation, and operation of vehicle fuel dispensers and dispensing stations. The provisions of Section 3.2, as modified by this section, shall apply.

3.9.2 Location.

3.9.2.1 Location shall be in accordance with Table 3.2.3.3.

3.9.2.2 Vehicle fuel dispensers and dispensing stations shall be located away from pits in accordance with Table 3.2.3.3 with no drains or blow-offs from the unit directed toward or within 15 ft (4.6 m) of a sewer systems opening.

3.9.3 General Installation Provisions.

3.9.3.1 Vehicle fuel dispensers and dispensing stations shall be installed in accordance with the manufacturer's installation instructions.

3.9.3.2 Vehicle fuel dispensers shall not be located within a building. Where installed under a weather shelter or canopy, the area shall be ventilated and shall not be enclosed for more than 50 percent of its perimeter.

3.9.3.3 Control for the pump used to transfer LP-Gas through the unit into containers shall be provided at the device in order to minimize the possibility of leakage or accidental discharge.

3.9.3.4 An excess-flow check valve or a differential back pressure valve shall be installed in or on the dispenser at the point at which the dispenser hose is connected to the liquid piping.

3.9.3.5 Piping and the dispensing hose shall be provided with hydrostatic relief valves in accordance with 3.2.21.

3.9.3.6 Protection against trespassing and tampering shall be in accordance with 3.3.6.

3.9.3.7 A manual shutoff valve and an excess-flow check valve shall be located in the liquid line between the pump and dispenser inlet where the dispensing device is installed at a remote location and is not part of a complete storage and dispensing unit mounted on a common base.

3.9.3.8 All dispensers either shall be installed on a concrete foundation or shall be part of a complete storage and dispensing unit

mounted on a common base and installed in accordance with 3.2.6.1(e). Protection against physical damage shall be provided.

3.9.3.9 A listed quick-acting shutoff valve shall be installed at the discharge end of the transfer hose.

3.9.3.10 An identified and accessible switch or circuit breaker shall be installed at a location not less than 20 ft (6.1 m) or more than 100 ft (30.5 m) from the dispensing device(s) to shut off the power in the event of a fire, accident, or other emergency. The marking for the switch(es) or breaker(s) shall be visible at the point of liquid transfer.

3.9.4 Installation of Vehicle Fuel Dispensers.

3.9.4.1 Hose length shall not exceed 18 ft (5.5 m). All hose shall be listed. When not in use, hose shall be secured to protect it from damage.

Exception: Hoses longer than 18 ft (5.5 m) shall be permitted where approved by the authority having jurisdiction.

3.9.4.2 A listed emergency breakaway device complying with UL 567, *Standard Pipe Connectors for Flammable and Combustible Liquids and LP-Gas*, and designed to retain liquid on both sides of the breakaway point, or other devices affording equivalent protection approved by the authority having jurisdiction, shall be installed.

3.9.4.3 Dispensing devices for liquefied petroleum gas shall be located as follows:

(a) Conventional systems shall be at least 10 ft (3.0 m) from any dispensing device for Class I liquids.

(b) Low-emission transfer systems in accordance with Section 3.11 shall be at least 5 ft (1.5 m) from any dispensing device for Class I liquids.

3.10 Fire Protection.

3.10.1 Application. This section shall apply to fire protection for LP-Gas facilities.

3.10.2* General.

3.10.2.1* The planning for effective measures for control of inadvertent LP-Gas release or fire shall be coordinated with local emergency handling agencies such as fire and police departments. Planning shall include consideration of the safety of emergency personnel, workers, and the public.

3.10.2.2* Fire protection shall be provided for installations of ASME containers with an aggregate water capacity of more than 4000 gal (15.1 m^3) and of ASME containers on roofs in accordance with 3.2.10. The mode of such protection shall be determined through a written fire safety analysis for new installations and, for existing installations, by 3 years from the effective date of this code.

The first consideration in any such analysis shall be an evaluation of the total product control system, including emergency shutoff and internal valves equipped for remote closure and automatic shutoff using thermal (fire) actuation pullaway protection, and the optional requirements of Section 3.11, if used.

Exception No. 1: If the analysis specified in 3.10.2.2 indicates a hazard does not exist, the fire protection provisions of 3.10.2.2 shall not apply.

Exception No. 2: If the analysis specified in 3.10.2.2 indicates that a hazard exists and the provisions of 3.10.2.2 cannot be met, special protection (see 1.7.66) shall be provided in accordance with 3.10.3.

3.10.2.3 Roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

3.10.2.4 Each industrial plant, bulk plant, and distributing point shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (8.2 kg) of dry chemical with a B:C rating.

3.10.2.5* LP-Gas fires shall not be extinguished until the source of the burning gas has been shut off.

3.10.2.6 Emergency controls shall be conspicuously marked, and the controls shall be located so as to be readily accessible in emergencies.

3.10.3 Special Protection.

3.10.3.1* 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. *(See Appendix H.)*

3.10.3.2 If mounding is utilized, the provisions of 3.2.9.3 shall be required.

3.10.3.3 If burial is utilized, the provisions of 3.2.9.1 shall be required.

3.10.3.4 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 shall also have a capability for manual actuation.

3.10.3.5 If monitor nozzles are used, they shall be located and arranged so that all container surfaces that can 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 shall also have a capability for manual actuation.

3.11 Alternate Provisions for Installation of ASME Containers.

3.11.1 Scope. This section shall apply to alternate provisions for the location and installation of ASME containers that incorporate the use of redundant fail-safe product control measures and low emission transfer concepts for the purpose of enhancing safety and to mitigate distance and special protection requirements.

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

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

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

3.11.3.1 All liquid withdrawal openings and all vapor withdrawal openings that are $1^1/_4$ in. (3.2 cm) or larger shall be equipped with an internal valve with an integral excess flow

valve or excess flow protection. The internal valves shall remain closed except during periods of operation. As required, the internal valves shall be equipped for remote closure and automatic shutoff through thermal (fire) actuation

3.11.3.2 In addition, a positive manual shutoff valve shall be installed as close as practical to each internal valve.

3.11.3.3 All liquid and vapor inlet openings shall be equipped in accordance with 3.11.3(a) and 3.11.3(b) or shall be equipped with a backflow check valve and a positive manual shutoff valve installed as close as practical to the backflow check valve.

3.11.4 Facility Piping Requirements. The following redundant fail-safe product control measures shall be required for systems covered in this section.

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

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

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

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

(b) At least one additional remote shutdown station shall be installed not less than 25 ft (7.6 m) or more than 100 ft (30.5 m) from the transfer point.

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

3.11.5 Low Emission Transfer. The transfer distance requirements of Table 3.2.3.3 and 3.9.4.3 shall be permitted to be reduced by one-half where the installation is in accordance with the following subsections.

3.11.5.1 Transfer into cylinders and ASME containers on vehicles shall meet the following provisions:

(a) The delivery valve and nozzle combination shall mate with the filler valve in the receiving container in such a manner that, when they are uncoupled following a transfer of product, not more than 4 cc (0.24 $in.^3$) of product (liquid equivalent) is released to the atmosphere.

(b) Fixed maximum liquid level gauges shall not be used to determine the maximum permitted filling limit at a low emission transfer site. The maximum permitted filling limit shall be determined by an overfilling prevention device or other approved means. Where fixed maximum liquid level gauges are installed, a label shall be placed near the gauge providing the following instructions: **"Do not use this fixed maximum liquid level gauge at low emission transfer stations."**

3.11.5.2 Transfer into stationary ASME containers shall meet the following provisions:

(a) Where transfer is made through a hose of nominal 1-in. (2.5-cm) size or smaller, the delivery valve and nozzle combination shall not contain an interstitial volume greater than 4 cc (0.24 $in.^3$).

(b) Where transfer is made through hose larger than 1 in. (2.5 cm) nominal size, no more than 15 cc (0.91 $in.^3$) of LP-Gas (liquid equivalent) shall be released to the atmosphere during the transfer operation. This includes uncoupling the transfer hose.

(c) Fixed maximum liquid level gauges on low emission transfer systems shall be installed and used to verify the (function) accuracy of liquid level gauges or other liquid level gauging devices.

(d) Fixed maximum liquid level gauges shall not be used in the routine filling of low emission transfer systems. The use of a float gauge or other approved nonventing device for containers of 2001 gal (7.6 m^3) w.c. or larger shall be the only means for determining the maximum filling limit.

(e) The maximum filling limit for containers of less than 2001 gal (7.6 m^3) w.c. in low emission transfer systems shall be controlled through the use of an overfilling prevention device or other device approved for this service.

Chapter 4 LP-Gas Liquid Transfer

4.1 Scope.

4.1.1 This chapter shall apply to transfers of liquid LP-Gas from one container to another wherever this transfer involves connections and disconnections in the transfer system or the venting of LP-Gas to the atmosphere. This chapter shall also apply to operational safety and methods for determining the quantity of LP-Gas permitted in containers.

4.1.2 Ignition source control at transfer locations shall be in accordance with Section 3.7. Fire protection shall be in accordance with Section 3.10.

4.2 Operational Safety.

4.2.1 Transfer Personnel.

4.2.1.1 Transfer operations shall be conducted by qualified personnel meeting the provisions of Section 1.5. At least one qualified person shall remain in attendance at the transfer operation from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

4.2.1.2 Transfer personnel shall exercise precaution to ensure that the LP-Gases transferred are those for which the transfer system and the containers to be filled are designed.

4.2.2 Containers to Be Filled or Evacuated.

4.2.2.1 Transfer of LP-Gas to and from a container shall be accomplished only by qualified persons trained in proper handling and operating procedures meeting the requirements of Section 1.5 and in emergency response procedures. Such persons shall notify the container owner and user in writing when noncompliance with Sections 2.2 and 2.3 is found.

4.2.2.2 Injection of compressed air, oxygen, or any oxidizing gas into containers to transfer LP-Gas liquid shall be prohibited.

When evacuating a container owned by others, the qualified person(s) performing the transfer shall not inject any material other than LP-Gas into the container.

4.2.2.3 Valve outlets on cylinders of 108-lb (49-kg) water capacity [nominal 45-lb (20-kg) propane capacity] or less shall be equipped with an effective seal such as a plug, cap, listed

quick-closing coupling, or a listed quick-connect coupling. This seal shall be in place whenever the cylinder is not connected for use.

Exception: Nonrefillable (disposable) and new unused cylinders shall not be required to comply.

4.2.2.4 Containers shall be filled only after determination that they comply with the design, fabrication, inspection, marking, and requalification provisions of this code. *(See 2.2.1.3 through 2.2.1.7.)*

4.2.2.5 Cylinders authorized as "single trip," "nonrefillable," or "disposable" cylinders shall not be refilled with LP-Gas.

4.2.2.6 Containers. Containers shall comply with the following with regard to service or design pressure requirements:

(a) The service pressure marked on the cylinder shall be not less than 80 percent of the vapor pressure of the LP-Gas for which the cylinder is designed at 130°F (54.4°C).

(b) The minimum design pressure for ASME containers shall be in accordance with Table 2.2.2.2.

4.2.3 Arrangement and Operation of Transfer Systems.

4.2.3.1 Public access to areas where LP-Gas is stored and transferred shall be prohibited.

Exception: Public access shall be allowed where necessary for the conduct of normal business activities.

4.2.3.2 Sources of ignition shall be turned off during transfer operations, while connections or disconnections are made, or while LP-Gas is being vented to the atmosphere.

(a) Internal combustion engines within 15 ft (4.6 m) of a point of transfer shall be shut down while such transfer operations are in progress:

Exception No. 1: Engines of LP-Gas cargo tank vehicles constructed and operated in compliance with Chapter 6 while such engines are driving transfer pumps or compressors on these vehicles to load containers in accordance with 3.2.3.2.

Exception No. 2: Engines installed in buildings as provided in Section 8.3.

(b) Smoking, open flame, metal cutting or welding, portable electrical tools, and extension lights capable of igniting LP-Gas shall not be permitted within 25 ft (7.6 m) of a point of transfer while filling operations are in progress. Materials that have been heated above the ignition temperature of LP-Gas shall be cooled before that transfer is started.

(c) Sources of ignition, shall be turned off during the filling of any LP-Gas container on the vehicle.

4.2.3.3 Cargo tank vehicles *(see Section 6.3)* unloading into storage containers shall be at least 10 ft (3.0 m) from the container and so positioned that the shutoff valves on both the truck and the container are readily accessible. The cargo tank vehicle shall not transfer LP-Gas into dispensing station storage while parked on a public way.

4.2.3.4 Transfers to containers serving agricultural or industrial equipment requiring refueling in the field shall comply with the following:

(a)*Where the intake of air-moving equipment is less than 50 ft (15 m) from a point of transfer, it shall be shut down while containers are being refilled.

(b) Equipment employing open flames, or equipment with integral containers shall be shut down while refueling.

4.2.3.5 During the time railroad tank cars are on sidings for loading or unloading, the following shall apply:

(a) A caution sign, with wording such as "STOP. TANK CAR CONNECTED" shall be placed at the active end(s) of the siding while the car is connected as required by DOT regulations.

(b) Wheel chocks shall be placed to prevent movement of the car in either direction.

4.2.3.6 Hose and Swivel Piping. Where a hose or swivel-type piping is used for loading or unloading railroad tank cars, it shall be protected as follows:

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

(b) An emergency shutoff valve or a backflow check valve shall be installed on the railroad tank car end of the hose or swivel piping where flow is only into the railroad tank car.

4.2.3.7 Transfer hoses larger than $^1/_2$-in. (12-mm) internal diameter shall not be used for making connections to individual cylinders being filled indoors.

4.2.3.8 Where cargo tank vehicles are filled directly from railroad tank cars on a private track with nonstationary storage tanks involved, the following requirements shall be met:

(a) Transfer protection shall be provided in accordance with 3.2.19.

(b) Ignition source control shall be in accordance with Section 3.7.

(c) Control of ignition sources during transfer shall be provided in accordance with 4.2.3.2.

(d) Fire extinguishers shall be provided in accordance with 3.10.2.4.

(e) Transfer personnel shall meet the provisions of 4.2.1.

(f) Cargo tank vehicles shall meet the requirements of 4.2.2.4.

(g) Arrangement and operation of the transfer system shall be in accordance with 4.2.3.

(h) The points of transfer shall be located in accordance with Table 3.2.3.3 with respect to exposures.

(i) Provision for anchorage and breaking shall be provided on the cargo tank vehicle side for transfer from a railroad tank car directly into a cargo tank vehicle. *(See A.3.2.19.6.)*

4.2.4 Hose Inspection. Hose assemblies shall be visually inspected for leakage or damage that will impair their integrity. Leaking or damaged hose shall be immediately repaired or removed from service.

4.3 Venting LP-Gas to the Atmosphere.

4.3.1 General. LP-Gas, in either liquid or vapor form, shall not be vented to the atmosphere.

Exception No. 1: Where fixed liquid level, rotary, or slip tube gauges are vented to the atmosphere, the maximum flow shall not exceed that from a No. 54 drill orifice.

Exception No. 2: Venting of LP-Gas between shutoff valves before disconnecting the liquid transfer line from the container. Where necessary, bleeder valves shall be used.

Exception No. 3: Where LP-Gas shall be permitted to be vented for the purposes described in Exceptions No. 1 and 2 within structures designed for container filling as provided in accordance with 3.2.3.1 and Chapter 7.

Exception No. 4: Venting vapor from listed liquid transfer pumps using such vapor as a source of energy, where the rate of discharge does not exceed that from a No. 31 drill size orifice.

Exception No. 5: Purging in accordance with 4.3.2.

Exception No. 6: Emergency venting in accordance with 4.3.3.

4.3.2 Purging. Venting of gas from containers for purging or for other purposes shall be accomplished according to the following subsections.

4.3.2.1 Venting of cylinder indoors, only in structures designed and constructed for cylinder filling in accordance with 3.2.3.1 and Chapter 7 and with the following provisions:

(a) Piping shall be installed to convey the vented product outdoor at least 3 ft (1 m) above the highest point of any building within 25 ft (7.6 m).

(b) Only vapors shall be exhausted to the atmosphere.

(c) If a vent manifold is used to allow for the venting of more than one cylinder at a time, each connection to the vent manifold shall be equipped with a backflow check valve.

4.3.2.2 Venting of containers outdoors shall be performed under conditions that result in rapid dispersion of the product being released.

4.3.2.3 If conditions are such that venting into the atmosphere cannot be accomplished safely, LP-Gas shall be burned at least 25 ft (7.6 m) from combustibles.

4.3.3 Emergency Venting. The procedure to be followed for the disposal of LP-Gas in an emergency will be dictated by the conditions present, requiring individual judgment in each case and using, where practical, the provisions of this code.

4.4 Quantity of LP-Gas in Containers.

4.4.1 Application. This section shall apply to the maximum permissible LP-Gas content of containers and the methods of verifying this quantity. *(See Appendix F.)*

4.4.2 LP-Gas Capacity of Containers The capacity of an LP-Gas container shall be determined either by weight in accordance with 4.4.2.1, or by volume in accordance with 4.4.2.2.

4.4.2.1* The maximum weight of LP-Gas in a container shall be in accordance with Table 4.4.2.1.

4.4.2.2* The maximum volume of LP-Gas in a container shall be in accordance with Tables 4.4.2.2(a), (b), and (c).

Table 4.4.2.1 Maximum Filling Limit by Weight of LP-Gas Containers (percent of marked water capacity in pounds)

	Aboveground Containers		
Specific Gravity at 60°F (15.6°C)	**0 to 1200 U.S. gal (0 to 4.5 m³) Total Water Capacities, %**	**Over 1200 U.S. gal (0 to 4.5 m³) Total Water Capacities, %**	**Underground Containers All Capacities, %**
0.496–0.503	41	44	45
0.504–0.510	42	45	46
0.511–0.519	43	46	47
0.520–0.527	44	47	48
0.528–0.536	45	48	49
0.537–0.544	46	49	50
0.545–0.552	47	50	51
0.553–0.560	48	51	52
0.561–0.568	49	52	53
0.569–0.576	50	53	54
0.577–0.584	51	54	55
0.585–0.592	52	55	56
0.593–0.600	53	56	57

Table 4.4.2.2(a) Maximum Permitted LP-Gas Volume (percent of total container volume): Aboveground Containers 0 to 1200 gal (0 to 4.5 m³)

Liquid Temperature		Specific Gravity												
°F	°C	0.496 to 0.503	0.504 to 0.510	0.511 to 0.519	0.520 to 0.527	0.528 to 0.536	0.537 to 0.544	0.545 to 0.552	0.553 to 0.560	0.561 to 0.568	0.569 to 0.576	0.577 to 0.584	0.585 to 0.592	0.593 to 0.600
–50	–45.6	70	71	72	73	74	75	75	76	77	78	79	79	80
–45	–42.8	71	72	73	73	74	75	76	77	77	78	79	80	80
–40	–40	71	72	73	74	75	75	76	77	78	79	79	80	81
–35	–37.2	71	72	73	74	75	76	77	77	78	79	80	80	81
–30	–34.4	72	73	74	75	76	76	77	78	78	79	80	81	81
–25	–31.5	72	73	74	75	76	77	77	78	79	80	80	81	82
–20	–28.9	73	74	75	76	76	77	78	79	79	80	81	81	82
–15	–26.1	73	74	75	76	77	77	78	79	80	80	81	82	83
–10	–23.3	74	75	76	76	77	78	79	79	80	81	81	82	83
–5	–20.6	74	75	76	77	78	78	79	80	80	81	82	82	83
0	–17.8	75	76	76	77	78	79	79	80	81	81	82	83	84
5	–15	75	76	77	78	78	79	80	81	81	82	83	83	84
10	–12.2	76	77	77	78	79	80	80	81	82	82	83	84	84
15	–9.4	76	77	78	79	80	80	81	81	82	83	83	84	85
20	–6.7	77	78	78	79	80	80	81	82	83	84	84	84	85
25	–3.9	77	78	79	80	80	81	82	82	83	84	84	85	85
30	–1.1	78	79	79	80	81	81	82	83	83	84	85	85	86
35	1.7	78	79	80	81	81	82	83	83	84	85	85	86	86
†40	4.4	79	80	81	81	82	82	83	84	84	85	86	86	87
45	7.8	80	80	81	82	82	83	84	84	85	85	86	87	87
50	10	80	81	82	82	83	83	84	85	85	86	86	87	88
55	12.8	81	82	82	83	84	84	85	85	86	86	87	87	88
60	15.6	82	82	83	84	84	85	85	86	86	87	87	88	88
65	18.3	82	83	84	84	85	85	86	86	87	87	88	88	89
70	21.1	83	84	84	85	85	86	86	87	87	88	88	89	89
75	23.9	84	85	85	85	86	86	87	87	88	88	89	89	90
80	26.7	85	85	86	86	87	87	87	88	88	89	89	90	90
85	29.4	85	86	87	87	88	88	88	89	89	89	90	90	91
90	32.2	86	87	87	88	88	88	89	89	90	90	90	91	91
95	35	87	88	88	88	89	89	89	90	90	91	91	91	92
100	37.8	88	89	89	89	89	90	90	90	91	91	92	92	92
105	40.4	89	89	90	90	90	90	91	91	91	92	92	92	93
110	43	90	90	91	91	91	91	92	92	92	92	93	93	93
115	46	91	91	92	92	92	92	92	92	93	93	93	94	94
120	49	92	92	93	93	93	93	93	93	93	94	94	94	94
125	51.5	93	94	94	94	94	94	94	94	94	94	94	95	95
130	54	94	95	95	95	95	95	95	95	95	95	95	95	95

†See 4.4.3.2(a).

Table 4.4.2.2(b) Maximum Permitted LP-Gas Volume (percent of total container volume): Aboveground Containers Over 1200 Gal (0 to 4.5 m^3)

Liquid Temperature		Specific Gravity												
°F	°C	0.496 to 0.503	0.504 to 0.510	0.511 to 0.519	0.520 to 0.527	0.528 to 0.536	0.537 to 0.544	0.545 to 0.552	0.553 to 0.560	0.561 to 0.568	0.569 to 0.576	0.577 to 0.584	0.585 to 0.592	0.593 to 0.600
–50	–45.6	75	76	77	78	79	80	80	81	82	83	83	84	85
–45	–42.8	76	77	78	78	79	80	81	81	82	83	84	84	85
–40	–40	76	77	78	79	80	80	81	82	83	83	84	85	85
–35	–37.2	77	78	78	79	80	81	82	82	83	84	84	85	86
–30	–34.4	77	78	79	80	80	81	82	83	83	84	85	85	86
–25	–31.5	78	79	79	80	81	82	82	83	84	84	85	86	86
–20	–28.9	78	79	80	81	81	82	83	83	84	85	85	86	87
–15	–26.1	79	79	80	81	82	82	83	84	85	85	86	87	87
–10	–23.3	79	80	81	82	82	83	84	84	85	86	86	87	87
–5	–20.6	80	81	81	82	83	83	84	85	85	86	87	87	88
0	–17.8	80	81	82	82	83	84	84	85	86	86	87	88	88
5	–15	81	82	82	83	84	84	85	86	86	87	87	88	89
10	–12.2	81	82	83	83	84	85	85	86	87	87	88	88	89
15	–9.4	82	83	83	84	85	85	86	87	87	88	88	89	90
20	–6.7	82	83	84	85	85	86	86	87	88	88	89	89	90
25	–3.9	83	84	84	85	86	86	87	88	88	89	89	90	90
30	–1.1	83	84	85	86	86	87	87	88	89	89	90	90	91
35	1.7	84	85	86	86	87	87	88	89	89	90	90	91	91
†40	4.4	85	86	86	87	87	88	88	89	90	90	91	91	92
45	7.8	85	86	87	87	88	88	89	89	90	91	91	92	92
50	10	86	87	87	88	88	89	90	90	91	91	92	92	92
55	12.8	87	88	88	89	89	90	90	91	91	92	92	92	93
60	15.6	88	88	89	89	90	90	91	91	92	92	93	93	93
65	18.3	88	89	90	90	91	91	91	92	92	93	93	93	94
70	21.1	89	90	90	91	91	91	92	92	93	93	94	94	94
75	23.9	90	91	91	91	92	92	92	93	93	94	94	94	95
80	26.7	91	91	92	92	92	93	93	93	94	94	95	95	95
85	29.4	92	92	93	93	93	93	94	94	95	95	95	96	96
90	32.2	93	93	93	94	94	94	95	95	95	95	96	96	96
95	35	94	94	94	95	95	95	95	96	96	96	96	97	97
100	37.8	94	95	95	95	95	96	96	96	96	97	97	97	98
105	40.4	96	96	96	96	96	97	97	97	97	97	98	98	98
110	43	97	97	97	97	97	97	97	98	98	98	98	98	99
115	46	98	98	98	98	98	98	98	98	98	99	99	99	99

†See 4.4.3.2(a).

Table 4.4.2.2(c) Maximum Permitted LP-Gas Volume (percent of total container volume): All Underground Containers

Liquid Temperature		Specific Gravity												
°F	°C	0.496 to 0.503	0.504 to 0.510	0.511 to 0.519	0.520 to 0.527	0.528 to 0.536	0.537 to 0.544	0.545 to 0.552	0.553 to 0.560	0.561 to 0.568	0.569 to 0.576	0.577 to 0.584	0.585 to 0.592	0.593 to 0.600
–50	–45.6	77	78	79	80	80	81	82	83	83	84	85	85	86
–45	–42.8	77	78	79	80	81	82	82	83	84	84	85	86	87
–40	–40	78	79	80	81	81	82	83	83	84	85	86	86	87
–35	–37.2	78	79	80	81	82	82	83	84	85	85	86	87	87
–30	–34.4	79	80	81	81	82	83	84	84	85	86	86	87	88
–25	–31.5	79	80	81	82	83	83	84	85	85	86	87	87	88
–20	–28.9	80	81	82	82	83	84	84	85	86	86	87	88	88
–15	–26.1	80	81	82	83	84	84	85	86	86	87	87	88	89
–10	–23.3	81	82	83	83	84	85	85	86	87	87	88	88	89
–5	–20.6	81	82	83	84	84	85	86	86	87	88	88	89	89
0	–17.8	82	83	84	84	85	85	86	87	87	88	89	89	90
5	–15	82	83	84	85	85	86	87	87	88	88	89	90	90
10	–12.2	83	84	85	85	86	86	87	88	88	89	90	90	91
15	–9.4	84	84	85	86	86	87	88	88	89	89	90	91	91
20	–6.7	84	85	86	86	87	88	88	89	89	90	90	91	91
25	–3.9	85	86	86	87	87	88	89	89	90	90	91	91	92
30	–1.1	85	86	87	87	88	89	89	90	90	91	91	92	92
35	1.7	86	87	87	88	88	89	90	90	91	91	92	92	93
40	4.4	87	87	88	88	89	90	90	91	91	92	92	93	93
45	7.8	87	88	89	89	90	90	91	91	92	92	93	93	94
†50	10	88	89	89	90	90	91	91	92	92	93	93	94	94
55	12.8	89	89	90	91	91	91	92	92	93	93	94	94	95
60	15.6	90	90	91	91	92	92	92	93	93	94	94	95	95
65	18.3	90	91	91	92	92	93	93	94	94	94	95	95	96
70	21.1	91	91	92	93	93	93	94	94	94	95	95	96	96
75	23.9	92	93	93	93	94	94	94	95	95	95	96	96	97
80	26.7	93	93	94	94	94	95	95	95	96	96	96	97	97
85	29.4	94	94	95	95	95	95	96	96	96	97	97	97	98
90	32.2	95	95	95	95	96	96	96	97	97	97	98	98	98
95	35	96	96	96	96	97	97	97	97	98	98	98	98	99
100	37.8	97	97	97	97	97	98	98	98	98	99	99	99	99
105	40.4	98	98	98	98	98	98	98	99	99	99	99	99	99

†See 4.4.3.3(a).

