

NFPA® 58

Liquefied Petroleum Gas Code

2014 Edition



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NFPA® 58

Liquefied Petroleum Gas Code

2014 Edition

This edition of NFPA 58, *Liquefied Petroleum Gas Code*, was prepared by the Technical Committee on Liquefied Petroleum Gases and acted on by NFPA at its June Association Technical Meeting held June 10–13, 2013, in Chicago, IL. It was issued by the Standards Council on August 1, 2013, with an effective date of August 21, 2013, and supersedes all previous editions.

Tentative interim amendments (TIAs) to Paragraphs 6.12.9, 11.1.1 and its Annex A material, and 11.15.2 (relocated to Section 6.26) were issued on August 1, 2013. For further information on tentative interim amendments, see Section 5 of the NFPA Regulations Governing Committee Projects available at: <http://www.nfpa.org/assets/files/PDF/CodesStandards/TIAErrataFI/TIARegs.pdf>.

This edition of NFPA 58 was approved as an American National Standard on August 21, 2013.

Origin and Development of NFPA 58

The first NFPA standard on LP-Gas was adopted in 1932. In 1940, several standards were combined and adopted as NFPA 58.

Revisions of NFPA 58 were adopted in 1934, 1937, 1939, 1940, 1943, 1946, 1948, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1965, 1967, 1969, 1972, 1974, 1976, 1979, 1983, 1986, 1989, 1992, 1995, 1998, 2001, 2004, 2008, and 2011.

The 2011 edition of NFPA 58 included several significant changes. The installation of underground LP-Gas storage containers required cathodic protection systems, and the systems were required to be monitored to verify that they were provided protection. The requirement that a pressure relief valve be piped vertically upward 7 ft from the valve was deleted because the committee could find no technical reason to justify it. Former railroad tank car tanks were no longer allowed to be installed as permanent storage containers because they were not constructed to the ASME *Boiler and Pressure Vessel Code*, and additional recommendations for training were added to Annex A.

The 2014 edition harmonizes container requirements for containers 4000 gal and less water capacity and greater than 4000 gal water capacity (wc). A *bulk plant* and an *industrial plant* are defined as facilities storing more than 4000 gal wc, which is the reason for the demarcation point of 4000 gal wc. A new definition was added for vehicular barrier protection (VBP). There are many installations where the container and valves are required to be protected from vehicular impact, but no specific information was provided as to what constituted such protection. A new definition to describe VBP is incorporated into the 2014 edition, along with extensive annex material. In addition, prescriptive requirements are added for VBP of LP-Gas dispensers.

Qualifications of personnel have been expanded for clarification in Chapter 4. The requirements, which originated as a Temporary Interim Amendment to the 2011 edition, specify which personnel must be trained and what topics they must be trained in. New requirements are included covering tank heaters, and requirements for vaporizers have been updated.

Finally, the 2014 edition includes new requirements to provide cathodic protection for underground metallic piping systems greater than 2 in. Previously, all underground metallic piping was only required to be coated or painted. The new requirements for piping systems are very similar to those for cathodic protection of underground containers.



Documents

Document Sharing Hub

Technical Committee on Liquefied Petroleum Gases

Frank J. Mortimer, *Chair*
EMC Insurance Company, IA [I]
Rep. Property Casualty Insurers Association of America

Donald Barber, Enmat International (UK), United Kingdom [SE]
James C. Belke, U.S. Environmental Protection Agency, DC [E]
Paul N. Bogan, Sea-3, Incorporated, NH [U]
David T. Burnell, New Hampshire Public Utilities Commission, NH [E]
Rep. U.S. Department of Transportation
Sharon E. Coates, State of Arkansas, AR [E]
Alberto Jose Fossa, MDJ, Assessoria & Engenharia Consultiva, Brasil [SE]
Rep. NFPA Latin American Section
Richard G. Fredenburg, State of North Carolina, NC [E]
Cesar E. Garza-Obregon, Gas Campanita, TX [IM]
Rep. Asociación Mexicana de Distribuidores de Gas
Steven T. Gentry, Worthington Cylinder Corporation, OH [M]
Rep. Compressed Gas Association
Richard A. Hoffmann, Hoffmann & Feige, NY [SE]
Stanley T. Kastanas, U.S. Department of Transportation, MA [E]
John W. King, Federated Mutual Insurance Company, MN [I]
Glenn Mahnken, FM Global, MA [I]
Bill Mahre, Propane Technical Services, MN [SE]