4.4.3 Compliance with Maximum Permitted Filling Limit Provisions.

4.4.3.1 The maximum permitted filling limit for any container shall be determined by weight or by the volumetric filling method in accordance with the following:

4.4.3.2 The volumetric method shall be limited to the following containers, where they are designed and equipped for filling by volume:

(1) Cylinders of less than 200-lb (91-kg) water capacity that are not subject to DOT jurisdiction
(2) Cylinders of 200-lb (91-kg) water capacity or more

(3) Cargo tanks or portable tank containers complying with DOT specifications MC-330, MC-331, or DOT 51
(4) ASME and API-ASME containers complying with 2.2.1.3 or 2.2.2.2

4.4.3.3 Where used, the volumetric method shall be in accordance with the following:

(a) If a fixed maximum liquid level gauge or a variable liquid level gauge without liquid volume temperature correction is used, the liquid level indicated by these gauges shall be computed based on the maximum permitted filling limit when the liquid is at 40°F (4°C) for aboveground containers or at 50°F (10°C) for underground containers.

(b) When a variable liquid level gauge is used and the liquid volume is corrected for temperature, the maximum permitted liquid level shall be in accordance with Tables 4.4.2.2(a), (b), and (c).

(c) ASME containers with a water capacity of 2000 gal (7.6 m) or less filled by the volumetric method shall be gauged in accordance with 4.4.3.3(a), utilizing the fixed maximum liquid level gauge.

Exception: Containers fabricated on or before December 31, 1965, shall be exempt from this provision.

4.4.3.4 Where containers are to be filled volumetrically by a variable liquid level gauge in accordance with 4.4.3.3(b), provisions shall be made for determining the liquid temperature.

4.4.3.5* An overfilling prevention device shall not be the primary means to determine when a cylinder is properly filled. Other means specified in this chapter shall be used when filling cylinders.

Chapter 5 Storage of Cylinders Awaiting Use, Resale, or Exchange

5.1 Scope.

5.1.1 Application.

5.1.1.1 The provisions of this chapter shall apply to the storage of cylinders of 1000-lb (454-kg) water capacity or less, whether filled, partially filled, or empty as follows:

(1) At consumer sites or dispensing stations, where not connected for use
(2) In storage for resale or exchange by dealer or reseller

Exception: This chapter shall not apply to new, unused cylinders.

5.1.1.2 The provisions of this chapter shall not apply to cylinders stored at bulk plants.

5.2 General Provisions.

5.2.1 General Location of Cylinders.

5.2.1.1 Cylinders in storage shall be located to minimize exposure to excessive temperature rises, physical damage, or tampering.

5.2.1.2 Cylinders in storage having individual water capacity greater than 2.7 lb (1.1 kg) [nominal 1 lb (0.45 kg)] LP-Gas capacity shall be positioned so that the pressure relief valve is in direct communication with the vapor space of the cylinder.

5.2.1.3 Cylinders stored in buildings in accordance with Section 5.3 shall not be located near exits, stairways, or in areas normally used, or intended to be used, for the safe egress of occupants.

5.2.1.4 If empty cylinders that have been in LP-Gas service are stored indoors, they shall be considered as full cylinders for the purposes of determining the maximum quantities of LP-Gas permitted in 5.3.1, 5.3.2.1, and 5.3.3.1.

5.2.1.5 Cylinders shall not be stored on roofs.

5.2.2 Protection of Valves on Cylinders in Storage. Cylinder valves shall be protected as required by 2.2.4.1. Screw-on-type caps or collars shall be in place on all cylinders stored, regardless of whether they are full, partially full, or empty, and cylinder outlet valves shall be closed and plugged or capped. The provisions of 4.2.2.3 for valve outlet plugs and caps shall apply.

5.3 Storage Within Buildings.

5.3.1 Storage Within Buildings Frequented by the Public and in Residential Occupancies. Where cylinders are stored or displayed in a building frequented by the public, the following subsections shall apply.

5.3.1.1 The quantity of LP-Gas shall not exceed 200 lb (91 kg).

5.3.1.2 The cylinders shall not exceed a water capacity of 2.7 lb (1.1 kg) [nominal 1 lb (0.45 kg) LP-Gas]

Exception: Storage in restaurants and at food service locations of 10-oz (283-g) butane nonrefillable containers shall be limited to no more than 24 containers, and an additional twenty-four 10-oz (283-g) butane nonrefillable containers stored in another location within the building, where constructed with at least a 2-hour fire wall protection.

5.3.2 Storage Within Buildings Not Frequented by the Public (Such as Industrial Buildings).

5.3.2.1 The maximum quantity allowed in one storage location shall not exceed 735-lb (334-kg) water capacity [nominal 300 lb (136 kg) LP-Gas].

Exception: Where additional storage locations are required on the same floor within the same building, they shall be separated by a minimum of 300 ft (91.4 m). Storage beyond these limitations shall comply with 5.3.3.

5.3.2.2 Cylinders carried as part of the service equipment on highway mobile vehicles shall not be part of the total storage capacity in the requirements of 5.3.2.1, where such vehicles are stored in private garages and carry no more than 3 cylinders with a total aggregate capacity per vehicle not exceeding 100 lb (45.4 kg) of LP-Gas. Cylinder valves shall be closed when not in use.

5.3.3 Storage Within Special Buildings or Rooms.

5.3.3.1 The maximum quantity of LP-Gas stored in special buildings or rooms shall be 10,000 lb (4540 kg).

5.3.3.2 Special buildings or rooms for storing LP-Gas cylinders shall not be located adjoining the line of property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering.

5.3.3.3 The construction of all such special buildings, and rooms within, or attached to, other buildings, shall comply with Chapter 7 and the following:

(a) Vents, to the outside only, shall be provided at both top and bottom and shall be located at least 5 ft (1.5 m) from any building opening.

(b) The entire area shall be classified for purposes of ignition source control in accordance with Section 3.7.

5.3.4 Storage Within Residential Buildings. Storage of cylinders within a residential building, including the basement or any storage area in a common basement storage area in multiple-family buildings and attached garages, shall be limited to cylinders each with a maximum water capacity of 2.7 lb (1.2 kg) and shall not exceed 5.4-lb (2.4-kg) aggregate water capacity for smaller cylinders per each living space unit. Each cylinder shall meet DOT specifications.

5.4 Storage Outside of Buildings.

5.4.1* Location of Storage Outside of Buildings. Storage outside of buildings for cylinders awaiting use, resale, or part of a cylinder exchange point shall be located as follows.

5.4.1.1 At least 5 ft (1.5 m) from any doorway or opening in a building frequented by the public where occupants have at least two means of egress as defined by NFPA *101, Life Safety Code*. For buildings, or sections of buildings, having only one means of egress, at least 10 ft from the doorway or opening.

5.4.1.2 At least 20 ft from any automotive service station fuel dispenser.

5.4.1.3 In accordance with Table 5.4.1.3 with respect to the following:

(1) Nearest important building or group of buildings
(2) Line of adjoining property that may be built upon
(3) Busy thoroughfares or sidewalks
(4) Line of adjoining property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering
(5) Dispensing station

Exception: Cylinders in the filling process shall not be considered to be in storage.

Table 5.4.1.3 Distances from Cylinders in Storage and Exposures

Quantity of LP-Gas Stored		Horizontal Distance to . . .					
		(1) & (2)		(3) & (4)		(5)	
lb	kg	ft	m	ft	m	ft	m
≤720	≤227	0	0	0	0	5	1.5
721 to 2500	227+ to 1134	0	0	10	3	10	3
2501 to 6000	1134+ to 2721	10	3	10	3	10	3
6001 to 10,000	2721+ to 4540	20	6.1	20	6.1	20	6.1
>10,000	>4540	25	7.6	25	7.6	25	7.6

5.4.2 Protection of Cylinders.

5.4.2.1 Cylinders at a location open to the public shall be protected by either of the following:

(1) An enclosure in accordance with 3.3.6(a)
(2) A lockable ventilated metal locker or rack that prevents tampering with valves and pilferage of the cylinder

5.4.2.2* Protection against vehicle impact shall be provided in accordance with good engineering practice where vehicle traffic normally is expected at the location.

5.4.3 Alternate Location and Protection of Storage. Where the provisions of 5.4.1 and 5.4.2.1 are impractical at construction sites or at buildings or structures undergoing major renovation or repairs, alternate storage of cylinders shall be acceptable to the authority having jurisdiction.

5.5* Fire Protection. Storage locations, where the aggregate quantity of propane stored is in excess of 720 lb (327 kg), shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (9.2 kg) dry chemical with B-C rating. The required fire extinguisher shall be located no more than 50 ft (15 m) from the storage location.

Chapter 6 Vehicular Transportation of LP-Gas

6.1 Scope.

6.1.1 Application.

6.1.1.1 This chapter shall apply to containers, container appurtenances, piping, valves, equipment, and vehicles used in the transportation of LP-Gas, as follows:

(a) Transportation of cylinders.

Exception: The provisions of this chapter shall not apply to cylinders and related equipment incident to their use on vehicles as covered in Section 3.8 and Chapter 8.

(b) Transportation in cargo tank vehicles, whether fabricated by mounting cargo tanks on conventional truck or trailer chassis or constructed as integral cargo units in which the container constitutes in whole, or in part, the stress member of the vehicle frame, is included.

Transfer equipment and piping, and the protection of such equipment and the container appurtenances against overturn, collision, or other vehicular accidents, shall also be included.

(c)*Vehicles and procedures under the jurisdiction of DOT shall comply with DOT regulations.

6.1.1.2 This chapter shall not apply to the transportation of LP-Gas containers on vehicles where the containers are used to fuel the vehicle or appliances located on the vehicle as covered in Sections 3.8, 8.5, and 8.6.

6.1.1.3 If LP-Gas is used for engine fuel, the LP-Gas system shall be designed, constructed, and installed in accordance with Chapter 8. Fuel systems (including fuel containers) shall be constructed and installed in accordance with Section 3.8. Fuel shall be used either from the cargo tank of the cargo tank vehicle or from engine fuel container installed in accordance with 8.2.6. Fuel shall not be used from cargo tanks on trailers or semitrailers.

6.1.1.4 Only electrical lighting shall be used with the vehicles covered by this chapter. Wiring shall be insulated and protected from physical damage.

6.2 Transportation in Portable Containers.

6.2.1 Application. This section shall apply to the vehicular transportation of portable containers filled with LP-Gas delivered as "packages," including containers built to DOT cylinder specifications and other portable containers.

6.2.2 Transportation of Cylinders.

6.2.2.1 Cylinders having an individual water capacity not exceeding 1000 lb (454 kg) [nominal 420 lb (191 kg) LP-Gas

capacity], when filled with LP-Gas, shall be transported in accordance with the requirements of this section.

6.2.2.2 Cylinders shall be constructed as provided in Section 2.2 and equipped in accordance with Section 2.3 for transportation as cylinders.

6.2.2.3 The quantity of LP-Gas in cylinders shall be in accordance with Chapter 4.

6.2.2.4 Valves of cylinders shall be protected in accordance with 2.2.4.1. Screw-on-type protecting caps or collars shall be secured in place. The provisions of 4.2.2.3 shall apply.

6.2.2.5 The cargo space of the vehicle shall be isolated from the driver's compartment, the engine, and its exhaust system. Open-bodied vehicles shall be considered to be in compliance with this provision. Closed-bodied vehicles having separate cargo, driver, and engine compartments shall also be considered to be in compliance with this provision.

Exception: Closed-bodied vehicles such as passenger cars, vans, and station wagons shall not be used for transporting more than 215 lb (98 kg) water capacity [nominal 90 lb (41 kg) LP-Gas capacity] but not more than 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) LP-Gas capacity] per cylinder (see 6.2.2.6 and 6.2.2.7), unless the driver and engine compartments are separated from the cargo space by a vaportight partition that contains no means of access to the cargo space.

6.2.2.6 Cylinders and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Cylinders shall be loaded into vehicles with flat floors or equipped with racks for holding cylinders. Cylinders shall be fastened in position to minimize the possibility of movement, tipping, and physical damage.

6.2.2.7 Cylinders being transported by vehicles shall be positioned in accordance with Table 6.2.2.7.

Table 6.2.2.7 Orientation of Cylinders on Vehicles

Propane Capacity of Cylinder			
lb w.c.	m^3	Open Vehicles	Enclosed Spaces of Vehicles
≤45	0.17	Any position	
>45	0.17	Relief valve in communication with the vapor space	
≤4.2	0.016		Any position
>4.2	0.016		Relief valve in communication with the vapor space

6.2.2.8 Vehicles transporting more than 1000 lb (454 kg), including the weight of the LP-Gas and the cylinders, shall be placarded as required by DOT regulations or state law.

6.2.3 Transportation of Portable Containers of More Than 1000 lb (454 kg) Water Capacity.

6.2.3.1 Portable containers having an individual water capacity exceeding 1000 lb (454 kg) [nominal 420 lb (191 kg) LP-Gas capacity] when filled with LP-Gas shall be transported in compliance with the requirements of this section.

6.2.3.2 Containers shall be constructed in accordance with Section 2.2 and equipped in accordance with Section 2.3 for portable use or shall comply with DOT portable tank specifications for LP-Gas service.

6.2.3.3 The quantity of LP-Gas put into containers shall be in accordance with Chapter 4.

6.2.3.4 Valves and other container appurtenances shall be protected in accordance with 2.2.4.2.

6.2.3.5 Transportation of containers and their appurtenances shall be in accordance with the following:

(a) Containers and their appurtenances shall be leak-free before being loaded into vehicles.

(b) Containers shall be transported in a rack or frame or on a flat surface.

(c) Containers shall be fastened in a position to minimize the possibility of movement, tipping, or physical damage, relative to each other or to the supporting structure, while in transit.

6.2.3.6 Containers shall be transported with pressure relief devices in communication with the vapor space.

6.2.3.7 Vehicles carrying more than 1000 lb (454 kg), including the weight of the LP-Gas and the containers, shall be placarded as required by DOT regulations or state law.

6.2.3.8 Where portable containers complying with the requirements of this section are installed permanently or semipermanently on vehicles to serve as cargo tanks, so that the assembled vehicular unit can be used for making liquid deliveries to other containers at points of use, the provisions of Section 6.3 shall apply.

6.2.4 Fire Extinguishers. Each truck or trailer transporting portable containers in accordance with 6.2.2 or 6.2.3 shall be equipped with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (8.2 kg) dry chemical with a B:C rating.

6.3 Transportation in Cargo Tank Vehicles.

6.3.1 Application.

6.3.1.1 This section shall apply to cargo tank vehicles used for the transportation of LP-Gas as liquid cargo. Transfer shall be permitted to be made by a pump or compressor mounted on the vehicle or by a transfer means at the delivery point.

6.3.1.2 All LP-Gas cargo tank vehicles, whether used in interstate or intrastate service, shall comply with the applicable portion of the U.S. Department of Transportation Hazardous Materials Regulations of the DOT *Federal Motor Carrier Safety Regulations* (Title 49, *Code of Federal Regulations*, Parts 171–180, 393, 396 and 397) and shall also comply with any added requirements of this code.

6.3.2 Containers Mounted on, or a Part of, Cargo Tank Vehicles.

6.3.2.1 Containers mounted on, or comprising in whole or in part, the stress member used in lieu of a frame for cargo tank vehicles shall comply with DOT cargo tank vehicle specifications for LP-Gas service. Such containers shall also comply with Section 2.2 and be equipped with appurtenances as provided in Section 2.3 for cargo service.

6.3.2.2 Liquid hose of $1^1/_2$-in. (nominal size) and larger and vapor hose of $1^1/_4$-in. (nominal size) and larger shall be protected with an internal self-closing stop valve complying with DOT requirements.

Exception: Where flow is only into the cargo tank, a backflow check valve or an internal valve shall be installed in the cargo tank.

6.3.3 Piping (Including Hose), Fittings, and Valves.

6.3.3.1 Pipe, tubing, pipe and tubing fittings, valves, hose, and flexible connectors shall comply with the following:

(1) Section 2.4
(2) The provisions of DOT cargo tank vehicle specifications for LP-Gas, and
(3) The working pressure specified in 2.5.1.2. In addition, the following shall apply:
   a. Pipe shall be wrought iron, steel, brass, or copper in accordance with 2.4.2.
   b. Tubing shall be steel, brass, or copper in accordance with 2.4.3(a), (b), or (c).
   c. Pipe and tubing fittings shall be steel, brass, copper, malleable iron, or ductile (nodular) iron suitable for use with the pipe or tubing used as specified in 6.3.3.1(a) or (b).
   d. Pipe joints shall be threaded, flanged, welded, or brazed. Fittings, where used, shall comply with 6.3.3.1(c).
      1. Where joints are threaded, or threaded and back welded, pipe and nipples shall be Schedule 80 or heavier. Copper or brass pipe and nipples shall be of equivalent strength.
      2. Where joints are welded or brazed, the pipe and nipples shall be Schedule 40 or heavier. Fittings or flanges shall be suitable for the service. *(See 6.3.3.2.)*
      3. Brazed joints shall be made with a brazing material having a melting point exceeding 1000°F (538°C).
   e. Tubing joints shall be brazed, using a brazing material having a melting point of at least 1000°F (538°C).

6.3.3.2 Pipe, tubing, pipe and tubing fittings, valves, hose, and flexible connectors, and complete cargo tank vehicle piping systems including connections to equipment *(see 6.3.4),* after assembly, shall comply with 2.5.1.2.

6.3.3.3 Valves, including shutoff valves, excess-flow valves, backflow check valves, and remotely controlled valves, used in piping shall comply with the following:

(1) DOT cargo tank vehicle specifications for LP-Gas service
(2) Subsection 2.4.5
(3) The minimum design pressure requirements of 2.5.1.2

6.3.3.4* Hose, hose connections, and flexible connectors shall comply with 2.4.6 and 6.3.3.1.

6.3.3.5 Flexible connectors used in the piping system to compensate for stresses and vibration shall be limited to 3 ft (1 m) in overall length and when replaced shall comply with 2.4.6.

6.3.3.6 Flexible connectors shall comply with the following:

(a) Flexible connectors assembled from rubber hose and couplings shall be permanently marked to indicate the date of installation of the flexible connector.

(b) The flexible portion of the connector shall be replaced with an unused connector within 10 years of the indicated date of installation of the connector and visually inspected before the first delivery of each day.

(c) The rubber hose portion of flexible connectors shall be replaced whenever a cargo unit is remounted on a different chassis, or whenever the cargo unit is repiped, if such repiping encompasses that portion of piping in which the connector is located.

Exception: Replacement shall not be required if the remounting or repiping is performed within 1 year of the date of assembly of the connector.

6.3.3.7 All threaded primary valves and fittings used in liquid filling or vapor equalization directly on the cargo container of transportation equipment shall be of steel, malleable, or ductile iron construction. All existing equipment shall be so equipped not later than the scheduled requalification date of the container.

6.3.4 Equipment.

6.3.4.1 LP-Gas equipment, such as pumps, compressors, meters, dispensers, regulators, and strainers, shall comply with Section 2.5 for design and construction and shall be installed in accordance with the applicable provisions of 3.2.25.

6.3.4.2 Equipment on vehicles shall be mounted in place and connected to the piping system in accordance with the manufacturer's instructions.

6.3.4.3 Container openings whose only function is for pump bypass return shall be provided with one of the following:

(1) A positive shutoff valve capable of being secured in the open position located as close to the tank as practical in combination with a steel backflow check valve installed in the tank
(2) An internal valve with excess flow protection
(3) A valve that is specifically recommended and listed by the manufacturer for bypass return service and that meets the requirements of 3.2.25.1(b)

6.3.4.4 Where an electric drive is used to power pumps or compressors mounted on vehicles and the energy is obtained from the electrical installation at the delivery point, the installation on the vehicle shall comply with 3.7.2.

6.3.4.5 The installation of compressors shall comply with the provisions of 3.2.25.2 and 6.3.4.1.

6.3.4.6 The installation of liquid meters shall be in accordance with 3.2.25.4(a).

6.3.4.7 Where wet hose is carried while connected to the truck's liquid pump discharge piping, an automatic device, such as a differential regulator, shall be installed between the pump discharge and the hose connection to prevent liquid discharge while the pump is not operating. Where a meter or dispenser is used, this device shall be installed between the meter outlet and the hose connection. If an excess-flow valve is used, it shall not be the exclusive means of complying with this provision.

6.3.5 Protection of Container Appurtenances, Piping System, and Equipment. Container appurtenances, piping, and equipment comprising the complete LP-Gas system on the cargo tank vehicle shall be mounted in position *(see 6.3.2.1 for container mounting),* shall be protected against damage, and shall be in accordance with DOT regulations.

6.3.6 Painting and Marking Cargo Tank Vehicles. Painting of cargo tank vehicles shall comply with *Code of Federal Regulations*, Title 49, Part 195. Placarding and marking shall comply with 49 *CFR*.

6.3.7* Fire Extinguishers. Each cargo tank vehicle or tractor shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (8.2 kg) dry chemical with a B:C rating.

6.3.8 Chock Blocks for Cargo Tank Vehicles. Each cargo tank vehicle and trailer shall carry chock blocks, which shall be used

to prevent rolling of the vehicle whenever it is being loaded or unloaded or is parked.

6.3.9 Exhaust Systems. The truck engine exhaust system shall comply with *Federal Motor Carrier Safety Regulations.*

6.3.10 Smoking Prohibition. No person shall smoke or carry lighted smoking material as follows:

(1) On or within 25 ft (7.6 m) of a vehicle that is containing LP-Gas liquid or vapor
(2) At points of liquid transfer and
(3) When delivering or connecting to containers

6.4 Trailers, Semitrailers, and Movable Fuel Storage Tenders, Including Farm Carts.

6.4.1 Application. This section shall apply to all cargo tank vehicles, other than trucks, that are parked at locations other than bulk plants.

6.4.2 Trailers or Semitrailers Comprising Parts of Vehicles in Accordance with Section 6.3. When parked, tank trailers or semitrailers covered by Section 6.3 shall be positioned so that the pressure relief valves communicate with the vapor space of the container.

6.4.3 Fuel Storage Tenders Including Farm Carts.

6.4.3.1 Movable fuel storage tenders including farm carts *(see 1.7.43)* shall comply with this section. Where used over public ways, they shall comply with applicable state regulations.

6.4.3.2 Movable fuel storage tenders shall be constructed in accordance with Section 2.2 and equipped with appurtenances as provided in Section 2.3.

6.4.3.3 Threaded piping shall be not less than Schedule 80, and fittings shall be designed for not less than 250 psig (1.7 MPag).

6.4.3.4 Piping, hoses, and equipment, including valves, fittings, pressure relief valves, and container accessories, shall be protected against collision or upset.

6.4.3.5 Tenders shall be so positioned that container pressure relief valves communicate with the vapor space.

6.4.3.6 Such tenders shall not be filled on a public way.

6.4.3.7 Such tenders shall contain no more than 5 percent of their water capacity in liquid form during transportation to or from the bulk plant.

6.4.3.8 The shortest practical route shall be used when transporting tenders between points of utilization.

6.5 Transportation of Stationary Containers to and from Point of Installation.

6.5.1 Application. This section shall apply to the transportation of containers designed for stationary service at the point of use and secured to the vehicle only for transportation. Such containers shall be transported in accordance with 6.5.2.1.

6.5.2 Transportation of Containers.

6.5.2.1 ASME containers of 125-gal (0.5-m^3) or more water capacity shall contain no more than 5 percent of their water capacity in liquid form during transportation.

Exception: Containers shall be permitted to be transported with more LP-Gas than 5 percent of their water capacity in a liquid form but less than the maximum permitted by Section 4.4, provided that all the following conditions apply:

(a) Transportation shall be permitted only to move containers from a stationary or temporary installation to a bulk plant.

(b) Valves and fittings shall be protected by a method approved by the authority having jurisdiction to minimize the possibility of damage.

(c) Lifting lugs shall not be used to move these containers.

6.5.2.2 Containers shall be installed to minimize movement relative to each other or to the carrying vehicle while in transit, giving consideration to vehicular operation.

6.5.2.3 Valves, regulators, and other container appurtenances shall be protected against physical damage during transportation.

6.5.2.4 Pressure relief valves shall be in direct communication with the vapor space of the container.

6.6 Parking and Garaging Vehicles Used to Carry LP-Gas Cargo.

6.6.1 Application. This section shall apply to the parking and garaging of vehicles used for the transportation of LP-Gas.

6.6.2 Parking.

6.6.2.1 Vehicles carrying or containing LP-Gas parked outdoors shall comply with the following:

(a) Vehicles shall not be left unattended on any street, highway, avenue, or alley, except for necessary absences from the vehicle associated with drivers' normal duties, including stops for meals and rest stops during the day or night.

Exception No. 1: This requirement shall not apply in an emergency.

Exception No. 2: This requirement shall not apply to vehicles parked in accordance with 6.6.2.1(b).

(b) Vehicles shall not be parked in congested areas. Where vehicles shall be permitted to be parked off the street in uncongested areas, they shall be at least 50 ft (15 m) from any building used for assembly, institutional, or multiple residential occupancy. Where vehicles carrying portable containers or cargo tank vehicles of 3500-gal (13-m^3) water capacity or less are parked on streets adjacent to the driver's residence in uncongested residential areas, the parking locations shall be at least 50 ft (15 m) from a building used for assembly, institutional, or multiple residential occupancy.