Samuel E. McTier, Propane Technologies, LLC, IL [M]
Rep. National Propane Gas Association
David W. Meyer, Gas Training & Development LLC, MN [SE]
Gerry E. Misel, Jr., Georgia Gas Distributors, Inc., GA [IM]
Rep. National Propane Gas Association
James T. Osterhaus, Railroad Commission of Texas, TX [E]
Phani K. Raj, Technology & Management Systems, Inc., MA [SE]
Phillip H. Ribbs, PHR Consultants, CA [L]
Rep. California State Pipe Trades Council
Matt Sigler, International Association of Plumbing & Mechanical Officials, CA [E]
David J. Stainbrook, Engineered Controls International, LLC, NC [M]
Bruce J. Swiecicki, National Propane Gas Association, IL [IM]
Frank R. Volgstadt, Volgstadt and Associates, OH [M]
Rep. Plastics Pipe Institute
Thomas A. Wilson, City of Winter Park, FL [E]
Rep. International Fire Marshals Association
Leslie Woodward, Fairview Fittings & Manufacturing Inc., NY [IM]
Rep. Canadian Propane Association
William J. Young, Superior Energy Systems, Ltd., OH [M]

Alternates

Hugo Aguilar, International Association of Plumbing & Mechanical Officials, CA [E]
(Alt. to M. Sigler)
Joseph M. Bloom, Bloom Fire Investigation, OR [SE]
(Alt. to B. Mahre)
Alexi I. Dimopoulos, ExxonMobil Corporation, VA [M]
(Voting Alt. to API Rep.)
James R. Freeman III, Freeman Gas & Electric, Inc., SC [IM]
(Alt. to G. E. Misel, Jr.)
Wesley W. Hayes, Polk County Fire Services Division, FL [E]
(Alt. to T. A. Wilson)
Swapan Kumar Hazra, GF Natural Gas LNG Ltd/CNG Technology Ltd., India [U]
(Alt. to P. N. Bogan)
Rayfield Hearne, Railroad Commission Of Texas, TX [E]
(Alt. to J. T. Osterhaus)

George K. Hess, U.S. Environmental Protection Agency, KS [E]
(Alt. to J. C. Belke)
Carlton S. Revere, Revere Gas & Appliance, Inc., VA [IM]
(Alt. to B. J. Swiecicki)
Steven D. Ruffcorn, Standby Systems, Inc., MN [M]
(Alt. to W. J. Young)
Russell T. Rupp, Suburban Propane Partners, FL [M]
(Alt. to S. E. McTier)
Eric C. Smith, Nevada LP-Gas Board, NV [E]
(Alt. to R. G. Fredenburg)
James H. Stannard, Jr., Stannard & Company, NJ [SE]
(Alt. to D. Barber)
Erich Wolf, Cavagna North America, OH [M]
(Alt. to S. T. Gentry)
Steven E. Younis, Prospective Technology, Inc., MA [SE]
(Alt. to P. K. Raj)
Robert A. Zeman, UL LLC, IL [RT]
(Voting Alt. to UL Rep.)

Nonvoting

Bernardo Bohorquez, Saena de Colombia S.A.,
Colombia [IM]

John A. Cedervall, Deerfield, IL
(Member Emeritus)

Matthew I. Chibbaro, U.S. Department of Labor, DC [E]

William R. Hamilton, U.S. Department of Labor, DC [E]

Al Linder, Watsonville, CA [SE]
(Member Emeritus)

Kenneth Lun, KL Consulting Engineers Ltd.,
China [SE]

Donald W. Switzer, U.S. Consumer Product Safety
Commission, MD [C]

Denise Beach, NFPA Staff Liaison

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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.

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

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex M. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1* Scope. This code shall apply to the storage, handling, transportation, and use of liquefied petroleum gas (LP-Gas).

1.2 Purpose. (Reserved)

1.3 Application.

1.3.1 Application of Code. 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, except for marine terminals associated with refineries, petrochemicals, gas plants, and 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 (DOT) 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.

1.3.2 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 at utility gas plants (including refrigerated storage) (see NFPA 59, *Utility LP-Gas Plant Code*)
- (4)*Chemical plants where specific approval of construction and installation plans is obtained from the authority having jurisdiction
- (5)*LP-Gas used with oxygen
- (6)*The portions of LP-Gas systems covered by NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*, where NFPA 54 (ANSI Z223.1) is adopted, used, or enforced
- (7) Transportation by air (including use in hot air balloons), rail, or water under the jurisdiction of the DOT
- (8)*Marine fire protection
- (9) Refrigeration cycle equipment and LP-Gas used as a refrigerant in a closed cycle
- (10) The manufacturing requirements for recreational vehicle LP-Gas systems that are addressed by NFPA 1192, *Standard on Recreational Vehicles*
- (11) Propane vehicle fuel dispensers located at multiple fuel refueling stations (see NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*)

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 it was issued.

1.4.1 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.

1.4.2 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.

1.4.3 Where the application of the retroactivity requirements of this code are determined to be impractical in the judgment of the authority having jurisdiction, alternate requirements that provide a reasonable degree of safety shall be provided by the authority having jurisdiction.

1.5 Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code.

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

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

1.6 Units and Formulas. (Reserved)

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

Chapter 2 Referenced Publications

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

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2012 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2012 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2012 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.

NFPA 54, *National Fuel Gas Code*, 2012 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2013 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2012 edition.

NFPA 70®, *National Electrical Code*®, 2014 edition.

NFPA 99, *Health Care Facilities Code*, 2012 edition.

NFPA 101®, *Life Safety Code*®, 2012 edition.

NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, 2011 edition.

NFPA 220, *Standard on Types of Building Construction*, 2012 edition.

- NFPA 1192, *Standard on Recreational Vehicles*, 2011 edition.

2.3 Other Publications.

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

API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, Pre-July 1, 1961.

API Standard 607, *Fire Test for Quarter-Turn Valves and Valves Equipped with Non-Metallic Seats*, 2010.

API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 2008 with 2009, 2010, and 2012 Addenda.

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

ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, 2010.

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

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ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, 2009.

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ANSI/UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*, 2005, Revised 2009.

ANSI/UL 147B, *Standard for Nonrefillable (Disposable) Type Metal Container Assemblies for Butane*, 2005, Revised 2008.

ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, 2011.

ANSI/UL 514B, *Standard for Conduit, Tubing, and Cable Fittings*, 2004, Revised 2009.

ANSI/UL 567, *Standard for Emergency Breakaway Fittings, Swivel Connectors, and Pipe-Connection Fittings for Petroleum Products and LP-Gas*, 2003, Revised 2011.

ANSI/UL 569, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas*, 1995, Revised 2009.

ANSI/UL 651, *Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings*, 2011, Revised 2012.

ANSI/UL 1660, *Standard for Liquid-Tight Flexible Nonmetallic Conduit*, 2004, Revised 2008.

ANSI/UL 1769, *Standard for Cylinder Valves*, 2006, Revised 2011.

ANSI/UL 2227, *Standard for Overfilling Prevention Devices*, 2007, Revised 2009.

2.3.9 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 49, Code of Federal Regulations, Parts 173.301(h)(3), 173.315(n), and 192.283(b).

Title 49, Code of Federal Regulations, Part 192.281(e), "Transportation." (Also available from the Association of American Railroads, American Railroads Bldg., 1920 L Street, N.W., Washington, DC 20036 and American Trucking Assns., Inc., 2201 Mill Road, Alexandria, VA 22314.)

Federal Motor Carrier Safety Regulations.

Interstate Commerce Commission (ICC) *Rules for Construction of Unfired Pressure Vessels*, U.S. Department of Transportation, Washington, DC.