6.6.2.2 Vehicles parked indoors shall comply with the following:

(a) Cargo tank vehicles parked in any public garage or building shall have LP-Gas liquid removed from the following:

(1) Cargo container
(2) Piping
(3) Pump
(4) Meter
(5) Hoses
(6) Related equipment

(b) Vehicles used to carry portable containers shall not be moved into any public garage or building for parking until all portable containers have been removed from the vehicle.

(c) The pressure in the delivery hose and related equipment shall be reduced to approximately atmospheric.

(d) All valves shall be closed before the vehicle is moved indoors. Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved indoors.

(e) Vehicles carrying or containing LP-Gas shall be permitted to be parked in buildings complying with Chapter 7 and located on premises owned or under the control of the operator of such vehicles, provided the following provisions apply:

(1) The public shall be excluded from such buildings.
(2) Floor level ventilation shall be provided in all parts of the building where such vehicles are parked.
(3) Leaks in the vehicle LP-Gas systems shall be repaired before the vehicle is moved indoors.
(4) Primary shutoff valves on cargo tanks and other LP-Gas containers on the vehicle (except propulsion engine fuel containers) shall be closed and delivery hose outlets plugged or capped to contain system pressure before the vehicle is moved indoors.
(5) Primary shutoff valves on LP-Gas propulsion engine fuel containers shall be closed while the vehicle is parked.
(6) No LP-Gas container shall be located near a source of heat or within the direct path of hot air being blown from a blower-type heater.
(7) LP-Gas containers shall be gauged or weighed to determine that they are not filled beyond the maximum filling limit according to Section 4.4.

6.6.2.3 Where vehicles are serviced or repaired indoors, the following shall apply:

(a) When it is necessary to move a vehicle into any building located on premises owned or operated by the operator of such vehicle for service on engine or chassis, the provisions of 6.6.2.2(a) or (e) shall apply.

(b) When it is necessary to move a vehicle carrying or containing LP-Gas into any public garage or repair facility for service on the engine or chassis, the provisions of 6.6.2.2(a) or (b) shall apply, or the driver or a qualified representative of an LP-Gas operator shall be in attendance at all times while the vehicle is indoors. The following provisions shall apply under the supervision of such qualified persons:

(1) Leaks in the vehicle LP-Gas systems shall be repaired before the vehicle is moved indoors.
(2) Primary shutoff valves on cargo tanks, portable containers, and other LP-Gas containers installed on the vehicle (other than propulsion engine fuel containers) shall be closed.
(3) LP-Gas liquid shall be removed from the piping, pump, meter, delivery hose, and related equipment and the pressure therein reduced to approximately atmospheric before the vehicle is moved inside.
(4) Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved indoors.
(5) No container shall be located near a source of heat or within the direct path of hot air blown from a blower or from a blower-type heater.
(6) LP-Gas containers shall be gauged or weighed to determine that they are not filled beyond the maximum filling capacity in accordance with Section 4.4.

(c) If repair work or servicing is to be performed on a cargo tank vehicle system, all LP-Gas shall be removed from the cargo tank and piping, and the system shall be thoroughly purged before the vehicle is moved indoors.

Chapter 7 Buildings or Structures Housing LP-Gas Distribution Facilities

7.1 Scope.

7.1.1 Application.

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

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

Exception: Buildings previously constructed under the provisions of 5.3.3. (Also see 1.1.4.)

7.2 Separate Structures or Buildings.

7.2.1 Construction of Structures or Buildings.

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

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

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

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

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

7.2.2.1 Where mechanical ventilation is used, the rate of air circulation shall be at least 1 $ft^3/min \cdot ft^2$ (0.3 $m^3/min \cdot m^2$) of floor area. Outlets shall discharge at least 5 ft (1.5 m) from any opening into the structure or any other structure.

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

7.2.3 Structure or Building Heating. Heating shall be by steam or hot water radiation or other heating transfer medium, with the heat source located outside of the building or structure *(see Section 3.7),* or by electrical appliances listed for Class I, Group D, Division 2 locations, in accordance with NFPA 70, *National Electrical Code.*

7.3 Attached Structures or Rooms Within Structures.

7.3.1 Construction of Attached Structures. Attached structures shall be spaces where 50 percent or less of the perimeter of the enclosed space is comprised of common walls.

7.3.1.1 Attached structures shall comply with 7.2.1.

7.3.1.2 Common walls of structures shall have the following features:

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

7.3.1.3 Where the building to which the structure is attached is occupied by operations or processes having a similar hazard, the provisions of 7.3.1.2 shall not apply.

7.3.1.4 Ventilation and heating shall comply with 7.2.2 and 7.2.3.

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

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

7.3.2.2 Walls, floors, ceilings, or roofs of the rooms shall be constructed of noncombustible materials.

7.3.2.3 Exterior walls and ceilings shall be of lightweight material designed for explosion venting.

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

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

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

7.3.2.6 Where the building to which the structure is attached is occupied by operations or processes having a similar hazard, the provisions of 7.3.1.2 shall not apply.

7.3.2.7 Ventilation and heating shall comply with 7.2.2 and 7.2.3.

Chapter 8 Engine Fuel Systems

8.1 Scope and Training.

8.1.1 Application.

8.1.1.1* This chapter shall apply to fuel systems using LP-Gas as a fuel for internal combustion engines. Included are provisions for containers, container appurtenances, carburetion equipment, piping, hose and fittings, and provisions for their installation. This chapter covers engine fuel systems for engines installed on vehicles for any purpose, as well as fuel systems for stationary and portable engines. It also includes provisions for garaging of vehicles upon which such systems are installed.

8.1.1.2 Containers supplying fuel to engines on vehicles, regardless of whether the engine is used to propel the vehicle or is mounted on it for other purposes, shall be constructed and installed in accordance with this section.

8.1.2 Nonapplication. Containers supplying fuel to stationary engines or to portable engines used in lieu of stationary engines shall be installed in accordance with Section 3.2. *(See Section 3.4 for portable engines used in buildings or on roofs or exterior balconies under certain conditions.).*

8.1.3 Training. In the interest of safety, each person engaged in installing, repairing, filling, or otherwise servicing an LP-Gas engine fuel system shall be properly trained in the necessary procedures.

8.2 General Purpose Vehicle Engines Fueled by LP-Gas.

8.2.1* This section shall apply to the installation of fuel systems supplying engines used to propel the following vehicles:

(1) Passenger cars
(2) Taxicabs
(3) Multipurpose passenger vehicles
(4) Buses
(5) Recreational vehicles
(6) Vans
(7) Trucks (including tractors, tractor semi-trailer units, and truck trains)
(8) Farm tractors

8.2.2 Containers.

8.2.2.1* Containers designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT); or the "Rules for Construction of Unfired Pressure Vessels," Section VIII, Division I, ASME *Boiler and Pressure Vessel Code*, for aboveground service applicable at the date of manufacture shall be used as follows.

(a) Adherence to applicable ASME Code Case Interpretations and Addenda shall be considered as compliance with the ASME Code.

(b) Containers that have been involved in a fire and that show no distortion shall be requalified for continued service in accordance with the code under which they were constructed before being reused.

(c) Cylinders shall be designed and constructed for at least 240 psi (1.6 MPa) service pressure.

(d) Cylinders shall be requalified in accordance with DOT regulations. The owner of the cylinder shall be responsible for such requalification. *(See Appendix C.)*

(e) ASME engine fuel and mobile containers shall have the following minimum design pressure:

(1) 250 psi (1.7 MPa) or 312.5 psig (2.2 MPag) where required if constructed prior to April 1, 2001
(2) 312.5 psig (2.2 MPag) if constructed on or after April 1, 2001

Exception: ASME containers installed in enclosed spaces on vehicles and all engine fuel containers for industrial trucks, buses (including school buses), recreational vehicles, and multipurpose passenger vehicles shall be constructed with a design pressure of at least 312.5 psi.

(f) Repair or alterations of containers shall comply with the regulations, rules, or code under which the container was fabricated. Field welding on containers shall be limited to attachments to nonpressure parts, such as the following:

(1) Saddle pads
(2) Wear plates
(3) Lugs
(4) Brackets installed by the container manufacturer

(g) Containers showing denting, bulging, gouging, or excessive corrosion shall be removed from service.

8.2.2.2 Containers shall comply with 8.2.2.1 or other codes acceptable to the authority having jurisdiction.

8.2.2.3 A stainless steel metal nameplate shall be attached to the ASME container and shall be located to remain visible after the container is installed. The nameplate shall be attached in such a way as to minimize corrosion of the nameplate or its fastening means and not cause corrosion of the container. The nameplate shall include the following information:

(1) Service for which the container is designed
(2) Name and address of container manufacturer or trade name of container
(3) Water capacity of container in pounds or U.S. gallons
(4) Design pressure in pounds per square inch (psi)
(5) The wording "This container shall not contain a product having a vapor pressure in excess of 215 psi (1.5 MPa) at 100°F (37.8°C)."
(6) Tare weight of container fitted for service in order for containers to be filled by weight
(7) Outside surface area in square feet
(8) Year of manufacture
(9) Shell thickness, head thickness
(10) OL (overall length), OD (outside diameter), HD (head design)
(11) Manufacturer's serial number
(12) ASME Code symbol

8.2.2.4 The maximum capacity of individual LP-Gas containers installed on highway vehicles shall be in accordance with Table 3.8.2.1(f).

8.2.2.5 Containers covered in this section shall be equipped for filling into the vapor space.

Exception: Containers having a water capacity of 30 gal (0.1 m^3) or less shall be permitted to be filled into the liquid space.

(a) The connections for pressure relief valves shall communicate directly with the vapor space of the container and shall not reduce the relieving capacity of the relief device.

(b) If the connection is located at any position other than the uppermost point of the container, it shall be internally piped to the uppermost point practical in the vapor space of the container.

8.2.2.6 The container openings shall be labeled to designate whether they communicate with the vapor or liquid space. The labels shall be on the container or valves connected to the container opening. Labels shall not be required on openings for pressure relief valves and gauging devices.

8.2.2.7 Engine fuel containers constructed of steel shall be painted to retard corrosion. *[See Appendix A.3.2.4.4.]*

8.2.3 Container Appurtenances. Container appurtenances (such as valves and fittings) shall comply with Section 2.3 and the following:

(a) Container appurtenances subject to working pressures in excess of 125 psig (0.9 MPag) shall be rated for a working pressure of at least 250 psig (1.7 MPag).

(b) Manual shutoff valves shall be designed to provide positive closure under service conditions and shall be equipped with an internal excess-flow check valve designed to close automatically at the rated flows of vapor or liquid specified by the manufacturers.

(c) Double backflow check valves shall comply with the following:

(1) Be of the spring-loaded type
(2) Close when flow is either stopped or reversed
(3) Installed in the fill opening on the container for either remote or direct filling.

(d) Containers shall be fabricated so they can be equipped with a fixed maximum liquid level gauge as follows:

(1) The fixed maximum liquid level gauge shall be capable of indicating the maximum permitted filling level in accordance with 4.4.2.2.
(2) Fixed maximum liquid level gauges in the container shall be designed so the bleeder valve maximum opening to the atmosphere is not larger than a No. 54 drill size.
(3) The container fixed maximum liquid level gauge opening and the remote bleeder valve opening shall not be larger than a No. 54 drill size where the bleeder valve is installed at a location remote from the container.

(e) Systems complying with the provisions of 3.11.3 shall have a water- and weather-resistant label placed near the bleeder valve with the following text: "Do not use fixed maximum liquid level gauge at low emission transfer stations."

(f) ASME containers shall be equipped with full internal or flush-type full internal pressure relief valves conforming with applicable requirements of UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, or other equivalent pressure relief valve standards. Fusible plugs shall not be used. The start-to-leak setting of such pressure relief valve, with relation to the design pressure of the container, shall be in accordance with Table 2.3.2.3. These relief valves shall be marked with the following:

(1) The pressure in psig (MPag) at which the valve is set to start to leak
(2) The rated relieving capacity in cubic feet per minute of air at 60°F (15.6°C) and 14.7 psia (an absolute pressure of 0.1 MPa)
(3) The manufacturer's name and catalog number.

(g) Cylinders shall be equipped with full internal or flush-type full internal pressure relief valves in accordance with DOT regulations *(see Appendix E)*.

(h) A float gauge, if used, shall be designed and approved for use with LP-Gas.

(i) A solid steel plug shall be installed in unused openings.

(j) Containers fabricated after January 1, 1984, for use as engine fuel containers on vehicles shall be equipped or fitted with an overfilling prevention device.

(k) Where an overfilling prevention device is installed on the container or exterior of the compartment and remote filling is used, a double backflow check valve shall be installed in the container fill valve opening.

(l) Where an overfilling prevention device is installed on an engine fuel container, venting of gas through a fixed maximum liquid level gauge during normal filling shall not be required.

8.2.4 Carburetion Equipment. Carburetion equipment shall comply with 8.2.4.1 through 8.2.4.3 or shall be approved.

8.2.4.1 Carburetion equipment subject to working pressures in excess of 125 psig (0.9 MPag) shall be designed for a working pressure of 250 psig (1.7 MPag), or for the design pressure of the container where the design pressure of the container is greater than 250 psig (1.7 MPag), and shall comply with the following subsections.

8.2.4.2 Vaporizers shall comply with the following requirements:

(a) Vaporizers shall be fabricated of materials resistant to corrosion by LP-Gas under service conditions.

(b) Vaporizers shall be designed and approved for engine fuel service. Vaporizers subjected to container pressure shall have a design pressure of 250 psig (1.7 MPag) or the design pressure of the container where the design pressure of the container is greater than 250 psig (1.7 MPag).

(c) Vaporizers shall be marked with the design pressure of the fuel containing portion in psi (MPa). The marking shall be visible when the vaporizer is installed.

(d) The vaporizer shall not be equipped with a fusible plug.

(e) Each vaporizer shall be capable of having the water or heating fluid drained from the engine cooling system drain or water hoses or shall have a valve or plug located at or near the lowest portion of the section occupied by the water or other heating fluid to allow drainage of the water or heating fluid.

(f) Where engine exhaust gases are used as a direct source of heat to vaporize the fuel, the materials of construction of those parts of the vaporizer in contact with the exhaust gases shall be resistant to corrosion by these gases and the vaporizer system shall be designed to prevent a pressure in excess of 200 psig (1.4 MPag).

(g) Devices that supply heat directly to the fuel container shall be equipped with an automatic device to cut off the supply of heat before the pressure in the container reaches 200 psig (1.4 MPag).

8.2.4.3 An approved automatic shutoff valve shall be provided in the fuel system as close as practical to the inlet of the gas regulator. The valve shall prevent flow of fuel to the carburetor when the engine is not running even if the ignition switch is in the on position. Atmospheric-type regulators (zero governors) shall not be considered as automatic shutoff valves for this purpose.

8.2.5 Piping, Hose, and Fittings.

8.2.5.1 Pipe shall be wrought iron or steel (black or galvanized), brass, or copper and shall comply with the following specifications:

(1) Wrought-iron pipe — ASME B 36.10M, *Welded and Seamless Wrought Steel Pipe*
(2) Steel pipe — ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
(3) Steel pipe — ASTM A 106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*
(4) Brass pipe — ASTM B 43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*
(5) Copper pipe — ASTM B 42, *Standard Specification for Seamless Copper Pipe, Standard Sizes*

8.2.5.2 Pipe used for LP-Gas vapor in excess of 125 psi (0.9 MPa) or for LP-Gas liquid shall be Schedule 80 or heavier. Pipe used for LP-Gas vapor at pressures of 125 psi (0.9 MPa) or less shall be Schedule 40 or heavier.

8.2.5.3 Tubing shall be steel, brass, or copper and shall comply with the following specifications:

(1) Steel tubing — ASTM A 539, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines*, with a minimum wall thickness of 0.049 in.
(2) Copper tubing, Type K or L — ASTM B 88, *Standard Specification for Seamless Copper Water Tube*
(3) Copper tubing — ASTM B 280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*
(4) Brass tubing — ASTM B 135, *Standard Specification for Seamless Brass Tube*

8.2.5.4 Cast-iron pipe fittings shall not be used. Fittings shall be steel, brass, copper, malleable iron, or ductile iron and shall comply with the following:

(a) Pipe joints in wrought iron, steel, brass, or copper pipe shall be screwed, welded, or brazed. Tubing joints in steel, brass, or copper tubing shall be flared, brazed, or made up with approved gas tubing fittings.

(b) Fittings used with liquid LP-Gas or with vapor LP-Gas at operating pressures over 125 psig (0.9 MPag) shall be designed for a working pressure of at least 250 psig (1.7 MPag) or the design pressure of the container, whichever is greater.

(c) Fittings for use with vapor LP-Gas at pressures in excess of 5 psig (34.5 kPag) and not in excess of 125 psig (0.9 MPag) shall be designed for a working pressure of 125 psig (0.9 MPag).

(d) Brazing filler material shall have a melting point exceeding 1000°F (538°C).

8.2.5.5 Hose, hose connections, and flexible connectors shall comply with the following requirements.

(a) Hose, hose connections, and flexible connectors *(see 1.7.26)* used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psig (34.5 kPag) shall be fabricated of materials resistant to the action of LP-Gas both as liquid and vapor and shall be of reinforced construction. The hose shall comply with the following:

(1) Hose that can be exposed to container pressure shall be designed for a working pressure of 350 psig (2.4 MPag) with a safety factor of 5 to 1, and the reinforcement shall be of corrosion resistant material.
(2) Hose that operates at lower than container pressure shall be designed for its maximum anticipated operating pressure.
(3) Hose shall be continuously marked with LP-GAS, PROPANE, 350 PSI WORKING PRESSURE and the manufacturer's name or trademark. Each installed piece of hose shall contain at least one such marking.
(4) Hose assemblies after the application of connections, shall have a design capability to withstand a pressure of not less than 700 psig (4.8 MPag). If a test is performed, such assemblies shall be leak tested at pressures between the operating pressure and 120 percent of the maximum working pressure [350 psig (24 MPag) minimum] of the hose.

(b) Hose used for vapor service at 5 psig (34.5 kPag) or less shall be constructed of material resistant to the action of LP-Gas.

(c) Hose in excess of 5 psig (34.5 kPag) service pressure and quick connectors shall be approved for this application by the authority having jurisdiction.

8.2.6 Installation of Containers and Container Appurtenances.

8.2.6.1 Containers shall be located to minimize the possibility of damage to the container and its fittings. Where containers are located in the rear of the vehicle, they shall be protected. Containers located less than 18 in. (460 mm) from the exhaust system, transmission, or a heat producing component of the internal combustion engine shall be shielded by a vehicle frame member or by a noncombustible baffle with an air space on both sides of the frame member or baffle.

8.2.6.2 After a container is permanently installed on a vehicle, container markings shall be readable either directly or with a portable lamp and mirror.

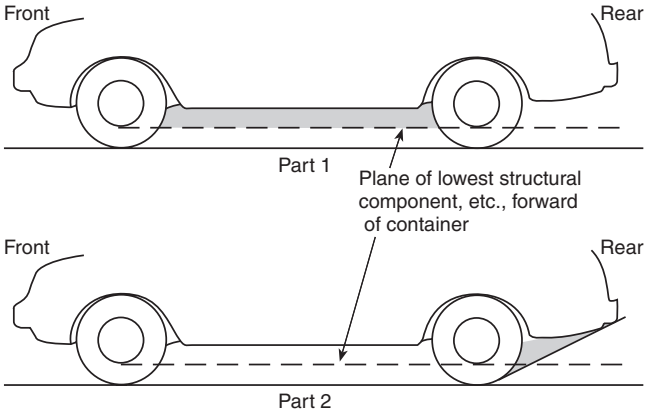
8.2.6.3 Container valves, appurtenances, and connections shall be protected to prevent damage due to accidental contacts with stationary objects or from stones, mud, or ice and from damage due to an overturn or similar vehicular accident. This protection shall be provided by location on the container where parts of the vehicle furnish the necessary protection by

the use of a fitting guard furnished by the manufacturer of the container or by other means.

8.2.6.4 Containers shall not be mounted directly on roofs or ahead of the front axle or beyond the rear bumper of the vehicles. No part of a container or its appurtenances shall protrude beyond the sides or top of the vehicle.

8.2.6.5 Containers shall be installed with as much road clearance as practical. This clearance shall be measured to the bottom of the container or the lowest fitting, support, or attachment on the container or its housing, if any, whichever is lowest, as follows *(see Figure 8.2.6.5)*.

FIGURE 8.2.6.5 Container installation clearances.



(a) Containers installed between axles shall comply with 8.2.6.5(c) or shall be not lower than the lowest point forward of the container on the following points:

(1) The lowest structural component of the body as illustrated in Figure 8.2.6.5
(2) The lowest structural component of the frame or subframe
(3) The lowest point on the engine
(4) The lowest point of the transmission (including the clutch housing or torque converter housing, as applicable)

(b) Containers installed behind the rear axle and extending below the frame shall comply with 8.2.6.5(c) or shall be not lower than the lowest of the following points and surfaces:

(1) They shall not be lower than the lowest point of a structural component of the body, engine, transmission (including clutch housing or torque converter housing, as applicable), forward of the container.
(2) They shall not be lower than lines extending rearward from each wheel at the point where the wheels contact the ground directly below the center of the axle to the lowest and most rearward structural interference as illustrated in the bottom diagram of Figure 8.2.6.5.

(c) Where an LP-Gas container is substituted for the fuel container installed by the original manufacturer of the vehicle, the LP-Gas container either shall fit within the space in which the original fuel container was installed or shall comply with 8.2.6.5(a) or (b).

8.2.6.6 Fuel containers shall be installed to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand without permanent deformation static loading in any direction equal to four times the weight of the container filled with fuel.

8.2.6.7 Welding for the repair or alterations of containers shall comply with 8.2.2.1(g).

8.2.6.8 Main shutoff valves on a container for liquid and vapor shall be readily accessible without the use of tools, or other equipment shall be provided to shut off the container valves.

8.2.6.9 The pressure relief valve discharge system(s) shall be installed to meet the following requirements:

(a) The relief valve discharge from fuel containers on vehicles other than industrial (and forklift) trucks shall be in accordance with the following:

(1) It shall be directed upward or downward within 45 degrees of vertical.
(2) It shall not directly impinge on the vehicle fuel container(s), the exhaust system, or any other part of the vehicle.
(3) It shall not be directed into the interior of the vehicle.

(b) Where the relief valve discharge must be piped away, the pipeaway system shall consist of the following:

(1) The breakaway adapter that has a melting point of not less than 1500°F (816°C). The adapter either shall be an integral part of the pressure relief valve or shall be a separate adapter attached directly to the pressure relief valve.
(2) A length of nonmetallic hose.
(3) A protective cover to minimize the possibility of the entrance of water or dirt into either the relief valve or its discharge system.
(4) No portion of the system shall have an internal diameter less than the internal diameter of the recommended breakaway adapter.
(5) The pipeaway system shall also comply with the following:
    a. The breakaway adapter either shall be threaded for direct connection to the relief valve and shall not interfere with the operation of the relief valve, or shall be an integral part of the pressure relief valve. It shall break away without impairing the function of the relief valve.
    b. The breakaway adapter shall have a melting point of not less than 1500°F (816°C).
    c. The nonmetallic hose shall be as short as practical and shall be able to withstand the downstream pressure from the relief valve in the full open position. The hose shall be fabricated of materials resistant to the action of LP-Gas.
    d. Where hose is used to pipe away the relief valve discharge on containers installed on the outside of the vehicle, the breakaway adapter and any attached fitting shall deflect the relief valve discharge upward or downward within 45 degrees of vertical and shall meet the other requirements of 8.2.6.9(a) without the hose attached. If an additional fitting is necessary to meet this requirement, it shall have a melting point not less than 1500°F (816°C) and shall meet the requirements of 8.2.6.9(b).

(c) The pipeaway system connections shall be mechanically secured and shall not depend on adhesives or sealing compounds. The system shall not be routed between a bumper system and the vehicle body.

(d) Where a pipeaway system is not required, the pressure relief valve shall have a protective cover in accordance with 8.2.6.9(b).

8.2.7 Containers Mounted in the Interior of Vehicles.

8.2.7.1 Containers mounted in the interior of vehicles shall be installed so that any LP-Gas released from container appurtenances due to operation, leakage, or connection of the appurtenances will not be in an area communicating directly with the driver or passenger compartment or with any space containing radio transmitters or other spark-producing equipment. This shall be accomplished by the following means:

(1)* Locating the container, including its appurtenances, as follows:

a. In an enclosure that is securely mounted to the vehicle
b. Gastight with respect to driver or passenger compartments and to any space containing radio transmitters or other spark-producing equipment
c. Vented outside the vehicle

(2) Enclosing the container appurtenances and their connections as follows:

a. In a structure that is securely mounted on the container
b. Gastight with respect to the driver or passenger compartments or with any space carrying radio transmitters or other spark-producing equipment
c. Vented outside the vehicle

8.2.7.2 Fuel containers shall be installed and fitted so that no gas from fueling and gauging operations can be released inside of the passenger or luggage compartments by permanently installing a remote filling device (single or double backflow check filler valve) and a fixed maximum liquid level gauging device to the outside of the vehicle.

8.2.7.3 Container pressure relief valve installation shall comply with 8.2.6.9.

8.2.7.4 Enclosures, structures, seals, and conduits used to vent enclosures shall be designed and fabricated of durable materials and shall be designed to resist damage, blockage, or dislodgement through movement of articles carried in the vehicle or by the closing of luggage compartment enclosures or vehicle doors and shall require the use of tools for removal.

8.2.8 Pipe and Hose Installation.

8.2.8.1 The piping system shall be designed, installed, supported, and secured in such a manner to minimize damage due to expansion, contraction, vibration, strains, and wear.

8.2.8.2 Piping (including hose) shall be installed in a protected location. If outside, piping shall be under the vehicle and below any insulation or false bottom. Fastening or other protection shall be installed to prevent damage due to vibration or abrasion.

8.2.8.3 At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chafing.

8.2.8.4 Fuel line piping that must pass through the floor of a vehicle shall be installed to enter the vehicle through the floor directly beneath or adjacent to the container. If a branch line is required, the tee connection shall be in the main fuel line under the floor and outside the vehicle.

8.2.8.5 Where liquid service lines of two or more individual containers are connected together, a spring-loaded backflow check valve or equivalent shall be installed in each of the liquid lines prior to the point where the liquid lines tee together to prevent the transfer of LP-Gas from one container to another.