2.3.10 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 54, *National Fuel Gas Code*, 2012 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

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

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

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

3.2.6 Shall. Indicates a mandatory requirement.

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

3.3 General Definitions.

3.3.1 Actuated Liquid Withdrawal Excess-Flow Valve. See 3.3.75.1.

3.3.2 Anodeless Riser. A transition assembly used between underground polyethylene or polyamide pipe and aboveground metal piping or equipment, and terminating aboveground outside of a building.

3.3.3 ANSI. American National Standards Institute.

3.3.4 API. American Petroleum Institute.

3.3.5 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.

3.3.6 ASME. American Society of Mechanical Engineers.

3.3.7 ASME Code. The American Society of Mechanical Engineers *Boiler and Pressure Vessel Code*.

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

3.3.9 ASTM. American Society for Testing and Materials.

3.3.10* Bulk Plant. A facility that stores LP-Gas in containers of more than 4000 gal (15.2 m³) water capacity prior to further distribution as a liquid for use at other facilities.

3.3.11 Cargo Tank. A container that is used to transport LP-Gas as liquid cargo that either is mounted on a conventional truck chassis or is an integral part of a cargo transporting vehicle.

3.3.12 CGA. The Compressed Gas Association.

3.3.13 Concrete Pad. A foundation consisting of solid concrete or masonry blocks, a placed concrete slab, or a poured concrete foundation.

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

3.3.15 Container Appurtenances. Devices installed in container openings for safety, control, or operating purposes.

3.3.16 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.

3.3.17 Cylinder. A container designed, constructed, tested, and marked in accordance with U.S. Department of Transportation specifications, Title 49, Code of Federal Regulations, or in accordance with a valid DOT special permit.

3.3.17.1 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.

3.3.18 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.

3.3.19 Design Pressure. The maximum pressure at which the equipment or system is designed to operate.

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

3.3.21 DOT. U.S. Department of Transportation.

3.3.22 Facility Hose. A hose and its couplings permanently installed for the purpose of unloading product from cargo tank motor vehicles in nonmetered service into a bulk plant or industrial plant.

3.3.23 Filling.

3.3.23.1 Volumetric Method Filling. Filling a container to not more than the maximum permitted liquid volume.

3.3.23.2 Weight Method Filling. Filling containers to not more than the maximum permitted filling limit by weighing the LP-Gas in the container.

3.3.24* Fire Protection. Includes fire prevention, fire detection, and fire suppression.

3.3.25 Flexible Connector. A short [not exceeding 60 in. (1.52 m) overall length] fixed piping system component that is fabricated from a flexible material and equipped with connections at both ends.

3.3.25.1 Flexible Hose Connector. A component fabricated from LP-Gas hose that is made from a material that is compatible with LP-Gas.

3.3.25.2 Flexible Metallic Connector. A component fabricated from metallic material that provides liquid and vapor LP-Gas confinement and is provided with connections on both ends.

3.3.25.3 Metallic-Protected Flexible Hose Connector. A flexible hose connector that is provided with a metallic material over wrap that provides mechanical protection of the inner hose but does not provide fluid confinement.

3.3.26 Gallon, U.S. Standard. 1 U.S. gal = 0.833 Imperial gal = 231 in.³ = 3.785 L.

3.3.27* Gas. For the purposes of this code, liquefied petroleum gas (LP-Gas) in either the liquid or vapor state.

3.3.28* 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.

3.3.29 Gauge.

3.3.29.1 Fixed Liquid Level Gauge. A liquid level indicator that uses a positive shutoff vent valve to indicate that the liquid level in a container being filled has reached the point at which the indicator communicates with the liquid level in the container.

3.3.29.2 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.

3.3.29.3 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.

3.3.29.4 Magnetic Gauge. See 3.3.29.3, Float Gauge.

3.3.29.5 Rotary Gauge. A type of variable liquid level gauge that indicates the liquid level on a dial gauge installed on an ASME container by manually rotating an open ended tube inside the container, which is connected to a positive shutoff vent valve.

3.3.29.6* Slip Tube Gauge. A variable liquid level gauge in which a small positive shutoff valve is located at the outside end of a straight tube that is installed vertically within a container.

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



3.3.30 GPA. Gas Processors Association.

3.3.31 ICC. U.S. Interstate Commerce Commission.

3.3.32 Ignition Source. See 3.3.69, Sources of Ignition.

3.3.33 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.

3.3.34* Industrial Plant. A facility that stores LP-Gas in containers of water capacity more than 4000 gal (15.2 m³) for use at the facility or to distribute vapor to other facilities.

3.3.35 kPa. Absolute pressure in kilo-Pascals.

3.3.36 kPag. Gauge pressure in kilo-Pascals.

3.3.37 Leak Check. An operation performed on a gas piping system to verify that the system does not leak. [54, 2012]

3.3.38* 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 (except propylene) or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes.

3.3.39* Low Emission Transfer. Establishes a maximum fugitive emissions standard for certain product transfer operations.

3.3.40 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.

3.3.41 Maximum Allowable Working Pressure (MAWP). The maximum pressure at which a pressure vessel is to operate as described by the ASME *Code*.

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

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

3.3.44* Movable Fuel Storage Tender. A container equipped with wheels (including a farm cart) not in excess of 1200 gal (4.5 m³) water capacity that is moved from one location to another.

3.3.45 MPa. Absolute pressure in mega-Pascals.

3.3.46 MPag. Gauge pressure in mega-Pascals.

3.3.47 NFPA. National Fire Protection Association.

3.3.48 NPGA. National Propane Gas Association.

3.3.49 Overfilling Prevention Device (OPD). 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.

3.3.50 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.

3.3.51 Permanent Installation. See 3.3.72, Stationary Installation.

3.3.52 Permitted. Allowed or acceptable, and not requiring a permit (a document granting permission) to be secured.

3.3.53 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.

3.3.54 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.

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

3.3.56* Portable Storage Container. A container that is designed and constructed to be moved over a highway from one usage location to another.

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

3.3.58 Pressure Relief Device. A device designed to open to prevent a rise of internal pressure in excess of a specified value.

3.3.59 Pressure Test. An operation performed to verify the gastight integrity of gas piping following its installation or modification. [54, 2012]

3.3.60 psi. Pounds per square inch.

3.3.61 psia. Pounds per square inch absolute.

3.3.62 psig. Pounds per square inch gauge.

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

3.3.64* Refrigerated LP-Gas. LP-Gas that is cooled to temperatures below ambient to maintain the product as a liquid with a vapor pressure of 15 psig (103 kPag) or less.

3.3.65 Regulator.

3.3.65.1* 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.

3.3.65.2 First-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce pressure from a container to 10 psig (69 kPag) or less.

3.3.65.3 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).

3.3.65.4 Integral 2 psi Service Regulator. A pressure regulator for LP-Gas vapor service that combines a high-pressure regulator and a 2 psi (14 kPag) service regulator into a single unit.

3.3.65.5 Integral Two-Stage Regulator. A pressure regulator for LP-Gas vapor service that combines a high-pressure regulator and a second-stage regulator into a single unit.

3.3.65.6 Line Pressure Regulator. A pressure regulator in accordance with ANSI Z21.80/CSA 6.22, *Standard for Line Pressure Regulators*, with no integral overpressure protection device for LP-Gas vapor service designed for installation inside a building to reduce a nominal 2 psig (14 kPag) inlet pressure to 14 in. w.c. (4.0 kPa) or less.

3.3.65.7 Second-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to the pressure required at the point of delivery.

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

3.3.65.9 2 psi Regulator System. An LP-Gas vapor delivery system that combines a first-stage regulator, a 2 psi (14 kPag) service regulator, and a line pressure regulator(s).

3.3.65.10 2 psi Service Regulator. A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to a nominal 2 psig (14 kPag).

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

3.3.66 SCFM. Standard cubic feet per minute.

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

3.3.68 Skid Tank. See 3.3.57, Portable Tank.

3.3.69 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.

3.3.70* 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.

3.3.71 Standard Cubic Foot (SCF). The volume of gas in cubic feet at the standard atmospheric conditions at 60°F (15.6°C) and 14.7 psia (101 kPa).

3.3.72 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.