8.2.8.6 Exposed parts of the piping system shall be of corrosion-resistant material or shall be adequately protected against exterior corrosion.

8.2.8.7 Piping systems, including hose, shall be tested and proven free of leaks at not less than normal operating pressure.

8.2.8.8 There shall be no fuel connection between a tractor and trailer or other vehicle units.

8.2.8.9 A hydrostatic relief valve or device providing pressure-relieving protection shall be installed in each section of piping (including hose) in which liquid LP-Gas can be isolated between shutoff valves so as to relieve to the atmosphere. This hydrostatic relief valve shall have a pressure setting not less than 400 psig (2.8 MPag) or more than 500 psig (3.5 MPag).

8.2.9 Equipment Installation.

8.2.9.1 Equipment installed on vehicles shall be protected against vehicular damage in accordance with 8.2.6.1.

8.2.9.2 The gas regulator and the automatic shutoff valve shall be installed as follows:

(a) Approved automatic pressure reducing equipment, properly secured, shall be installed between the fuel supply container and the carburetor.

(b) An approved automatic shutoff valve in compliance with 8.2.4.3 shall be installed in the fuel system.

8.2.10 Marking. Each over-the-road general-purpose vehicle powered by LP-Gas shall be identified with a weather-resistant diamond-shaped label located on an exterior vertical or near vertical surface on the lower right rear of the vehicle (on the trunk lid of a vehicle so equipped but not on the bumper of any vehicle) inboard from any other markings. The label shall be approximately $4^3/_4$ in. (120 mm) long by $3^1/_4$ in. (83 mm) high. The marking shall consist of a border and the word PROPANE [1 in. (25 mm) minimum height centered in the diamond] in silver or white reflective luminous material on a black background. *(See Figure 8.2.10.)*

FIGURE 8.2.10 Example of vehicle identification marking.

8.3 Industrial (and Forklift) Trucks Powered by LP-Gas.

8.3.1 This subsection shall apply to LP-Gas installation on industrial trucks (including forklift trucks), both to propel them and to provide the energy for their materials-handling attachments. LP-Gas fueled industrial trucks shall comply with

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation.*

8.3.2 Cylinders used as fuel containers shall comply with 8.2.2 and 8.2.3(a) through (i).

(a) Cylinders shall be designed, constructed, or fitted for installation and filling in either the vertical or horizontal position or, if of the universal type, in either position. The cylinder shall be in the appropriate position while being filled or, if of the universal type, shall be filled in either position with the following provisions.

(1) The fixed maximum liquid level gauge indicates the maximum permitted filling level in either position.
(2) The pressure relief valves are in direct communication with the vapor space of the cylinder in either position.
(3) The cylinder vapor or liquid withdrawal valves shall function properly in either position.

8.3.3 The cylinder pressure relief valve discharge shall be directed upward within 45 degrees of vertical and otherwise shall not impinge on the cylinder, the exhaust system, or any other part of the industrial truck. The discharge opening shall be provided with a protective cover to minimize the possibility of the entry of water or any extraneous matter.

8.3.4 Gas regulating and vaporizing equipment shall comply with 8.2.4.2(a) through (e) and 8.2.4.3.

8.3.5 Piping and hose shall comply with 8.2.5.1 through 8.2.5.4.

Exception: Hose 60 in. (1.5 m) in length or less shall not be required to be of stainless steel wire braid construction.

8.3.6 The operation of industrial trucks (including forklift trucks) powered by LP-Gas engine fuel systems shall comply with NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*, and with the following.

(a) Refueling of such trucks shall be accomplished as follows:

(1) Trucks with permanently mounted containers shall be refueled outdoors.
(2) Where cylinders are exchanged indoors, the fuel piping system shall be equipped to minimize the release of fuel when cylinders are exchanged, in accordance with either of the following:
   a. Using an approved quick-closing coupling in the fuel line
   b. Closing the shutoff valve at the fuel cylinder and allowing the engine to run until the fuel in the line is exhausted.

(b) Where LP-Gas fueled industrial trucks are used in buildings or structures the following shall apply:

(1) The number of fuel cylinders on such a truck shall not exceed two.
(2) The use of industrial trucks in buildings frequented by the public, including those times when such buildings are occupied by the public, shall require the approval of the authority having jurisdiction. The total water capacity of the fuel cylinders on an individual truck shall not exceed 105-lb (48-kg) [nominal 45-lb (20-kg) LP-Gas capacity].
(3) Trucks shall not be parked and left unattended in areas occupied by or frequented by the public without the approval of the authority having jurisdiction. If left unattended with approval, the cylinder shutoff valve shall be closed.
(4) In no case shall trucks be parked and left unattended in areas of excessive heat or near sources of ignition.

8.3.7 All cylinders used in industrial truck service (including forklift truck cylinders) shall have the cylinder pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the cylinder and every 10 years thereafter.

8.4 General Provisions for Vehicles Having Engines Mounted on Them (Including Floor Maintenance Machines).

8.4.1 This section shall apply to the installation of equipment on vehicles that supply LP-Gas as a fuel for engines mounted on these vehicles. Vehicles shall include floor maintenance and any other portable mobile unit, whether the engine is used to propel the vehicle or is mounted on it for other purposes.

8.4.2 Gas vaporizing, regulating, and carburetion equipment to provide LP-Gas as a fuel for engines shall be installed in accordance with 8.2.8 and 8.2.9 and the following:

(a) Industrial trucks (including forklift trucks) and other engines on vehicles operating in buildings other than those used exclusively to house engines, shall have an approved automatic shutoff valve installed in the fuel system in accordance with 8.2.4.3.

(b) The source of air for combustion shall be isolated from the driver and passenger compartment, ventilating system, or air conditioning system on the vehicle.

8.4.3 Piping and hose shall comply with 8.2.5.1 through 8.2.5.4.

8.4.4 Non-self-propelled floor maintenance machinery (floor polishers, scrubbers, buffers) and other similar portable equipment shall be listed and shall comply with the following:

(a) The provisions of 8.3.2 through 8.3.5 and 8.3.6(1) and (2) shall apply.

(b) The storage of cylinders mounted or used on such machinery or equipment shall comply with Chapter 5.

(c) A label shall be affixed to the machinery or equipment, with the label facing the operator, denoting that the cylinder or portion of the machinery or equipment containing the cylinder shall be stored in accordance with Chapter 5.

8.4.5 The use of floor maintenance machines in buildings frequented by the public, including the times when such buildings are occupied by the public shall require the approval of the authority having jurisdiction.

8.5 Engine Installation Other than on Vehicle.

8.5.1 Stationary engines and gas turbines installed in buildings, including portable engines used in lieu of, or to supplement, stationary engines, shall comply with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, and the applicable provisions of Chapters 1 and 2 and Section 3.2 of this code.

8.5.2 The use of portable engines in buildings shall be limited to emergencies in accordance with the following:

(a) The capacity of the cylinders used to fuel engines shall be in accordance with Section 3.4.

(b) An approved automatic shutoff valve in accordance with the requirements of 8.2.4.3 shall be provided in the fuel system. Atmospheric-type regulators (zero governors) used for portable

engines of 12 horsepower or less with magneto ignition and used exclusively outdoors shall be in compliance with 8.2.4.3.

(c) Air for combustion and cooling shall be supplied. Exhaust gases shall be discharged to a point outside the building or to an area in which they will not constitute a hazard.

8.5.3 Piping and hose shall comply with 8.2.5.1 through 8.2.5.4.

8.5.4 Gas regulating, vaporizing, and carburetion equipment shall comply with 8.2.4.2 and 8.2.4.3.

8.5.5 Installation of piping, carburetion, vaporizing, and regulating equipment for the engine fuel system shall comply with 8.2.8 and 8.2.9.

8.5.6 Engines installed or operated only outdoors shall comply with 8.5.3, 8.5.4, and 8.5.5.

Where atmospheric-type regulators (zero governors) are used on engines operated only outdoors, a separate automatic shutoff valve shall not be required.

8.5.7 Engines used to drive portable pumps and compressors or pumps shall be equipped in accordance with 2.5.2.

8.6 Garaging of Vehicles. Where vehicles with LP-Gas engine fuel systems mounted on them and general-purpose vehicles propelled by LP-Gas engines are stored or serviced inside garages, the following conditions apply:

(a) The fuel system shall be leak-free.

(b) The cylinder(s) shall not be filled beyond the limits specified in Chapter 4.

(c) The cylinder shutoff valve shall be closed when vehicles or engines are under repair except when engine is operated.

(d) The vehicle shall not be parked near sources of heat, open flames, or similar sources of ignition, or near inadequately ventilated pits.

Chapter 9 Refrigerated Containers

9.1 Provisions for Construction, Design, Installation, and Testing of Refrigerated Containers.

9.1.1 General Requirements. Refrigerated LP-Gas containers shall be designed, constructed, and tested in accordance with the following codes.

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

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

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

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

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

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

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

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

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

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

9.1.3 Installation.

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

9.1.3.2 The design seismic loading on refrigerated LP-Gas containers shall be based on forces recommended in the ICBO *Uniform Building Code (UBC)*. For those areas identified as Zones 3 and 4 on the seismic risk map of the United States (Figures 1, 2, and 3 of Chapter 23 of the *UBC*), a seismic analysis of the proposed installation that meets the approval of the authority having jurisdiction shall be made.

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

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

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

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

9.1.4 Foundations.

9.1.4.1 Refrigerated aboveground containers shall be installed on foundations that have been engineered with consideration for soil conditions and loadings.

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

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

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

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

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

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

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

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

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

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

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

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

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

9.1.5 Other Requirements.

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

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

9.2 Refrigerated LP-Gas Container Instruments and Controls.

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

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

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

9.2.2.2 The alarm shall be located so that it is visible and audible to the personnel who control the filling.

9.2.2.3 A high-liquid level flow cutoff device shall not be a substitute for the alarm.

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

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

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

9.3 Refrigerated LP-Gas Container Impoundment.

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

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

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

9.3.3 Impoundment for refrigerated LP-Gas containers shall have a volumetric holding capacity, with an allowance made for the displacement of snow accumulation, other containers, or equipment that is equal to the total liquid volume of the largest container served, assuming that container is full to the high-liquid level flow cutoff device required in 9.2.3.

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

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

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

9.3.6 Provisions to clear rain or other water from the impounding area shall be in accordance with the following:

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

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

9.3.6.3 Gravity drainage utilizing piping penetrations through or below impoundment dikes shall not be permitted.

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

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

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

9.4 Inspection of Refrigerated LP-Gas Containers and Systems.

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

9.4.2 The inspections or tests required shall be the responsibility of the operator. Where any part of the inspections or tests is delegated to the operator's employees or a third-party engineering, scientific, recognized insurance, or inspection organization, each inspector shall be qualified in accordance with the code or standard that is applicable to the test or inspection being performed.

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

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

9.5 Locating Aboveground Refrigerated LP-Gas Containers.

9.5.1 Spacing of refrigerated LP-Gas containers designed to operate at greater than 15 psi (103 kPa) from occupied buildings, storage containers for flammable or combustible liquids, and lines of adjoining property that can be built upon shall be in accordance with Table 9.5.1.

Table 9.5.1 Minimum Distances

Water Capacity per Container		Aboveground Containers	
gal	**m^3**	**ft**	**m**
≤70,000	≤ 265	75	23
70,001–90,000	265–341	100	30
90,001–120,000	341–454	125	38
120,001–200,000	454– 57	200	61
200,001–1,000,000	757–3785	300	91
>1,000,000	>3785	400	122

9.5.2 Spacing of refrigerated LP Gas containers that operate at below 15 psi (103 kPa) from occupied buildings, storage containers for flammable or combustible liquids, and lines of adjoining property that can be built upon shall be in accordance with Table 9.5.2.

Table 9.5.2 Minimum Distances

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

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

9.5.4 Nonrefrigerated LP-Gas containers or flammable liquid tanks shall not be located within dikes or impoundments enclosing refrigerated LP-Gas containers.

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

9.5.6 The minimum distance between aboveground refrigerated LP-Gas containers shall be one-half the diameter of the larger container.

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

9.6 Pressure and Vacuum Control.

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

9.6.2 The option of gas admission (or other gas or vapor if so designed) through the vacuum relief valves provided in API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, paragraph 7-2.3, shall not be permitted.

9.7 Relief Devices.

9.7.1 General.

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

(1) API Standard 620 *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, for containers designed to operate at 15 psig (103 kPag) and below. The relief devices shall be sized in accordance with Section 9.7.
(2) The ASME *Boiler and Pressure Vessel Code*, Section VIII, for containers designed to operate at above 15 psig (13 kPag). The relief devices shall be sized in accordance with Section 9.7.

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

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

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

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

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

9.7.1.7 Safety relief valve discharge stacks or vents shall be designed and installed to prevent an accumulation of water, ice, snow, or other foreign matter and shall discharge vertically upward.

9.7.2 Pressure Relief Device Sizing.

9.7.2.1 Conditions to be evaluated in determining the capacity of pressure relief devices include the following:

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

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

9.7.2.2 Recognizing that some conditions are not predictable with reasonable accuracy, it is an additional requirement of this code that the minimum pressure relieving capacity in kg/hr (1 b/hr) be not less than 3 percent of the full tank contents in 24 hours.

9.7.3 Vacuum Relief Device Sizing.

9.7.3.1 Conditions to be evaluated in determining the capacity of vacuum relief devices include the following:

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

9.7.3.2 The vacuum relief devices shall be sized to relieve the flow capacity determined for the largest single contingency or any reasonable and probable combination of contingencies. It is permissible to reduce the requirement for vacuum relief capacity by the rate of vaporization that results from minimum normal heat gain to the contents. No vacuum relief capacity credit shall be permitted for gas-repressuring or vapor make-up systems.

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

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

where:

W = relieving capacity in lb/hr or product vapor at relieving conditions
H_n = normal heat leak in refrigerated tanks in btu/hr
A = exposed wetted surface area of the container in ft^2. In the case of large containers, the exposed wetted area is the area up to a height of 30 ft above grade.
L = latent heat of vaporization of the stored liquid at the relieving pressure and temperature, in Btu/lb
F = Environmental factor as follows:

Basis, F: factor
Base container: 1.0
Water application facilities: 1.0
Depressuring and emptying facilities: 1.0
Underground container: 0
Earth-covered, abovegrade container: 0.03
Insulation or thermal protection:

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

where:

U = the overall heat transfer coefficient (Btu/hr·ft^2-F) of the insulation system using the mean value for the temperature range from T_f to +1660°F
T_f = temperature of vessel content at relieving conditions, °F

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

9.7.4.2 Once the relieving capacity, *W*, has been determined, the equivalent airflow shall be calculated by the following equation:

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

where:

SCFM (air) = equivalent airflow in standard ft^3/min

W = relieving capacity of product vapor at relieving conditions: lb/hr

Z = compressibility factor product vapor at relieving conditions

T = absolute temperature of product vapor at relieving conditions, °R

M = product vapor molecular weight

Chapter 10 Marine Shipping and Receiving

10.1 Piers.

10.1.1* Design, construction, and operation of piers, docks, and wharves shall comply with relevant regulations and the requirements of the authorities having jurisdiction.

10.1.2 General cargo, flammable liquids, or compressed gases, other than ships' general stores for the LP-Gas tank vessel, shall not be handled over a pier or dock within 100 ft (30.5 m) of the point of transfer connection while LP-Gas or other flammable liquids are being transferred. Ship bunkering operations shall not be permitted prior to or during cargo transfer operations.

10.1.3 Ship bunkering operations shall be prohibited prior to or during cargo transfer operations.

10.1.4 Trucks and other motorized vehicles shall be prohibited on the pier or dock within 100 ft (30.5 m) of the transfer connection while transfer operations are in progress. Authorized parking areas, if provided for in the waterfront area, shall be marked. Warning signs or barricades shall be used to indicate when transfer operations are in progress.

10.1.5 Unauthorized individuals shall not be allowed access to the waterfront area while the LP-Gas vessel is alongside the pier or dock. Security personnel shall restrict the entry of visitors, delivery trucks, and service personnel to those authorized by the facility operator.

10.1.6 The shore mooring equipment shall be designed and maintained to safely hold the vessel to the pier or dock.

10.1.7 All electrical equipment and wiring installed on the pier or dock shall comply with 3.7.2.1 and 3.7.2.2.

10.1.8 If the terminal conducts transfers between sunset and sunrise, the pier or dock area shall have a lighting system that illuminates the following:

(1) Transfer connection area
(2) Control valves
(3) Storage containers
(4) Other equipment
(5) Walkways of communications, fire fighting, and other emergency areas

All lighting shall be located or shielded so that it is not confused with any aids to navigation and does not interfere with navigation on the adjacent waterway.

10.1.9 Welding and cutting, shall be in accordance with NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*. Smoking shall be prohibited in other than conspicuously marked, designated areas.

10.1.10 The shore facility shall install medical first aid equipment and fire extinguishers. This equipment shall be in accordance with the following:

(a) Extinguishers shall be installed and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. They shall be ready for use at all times.

(b) Emergency equipment shall be positioned and ready to operate prior to the start of the transfer operation.

(c) The locations of all fire extinguishers shall be marked and readily accessible.

10.1.11 Prior to the start of the transfer, warning signs be placed in the marine transfer area, visible from the shoreline and berth areas. The warning signs shall read as follows:

Warning

Dangerous Cargo

No Visitors

No Smoking

No Open Light

10.1.12 A LP-Gas detector shall be readily available for use at the berth.

10.1.13 Portable electrical equipment used within 100 ft (30.5 m) of the transfer connection while transfer operations are in progress either shall be listed for Class I, Division I or shall be intrinsically safe. When the transfer operation is completed (secured) and the transfer piping is disconnected, the equipment used shall be in compliance with 3.7.2.1 and 3.7.2.2.

10.1.14 Life safety equipment shall be positioned on the berth and be ready for immediate use while personnel are working on the berth or a vessel is alongside. The equipment shall include the following:

(1) Life rings with attendant rope of sufficient length
(2) Approved fire blanket
(3) Flotation vests or immersion suits suitable for the water temperature at the berth and the personnel involved in the work

10.2 Pipelines.

10.2.1* Pipelines shall be located on the dock or pier so that they are not exposed to damage from vehicular traffic or other possible cause of physical damage. Underwater pipelines shall be located or protected so that they are not exposed to damage from marine traffic, and their locations shall be posted or identified in accordance with federal regulations.

10.2.2 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 or pumped out, and depressurized before disconnecting. Liquid

isolation valves and vapor valves 8 in. (20 mm) and larger in size shall be equipped with powered operators in addition to means for manual operation. Power-operated valves shall be capable of being closed from a remote control station located at least 50 ft (15 m) from the manifold area, as well as locally. Unless the valve will automatically fail closed on loss of power, the valve actuator and its power supply within 50 ft (15 m) of the valve shall be protected against operational failure due to fire exposure of at least 10 minutes. Valves shall be located at the point of hose or arm connection to the manifold.

10.2.3 In addition to the isolation valves at the manifold, each vapor return and liquid transfer line shall be provided with a readily accessible isolation valve located on shore near the approach to the pier or dock. Where more than one line exists, the valves shall be grouped in one location. Valves shall be identified as to their service. Valves 8 in. (20 mm) and larger in size shall be equipped with power operators. Means for manual operation shall be provided.

10.2.4 Pipelines used for liquid unloading only shall be provided with a check valve located at the manifold adjacent to the manifold isolation valve.

10.2.5 All pipelines, conduits and other conductive lines on the berth, capable of carrying an electrical charge, shall be equipped with insulating flanges or other means to electrically isolate them from stray currents and the rest of the terminal. If a stray current (bonding) cable is not used between the facility and the vessel, insulating flanges shall be installed in the pipe risers to the off-loading connections between the vessel and the shore facility.

10.2.6 All shore facilities shall provide a low-resistance stray current (bonding) cable to be connected to the vessels. The facility operator shall ensure that there is continuity between the vessel and the berth. The installation shall comply with NFPA 70, *National Electrical Code*, and local electrical code. The cable shall be connected to the vessel prior to the connection of the unloading hoses/arms and shall remain connected until after the hoses/arms have been disconnected.

10.3 Prior to Transfer.

10.3.1* Prior to starting transfer operations, the officer in charge of the vessel transfer operation and the person in charge of the shore facility shall inspect their respective facilities. The inspection shall ensure that all cargo transfer equipment and hoses have been maintained and tested and are in operating condition. Following this inspection, they shall meet to discuss the transfer procedures and, when ready, each will notify the other that each facility is ready in all respects to start transfer operations.

10.3.2* The supervisor in charge of the shore facility and the officer in charge of vessel operations shall verify that their respective facilities are ready to start transfer operations.

10.3.3 The shore facility transfer system shall be equipped with a remotely operated emergency shutdown system.

10.3.4 A facilities emergency procedures manual shall be readily available and shall contain the following information:

(1) LP-Gas release response and emergency shutdown procedures
(2) Telephone number for all emergency response organizations, U.S. Coast Guard, emergency medical facilities, and hospital(s)
(3) Description and location of the facility fire systems and emergency equipment

10.3.5 A facilities standard operating procedures manual shall be readily available and shall contain the following information:

(1) Procedures for startup, operation, and shutdown of the transfer system and equipment
(2) Procedures for cooling down the transfer hose and line where refrigerated LP-Gas is transferred
(3) Telephone numbers for all emergency response organizations, U.S. Coast Guard, emergency medical facilities, and hospital(s)
(4) Description, location, and operational guidelines for the facility fire systems and emergency equipment

Each transfer operation shall be conducted in accordance with the operations manual.

10.3.6 At the completion of the transfer, and prior to disconnect of the transfer hose or arm, the transfer connection shall be purged of all liquid and depressurized. The liquid and vapor pressure shall be returned either to the vessel or to the shore facility. LP-Gas shall not be vented to the atmosphere.

Chapter 11 Operations and Maintenance

11.1* Scope. This chapter includes requirements related to the operations and maintenance of bulk plant and industrial plant LP-Gas systems. New operations and maintenance requirements have been placed in this chapter. Operations and maintenance requirements that are located in other chapters of this code are not included here.

11.2 Operating Requirements.

11.2.1* Operating Procedures. Persons who operate LP-Gas bulk or industrial plant systems shall use written procedures for safely conducting activities associated with these duties. Equipment owners or operators shall ensure that the operating procedures are updated, if necessary, whenever a major change occurs and prior to startup of a changed system.

11.2.2* Maintenance. Owners or operators of LP-Gas bulk or industrial plant systems shall prepare and implement procedures to maintain the ongoing mechanical integrity of LP-Gas systems. Persons who perform maintenance on these LP-Gas systems should be trained in the hazards of the system and in the maintenance and testing procedures applicable to the installation. Any maintenance contractor should ensure that each contract maintenance employee is trained or supervised to perform the maintenance procedures.

Chapter 12 Pipe and Tubing Sizing Tables

12.1 Tables for Sizing Pipe and Tubing. Tables 12.1 through 12.17 can be used to size piping systems as required in Chapter 3. For SI units, 1 ft^3 = 0.028 m^3, l ft = 0.305 m, 1 in. water column = 2.49 kPa, 1 psi = 6.894 kPa, 1000 Btu/hr = 0.203 kW.

Table 12.1 Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Pipe Size, Schedule 40

Pipe Length, ft	1/2 in. 0.622	3/4 in. 0.824	1 in. 1.049	1 1/4 in. 1.38	1 1/2 in. 1.61	2 in. 2.067	3 in. 3.068	3 1/2 in. 3.548	4 in. 4.026
30	1843	3854	7259	14904	22331	43008	121180	177425	247168
40	1577	3298	6213	12756	19113	36809	103714	151853	211544
50	1398	2923	5507	11306	16939	32623	91920	134585	187487
60	1267	2649	4989	10244	15348	29559	83286	121943	169877
70	1165	2437	4590	9424	14120	27194	76622	112186	156285
80	1084	2267	4270	8767	13136	25299	71282	104368	145393
90	1017	2127	4007	8226	12325	23737	66882	97925	136417
100	961	2009	3785	7770	11642	22422	63176	92499	128859
150	772	1613	3039	6240	9349	18005	50733	74280	103478
200	660	1381	2601	5340	8002	15410	43421	63574	88564
250	585	1224	2305	4733	7092	13658	38483	56345	78493
300	530	1109	2089	4289	6426	12375	34868	51052	71120
350	488	1020	1922	3945	5911	11385	32078	46967	65430
400	454	949	1788	3670	5499	10591	29843	43694	60870
450	426	890	1677	3444	5160	9938	28000	40997	57112
500	402	841	1584	3253	4874	9387	26449	38725	53948
600	364	762	1436	2948	4416	8505	23965	35088	48880
700	335	701	1321	2712	4063	7825	22047	32280	44969
800	312	652	1229	2523	3780	7279	20511	30031	41835
900	293	612	1153	2367	3546	6830	19245	28177	39253
1000	276	578	1089	2236	3350	6452	18178	26616	37078
1500	222	464	875	1795	2690	5181	14598	21373	29775
2000	190	397	748	1537	2302	4434	12494	18293	25483

Note: Maximum undiluted propane capacities listed are based on a gauge pressure of 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

Table 12.2 Pipe Sizing Between 2-psi Service Regulator and Line Pressure Regulator: Nominal Pipe Size, Schedule 40

Pipe Length, ft	1/2 in. 0.622	3/4 in. 0.824	1 in. 1.049	1 1/4 in. 1.380	1 1/2 in. 1.610	2 in. 2.067	3 in. 3.068	3 1/2 in. 3.548	4 in. 4.026
10	2687	5619	10585	21731	32560	62708	176687	258696	360385
20	1847	3862	7275	14936	22378	43099	121436	177800	247690
30	1483	3101	5842	11994	17971	34610	97517	142780	198904
40	1269	2654	5000	10265	15381	29621	83462	122201	170236
50	1125	2352	4431	9098	13632	26253	73971	108305	150877
60	1019	2131	4015	8243	12351	23787	67023	98132	136706
70	938	1961	3694	7584	11363	21884	61660	90280	125767
80	872	1824	3436	7055	10571	20359	57363	83988	117002
90	819	1712	3224	6620	9918	19102	53822	78803	109779
100	773	1617	3046	6253	9369	18043	50840	74437	103697
150	621	1298	2446	5021	7524	14490	40826	59776	83272
200	531	1111	2093	4298	6439	12401	34942	51160	71270
250	471	985	1855	3809	5707	10991	30968	45342	63166
300	427	892	1681	3451	5171	9959	28060	41083	57233
350	393	821	1546	3175	4757	9162	25814	37796	52653
400	365	764	1439	2954	4426	8523	24015	35162	48984
450	343	717	1350	2771	4152	7997	22533	32991	45960
500	324	677	1275	2618	3922	7554	21284	31164	43413
600	293	613	1155	2372	3554	6844	19285	28236	39336
700	270	564	1063	2182	3270	6297	17742	25977	36188
800	251	525	989	2030	3042	5858	16506	24167	33666
900	236	493	928	1905	2854	5496	15487	22675	31588
1000	222	465	876	1799	2696	5192	14629	21419	29838
1500	179	374	704	1445	2165	4169	11747	17200	23961
2000	153	320	602	1237	1853	3568	10054	14721	20507

Note: Maximum undiluted propane capacities listed are based on a 2-psig setting and a 1-psi pressure drop. Capacities in 1000 Btu/hr.

Table 12.3 Pipe Sizing Between Second-Stage Regulator and Appliance: Nominal Pipe Size, Schedule 40

Pipe Length, ft	1/2 in. 0.622	3/4 in. 0.824	1 in. 1.049	1 1/4 in. 1.38	1 1/2 in. 1.61	2 in. 2.067	3 in. 3.068	3 1/2 in. 3.548	4 in. 4.026
10	291	608	1146	2353	3525	6789	19130	28008	39018
20	200	418	788	1617	2423	4666	13148	19250	26817
30	161	336	632	1299	1946	3747	10558	15458	21535
40	137	287	541	1111	1665	3207	9036	13230	18431
50	122	255	480	985	1476	2842	8009	11726	16335
60	110	231	435	892	1337	2575	7256	10625	14801
80	94	198	372	764	1144	2204	6211	9093	12668
100	84	175	330	677	1014	1954	5504	8059	11227
125	74	155	292	600	899	1731	4878	7143	9950
150	67	141	265	544	815	1569	4420	6472	9016
200	58	120	227	465	697	1343	3783	5539	7716
250	51	107	201	412	618	1190	3353	4909	6839
300	46	97	182	374	560	1078	3038	4448	6196
350	43	89	167	344	515	992	2795	4092	5701
400	40	83	156	320	479	923	2600	3807	5303

Note: Maximum undiluted propane capacities listed are based on 11-in w.c. setting and 0.5 in pressure drop. Capacities in Btu/hr.
Source: NFPA 54, *National Fuel Gas Code*, 1999 edition, Table 9.26.

Table 12.4 Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Pipe Size, Schedule 80

Pipe Length, ft	1/2 in. 0.546	3/4 in. 0.742	1 in. 0.957	1 1/4 in. 1.278	1 1/2 in. 1.5	2 in. 1.939	3 in. 2.9	3 1/2 in. 3.364	4 in. 3.826
30	1309	2927	5706	12185	18548	36368	104539	154295	216246
40	1121	2505	4884	10429	15875	31127	89472	132057	185079
50	993	2221	4328	9243	14069	27587	79297	117039	164032
60	900	2012	3922	8375	12748	24996	71849	106046	148625
70	828	1851	3608	7705	11728	22996	66100	97561	136733
80	770	1722	3357	7168	10911	21393	61494	90762	127204
90	723	1616	3149	6725	10237	20073	57697	85159	119351
100	683	1526	2975	6353	9670	18960	54501	80440	112738
150	548	1226	2389	5105	7765	15236	43766	64596	90533
200	469	1049	2045	4366	6646	13031	37458	55286	77484
250	416	930	1812	3870	5890	11549	33198	48999	68673
300	377	842	1642	3506	5337	10465	30080	44397	62223
350	347	775	1511	3226	4910	9627	27673	40844	57244
400	322	721	1405	3001	4568	8956	25745	37998	53255
450	303	676	1318	2816	4286	8403	24155	35652	49967
500	286	639	1245	2660	4048	7938	22817	33677	47199
600	259	579	1128	2410	3668	7192	20674	30514	42765
700	238	533	1038	2217	3375	6617	19020	28072	39344
800	222	495	966	2062	3139	6156	17694	26116	36602
900	208	465	906	1935	2946	5776	16602	24504	34342
1000	196	439	856	1828	2782	5456	15682	23146	32439
1500	158	353	687	1468	2234	4381	12593	18587	26050
2000	135	302	588	1256	1912	3750	10778	15908	22295

Notes:
1. Maximum undiluted propane capacities listed are based on a gauge pressure of 10-psi first-stage setting and 1-psi pressure drop. Capacities in 1000 Btu/hr.
2. To convert to capacities at a gauge pressure of 5 psi with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15 psi with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

Table 12.5 Pipe Sizing Between Second-Stage Regulator and Appliance: Nominal Pipe Size, Schedule 80

Pipe Length, ft	1/2 in. 0.546	3/4 in. 0.742	1 in. 0.957	1 1/4 in. 1.278	1 1/2 in. 1.5	2 in. 1.939	3 in. 2.9	3 1/2 in. 3.364	4 in. 3.826
10	207	462	901	1924	2928	5741	16503	24357	34137
20	142	318	619	1322	2012	3946	11342	16740	23462
30	114	255	497	1062	1616	3169	9108	13443	18841
40	98	218	426	909	1383	2712	7795	11506	16125
50	87	193	377	805	1226	2404	6909	10197	14292
60	78	175	342	730	1111	2178	6260	9239	12949
80	67	150	292	625	951	1864	5358	7908	11083
100	59	133	259	553	842	1652	4748	7009	9823
125	53	118	230	491	747	1464	4208	6212	8706
150	48	107	208	444	677	1327	3813	5628	7888
200	41	91	178	380	579	1135	3264	4817	6751
250	36	81	158	337	513	1006	2892	4269	5983
300	33	73	143	305	465	912	2621	3868	5421
350	30	68	132	281	428	839	2411	3559	4987
400	28	63	122	261	398	780	2243	3311	4640

Note: Maximum undiluted propane capacities listed are based on a 11-in. w.c. setting and 0.5-in. w.c. pressure drop. Capacities in 1000 Btu/hr.

Table 12.6 Pipe Sizing Between First-Stage and Second-Stage Regulators: Outside Diameter Copper Tubing, Type K

Tubing Length, ft	3/8 in. 0.305	1/2 in. 0.402	5/8 in. 0.527	3/4 in. 0.652	7/8 in. 0.745
30	284	587	1193	2085	2959
40	243	502	1021	1785	2532
50	216	445	905	1582	2244
60	195	403	820	1433	2033
70	180	371	754	1319	1871
80	167	345	702	3227	1740
90	157	374	659	1151	1633
100	148	306	622	1087	1542
150	119	246	500	873	1239
200	102	210	428	747	1060
250	90	186	379	662	940
300	82	169	343	600	851
350	75	155	316	552	783
400	70	144	294	514	729
450	66	136	276	482	654
500	62	128	260	455	646
600	56	116	236	412	585
700	52	107	217	379	538
800	48	99	202	353	501
900	45	93	189	331	470
1000	43	88	179	313	444
1500	34	71	144	251	356
2000	29	60	123	215	305

Notes:
1. Maximum undiluted propane capacities listed are based on a gauge pressure of 10-psi first-stage setting and 1-psi pressure drop. Capacities in 1000 Btu/hr.
2. To convert to capacities at a gauge pressure of 5 psi setting with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15 psi setting with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

Table 12.7 Copper Tube Sizing Between Second-Stage Regulator and Appliance: Outside Diameter Copper Tubing, Type K

Tubing Length, ft	3/8 in. 0.305	1/2 in. 0.402	5/8 in. 0.527	3/4 in. 0.652	7/8 in. 0.745
10	45	93	188	329	467
20	31	64	129	226	321
30	25	51	104	182	258
40	21	44	89	156	221
50	19	39	79	138	196
60	17	35	71	125	177
80	15	30	61	107	152
100	13	27	54	95	134
125	11	24	48	84	119
150	10	21	44	76	108
200	9	18	37	65	92
250	8	16	33	58	82
300	7	15	30	52	74
350	7	14	28	48	68
400	6	13	26	45	63

Note: Maximum undiluted propane capacities listed are based on an 11-in. w.c. setting and 0.5-in. w.c. pressure drop. Capacities in 1000 Btu/hr.

Table 12.8 Copper Tube Sizing Between First-Stage and Second-Stage Regulators

Tubing Length, ft	Outside Diameter Copper Tubing, Type L					Tubing Length, ft	Outside Diameter Copper Tubing, Type L				
	3/8 in. 0.315	1/2 in. 0.430	5/8 in. 0.545	3/4 in. 0.666	7/8 in. 0.785		3/8 in. 0.315	1/2 in. 0.430	5/8 in. 0.545	3/4 in. 0.666	7/8 in. 0.785
30	309	700	1303	2205	3394	350	82	185	345	584	898
40	265	599	1115	1887	2904	400	76	172	321	543	836
50	235	531	988	1672	2574	450	71	162	301	509	784
60	213	481	896	1515	2332	500	68	153	284	481	741
70	196	443	824	1394	2146	600	61	138	258	436	671
80	182	412	767	1297	1996	700	56	127	237	401	617
90	171	386	719	1217	1873	800	52	118	221	373	574
100	161	365	679	1149	1769	900	49	111	207	350	539
150	130	293	546	923	1421	1000	46	105	195	331	509
200	111	251	467	790	1216	1500	37	84	157	266	409
250	90	222	414	700	1078	2000	32	72	134	227	350
300	89	201	375	634	976						

Note: Maximum undiluted propane capacities listed are based on a pressure of 10-psig first-stage setting and 1-psi pressure drop. Capacities in 1000 Btu/hr.

Table 12.9 Copper Tube Sizing Between 2-psi Service Regulator and Line Pressure Regulator: Outside Diameter Copper Tubing, Type L

Tubing (O.D.)	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
Tubing (I.D.)	0.315	0.430	0.545	0.666	0.785
Length, ft					
10	451	1020	1900	3215	4948
20	310	701	1306	2210	3401
30	249	563	1049	1774	2731
40	213	482	898	1519	2337
50	189	427	795	1346	2071
60	171	387	721	1219	1877
70	157	356	663	1122	1727
80	146	331	617	1044	1606
90	137	311	579	979	1507
100	130	294	547	925	1424
150	104	236	439	743	1143
200	89	202	376	636	979
250	79	179	333	563	867
300	72	162	302	511	786
350	66	149	278	470	723
400	61	139	258	437	673
450	58	130	242	410	631
500	54	123	229	387	596
600	49	111	207	351	540
700	45	102	191	323	497
800	42	95	177	300	462
900	40	89	167	282	434
1000	37	84	157	266	410
1500	30	68	126	214	329
2000	26	58	108	183	282

Note: Maximum undiluted propane capacity based on a gauge pressure setting of 2 psig and 1-psi pressure drop. Capacities in 1000 Btu/hr.

Table 12.10 Copper Tube Sizing Between Single-Stage or Second-Stage Regulator and Appliance: Outside Diameter Copper Tubing, Type L

Tubing Length, ft	3/8 in. 0.315	1/2 in. 0.430	5/8 in. 0.545	3/4 in. 0.666	7/8 in. 0.785
10	49	110	206	348	536
20	34	76	141	239	368
30	27	61	114	192	296
40	23	52	97	164	253
50	20	46	86	146	224
60	19	42	78	132	203
80	16	36	67	113	174
100	14	32	59	100	154
125	12	28	52	89	137
150	11	26	48	80	124
200	10	22	41	69	106
250	9	19	36	61	94
300	8	18	33	55	85
350	7	16	30	51	78
400	7	15	28	47	73

Note: Maximum undiluted propane capacities listed are based on an 11-in. setting and a 0.5-in. w.c. drop.

Table 12.11 Pipe Sizing Between First-Stage and Second-Stage Regulators: Outside Diameter Refrigeration Tubing

Tubing Length, ft	3/8 in. 0.311	1/2 in. 0.436	5/8 in. 0.555	3/4 in. 0.68	7/8 in. 0.785
30	299	726	1367	2329	3394
40	256	621	1170	1993	2904
50	227	551	1037	1766	2574
60	206	499	939	1600	2332
70	189	459	864	1472	2146
80	176	427	804	1370	1996
90	165	401	754	1285	1873
100	156	378	713	1214	1769
150	125	304	572	975	1421
200	107	260	490	834	1216
250	95	230	434	739	1078
300	86	209	393	670	976
350	79	192	362	616	898
400	74	179	337	573	836
450	69	168	316	538	784
500	65	158	298	508	741
600	59	144	270	460	671
700	54	132	249	424	617
800	51	123	231	394	574
900	48	115	217	370	539
1000	45	109	205	349	509
1500	36	87	165	281	409
2000	31	75	141	240	350

Notes:
1. Maximum undiluted propane capacities listed are based on a gauge pressure of 10-psi first-stage setting and 1-psi pressure drop. Capacities in 1000 Btu/hr.
2. To convert to capacities at a gauge pressure of 5-psi setting with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15-psi setting with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

Table 12.12 Copper Tube Sizing Between Second-Stage Regulator and Appliance: Outside Diameter of Copper Refrigeration Tubing

Tubing Length, ft	3/8 in. 0.311	1/2 in. 0.436	5/8 in. 0.555	3/4 in. 0.68	7/8 in. 0.785
10	47	115	216	368	536
20	32	79	148	253	368
30	26	63	119	203	296
40	22	54	102	174	253
50	20	48	90	154	224
60	18	43	82	139	203
80	15	37	70	119	174
100	14	33	62	106	154
125	12	29	55	94	137
150	11	26	50	85	124
200	9	23	43	73	106
250	8	20	38	64	94
300	8	18	34	58	85
350	7	17	32	54	78
400	6	16	29	50	73

Note: Maximum undiluted propane capacities listed are based on an 11-in. w.c. setting and 0.5-in. w.c. pressure drop. Capacities in 1000 Btu/hr.

Table 12.13 Maximum Capacity of CSST in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases at a Pressure of 2 psig and a Pressure Drop of 1 psi (based on 1.52 specific gravity gas)

EHD* Flow Designation	Tubing Length, ft													
	10	25	30	40	50	75	80	110	150	200	250	300	400	500
13	426	262	238	203	181	147	140	124	101	86	77	69	60	53
15	558	347	316	271	243	196	189	169	137	118	105	96	82	72
18	927	591	540	469	420	344	333	298	245	213	191	173	151	135
19	1106	701	640	554	496	406	393	350	287	248	222	203	175	158
23	1735	1120	1027	896	806	663	643	578	477	415	373	343	298	268
25	2168	1384	1266	1100	986	809	768	703	575	501	448	411	355	319
30	4097	2560	2331	2012	1794	1457	1410	1256	1021	880	785	716	616	550
31	4720	2954	2692	2323	2072	1685	1629	1454	1182	1019	910	829	716	638

Notes:
1. Table does not include effect of pressure drop across the line regulator. If regulator loss exceeds 1/2 psi (based on 13-in. water column outlet pressure), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator can vary with flow rate.
2. CAUTION: Capacities shown in table can exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
3. Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger number of bends or fittings shall be increased by an equivalent length of tubing according to the following equation: $L = 1.3n$. where L is additional length (ft) of tubing and n is the number of additional fittings or bends.
*EHD — equivalent hydraulic diameter — a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
Source: NFPA 54, *National Fuel Gas Code*, 1999 edition, Table 9.30.

Table 12.14 Maximum Capacity of CSST in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases at a Pressure of 11-in. Water Column and a Pressure Drop of 0.5-in. Water Column (based on a 1.52 specific gravity gas)

EHD* Flow Designation	Tubing Length, ft																
	5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	300
13	72	50	39	34	30	28	23	20	19	17	15	15	14	11	9	8	8
15	99	69	55	49	42	39	33	30	26	25	23	22	20	15	14	12	11
18	181	129	104	91	82	74	64	58	53	49	45	44	41	31	28	25	23
19	211	150	121	106	94	87	74	66	60	57	52	50	47	36	33	30	26
23	355	254	208	183	164	151	131	118	107	99	94	90	85	66	60	53	50
25	426	303	248	216	192	177	153	137	126	117	109	102	98	75	69	61	57
30	744	521	422	365	325	297	256	227	207	191	178	169	159	123	112	99	90
31	863	605	490	425	379	344	297	265	241	222	208	197	186	143	129	117	107

Note: Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends or fittings shall be increased by an equivalent length of tubing to the following equation: $L = 1.3n$ where L is additional length (ft) of tubing and n is the number of additional fittings or bends.
*EHD — equivalent hydraulic diameter — a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
Source: NFPA 54, *National Fuel Gas Code*, 1999 edition, Table 9.29.

Table 12.15 Polyethylene Plastic Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Outside Diameter (IPS)

Plastic Pipe Length, ft	$^1/_2$ in. SDR 9.33 (0.660)	$^3/_4$ in. SDR 11.0 (0.860)	1 in. SDR 11.00 (1.077)	$1^1/_4$ in. SDR 10.00 (1.328)	$1^1/_2$ in. SDR 11.00 (1.554)	2 in. SDR 11.00 (1.943)
30	2143	4292	7744	13416	20260	36402
40	1835	3673	6628	11482	17340	31155
50	1626	3256	5874	10176	15368	27612
60	1473	2950	5322	9220	13924	25019
70	1355	2714	4896	8483	12810	23017
80	1261	2525	4555	7891	11918	21413
90	1183	2369	4274	7404	11182	20091
100	1117	2238	4037	6994	10562	18978
125	990	1983	3578	6199	9361	16820
150	897	1797	3242	5616	8482	15240
175	826	1653	2983	5167	7803	14020
200	778	1539	2775	4807	7259	13043
225	721	1443	2603	4510	6811	12238
250	681	1363	2459	4260	6434	11560
275	646	1294	2336	4046	6111	10979
300	617	1235	2228	3860	5830	10474
350	567	1136	2050	3551	5363	9636
400	528	1057	1907	3304	4989	8965
450	495	992	1789	3100	4681	8411
500	468	937	1690	2928	4422	7945
600	424	849	1531	2653	4007	7199
700	390	781	1409	2441	3686	6623
800	363	726	1311	2271	3429	6161
900	340	682	1230	2131	3217	5781
1000	322	644	1162	2012	3039	5461
1500	258	517	933	1616	2441	4385
2000	221	443	798	1383	2089	3753

Notes:
1. Maximum undiluted propane capacities listed are based on a pressure of 10 psig first-stage setting and 1-psi pressure drop. Capacities in 1000 Btu/hr.
2. Dimensions in parentheses are inside diameter.

Table 12.16 Polyethylene Plastic Tube Sizing Between First-Stage and Second-Stage Regulators: Nominal Outside Diameter (CTS)

Plastic Tubing Length, ft	1/2 in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
30	762	5225
40	653	4472
50	578	3964
60	524	3591
70	482	3304
80	448	3074
90	421	2884
100	397	2724
125	352	2414
150	319	2188
175	294	2013
200	273	1872
225	256	1757
250	242	1659
275	230	1576
300	219	1503
350	202	1383
400	188	1287
450	176	1207
500	166	1140
600	151	1033
700	139	951
800	129	884
900	121	830
1000	114	784
1500	92	629
2000	79	539

Notes:
1. Maximum undiluted propane capacities listed are based on 10-psig first-stage setting and 1-psi pressure drop. Capacities in 1000 Btu/hr.
2. Dimensions in parentheses are inside diameter.

Table 12.17 Polyethylene Plastic Tube Sizing Between Second-Stage Regulator and Building: Nominal Outside Diameter (CTS)

Plastic Tubing Length, ft	1/2 in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
10	121	829
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113

Notes:
1. Maximum undiluted propane capacities listed are based on 11-in. w.c. setting and a 0.5-in. w.c. pressure drop. Capacities in 1000 Btu/hr.
2. Dimensions in parentheses are inside diameter.

Chapter 13 Referenced Publications

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

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

NFPA 10, *Standard for Portable Fire Extinguishers,* 1998 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 1996 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2000 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 1998 edition.

NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites,* 1999 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 1997 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 1999 edition.

NFPA 54, *National Fuel Gas Code,* 1999 edition.

NFPA 59, *Utility LP-Gas Plant Code,* 2001 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities,* 1999 edition.

NFPA 70, *National Electrical Code®,* 1999 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 1999 edition.

NFPA 86, *Standard for Ovens and Furnaces,* 1999 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 1998 edition.

NFPA *101®, Life Safety Code®,* 2000 edition.

NFPA 220, *Standard on Types of Building Construction,* 1999 edition.

NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials,* 1999 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft,* 1998 edition.

NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities,* 2000 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation,* 1999 edition.

NFPA 1192, *Standard on Recreational Vehicles*, 1999 edition.

13.1.2 Other Publications.

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

API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases,* Pre-July 1, 1961.

API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 1996.

13.1.2.2 ASCE Publications. American Society of Civil Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

ASCE 7, *Minimum Design Loads for Buildings and Other Structures,* 1998.

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

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

"Rules for the Construction of Unfired Pressure Vessels," Section VIII, ASME *Boiler and Pressure Vessel Code,* 1998.

ASME B 31.3, *Chemical Plant and Petroleum Refinery Piping,* 1999.

ASME B 36.10M, *Welded and Seamless Wrought Steel Pipe,* 1996.

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

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

ASTM A 48, *Standard Specification for Gray Iron Castings,* 1994.

ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless,* 1999.

ASTM A 106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service,* 1999.

ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* 1998.

ASTM A 513, *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing,* 2000.

ASTM A 536, *Standard Specification for Ductile Iron Castings,* 1999.

ASTM A 539, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines,* 1999.

ASTM B 42, *Standard Specification for Seamless Copper Pipe, Standard Sizes,* 1998.

ASTM B 43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes,* 1998.

ASTM B 86, *Standard Specification for Zinc-Alloy Die Casting,* 1998.

ASTM B 88, *Standard Specification for Seamless Copper Water Tube,* 1999.

ASTM B 135, *Standard Specification for Seamless Brass Tube,* 1996.

ASTM B 280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service,* 1999.

ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings,* 2000.

ASTM D 2683, *Standard Specification for Socket-Type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe,* 1998.

ASTM D 3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing,* 1997.

ASTM F 1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing,* 1998.

13.1.2.5 AWS Publication. American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 1999.

13.1.2.6 CGA Publications. Compressed Gas Association, 1725 Jefferson Davis Highway, Arlington, VA 22202-4100.

ANSI/CGA C-7, *Guide to the Preparation of Precautionary Labeling and Markings of Compressed Gas Containers*, 2000.

CGA S-1.1, *Pressure Relief Device Standards, Part 1, Cylinders for Compressed Gases*, 1994.

13.1.2.7 IAS Publications. International Approval Services, U.S., Inc., 8501 East Pleasant Valley Road, Cleveland, OH 44131.

AGA LC-1, *Interior Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing,* 1991.

ANSI Z-21.80/CSA 6.22, *Standard for Line Pressure Regulators*, 1997.

13.1.2.8 ICBO Publications. International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, CA 90601.

Uniform Building Code, 1997.

ICC, *Rules for Construction of Unfired Pressure Vessels.*

13.1.2.9 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

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

UL 144, *Standard for LP-Gas Regulators,* 1999.

UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies,* 1996.

UL 147B, *Standard for Nonrefillable (Disposal) Type Metal Container Assemblies for Butane,* 1996.

UL 567, *Standard Pipe Connectors for Flammable and Combustible Liquids and LP-Gas,* 1996.

UL 651, *Schedule 40 or 80 Rigid PVC Conduit*, 1995.

13.1.2.10 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20401.

Title 16, *Code of Federal Regulations*, "Commercial Practices," Chapter 11, "Consumer Product Safety Commission."

Title 33, *Code of Federal Regulations*, "Navigation and Navigable Waters."

Title 49, *Code of Federal Regulations*, "Transportation." (Also available from the Association of American Railroads, American Railroads Bldg., 1920 L Street, NW, Washington, DC 20036 and American Trucking Assns., Inc., 2201 Mill Road, Alexandria, VA 22314.)

Federal Motor Carrier Safety Regulations.

Appendix A Explanatory Material

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

A.1.1 *General Properties of LP-Gas.* Liquefied petroleum gases (LP-Gases), as defined in this code *(see Section 1.7),* are gases at normal room temperature and atmospheric pressure. They liquefy under moderate pressure, readily vaporizing upon

release of the pressure. It is this property that permits transportation and storage of LP-Gases in concentrated liquid form, although they normally are used in vapor form.

For additional information on other properties of LP-Gases, see Appendix B.

Federal Regulations. Regulations of the U.S. Department of Transportation (DOT) are referenced throughout this code. Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission (ICC). The Federal Hazardous Substances Act (15 U.S.C. 1261) requires cautionary labeling of refillable cylinders of liquefied petroleum gases distributed for consumer use. They are typically 40 lb (18 kg) and less and are used with outdoor cooking appliances, portable lamps, camp stoves, and heaters. The Federal Hazardous Substances Act is administrated by the U.S. Consumer Product Safety Commission under regulations codified at 16 *CFR* 1500, *Commercial Practices*, Chapter 11, "Consumer Product Safety Commission."

A.1.1.1(4) For further information on the storage and handling of LP-Gas at natural gas processing plants, refineries, and petrochemical plants, see API 2510, *Design and Construction of LP-Gas Installations.*

A.1.1.2(6) Several types of LP-Gas systems are not covered by NFPA 54, *National Fuel Gas Code*, as noted. These include, but are not restricted to, most portable applications; many farm installations; vaporization, mixing, and gas manufacturing; temporary systems, for example, in construction; and systems on vehicles.

A.1.3.1 It is recognized that no odorant will be completely effective as a warning agent in every circumstance.

It is recommended that odorants be qualified as to compliance with 1.3.1 by tests or experience. Where qualifying is by tests, such tests should be certified by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb (0.45 kg) per 10,000 gal (37.9 m^3) of liquid LP-Gas has been recognized as an effective odorant. Other odorants and quantities meeting the provisions of 1.3.1 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 (37.9 m^3) of liquid LP-Gas might satisfy the requirements of 1.3.1.

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

A.1.3.2 Another method of determining the presence of odorant is the stain tube test. This method uses a small handheld pump to draw a sample across a filled glass tube and reading the length of color change. For additional information, see GPA Standard 2188, *Tentative Method for the Determination of Ethyl Mercaptan in LP-Gas Using Length of Stain Tubes* and CAN/CGSB-3.0 No. 18.5, *Test for Ethyl Mercaptan Odorant in Propane, Field Method.* At the time of the preparation of this code, additional analytical methods were under development.

A.1.5 The term *refresher* indicates that the periodic training could be less intensive than the original training, whose primary purpose is to reinforce initial training rather than repeat it.