3.3.73 Tank Heater (Indirect and Direct Types). A device used to apply heat either directly to a portion of the container surface in contact with LP-Gas liquid or indirectly by circulating LP-Gas liquid from the container to the device and then back to the container.

3.3.73.1 Direct Gas-Fired Tank Heater. A gas-fired device that applies heat directly to the container surface in contact with LP-Gas liquid.

3.3.74 UL. Underwriters Laboratories Inc.

3.3.75 Valve.

3.3.75.1 Actuated Liquid Withdrawal Excess-Flow Valve. A container valve that is opened and closed by an adapter, incorporates an internal excess flow valve, and is used to withdraw liquid from the container.

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

3.3.75.3 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.

3.3.75.4 Filler Valve. A valve that is designed to allow liquid flow into a container.

3.3.75.5 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.

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

3.3.75.7 Positive Shutoff Valve. A shutoff valve that, in the closed position, does not allow the flow of product in either direction.

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

3.3.75.8.1* External Pressure Relief Valve. A pressure relief valve where all the working parts are located entirely outside the container or piping.

3.3.75.8.2* 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.

3.3.75.8.3* Full Internal Pressure Relief Valve. A pressure relief valve in which all working parts are recessed within a threaded connection of the valve, and the spring and guiding mechanism are not exposed to the atmosphere.

3.3.75.8.4* Internal Spring-Type Pressure Relief Valve. A pressure relief valve that is similar to a full internal relief valve except the wrenching pads and seating section are above the container connection in which the adjusting spring and the stem are below the seat and are not exposed to the atmosphere.

3.3.76 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.

3.3.76.1 Direct-Fired Vaporizer. A vaporizer in which heat furnished by a flame is directly applied to a heat exchange surface in contact with the liquid LP-Gas to be vaporized.

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

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



3.3.76.2.2 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.

3.3.76.3 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.

3.3.76.4 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.

3.3.77 Vaporizing Burner (Self-Vaporizing Liquid Burner). A burner that also vaporizes liquid LP-Gas prior to burning it.

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

3.3.79* Vehicular Barrier Protection (VBP). A system or method to provide physical protection for LP-Gas storage areas or installations from vehicular incursion.

3.3.80 Volumetric Loading. See 3.3.23.1, Volumetric Method Filling.

3.3.81 Water Capacity. The amount of water at 60°F (16°C) required to fill a container.

Chapter 4 General Requirements

4.1 Acceptance of Equipment and Systems.

4.1.1 Systems or components assembled to make up systems shall be approved as specified in Table 4.1.1.

Table 4.1.1 Containers

Containers Used	Water Capacity		Approval Applies to ...
	gal	m ³	
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 are permitted to be made by the use of approved components.

4.1.2 Where it is necessary to alter or repair such systems or assemblies, approved components shall be used.

4.1.3 Acceptance applies to the complete system or to the individual components of which it is comprised as specified in Table 4.1.1.

4.2 LP-Gas Odorization.

4.2.1* 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.

4.2.2 Odorization shall not be required if it is 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.

4.2.3* 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

4.3 Notification of Installations.

4.3.1 Stationary Installations. Plans for stationary installations utilizing storage containers with aggregate water capacity exceeding 4000 gal (15.2 m³) and all rooftop installations of ASME containers shall be submitted to the authority having jurisdiction before the installation is started by the person or company that either installs or contracts to have the containers installed. [See also 6.20.11.1(F).]

4.3.2 Temporary Installations.

4.3.2.1 The authority having jurisdiction shall be notified of temporary installations of the container sizes covered in 4.3.1 before the installation is started.

4.3.2.2 Where temporary installations exceed 12 months, approval shall be obtained.

4.3.3 Railcar to Cargo Tank Transfer.

4.3.3.1 Notification of intent for transfer of LP-Gas directly from railcar to cargo tank shall be submitted to the authority having jurisdiction before the first transfer.

4.3.3.2 The authority having jurisdiction shall have the authority to require inspection of the site or equipment for such transfer prior to the initial transfer.

4.4* Qualification of Personnel.