A.1.6 To test for the presence of ammonia, allow a moderate vapor stream of the product to be tested to escape from the container. A rotary, slip tube, or fixed level gauge is a convenient vapor source. Wet a piece of red litmus paper by pouring distilled water over it while holding it with clean tweezers. Hold the wetted litmus paper in the vapor stream from the container for 30 seconds. The appearance of any blue color on the litmus paper indicates that ammonia is present in the product.

NOTE 1: Since the red litmus paper will turn blue when exposed to any basic (alkaline) solution, care is required in making the test and interpreting the results. Tap water, saliva, perspiration, or hands that have been in contact with water having a pH greater than 7, or with any alkaline solution, will give erroneous results.

NOTE 2: For additional information on the nature of this problem and conducting the test, see NPGA Safety Bulletin 122, *Recommendations for Prevention of Ammonia Contamination of LP-Gas*, published by the National Propane Gas Association.

A.1.7.6 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.1.7.11 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.1.7.12 Bulk Plant. Bulk plants receive gas through a variety of methods, such as railroad tank car, transport, cargo tank vehicle, gas piping, or watercraft. These plants are generally utilized for domestic, commercial, agricultural, institutional, and industrial applications, or for the storage of product awaiting delivery to the end user. A facility that transfers LP-Gas from railroad tank cars from a private track directly into cargo tank vehicles is also in this category. Such plants may have container-filling and truck loading/unloading facilities on the premises. Normally, no persons other than the plant management or plant employees have access to these facilities.

A.1.7.26 Flexible Connector. LP-Gas-resistant rubber and fabric (or metal), a combination of such rubber and fabric, or metal only should be used. Flexible connectors should be used where there is the need for, or the possibility of, greater relative movement between the points connected than is acceptable for rigid pipe.

A.1.7.30 Gas–Air Mixer. A gas–air mixture normally is used in industrial or commercial facilities as a substitute for another fuel gas.

A.1.7.39 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.1.7.40 Low Emission Transfer. Specifications for low emission transfer might be employed to comply with environmental regulations or to determine certain minimum distance requirements.

A.1.7.43 Movable Fuel Storage Tender. Movable fuel storage tenders or farm carts are basically non-highway vehicles but can occasionally be moved over public roads or highways for short distances to supply fuel for farm tractors, construction machinery, and similar equipment.

A.1.7.54 Portable Container. Portable containers, designed for transportation, include "cylinders," "cargo tanks," and "portable tanks," which are defined separately in this code. Containers that are designed to be readily moved from one location of use to another but that are substantially empty of product are "portable storage containers" and are also defined separately in this code.

A.1.7.55 Portable Storage Container. Portable storage containers either have legs or other supports attached or are mounted on running gear (such as trailer or semitrailer chassis) with suitable supports that can be of the fold-down type. Such supports allow them to be placed on a reasonably firm and level surface. For large-volume, limited-duration product usage (such as at construction sites and normally for 12 months or less), portable storage containers serve as permanently installed stationary containers.

A.1.7.62.1 Automatic Changeover Regulator. An automatic changeover regulator incorporates two inlet connections and a service-reserve indicator. The system automatically changes the LP-Gas vapor withdrawal from the designated service cylinder(s) when depleted to the designated reserve cylinder(s) without interruption of service. The service reserve indicator gives a visual indication of the cylinder(s) that is supplying the system.

A.1.7.66 Special Protection. Where required in this code, special protection consists of one of the following:

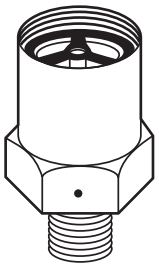
(1) Applied insulating coating
(2) Mounding
(3) Burial
(4) Water spray fixed systems
(5) Fixed monitor nozzles that meet the criteria specified in this code
(6) Any means listed for this purpose

See Section 3.10 for more information on fire protection and special protection.

A.1.7.71.4 Internal Valve. An internal valve has provision for the addition of a means of remote closure. An internal valve closes when flow through the valve exceeds its rated excess-flow capacity or when pump actuation differential pressure drops to a predetermined point.

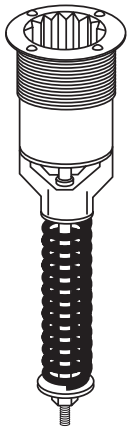
A.1.7.71.5.1 External Pressure Relief Valve. See Figure A.1.7.71.5.1.

FIGURE A.1.7.71.5.1 External pressure relief valve.



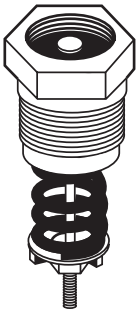
A.1.7.71.5.2 Flush-Type Full Internal Pressure Relief Valve. See Figure A.1.7.71.5.2.

FIGURE A.1.7.71.5.2 Flush-type full internal pressure relief valve.



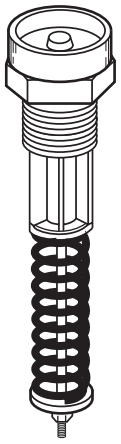
A.1.7.71.5.3 Full Internal Pressure Relief Valve. See Figure A.1.7.71.5.3.

FIGURE A.1.7.71.5.3 Full internal pressure relief valve.



A.1.7.71.5.4 Internal Spring-Type Pressure Relief Valve. See Figure A.1.7.71.5.4.

FIGURE A.1.7.71.5.4 Internal spring-type pressure relief valve.



A.2.2.1.3 Prior to April 1, 1967, regulations of the U.S. Department of Transportation were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply and are available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

Construction of containers to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, has not been authorized after July 1, 1961.

A.2.2.1.5 See CGA Publication C-6 or C-6.3, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, for further information regarding cylinder inspection.

A.2.2.6.3 Head design refers to the shape of the head. Shapes include hemispherical, semi-ellipsodial, and others. *(Refer to the ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases, for more information.)*

A.2.3.1.5(a) See Table F.5.3.3.

A.2.4.4.3 Persons joining PE pipe should be trained under the applicable joining procedure established by the manufacturer, including the following:

(1) Appropriate training in the use of joining procedures
(2) Making a specimen joint from pipe sections joined according to the procedures
(3) Visually examining these joints during and after assembly

A.2.4.4.3(c) The *Code of Federal Regulations,* Title 49, Part 192.281(e), states the following:

Mechanical joints. Each compression-type mechanical joint on plastic pipe must comply with the following:

(a) The gasket material in the coupling must be compatible with the plastic.

(b) A rigid internal tubing stiffener, other than a split tubular stiffener, must be used in conjunction with the coupling.

Part 192.283(b) states the following:

(1) *Mechanical joints.* Before any written procedure established under 192.273(b) is used for plastic making mechanical plastic pipe joints that are designed to withstand tensile forces, the procedure must be qualified by subjecting 5 specimen joints made according to the procedure to the following tensile test:

a. Use an apparatus for the test as specified in ASTM D638.77a (except for conditioning).
b. The specimen must be of such length that the distance between the grips of the apparatus and the end of the stiffener does not affect the joint strength.
c. The speed of testing is 5.0 mm (0.2 in.) per min, plus or minus 25 percent.
d. Pipe specimens less than 102 mm (4 in.) in diameter are qualified if the pipe yields to an elongation less than 25 percent or failure initiates outside the joint area.
e. Pipe specimens 102 mm (4 in.) and larger in diameter shall be pulled until the pipe is subjected to a tensile stress equal to or greater than the maximum thermal stress that would be produced by a temperature change of 55°C (100°F) or until the pipe is pulled from the fitting. If the pipe pulls from the fitting, the lowest value of the five test results or the manufacturer's rating, whichever is lower, must be used in the design calculations for stress.
f. Each specimen that fails at the grips must be retested using new pipe.
g. Results obtained pertain only to the outside diameter and material of the pipe tested, except that testing of a heavier wall pipe may be used to qualify pipe of the same material but with a lesser wall thickness.

A.2.4.8 UL 651, *Schedule 40 or 80 Rigid PVC Conduit*, listed rigid PVC electrical conduit has been designed, manufactured, and tested for use in a wide variety of operating conditions, including low temperatures and exposure to sunlight and outdoor weather. UL 651 conduit is widely available and can be purchased in hardware and electrical supply stores, where it is usually sold as electrical conduit.

A.2.5.5.6(f) See NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities,* for ignition and combustion controls applicable to vaporizing burners associated with grain dryers.

A.2.6.2.5 See NFPA 1192, *Standard on Recreational Vehicles*, for additional requirements where used on recreational vehicles.

A.3.1.1 Section 3.2 includes general provisions that are applicable to most stationary systems. Sections 3.3 through 3.8 extend and modify Section 3.2 for systems installed for specific purposes.

A.3.2.2.6(c) For information on determination of flash points see NFPA 30, *Flammable and Combustible Liquids Code.*

A.3.2.2.6(f) Also see NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites*, and NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes,* for oxygen systems, and NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites,* for gaseous hydrogen systems.

A.3.2.2.7 Because of the anticipated flash of nonrefrigerated LP-Gas when it is released to the atmosphere, dikes normally serve no useful purpose for nonrefrigerated installations.

A.3.2.2.8 The presence of such structures can create significant hazards, such as the following:

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

A.3.2.3.1 It is the intent to allow transfer of liquid into containers in open areas under canopies or roofs where 50 percent or more of the perimeter is not enclosed.

A.3.2.4.4 Generally, a light reflecting color paint is preferred unless the system is installed in an extremely cold climate.

A.3.2.9.1(f)2 If vapor is vented too rapidly, the pressure drop due to the refrigeration of the liquid can lead to the erroneous conclusion that no liquid remains in the container.

A.3.2.9.1(i) Firm earth can be used.

A.3.2.9.3(a) Noncombustible, noncorrosive materials include vermiculite and perlite.

A.3.2.9.3(d) For information on corrosion protection of containers and piping systems, see the following:

(a) API Publication 1632, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems,* 1983

(b) Underwriters Laboratories of Canada, ULC S603.1-M, *Standard for Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids*

(c) National Association of Corrosion Engineers Standard RP-01-69, Recommended Practice, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*

(d) National Association of Corrosion Engineers Standard RP-02-85, Recommended Practice, *Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems*

(e) Underwriters Laboratories Inc., UL 1746, *External Corrosion Protection Systems for Steel Underground Storage Tanks*

A.3.2.12.8 Two-psi regulator systems operate with 2 psi (13.8 kPa) downstream of three 2-psi service regulators to the line pressure regulator, which reduces the pressure to an appropriate inches-of-water-column pressure.

A.3.2.13(c) Complete compliance with Chapter 7 for buildings or separate areas of buildings housing industrial processes and other occupancies cited in 3.2.13(c), Exception No. 1(b), is not always necessary, depending on the prevailing conditions. Construction of buildings or separate areas of buildings housing certain internal combustion engines is covered in NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.*

A.3.2.16.8 Polyethylene will expand or contract 1 in. (25 mm) for every 10°F (18°C) temperature change for every 100 ft (30.5 m) of pipe.

A.3.2.17(b) This is not to be construed to mean that flexible connectors must be used if provisions were incorporated in the design to compensate for these effects.

A.3.2.19.6 Anchorage can be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting.

A.3.2.24 For information on protection of underground components see NACE RP-01-69, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems.*

A.3.4.8.3 The weight will be affected by the specific gravity of the liquefied petroleum (LP) gas. Weights varying from 16.0 oz (454 g) to 16.8 oz (476 g) are recognized as being within the range of what is nominal.

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

A.3.7.1.3 Because liquefied petroleum gas is contained in a closed system of piping and equipment, the system need not be electrically conductive or electrically bonded for protection against static electricity. For information on grounding and bonding for protection against static electricity, see NFPA 77, *Recommended Practice on Static Electricity.*

A.3.7.2.2 When classifying the extent of hazardous area, consideration should be given to possible variations in the spotting of railroad tank cars and cargo tank vehicles at the unloading points and the effect these variations of actual spotting point may have on the point of connection.

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

A.3.10.2 The wide range in size, arrangement, and location of LP-Gas installations covered by this code precludes the inclusion of detailed fire protection provisions completely applicable to all installations. Provisions in this section are subject to verification or modification through analysis of local conditions.

A.3.10.2.1 The National Fire Protection Association, American Petroleum Institute, and National Propane Gas Association publish material, including visual aids, useful in such planning.

A.3.10.2.2 In recent years the concept of total product control systems has been developed. Facilities that have redundant automatic product controls systems provide a high level of confidence that propane will not be released during an emergency. Therefore, not only will the storage be protected from a fire that could lead to container rupture, but major fires at the facility would be prevented. The public would be protected, fire fighting operations would be safer, and applications of large quantities of water would not be needed to prevent tank failure.

A fire safety analysis should include the following:

(1) The effectiveness of product control measures
(2) An analysis of local conditions of hazard within the container site
(3) Exposure to or from other properties, population density, and congestion within the site
(4) The probable effectiveness of plant fire brigades or local fire departments based on adequate water supply, response time, and training
(5) Consideration for the adequate application of water by hose stream or other method for effective control of leakage, fire, or other expenses
(6) If necessary, a designed time period for review of the fire safety analysis with local emergency response agencies to ensure preplanning and emergency response plans for the installation are current

A.3.10.2.5 LP-Gas fires should not normally be extinguished until the source of the burning gas has been shut off or can be shut off.

A.3.10.3.1 For LP-Gas fixed storage facilities of 60,000-gal (227-m^3) water capacity or less, a competent fire safety analysis

(see 3.10.2.3) could indicate that applied insulating coatings are quite often the most practical solution for special protection.

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

A.4.2.3.4(a) Air-moving equipment includes large blowers on crop dryers, space heaters, and some central heating equipment. Equipment employing open flames includes flame cultivators, weed burners, and tar kettles.

A.4.4.2.1 The maximum permitted filling limit in percent by weight should be as shown in Table 4.4.2.1.

A.4.4.2.2 The maximum permitted LP-Gas volume of any container depends on the size of the container, whether it is installed above ground or under ground, the specific gravity, and the temperature of the liquid. *[See Tables 4.4.2.2(a), (b), and (c).]*

See F.5.1.2 for the method of computing the values in Tables 4.4.2.2(a), (b), and (c).

A.4.4.3.5 The overfilling prevention device is intended to be a backup safety device to prevent overfilling of cylinders. Other means as provided in the chapter must be used when filling containers, even if an overfilling prevention device is present and expected to stop flow into the container before the other means indicate the container is properly filled.

A.5.4.1 The filling process in 5.4.1.3(5) Exception refers to the time period beginning when a cylinder or cylinders are brought to a dispensing station to be filled and ending when the last cylinder is filled and all the cylinders are removed from the filling area. This is meant to define a continuous process with the cylinders being unattended for only brief periods, such as operator breaks or lunch.

A.5.4.2.2 There are numerous effective means to provide protection against accidental vehicle impact or damage. The method selected may depend upon local conditions with regard to the kinds of traffic that can be reasonably expected and the environment surrounding the location. While additional protection over and above that used to protect the building may not be needed at some locations, others may need additional protection. Examples of such additional protection could be the following:

(1) Guard rails
(2) Steel bollards
(3) Raised sidewalks

A.5.5 See 3.10.2.6.

A.6.1.1.1(c) Most truck transportation of LP-Gas is subject to regulation by the U.S. Department of Transportation. Many of the provisions of this chapter are identical or similar to DOT regulations and are intended to extend these provisions to areas not subject to DOT regulation.

A.6.3.3.4 For more information, see NPGA Safety Bulletin 114, *Guide to Hose Inspection.*

A.6.3.7 Also see NFPA 10, *Standard for Portable Fire Extinguishers.*

A.7.3.2.5 See NFPA 80, *Standard for Fire Doors and Fire Windows.*

A.8.1.1.1 See Section 3.8 for systems on vehicles for purposes other than for engine fuel.

A.8.2.1 Containers for engine fuel systems can be of the permanently installed or exchange type.

A.8.2.2.1 Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply, which are available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

A.8.2.7.1(1) The luggage compartment (trunk) of a vehicle can constitute such an enclosure provided it meets all these requirements.

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

A.10.1.1 Federal regulations applicable to marine terminals are contained in Title 33 of the U.S. *Code of Federal Regulations.*

A.10.2.1 Refer to *Code of Federal Regulations,* Title 49, Part 195.

A.10.3.1 For guidance refer to *Code of Federal Regulations,* Title 33.

A.10.3.2 For guidance refer to Title 46, *Code of Federal Regulations,* Part 35, 35-30, "Shipping."

A.11.1 The new Chapter 11, Operations and Maintenance, has been created to locate operating and maintenance requirements in one location for installations covered by this code. In this edition only new operating and maintenance requirements are included in the new chapter. A task force has been established to review future additions to this chapter. Users of the code are invited to submit proposals on this subject.

A.11.2.1 The procedures should address normal startup, operations, shutdown, emergency shutdown and operations, startup following a major change to the system, consequences of deviations and steps required to correct or avoid deviations, and equipment inspections.

A.11.2.2 The owner or operator may use procedures or instructions provided by equipment vendors, procedures found in industrial codes, or procedures prepared by persons or organizations knowledgeable about the process and equipment as the basis for maintenance procedures.

Appendix B Properties of LP-Gases

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

B.1 Approximate Properties of LP-Gases.

B.1.1 Source of Property Values.

B.1.1.1 The property values for the LP-Gases are based on average industry values and include values for LP-Gases coming from natural gas liquid plants as well as those coming from petroleum refineries. Thus, any particular commercial propane or butane might have properties varying slightly from the values shown. Similarly, any propane–butane mixture might have properties varying from those obtained by computation from these average values *(see B.1.2 for computation method used).* Since these are average values, the interrelationships between them (e.g., lb per gal, specific gravity) will not cross check perfectly in all cases.

B.1.1.2 Such variations are not sufficient to prevent the use of these average values for most engineering and design purposes. They stem from minor variations in composition. The commercial grades are not pure (CP—Chemically Pure) propane or butane, or mixtures of the two, but might also contain small and varying percentages of ethane, ethylene, propylene,

isobutane, or butylene, which can cause slight variations in property values. There are limits to the accuracy of even the most advanced testing methods used to determine the percentages of these minor components in any LP-Gas.

B.1.2 Approximate Properties of Commercial LP-Gases.

The principal properties of commercial propane and commercial butane are shown in Tables B.1.2(a) and (b). Reasonably accurate property values for propane–butane mixtures can be obtained by computation, applying the percentages by weight of each in the mixture to the values for the property it is desired to obtain. Slightly more accurate results for vapor pressure are obtained by using the percentages by volume. Very accurate results can be obtained using data and methods explained in petroleum and chemical engineering data books.

Table B.1.2(a) (English) Approximate Properties of LP-Gases

	Commercial Propane	Commercial Butane
Vapor pressure in psi (absolute pressure) at		
70°F	145	32
100°F	218	52
105°F	233	56
130°F	315	84
Specific gravity of liquid at 60°F	0.504	0.582
Initial boiling point at 14.7 psia, °F	–44	15
Weight per gallon of liquid at 60°F, lb	4.20	4.81
Specific heat of liquid, Btu/lb at 60°F	0.630	0.549
Cubic feet of vapor per gallon at 60°F	36.38	31.26
Cubic feet of vapor per pound at 60°F	8.66	6.51
Specific gravity of vapor (air = 1) at 60°F	1.50	2.01
Ignition temperature in air, °F	920–1,120	900–1,000
Maximum flame temperature in air, °F	3,595	3,615
Limits of flammability in air, percent of vapor in air–gas mixture:		
Lower	2.15	1.55
Upper	9.60	8.60
Latent heat of vaporization at boiling point		
Btu per pound	184	167
Btu per gallon	773	808
Total heating values after vaporization		
Btu per cubic foot	2,488	3,280
Btu per pound	21,548	21,221
Btu per gallon	91,502	102,032

Table B.1.2(b) (Metric) Approximate Properties of LP-Gases

	Commercial Propane	Commercial Butane
Vapor pressure in kPa (absolute pressure) at		
20°C	1,000	220
40°C	1,570	360
45°C	1,760	385
55°C	2,170	580
Specific gravity	0.504	0.582
Initial boiling point at 1.00 atm. pressure, °C	–42	–9
Weight per cubic meter of liquid at 15.56°C, kg	504	582
Specific heat of liquid, kilojoule per kilogram, at 15.56°C	1.464	1.276
Cubic meter of vapor per liter of liquid at 15.56°C	0.271	0.235
Cubic meter of vapor per kilogram of liquid at 15.56°C	0.539	0.410
Specific gravity of vapor (air = 1) at 15.56°C	1.50	2.01
Ignition temperature in air, °C	493–549	482–538
Maximum flame temperature in air, °C	1,980	2,008
Limits of flammability in air, % of vapor in air–gas mixture		
Lower	2.15	1.55
Upper	9.60	8.60
Latent heat of vaporization at boiling point		
Kilojoule per kilogram	428	388
Kilojoule per liter	216	226
Total heating value after vaporization		
Kilojoule per cubic meter	92,430	121,280
Kilojoule per kilogram	49,920	49,140
Kilojoule per liter	25,140	28,100

B.1.3 Specifications of LP-Gases. Specifications of LP-Gases covered by this code are listed in Gas Processors Association, Standard 2140, *Liquefied Petroleum Gas Specifications for Test Methods,* or ASTM D 1835, *Standard Specification for Liquefied Petroleum (LP) Gases.*

Appendix C Design, Construction, and Requalification of DOT (ICC) Cylinders

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

C.1 Scope.

C.1.1 Application.

C.1.1.1 This appendix provides general information on cylinders referred to in this code. For complete information, consult the applicable specification *(see C.2.1)*. The water capacity of such cylinders is not permitted to be more than 1000 lb (454 kg).

C.1.1.2 This appendix is not applicable to Department of Transportation (DOT) tank car portable tank container or cargo tank specifications. Portable and cargo tanks are basically ASME containers and are covered in Appendix D.

C.1.1.3 Prior to April 1, 1967, these specifications were promulgated by the Interstate Commerce Commission (ICC). On this date, certain functions of the ICC, including the promulgation of specifications and regulations dealing with LP-Gas cylinders, were transferred to the Department of Transportation. Throughout this appendix, both ICC and DOT are used, ICC applying to dates prior to April 1, 1967, and DOT to subsequent dates.

C.2 LP-Gas Cylinder Specifications.

C.2.1 Publishing of DOT Cylinder Specifications. DOT cylinder specifications are published under 49 *CFR* 171–190, "Transportation of Hazards Liquids by Pipeline," available from the U.S. Government Printing Office, Washington, DC. The information in this publication is also issued as a Tariff at approximately three-year intervals by the Bureau of Explosives, American Railroads Building, 1920 L Street, NW, Washington, DC 20036.

C.2.2 DOT Specification Nomenclature.

C.2.2.1 The specification designation consists of a one-digit number, sometimes followed by one or more capital letters, then by a dash and a three-digit number. The one-digit number alone, or in combination with one or more capital letters, designates the specification number. The three-digit number following the dash shows the service pressure for which the cylinder is designed. Thus, "4B-240" indicates a cylinder built to Specification 4B for a 240-psig (1650-kPag) service pressure. *(See C.2.2.3.)*

C.2.2.2 The specification gives the details of cylinder construction, such as material used, method of fabrication, tests required, and inspection method, and prescribes the service pressure or range of service pressures for which that specification can be used.

C.2.2.3 The term *service pressure* is analogous to, and serves the same purpose as, the ASME *design pressure*. However, it is not identical, representing instead the highest pressure to which the cylinder will normally be subjected in transit or in use but not necessarily the maximum pressure to which it might be subjected under emergency conditions in transportation. The service pressure stipulated for the LP-Gases is based on the vapor pressures exerted by the product in the cylinder at two different temperatures, the higher pressure of the two becoming the service pressure, as follows:

(1) The pressure in the cylinder at 70°F (21°C) must be less than the service pressure for which the cylinder is marked.
(2) The pressure in the container at 130°F (54.4°C) must not exceed $^5/_4$ times the pressure for which the cylinder is marked.

Example: Commercial propane has a vapor pressure at 70°F (21°C) of 132 psig (910 kPag). However, its vapor pressure at 130°F (54.4°C) is 300 psig (2070 kPag), so service pressure [$^5/_4$ times, which must not exceed 300 psig (2070 kPag)] is 300 divided by $^5/_4$, or 240 psig (1650 kPag). Thus, commercial propane requires at least a 240-psig (1650-kPag) service pressure cylinder.

C.2.3 DOT Cylinder Specifications Used for LP-Gas.

C.2.3.1 A number of different specifications were approved by DOT (and its predecessor ICC) for use with LP-Gases. Some of these are no longer published or used for new construction. However, cylinders built under these old specifications, if properly maintained and requalified, are still acceptable for LP-Gas transportation.

C.2.3.2 DOT specifications cover primarily safety in transportation. However, for the product to be used, it is necessary for it to come to rest at the point of use and serve as LP-Gas storage during the period of use. Cylinders adequate for transportation are also deemed to be adequate for use as provided in this code. As small-size ASME containers were not available at the time cargo tank vehicle delivery was started, ICC (now DOT) cylinders have been equipped for cargo tank vehicle deliveries and permanently installed.

C.2.3.3 The DOT cylinder specifications most widely used for the LP-Gases are shown in Table C.2.3.3. The differing materials of construction, the method of fabrication, and the date of the specification reflect the progress made in knowledge of the products to be contained and the improvement in metallurgy and methods of fabrication.

Table C.2.3.3 DOT Cylinder Specifications

Specification No. and Marking	Material of Construction	Method of Fabrication
26–150*	Steel	Welded and brazed
3B–300	Steel	Seamless
4–300	Steel	Welded
4B–300	Steel	2 piece welded and brazed
4B–240	Steel	2 piece welded and brazed
4BA–240	Alloy steel	2 piece welded and brazed
4E–240	Aluminum	Welded and brazed
4BW–240	Steel	3 piece welded

*The term *service pressure* had a different connotation at the time the specification was adopted.

C.3 Requalification, Retesting, and Repair of DOT Cylinders.

C.3.1 Application. This section outlines the requalification, retesting, and repair requirements for cylinders but should be used only as a guide. For official information, the applicable DOT regulations should be consulted.

C.3.2 Requalification (Including Retesting) of DOT Cylinders.

C.3.2.1 DOT rules prohibit cylinders from being refilled, continued in service, or transported unless they are properly qualified or requalified for LP-Gas service in accordance with DOT regulations.

C.3.2.2 DOT rules require a careful examination of every cylinder each time it is to be filled, and it must be rejected if there is evidence of exposure to fire, bad gouges or dents, seriously corroded areas, leaks, or other conditions indicating possible weaknesses that might render it unfit for service. The following disposition is to be made of rejected cylinders:

(a) Cylinders subjected to fire are required to be requalified, reconditioned, or repaired in accordance with C.3.3 or permanently removed from service except that DOT 4E (aluminum) cylinders must be permanently removed from service.

(b) Cylinders showing serious physical damage or leaks or showing a reduction in the marked tare weight of 5 percent or more are required to be retested in accordance with C.3.2.4(a) or (b) and, if necessary, repaired in accordance with C.3.3.

C.3.2.3 All cylinders, including those apparently undamaged, are required to be periodically requalified for continued service. The first requalification for a new cylinder is required within 12 years after the date of manufacture. Subsequent requalifications are required within the periods specified under the requalification method used.

C.3.2.4 DOT regulations permit three alternative methods of requalification for most commonly used LP-Gas cylinders *(see DOT regulations for permissible requalification methods for specific cylinder specifications)*. Two use hydrostatic testing, and the third uses a carefully made and duly recorded visual examination by a competent person. In the case of the two hydrostatic test methods, only test results are recorded, but a careful visual examination of each cylinder is also required. DOT regulations cite in detail the data to be recorded for the hydrostatic test methods, the observations to be made during the recorded visual examination method, and the marking of cylinders to indicate the requalification date and the method used. The three methods are outlined as follows:

(a) The water jacket-type hydrostatic test is permitted to be used to requalify cylinders for 12 years before the next requalification is due. A pressure of twice the marked service pressure is applied, using a water jacket (or the equivalent) so that the total expansion of the cylinder during the application of the test pressure can be observed and recorded for comparison with the permanent expansion of the cylinder after depressurization. The following disposition is made of cylinders tested in this manner:

(1) Cylinders that pass the retest and the visual examination required with it *(see C.3.2.4)* are marked with the date and year of the test (example: "6-90," indicating requalification by the water jacket test method in June 1990) and are permitted to be placed back in service.
(2) Cylinders that leak, or for which the permanent expansion exceeds 10 percent of the total expansion (12 percent for Specification 4E aluminum cylinders), must be rejected. If rejected for leakage, cylinders are permitted to be repaired in accordance with C.3.3.

(b) Cylinders are requalified for seven years before the next requalification is due. A pressure of twice the marked service pressure is applied, but no provision is made for measuring total and permanent expansion during the test outlined in C.3.2.4(a). The cylinder is carefully observed while under the test pressure for leaks, undue swelling, or bulging indicating weaknesses. The following disposition is made of cylinders tested in this matter:

(1) Cylinders that pass the test and the visual examination required with it *(see C.3.2.4)* are marked with the date and year of the retest followed by an *S* (Example: 8-91S, indicating requalification by the simple hydrostatic test method in August 1991) and are permitted to be placed back in service.
(2) Cylinders are requalified developing leaks or showing undue swelling or bulging must be rejected. If rejected for leaks, cylinders are permitted to be repaired in accordance with C.3.3.

(c) The recorded visual examination is permitted to be used to requalify cylinders for five years before the next qualification is due provided the cylinder has been used exclusively for LP-Gas commercially free of corroding components. Inspection is to be made by a competent person, using as a guide the CGA *Standard for Visual Inspection of Steel Compressed Gas Cylinders* (CGA Pamphlet C-6), and recording the inspection results as required by DOT regulations. The following disposition is to be made of cylinders inspected in this manner:

(1) Cylinders that pass the visual examination are marked with the date and year of the examination followed by an *E* (Example: 7-90E, indicating requalification by the recorded visual examination method in July 1990) and are permitted to be placed back in service.
(2) Cylinders that leak, show serious denting or gouging, or excessive corrosion must be either scrapped or repaired in accordance with C.3.3.

C.3.3 Repair of DOT Cylinders. Repair of DOT cylinders is required to be performed by a manufacturer of the type of cylinder to be repaired or by a repair facility authorized by DOT.

Repairs normally made are for fire damage, leaks, denting, and gouges and for broken or detached valve-protecting collars or foot rings.

Appendix D Design of ASME and API-ASME Containers

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

D.1 General.

D.1.1 Application.

D.1.1.1 This appendix provides general information on containers designed and constructed in accordance with ASME or API-ASME codes, usually referred to as ASME containers. For complete information on either ASME or API-ASME containers, the applicable code should be consulted. Construction of containers to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases* has not been authorized since July 1, 1961.

D.1.1.2 DOT (ICC) specification portable tank containers and cargo tanks are either ASME or API-ASME containers. In writing these specifications, which should be consulted for complete information, additions were made to these pressure vessel codes to cover the following:

(1) Protection of container valves and appurtenances against physical damage in transportation

(2) Hold-down devices for securing cargo containers to conventional vehicles
(3) Attachments to relatively large [6000-gal (22.7-m^3) or more water capacity] cargo containers in which the container serves as a stress member in lieu of a frame

D.1.2 Development of ASME and API-ASME Codes.

D.1.2.1 ASME-type containers of approximately 12,000-gal (45.4-m^3) water capacity or more were initially used for bulk storage in processing, distribution, and industrial plants. As the industry expanded and residential and commercial usage increased, the need for small ASME containers with capacities greater than the upper limit for cylinders grew. This ultimately resulted in the development of cargo containers for cargo tank vehicles and the wide use of ASME containers ranging in size from less than 25 gal (0.1 m^3) to 120,000 gal (454 m^3) water capacity.

D.1.2.2 The American Society of Mechanical Engineers (ASME) in 1911 set up the Boiler and Pressure Vessel Committee to formulate "standard rules for the construction of steam boilers and other pressure vessels." The ASME *Boiler and Pressure Vessel Code*, first published in 1925, has been revised regularly since that time. During this period there have been changes in the code as materials of construction improved and more was known about them and as fabrication methods changed and inspection procedures were refined.

D.1.2.3 One major change involved the so-called "factor of safety" (the ratio of the ultimate strength of the metal to the design stress used). Prior to 1946, a 5:1 safety factor was used. Fabrication changed from the riveting widely used when the code was first written (some forge welding was used) to fusion welding. This latter method was incorporated into the code as welding techniques were perfected and now predominates.

D.1.2.4 The safety factor change in the ASME Code was based on the technical progress made since 1925 and on experience with the use of the API-ASME code. This offshoot of the ASME code, initiated in 1931, was formulated and published by the American Petroleum Institute (API) in cooperation with ASME. It justified the 4:1 safety factor on the basis of certain quality and inspection controls not at that time incorporated in the ASME code editions.

D.1.2.5 ASME *Code Case Interpretations and Addenda* are published between code editions and normally become part of the code in the new edition. Adherence to these is considered compliance with the code. *[See 2.2.1.3(a).]*

D.2 Design of Containers for LP-Gas.

D.2.1 ASME Container Design.

D.2.1.1 When ASME containers were first used to store LP-Gas, the properties of the CP grades of the principal constituents were available, but the average properties for the commercial grades of propane and butane were not. Also, there was no experience as to what temperatures and pressures to expect for product stored in areas with high atmospheric temperatures. A 200-psig (1378 kPag) design pressure was deemed appropriate for propane [the CP grade of which has a gauge vapor pressure of 176 psig (1210 kPag) at 100°F (37.8°C)] and 80 psig (550 kPag) for butane [CP grade has vapor pressure of 37 psig (255 kPag) at 100°F (37.8°C)]. These containers were built with a 5:1 safety factor *(see D.1.2.3)*.

D.2.1.2 Pressure vessel codes, following boiler pressure relief valve practice, require that the pressure relief valve start-to-leak setting be the design pressure of the container. In specifying pressure relief valve capacity, however, they stipulate that this relieving capacity be adequate to prevent the internal pressure from rising above 120 percent of the design pressure under fire exposure conditions.

D.2.1.3 Containers built in accordance with D.2.1.1 were entirely adequate for the commercial grades of the LP-Gases [the vapor pressure of propane at 100°F (37.8°C) is 220 psig (1515 kPag); the gauge vapor pressure of commercial butane at 100°F (37.8°C) is 37 psig (255 kPag)]. However, because they were equipped with pressure relief valves set to start-to-leak at the design pressure of the container, these relief valves occasionally opened on an unusually warm day. Since any unnecessary release of a flammable gas is potentially dangerous, and considering recommendations of fire prevention and insurance groups as well as to the favorable experience with API-ASME containers *(see D.2.2.1),* relief valve settings above the design pressure [up to 250 psig (1720 kPag) for propane and 100 psig (690 kPag) for butane] were widely used.

D.2.1.4 In determining safe filling limits for compressed liquefied gases, DOT (ICC) uses the criterion that the container not become liquid full at the highest temperature the liquid is expected to reach due to the normal atmospheric conditions to which the container may be exposed. For containers of more than 1200-gal (4.5-m^3) water capacity, the liquid temperature selected is 115°F (46°C). The vapor pressure of the gas to be contained at 115°F (46°C) is specified by DOT as the minimum design pressure for the container. The gauge vapor pressure of CP propane at 115°F (46.1°C) is 211 psig (1450 kPag), and of commercial propane, 255 psig (1756 kPag). The gauge vapor pressure of both normal butane and commercial butane at 115°F (46.1°C) is 51 psig (350 kPag).

D.2.1.5 The ASME *Boiler and Pressure Vessel Code* editions generally applicable to LP-Gas containers, and the design pressures, safety factors, and exceptions to these editions for LP-Gas use, are shown in Table D.2.1.5. They reflect the use of the information in D.2.1.1 through D.2.1.4.

D.2.2 API-ASME Container Design.

D.2.2.1 The API-ASME Code was first published in 1931. Based on petroleum industry experience using certain material quality and inspection controls not at that time incorporated in the ASME Code, the 4:1 safety factor was first used. Many LP-Gas containers were built under this code with design pressures of 125 psig (860 kPag) [100 psig (690 kPag) until December 31, 1947] for butane and 250 psig (1725 kPag) for propane. Containers constructed in accordance with the API-ASME Code were not required to comply with Section 1 or to the appendix to Section 1. Paragraphs W-601 through W-606 of the 1943 and earlier editions were not applicable to LP-Gas containers.

D.2.2.2 The ASME Code, by changing from the 5:1 to the 4:1 safety factor through consideration of the factors described in D.2.1.1 through D.2.1.4, became nearly identical in effect to the API-ASME code by the 1950s. Thus, the API-ASME code was phased out, and construction was not authorized after July 1, 1961.

Table D.2.1.5 Minimum Container Design Pressure and Safety Factors for Various Editions of the ASME Code

Year ASME Code Edition Published	Design Pressure, psig (MPag)		Safety Factor
	Butane	Propane	
1931 through 1946[a]	100[a](0.7)	200 (1.4)	5:1
1949, Par. U-68 & U-69[b]	100 (0.7)	200 (1.4)	5:1
1949, Par. U-200 & U-201[c]	125 (0.9)	250 (1.7)	4:1
1952 through 80	125 (0.9)	250 (1.7)	4:1

[a]Until December 31, 1947, containers designed for 80 psig (550 kPag) under prior (5:1 safety factor) codes were authorized for butane. Since that time, either 100 psig (690 kPag) (under prior codes) or 125 psig (860 kPag) (under present codes) is required.
[b]Containers constructed in accordance with the 1949 edition and prior editions of the ASME Code were not required to be in compliance with paragraphs U-2 to U-10 inclusive or with paragraph U-19. Construction in accordance with paragraph U-70 of these editions was not authorized.
[c]Higher design pressure [312.5 psig (2.2 MPag)] is required for small ASME containers used for vehicular installations because they may be exposed to higher temperatures and consequently develop higher internal pressure.

D.2.3 Design Criteria for LP-Gas Containers. To prevent confusion in earlier editions of this code, the nomenclature *container type* was used to designate the design pressure of the container to be used for various types of LP-Gases. With the adoption of the 4:1 safety factor in the ASME code and the phasing out of the API-ASME code, the need for *container type* ceased to exist.

D.2.4 DOT (ICC) Specifications Utilizing ASME or API-ASME Containers.

D.2.4.1 DOT (ICC) specifications for portable tank containers and cargo tanks require ASME or API-ASME construction for the container proper *(see D.1.1.2)*. Several such specifications were written by the ICC prior to 1967, and DOT has continued this practice.

D.2.4.2 ICC specifications written prior to 1946, and to some extent through 1952, used ASME containers with a 200-psig (1380-kPag) design pressure for propane and 80 psig (550 kPag) for butane [100 psi (690 kPa) after 1947] with a 5:1 safety factor. During this period and until 1961, ICC specifications also permitted API-ASME containers with a 250-psig (1720-kPag) design pressure for propane and 100 psig (690 kPag) for butane [125 psig (862 kPag) after 1947].

D.2.4.3 To prevent any unnecessary release of flammable vapor during transportation *(see D.2.1.3)*, the use of safety relief valve settings 25 percent above the design pressure was common for ASME 5:1 safety factor containers. To eliminate confusion, and in line with the good experience with API-ASME containers, the ICC permitted the rerating of these particular ASME containers used under its specifications to 125 percent of the originally marked design pressure.

D.2.4.4 DOT (ICC) specifications applicable to portable tank containers and cargo tanks currently in use are listed in Table D.2.4.4. New construction is not permitted under the older specifications. However, use of these older containers is permitted to continue provided they have been maintained in accordance with DOT (ICC) regulations.

D.3 Underground ASME or API-ASME Containers.

D.3.1 Use of Containers Underground.

D.3.1.1 ASME or API-ASME containers are used for underground or partially underground installation in accordance with 3.2.9.1 or 3.2.9.2. The temperature of the soil is normally low so that the average liquid temperature and vapor pressure of product stored in underground containers will be lower than in aboveground containers.

D.3.1.2 Containers listed to be used interchangeably for installation either above ground or under ground must comply as to pressure relief valve rated relieving capacity and filling limit with aboveground provisions when installed above ground *(see 2.3.2.4)*. When installed under ground, the pressure relief valve rated relieving capacity and filling limit can be in accordance with underground provisions *[see 2.3.2.4(c)]*, provided all other underground installation provisions are met. Partially underground containers are considered as aboveground insofar as filling limit and pressure relief valve rated relieving capacity are concerned.

Table D.2.4.4 DOT Pressure Specification for Cargo Tanks

Specification Number	ASME Construction			API-ASME Construction		
	Design Pressure, psig		Safety Factor	Design Pressure, psig		Safety Factor
	Propane	Butane		Propane	Butane	
ICC-50[a]	200[c]	100[c]	5:1	250	125	4:1
ICC-51[a]	250	125	4:1	250	125	4:1
MC-320[b,d]	200[c]	100[c]	5:1	250	125	4:1
MC-330[b]	250	125	4:1	250	125	4:1
MC-331[b]	250	125	4:1	250	125	4:1

Note: For SI units, 100 psi = 0.69 MPa; 125 psi = 0.86 MPa; 200 psi = 1.40 MPa; 250 psi = 1.72 MPa
[a]Portable tank container.
[b]Cargo tank.
[c]Permitted to be rerated to 125 percent of original ASME design pressure.
[d]Requires DOT exemption.

Appendix E Pressure Relief Devices

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

E.1 Pressure Relief Devices for DOT Cylinders.

E.1.1 Source of Provisions for Relief Devices. The requirements for relief devices on DOT cylinders are established by the DOT. Complete technical information regarding these requirements will be found in the CGA Publication S-1.1, *Pressure-Relief Device Standards*, Part 1 — *Cylinders for Compressed Gases*.

E.2 Pressure Relief Devices for ASME Containers.

E.2.1 Source of Provisions for Pressure Relief Devices. Capacity requirements for pressure relief devices are in accordance with the applicable provisions of CGA Publication S-1.2, *Pressure-Relief Device Standards*, Part 2 — *Cargo and Portable Tanks for Compressed Gases*; or with CGA Publication S-1.3, *Pressure Relief-Device Standards*, Part 3 — *Compressed Gas Storage Containers*.

E.2.2 Spring-Loaded Pressure Relief Valves for Aboveground and Cargo Containers. The minimum rate of discharge for spring-loaded pressure relief valves is based on the outside surface of the containers on which the valves are installed. Paragraph 2.2.6.3(6) provides that new containers be marked with the surface area in square feet. The surface area of containers not so marked (or not legibly marked) can be computed by use of the applicable formula.

(1) Cylindrical container with hemispherical heads:

Surface area = overall length × outside diameter × 3.1416

(2) Cylindrical container with other than hemispherical heads:

Surface area = (overall length + 0.3 outside diameter) × outside diameter × 3.1416

NOTE: This formula is not precise but will give results with limits of practical accuracy in sizing relief valves.

(3) Spherical containers:

Surface area = outside diameter squared × 3.1416

Flow rate CFM Air = $53.632 \times A^{0.82}$

where

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

E.2.3 Pressure Relief Valve Testing.

E.2.3.1 Frequent testing of pressure relief valves on LP-Gas containers is not considered necessary for the following reasons:

(a) The LP-Gases are so-called "sweet gases" having no corrosive or other deleterious effect on the metal of the containers or relief valves.

(b) The relief valves are constructed of corrosion-resistant materials and are installed so as to be protected against the weather. The variations of temperature and pressure due to atmospheric conditions are not sufficient to cause any permanent set in the valve springs.

(c) The required odorization of the LP-Gases makes escape almost instantly evident.

(d) Experience over the years with the storage of LP-Gases has shown a good safety record on the functioning of pressure relief valves.

E.2.3.2 Since no mechanical device can be expected to remain in operative condition indefinitely, it is suggested that the pressure relief valves on containers of more than 2000-gal (7.6-m^3) water capacity be tested at approximately 10-year intervals.

Appendix F Liquid Volume Tables, Computations, and Graphs

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

F.1 Scope.

F.1.1 Application. This appendix explains the basis for Table 4.4.2.1, includes the LP-Gas liquid volume temperature correction table, Table F.3.3, and describes its use. It also explains the methods of making liquid volume computations to determine the maximum permissible LP-Gas content of containers in accordance with Tables 4.4.2.2(a), (b), and (c).

F.2 Basis for Determination of LP-Gas Container Capacity. The basis for determination of the maximum permitted filling limits shown in Table 4.4.2.1 is the maximum safe quantity that will assure that the container will not become liquid full when the liquid is at the highest anticipated temperature.

F.2.1 For portable containers built to DOT specifications and other aboveground containers with water capacities of 1200 gal (4.5 m^3) or less, this temperature is assumed to be 130°F (54°C).

F.2.2 For other aboveground uninsulated containers with water capacities in excess of 1200 gal (4.5 m^3), including those built to DOT portable or cargo tank specifications, this temperature is assumed to be 115°F (46°C).

F.2.3 For all containers installed under ground, this temperature is assumed to be 105°F (41°C).

F.3 Liquid Volume Correction Table. Correction of observed volume to standard temperature condition (60°F and equilibrium pressure).

F.3.1 The volume of a given quantity of LP-Gas liquid in a container is directly related to its temperature, expanding as temperature increases and contracting as temperature decreases. Standard conditions, often used for weights and measures purposes and, in some cases, to comply with safety regulations, specify correction of the observed volume to what it would be at 60°F (16°C).

F.3.2 To correct the observed volume to 60°F (16°C), the specific gravity of LP-Gas at 60°F (16°C) in relation to water at 60°F (16°C) (usually referred to as "60°/60°F") and its average temperature must be known. The specific gravity normally appears on the shipping papers. The average liquid temperature can be obtained as follows:

(1) Insert a thermometer in a thermometer well in the container into which the liquid has been transferred, and read the temperature after the completion of the transfer *[see F.3.2(c) for proper use of a thermometer]*.

(2) If the container is not equipped with a well, but is essentially empty of liquid prior to loading, the temperature of the liquid in the container from which liquid is being withdrawn can be used. Otherwise, a thermometer can be inserted in a thermometer well or other temperature-sensing device installed in the loading line at a point close to the container being loaded. Read temperatures at intervals during transfer and averaging. *[See F.3.2(c).]*

(3) A suitable liquid should be used in thermometer wells to obtain an efficient heat transfer from the LP-Gas liquid in the container to the thermometer bulb. The liquid used should be noncorrosive and should not freeze at the temperatures to which it will be subjected. Water should not be used.

F.3.3 The volume observed or measured is corrected to 60°F (16°C) by use of Table F.3.3. The column headings, across the top of the tabulation, list the range of specific gravities for the LP-Gases. Specific gravities are shown from 0.500 to 0.590 by 0.010 increments, except that special columns are inserted for chemically pure propane, isobutane, and normal butane. To obtain a correction factor, follow down the column for the specific gravity of the particular LP-Gas to the factor corresponding with the liquid temperature. Interpolation between the specific gravities and temperatures shown can be used if necessary.

Table F.3.3 Liquid Volume Correction Factors

	Specific Gravities at 60°F/60°F												
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**
	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	1.210	1.021	1.020

(Sheet 1 of 2)

Table F.3.3 Liquid Volume Correction Factors ***(Continued)***

Observed Temperature, Degrees Fahrenheit	Specific Gravities at 60°F/60°F												
	0.500	Propane 0.5079	0.510	0.520	0.530	0.540	0.550	0.560	iso-Butane 0.5631	0.570	0.580	n-Butane 0.5844	0.590
	Volume Correction Factors												
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

(Sheet 2 of 2)

F.4 Use of Liquid Volume Correction Factors, Table F.3.3.

F.4.1 To correct the observed volume in gallons for any LP-Gas (the specific gravity and temperature of which is known) to gallons at 60°F (16°C), Table F.3.3 is used as follows:

(a) Obtain the correction factor for the specific gravity and temperature as described in F.3.3.

(b) Multiply the gallons observed by this correction factor to obtain the gallons at 60°F (16°C).

Example: A container has in it 4055 gal of LP-Gas with a specific gravity of 0.560 at a liquid temperature of 75°F. The correction factors in the 0.560 column are 0.980 at 76°F and 0.983 at 74°F, or, interpolating, 0.9815 for 75°F. The volume of liquid at 60°F is 4055 × 0.9815, or 3980 gal.

F.4.2 To determine the volume in gallons of a particular LP-Gas at temperature *t* to correspond with a given number of gallons at 60°F (16°C), Table F.3.3 is used as follows:

(a) Obtain the correction factor for the LP-Gas, using the column for its specific gravity and reading the factor for temperature *t*.

(b) Divide the number of gallons at 60°F (16°C) by this correction factor to obtain the volume at temperature *t*.

Example: It is desired to pump 800 gal (3.03 m^3) at 60°F (15.5°C) into a container. The LP-Gas has a specific gravity of 0.510, and the liquid temperature is 44°F. The correction factor in the 0.510 column for 44°F is 1.025. Volume to be pumped at 44°F is 800 / 1.025 = 780 gal (2.95 m^3).

F.5 Maximum Liquid Volume Computations.

F.5.1 Maximum Liquid LP-Gas Content of a Container at Any Given Temperature.

F.5.1.1 The maximum liquid LP-Gas content of any container depends on the size of the container, whether it is installed above ground or under ground, the maximum permitted filling limit, and the temperature of the liquid *[see Tables 4.4.2.2(a), (b), and (c).]*

F.5.1.2 The maximum volume fraction V_t (in percent of container capacity) of an LP-Gas at temperature *t,* having a specific gravity *G* and a filling limit and weight percent filling limit of *L,* is computed by use of the following formula:

$$V_t = \frac{L}{G} \div F$$

or

$$V_t = \frac{L}{G \times F}$$

where:

V_t = percent of container capacity that can be filled with liquid

L = maximum permitted filling limit by weight *(see Table 4.4.2.1)*

G = specific gravity of particular LP-Gas

F = correction factor to correct volume at temperature t to 60°F (16°C)

Example: The maximum liquid content, in percent of container capacity, for an aboveground 30,000-gal (114-m^3) water capacity container of LP-Gas having a specific gravity of 0.508 and at a liquid temperature of 80°F (27°C) is computed as follows:

From Table 4.4.2.1, L = 0.45, and from Table F.3.3, F = 0.967. Thus,

$$V_{80} = \frac{0.45}{0.508 \times 0.967}$$

$$= 0.915\ (91\%) \text{ or } 27{,}300 \text{ gal } (103\ m^3)$$

F.5.2 Alternate Method of Filling Containers.

F.5.2.1 Containers equipped with fixed maximum level gauges or with variable liquid level gauges when temperature determinations are not practical can be filled with either gauge provided that the fixed maximum liquid level is installed or the variable gauge is set to indicate the volume equal to the maximum permitted filling limit as provided in 4.4.3.3(a). The level is computed on the basis of the liquid temperature being 40°F (4.4°C) for aboveground containers or 50°F (10°C) for underground containers.

F.5.2.2 The percentage of container capacity that can be filled with liquid is computed by use of the formula shown in F.5.1.2, substituting the appropriate values as follows:

$$V_t = \frac{L}{G \times F}$$

where:

t = the liquid temperature [assumed to be 40°F (4.4°C) for aboveground containers or 50°F (10°C) for underground containers]

L = the loading limit obtained from Table 4.4.2.1 for:

(a) The specific gravity of the LP-Gas to be contained

(b) The method of installation, aboveground or underground, and if aboveground, then:

(1) For containers of 1200 gal (4.5 m^3) water capacity or less

(2) For containers of more than 1200-gal (4.5-m^3) water capacity

G = the specific gravity of the LP-Gas to be contained

F = the correction factor (obtained from Table F.3.3, using G and 40°F (4°C) for aboveground containers or 50°F (10°C) for underground containers)

Example: The maximum volume of LP-Gas with a specific gravity of 0.508 that can be in a 1000-gal (3.8-m^3) water capacity aboveground container that is filled by use of a fixed maximum liquid level gauge is computed as follows:

t is 40°F (4.4°C) for an aboveground container.

L for 0.508 specific gravity, and an aboveground container of less than 1200-gal (4.5-m^3) water capacity, from Table 4.4.2.1, is 42 percent.

G is 0.508.

F for 0.508 specific gravity at 40°F (4.4°C) from Table F.3.3 is 1.033.

Thus,

$$V_{40} = \frac{0.42}{0.508 \times 1.033}$$

$$= 0.800\ (80\%) \text{ or } 800 \text{ gal } (3\ m^3)$$

F.5.2.3 Percentage values, such as in the example in F.5.2.2, are rounded off to the next lower full percentage point, or to 83 percent in this example.

F.5.3 Location of Fixed Maximum Liquid Level Gauges in Containers.

F.5.3.1 Due to the diversity of fixed maximum liquid level gauges, and the many sizes [from cylinders to 120,000 gal (454 m^3) ASME vessels] and types (vertical, horizontal, cylindrical, and spherical) of containers in which gauges are installed, it is not possible to tabulate the liquid levels such gauges should indicate for the maximum permitted filling limits *[see Tables 4.4.2.1 and 4.4.2.2(a)]*.

F.5.3.2 The percentage of container capacity that these gauges should indicate is computed by use of the formula in F.5.1.2. The liquid level this gauge should indicate is obtained by applying this percentage to the water capacity of the container in gallons [water at 60°F (16°C)] and then using the strapping table for the container (obtained from its manufacturer) to determine the liquid level for this gallonage. If such a table is not available, this liquid level is computed from the internal dimensions of the container, using data from engineering handbooks.

F.5.3.3 Table F.5.3.3 can be used to determine minimum dip tube length when installing an overfilling prevention device on cylinders for vapor service.

Table F.5.3.3 Recommended Dip Tube Lengths for Various Cylinders

Cylinder Size	Material	Cylinder I.D. (in.)	Cylinder Water Capacity (lb)	Recommended Dip Tube Length (in.)
4.25#	Steel	8.9	10.2	2.2
5#	Steel	7.8	11.9	3.0
6#	Steel	7.5	15.5	3.2
10#	Steel	8.9	26.1	3.6
11#	Steel	8.9	26.2	3.6
11#	Steel	12.0	26.2	3.0
11.5#	Steel	12.0	27.3	3.2
20#	Steel	12.0	47.6	4.0
25#	Steel	12.0	59.7	4.8
30#	Steel	12.0	71.5	4.8
40#	Steel	12.0	95.3	6.5
6#	Aluminum	6.0	15.0	4.8
10#	Aluminum	10.0	23.6	4.0
20#	Aluminum	12.0	47.6	4.8
30#	Aluminum	12.0	71.5	6.0
40#	Aluminum	12.0	95.2	7.0

Notes:
1. This table indicates the approximate fixed maximum liquid level gauge dip tube lengths to be used for retrofitting cylinders with valves incorporating an overfilling prevention device. This table does not cover every cylinder design or configuration.
2. Important: If the dip tube length that is marked on the cylinder does not appear in this table, use the next longer dip tube shown in the table. Example: When the dip tube length marked on the cylinder is 3.8 in., use a 4.0-in. dip tube for the retrofit.
If the dip tube length is not marked on the cylinder, contact the manufacturer for the recommended dip tube length.

Appendix G Wall Thickness of Copper Tubing

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

G.1 Tables G.1(a) and G.1(b) contain the nominal wall thicknesses of Types K, L, and ACR copper tubing.

Table G.1(a) Wall Thickness of Copper Tubing (Specification for Copper Water Tube, ASTM B 88)

Standard Size (in.)	Nominal OD (in.)	Nominal Wall Thickness (in.)	
		Type K	Type L
1/4	0.375	0.035	0.030
3/8	0.500	0.049	0.035
1/2	0.625	0.049	0.040
5/8	0.750	0.049	0.042
3/4	0.875	0.065	0.045

Table G.1(b) Wall Thickness of Copper Tubing (Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service, ASTM B 280)

Standard Size (in.)	Outside Diameter (in.)	Wall Thickness (in.)
1/4	0.250	0.030
5/16	0.312	0.032
3/8	0.375	0.032
1/2	0.500	0.032
5/8	0.625	0.035
3/4	0.750	0.042
7/8	0.875	0.045

Appendix H 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 informational purposes only.

H.1 Performance Standard. Thermal protection insulating systems, proposed for use on LP-Gas containers as a means of "Special Protection" under 3.10.3.1, 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 a container's contents in a fire environment of 50 minutes duration and that will resist a concurrent hose stream of 10 minutes duration.

H.2 Reference Test Standards. The testing procedure described herein was taken with some modification from segments of the following two test standards:

(a) 49 *CFR*, *Transportation*, Part 179.105-4, "Thermal Protection."

(b) NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, Chapter 4, Section 4.3, Hose Stream Test.

H.3 Thermal Insulation Test.

H.3.1 A torch fire environment shall be created in the following manner:

(a) The source of the simulated torch shall be a hydrocarbon fuel. The flame temperature from the simulated torch shall be 2200°F ± 100°F (1200°C ± 56°C) throughout the test duration. Torch velocities shall be 40 mph ± 10 mph (64 km/h ± 16 km/h) throughout the duration of the test.

(b) An uninsulated square steel plate with thermal properties equivalent to ASME pressure vessel steel shall be used. The plate dimensions shall be not less than 4 ft × 4 ft (1.2 m × 1.2 m) by nominal $^5/_8$ in. (16 mm) thick. The plate shall be instrumented with not less than nine thermocouples to record the thermal response of the plate. The thermocouples shall be attached to the surface not exposed to the simulated torch and shall be divided into nine equal squares with a thermocouple placed in the center of each square.

(c) The steelplate holder shall be constructed in such a manner that the only heat transfer to the back side of the plate is by heat conduction through the plate and not by other heat paths. The apex of the flame shall be directed at the center of the plate.

(d) Before exposure to the torch fire, none of the temperature recording devices shall indicate a plate temperature in excess of 100°F (38°C) or less than 32°F (0°C).

(e) A minimum of 2 thermocouples shall indicate 800°F (427°C) in a time of 4.0 ± 0.5 minutes of torch fire exposure.

H.3.2 A thermal insulation system shall be tested in the torch fire environment described in H.3.1 in the following manner:

(a) The thermal insulation system shall cover one side of a steel plate identical to that used under H.3.1(b).

(b) The back of the steel plate shall be instrumented with not less than nine thermocouples placed as described in paragraph H.3.1(b) to record the thermal response of the steel.

(c) Before exposure to the torch fire, none of the thermocouples on the thermal insulation system steel plate configuration shall indicate a plate temperature in excess of 100°F (37.8°C) or less than 32°F (0°C).

(d) The entire outside surface of the thermal insulation system shall be exposed to the torch fire environment.

(e) A torch fire test shall be run for a minimum of 50 minutes. The thermal insulation system shall retard the heat flow to the steel plates so that none of the thermocouples on the uninsulated side of the steel plate indicate a plate temperature in excess of 800°F (427°C).

H.4 Hose Stream Resistance Test. After 20 minutes exposure to the torch test, the test sample shall be hit with a hose stream concurrently with the torch for a period of 10 minutes. The hose stream test shall be conducted in the following manner:

(a) The stream shall be directed first at the middle and then at all parts of the exposed surface, making changes in direction slowly.

(b) The hose stream shall be delivered through a $2^1/_2$-in. (64-mm) hose discharging through a National Standard playpipe of corresponding size equipped with $1^1/_8$-in. (29-mm) discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure at the base of the nozzle and for the duration of the test shall be 30 psig (207 kPag). [Estimated delivery rate is 205 gpm (776 L/min).]

(c) The tip of the nozzle shall be located 20 ft (6 m) from, and on a line normal to, the center of the test specimen. If impossible to be so located, the nozzle may be on a line deviating not to exceed 30 degrees from the line normal to the center of the test specimen. When so located, the distance from the center shall be less than 20 ft (6 m) by an amount equal to 1 ft (0.3 m) for each 10 degrees of deviation from the normal.

(d) Subsequent to the application of the hose stream, the torching shall continue until any thermocouple on the uninsulated side of the steel plate indicates a plate temperature in excess of 800°F (427°C).

(e) The thermal insulation system shall be judged to be resistant to the action of the hose stream if the time from initiation of torching for any thermocouple on the uninsulated side of the steel plate to reach in excess of 800°F (427°C) is 50 minutes or greater.

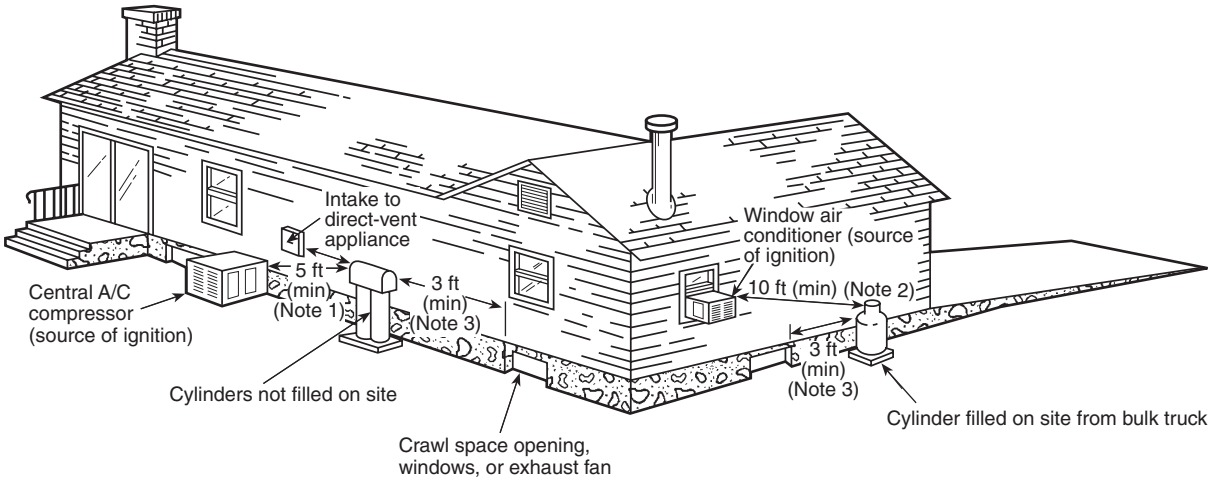
(f) One (1) successful combination torch fire and hose stream test shall be required for certification.

Appendix I Container Spacing

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

I.1 Spacing of Containers. Figures I.1(a), I.1(b), and I.1(c) illustrate container spacing required in 3.2.2.2.

FIGURE I.1(a) Cylinders. ***(This figure for illustrative purposes only; code shall govern.)***



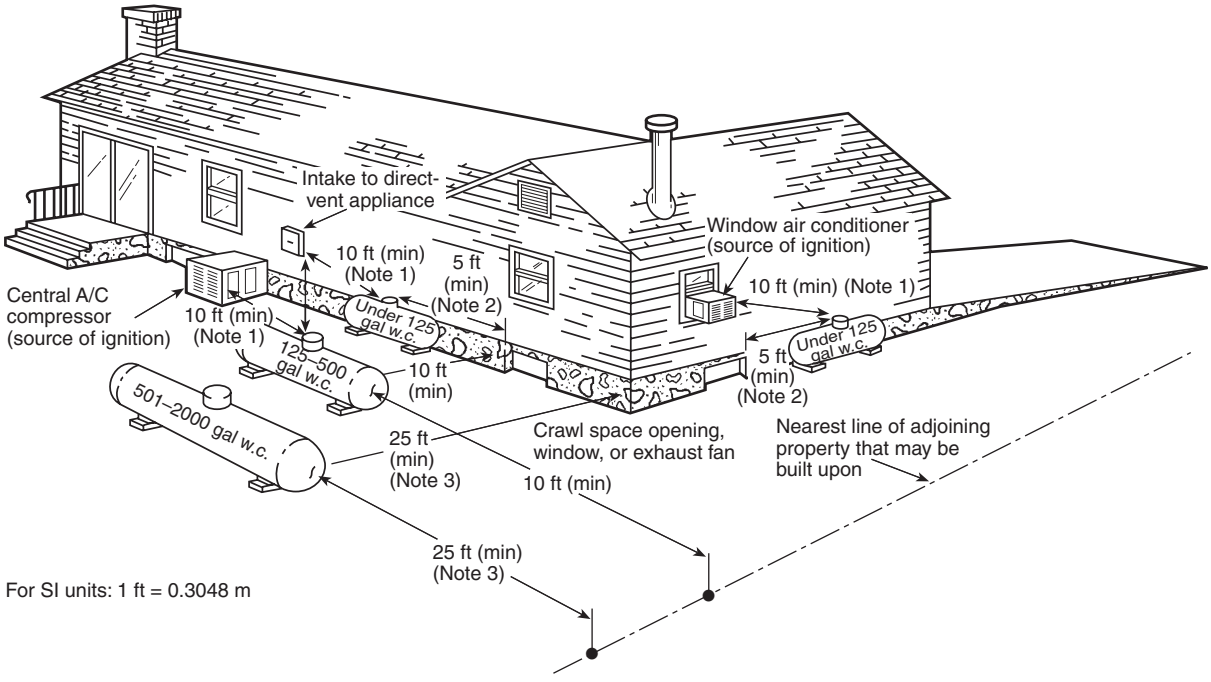
For SI units: 1 ft = 0.3048 m

Note 1: 5-ft minimum from relief valve in any direction away from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to 3.2.2.2(b).

Note 2: If the cylinder is filled on site from a bulk truck, the filling connection and vent valve must be at least 10 ft from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to 3.2.2.2(d).

Note 3: Refer to 3.2.2.2(b).

FIGURE I.1(b) Aboveground ASME containers. ***(This figure for illustrative purposes only; code shall govern.)***



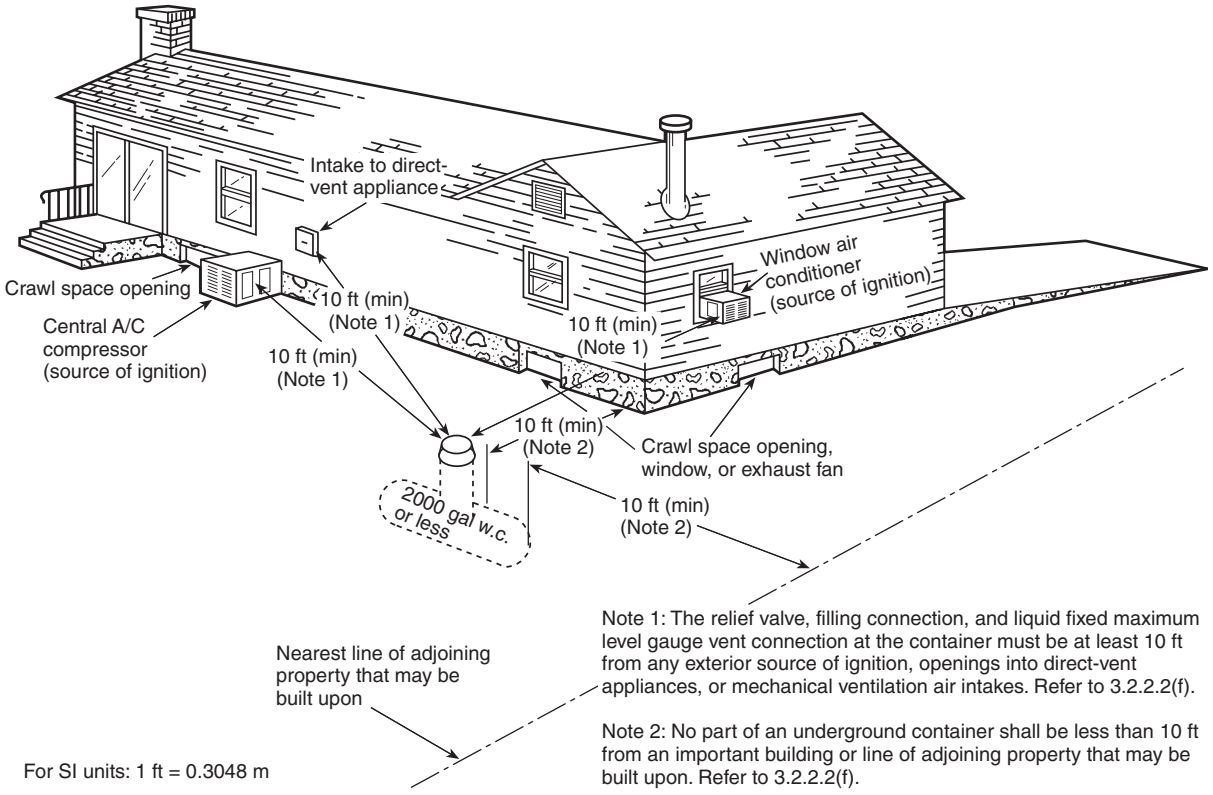
For SI units: 1 ft = 0.3048 m

Note 1: Regardless of its size, any ASME container filled on site must be located so that the filling connection and fixed maximum liquid level gauge are at least 10 ft from any external source of ignition (e.g., open flame, window A/C, compressor), intake to direct-vented gas appliance, or intake to a mechanical ventilation system. Refer to 3.2.2.2(d).

Note 2: Refer to 3.2.2.2(c)

Note 3: This distance may be reduced to no less than 10 ft for a single container of 1200 gal (4.5 m^3) water capacity or less, provided such container is at least 25 ft from any other LP-Gas container of more than 125 gal (0.5 m^3) water capacity. Refer to 3.2.2.2(e).

FIGURE I.1(c) Underground ASME containers. ***(This figure for illustrative purposes only; code shall govern.)***



Appendix J Referenced Publications

J.1 The following documents or portions thereof are referenced within this code for informational purposes only and are thus not considered part of the requirements of this code unless also listed in Chapter 13. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this code.

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

NFPA 10, *Standard for Portable Fire Extinguishers,* 1998 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2000 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 1998 edition.

NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites,* 2001 edition.

NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites,* 1999 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 1997 edition.

NFPA 54, *National Fuel Gas Code,* 1999 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities,* 1999 edition.

NFPA 68, *Guide for Venting of Deflagrations,* 1998 edition.

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

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

NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials,* 1999 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* 1999 edition.

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

NFPA 1192, *Standard on Recreational Vehicles,* 1996 edition.

J.1.2 Other Publications.

J.1.2.1 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 1996.

API 1632, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems,* 1996.

API 2510, *Design and Construction of LP-Gas Installations,* 1995.

API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases.*

J.1.2.2 ASCE Publication. American Society of Civil Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

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

J.1.2.3 ASME Publication. American Society for Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code*, 1998.

ASME *Code Case Interpretations and Addenda.*

J.1.2.4 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, Conshohocken, PA 19428-2959.

ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, 1999.

ASTM B 280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, 1999.

ASTM D 638, *Standard Test Method for Tensile Properties of Plastics*, 1999.

ASTM D 1835, *Standard Specification for Liquefied Petroleum (LP) Gases,* 1997.

J.1.2.5 CAN/CSGB Publication. Canadian General Standards Board, 222 Queen St., Suite 1402, Ottawa, Ontario K1A 1G6.

CAN/CGSB-3.0 No. 18.5, *Test for Ethyl Mercaptan Odorant in Propane, Field Method*, March, 1995.

J.1.2.6 CGA Publications. Compressed Gas Association, Inc., 1725 Jefferson Davis Highway, Arlington, VA 22202.

CGA Pamphlet C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders,* 1993.

Pressure-Relief Device Standards:

S-1.1, *Part 1 — Cylinders for Compressed Gases* (Errata, 1982), 1994.

S-1.2, *Part 2 — Cargo and Portable Tanks for Compressed Gases,* 1995.

S-1.3, *Pressure Relief Device Standards, Part 3 — Compressed Gas Storage Containers,* 1995.

J.1.2.7 GPA Publications. Gas Processors Association, 6526 E 60th Street, Tulsa, OK 74103.

Standard 2140, *Liquefied Petroleum Gas Specifications for Test Methods,* 1997.

Standard 2188, *Tentative Method for the Determination of Ethyl Mercaptan in LP-Gas Using Length of Stain Tubes,* 1989.

J.1.2.8 NACE Publications. National Association of Corrosion Engineers, 1440 South Creek Drive, Houston, TX 77084.

RP-01-69, *Recommended Practice, Control of External Corrosion of Underground or Submerged Metallic Piping Systems,* 1996.

RP-02-85, *Recommended Practice, Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems,* 1985.

J.1.2.9 NPGA Publications. National Propane Gas Association, 1600 Eisenhower Lane, Lisle, IL 60532.

NPGA Safety Bulletin 114, *Guide to Hose Inspection*, 1991.

NPGA Safety Bulletin 122, *Recommendations for Prevention of Ammonia Contamination of LP-Gas,* 1992.

J.1.2.10 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

UL 651, *Schedule 40 or 80 Rigid PVC Conduit.*

UL 1746, *External Corrosion Protection Systems for Steel Underground Storage Tanks,* 1993.

J.1.2.11 ULC Publication. Underwriters Laboratories of Canada, 7 Crouse Road, Scarborough, Ontario MIR 3A9.

ULC-S603.1-M, *Standard for Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids,* 1992.

J.1.2.12 U.S. Government Publications. National Technical Information Service, U.S. Dept. of Commerce, Springfield, VA 22161.

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

Title 16, *Code of Federal Regulations*, "Commercial Practices," Chapter 11, "Consumer Product Safety Commission."

Title 33, *Code of Federal Regulations.*

Title 46, *Code of Federal Regulations,* Part 33.

Title 46, *Code of Federal Regulations*, Part 35, 35–30.

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

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

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

Index

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 2.4.4.3(c)
FI 92-1

Question: Was it the intention of the Technical Committee on Liquefied Petroleum Gases, when they adopted 2.4.4.3(c) in the 1992 edition of NFPA 58, to restrict the choice of any, or all, of the materials that might be utilized in the several components that comprise the total assembly of mechanical joints to those specifically "listed" or mentioned in the ASTM Standard D2513-90.

Answer: No.

It was not the intent of the committee in 2.4.4.3(c) to specify materials of construction. Materials of construction of mechanical fittings are covered in 2-4.4 where it was the committee's intent to limit fittings to be constructed of materials listed in ASTM D2513, except for gasket materials, which are covered in 2.4.4.3(c)(3).

In 1-2.4, Alternate Materials and Provisions, the committee provides a method of use of alternate materials when supported by sufficient evidence acceptable to the authority having jurisdiction.

Issue Edition: 1992
Reference: 2-4.4(c)(2)
Issue Date: January 15, 1993
Effective Date: February 3, 1993

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: Table 3.2.3.3
F.I. 95-1

Question: Was it the intention of the Committee that the 20 ft (6.1 m) minimum horizontal distance refer to the fill and vent connections of underground containers rather than the shells and heads of the containers?

Answer: Yes.

Issue Edition: 1995
Reference: Table 3-2.3.3
Issue Date: April 3, 1995
Effective Date: April 23, 1995

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 3.2.15.1
F.I. 95-2

Question No. 1: Is it the intent of NFPA 58, 3.2.15.1 to apply to welded piping only?

Answer: Yes. When the current 3.2.15.1 was added to the standard in the 1995 edition, the committee discussions were centered on concerns over welding quality, and the addition was intended to provide standards for welding.

Question No. 2: Is it the intent to classify LP-Gas as a normal fluid when using ASME B31.3?

Answer: Yes

Issue Edition: 1995
Reference: 3-2.15.1
Issue Date: December 8, 1995
Effective Date: December 28, 1995

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 3.2.19.2
F.I. 79-1

Question: Is it the intent of 3.2.19.2 to require either an emergency shutoff valve or a backflow check valve in each leg of the piping when two or more hoses are used?

Answer: Yes.

Committee Comment: Unless these provisions are made, it would be possible for flow from one leg of the piping to escape through a leak in the other leg.

Issue Edition: 1979
Reference: 3168(a)
Date: November 1979

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 3.2.19.2
F.I. 79-2

Question: In an LP-Gas installation subject to the provisions of 3.2.8.9 of NFPA 58 by virtue of the container capacity qualifications, the vapor piping used in liquid transfer operations is 1¼-inches nominal size. However, a vapor hose permanently affixed to the delivery end of this piping (by the use of a 1¼ -inch-to-1-inch reducing elbow) is 1-inch nominal size. No backflow check valve is installed in this piping.

Is it the intent of 3.2.19.2 of NFPA 58 to require that an emergency shutoff valve be installed in the fixed vapor piping?

Answer: No.

Committee Comment: The Committee notes that, in the absence of either an emergency shutoff valve or a backflow check valve, 3-3.3.8(a) or (b) would require an excess flow valve in the fixed vapor piping cited.

Issue Edition: 1979
Reference: 3168(a)
Date: December 1980

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 3.4.5
F.I. 79-3

Question: An LP-Gas fired infra-red space heater and an LP-Gas cylinder are located and used inside of a foundry. They are connected, through a regulator, by means of a hose. The pressure in the hose is less than 1 psi.

What provisions in NFPA 58 characterize the hose that should be used?

Answer: This application is covered under 3.4.5, "Buildings Housing Industrial Occupancies," of NFPA 58. It is therefore also subject to the provisions of 3.4.1 and 3.4.2.3 of Section 3.4, which, through references, characterize the type of hose to be used as follows: Paragraph 3.4.2.3 provides: "Piping, including pipe, tubing, fittings, valves and hose, shall comply with Section 2.4, except that a minimum working pressure 250 psi (17 MPa), shall apply to all components. The following shall also apply: ...

(b) Hose, hose connections and flexible connectors used shall be designed for a working pressure of at least 350 psi (2.4 MPa), shall comply with 2.4.6..."

Paragraph 2.4.6.1 requires that the hose be fabricated of materials resistant to the action of LP-Gas both as liquid and vapor, and, if wire braid is used for reinforcement, it shall be corrosive-resistant material such as stainless steel.

Paragraph 2.4.6.2 provides: "Hose and quick connectors shall be approved."

Paragraph 2.4.6.3(a) reiterates the requirement in 3.4.2.3(b) for a 350 psi working pressure regardless of the actual pressure and stipulates hose marking and other pressure criteria applicable to the assembly of hose and hose connections.

Issue Edition: 1979
Reference: 334
Issue Date: August 1982
Reissued to correct error: August 1995

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 3.4.6
F.I. 89-2

Question: Is it a violation of NFPA 58, 3.4.6 to install a 20 lb LP-Gas tank in a high school chemistry laboratory to supply Bunsen burners on the student lab tables, connected by permanently installed piping which complies with NFPA 58?

Answer: Yes.

Issue Edition: 1989
Reference: 3-4.6.1
Issue Date: May 22, 1990
Effective Date: June 10, 1990

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 3.4.8.1
F.I. 89-3

Question: Does the use of an approved portable cooking appliance utilizing a 2 lb LP-Gas container as its fuel supply for temporary table side cooking within a restaurant meet the intent of "public exhibition" as described in 3.4.8.1?

Answer: No.

Issue Edition: 1989
Reference: 3-4.8.1
Issue Date: March 19, 1991
Effective Date: April 8, 1991

Formal Interpretation

NFPA 58

Liquefied Petroleum Gas Code

2001 Edition

Reference: 8.2.6(h)
F.I. 89-1

Question: Is it the intent of the above referenced code provision to prohibit installation of an underbody van propane tank(s) which require the operator to reach underneath the vehicle to open or close the shut off valve, assuming the shut off valve does not require tools to gain access to it or to operate it?

Answer: No.

Issue Edition: 1989
Reference: 3-6.2.6(h)
Issue Date: May 4, 1990
Effective Date: May 24, 1990