4.4.1 Persons whose duties fall within the scope of this code shall be provided with training that is consistent with the scope of their job activities and that includes proper handling and emergency response procedures.

4.4.2 Persons whose primary duties include transporting LP-Gas, transferring liquid LP-Gas into or out of stationary containers, or making stationary installations shall complete training that includes the following components:

- (1) Safe work practices
- (2) The health and safety hazards of LP-Gas
- (3) Emergency response procedures
- (4) Supervised, on-the-job training
- (5) An assessment of the person's ability to perform the job duties assigned

4.4.3* Refresher training shall be provided at least every 3 years.

4.4.4 Initial and subsequent refresher training shall be documented.

4.5* Ammonia Contamination.

4.5.1 LP-Gas stored or used in systems within the scope of this code shall contain less ammonia than is required to turn the color of red litmus paper to blue.

4.5.2 A test for ammonia shall be performed on the LP-Gas prior to the initial use or transfer of LP-Gas from a transportation or storage system that has been converted from ammonia service.

4.6* Minimum Requirements. For any purpose or application addressed within the scope of this code, where the minimum requirements of the code are met, additional features or components of equipment not prohibited by the code shall be permitted to be used.

Chapter 5 LP-Gas Equipment and Appliances

5.1* Scope. This chapter applies to individual components and components shop-fabricated into subassemblies, container assemblies, and complete container systems.

5.2 Containers.

5.2.1 General.

5.2.1.1* 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 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.

(A) Used containers constructed to specifications of the Association of American Railroads shall not be installed.

(B) 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.

(C) Where containers fabricated to earlier editions of regulations, rules, or codes listed in 5.2.1.1, and of the Interstate Commerce Commission (ICC) *Rules for Construction of Unfired Pressure Vessels*, prior to April 1, 1967, are used, the requirements of Section 1.4 shall apply.

5.2.1.2 Containers that have been involved in a fire and show no distortion shall be requalified for continued service before being used or reinstalled.

(A) Cylinders shall be requalified by a manufacturer of that type of cylinder or by a repair facility approved by DOT.

(B) ASME or API-ASME containers shall be retested using the hydrostatic test procedure applicable at the time of the original fabrication.

(C) All container appurtenances shall be replaced.

(D) DOT 4E specification (aluminum) cylinders and composite cylinders involved in a fire shall be permanently removed from service.

5.2.1.3 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 5.2, Table 5.2.4.2 and Table 5.7.2.5(A), and Annex D.]

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

5.2.1.5 Except for containers used in cargo tank vehicle service, ASME containers of 3000 gal (11.4 m³) water capacity or less used to store anhydrous ammonia shall not be converted to LP-Gas fuel service.

5.2.1.6 Repairs or alteration of a container shall comply with the regulations, rules, or code under which the container was fabricated. Repairs or alteration to ASME containers shall be in accordance with the ANSI/NB23 *National Board Inspection Code*.

5.2.1.7 Field welding shall be permitted only on saddle plates, lugs, pads, or brackets that are attached to the container by the container manufacturer.

5.2.1.8 Containers for general use shall not have individual water capacities greater than 120,000 gal (454 m³).

5.2.1.9 Containers in dispensing stations not located in LP-Gas bulk plants or industrial plants shall have an aggregate water capacity not greater than 30,000 gal (114 m³).

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

5.2.1.11 ASME containers installed underground, partially underground, or as mounded installations shall incorporate provisions for cathodic protection and shall be coated with a material recommended for the service that is applied in accordance with the coating manufacturer's instructions.

5.2.2 Cylinders.

5.2.2.1* Cylinders shall be continued in service and transported in accordance with DOT regulations.



5.2.2.2 A cylinder with an expired requalification date shall not be refilled until it is requalified by the methods prescribed in DOT regulations.

5.2.3 Cylinders Filled on Site at the Point of Use.

5.2.3.1 DOT cylinders in stationary service that are filled on site at the point of use and, therefore, are not under the jurisdiction of DOT shall comply with one of the following criteria:

- (1) They shall be requalified in accordance with DOT requirements.
- (2) They shall be visually inspected within 12 years of the date of manufacture and within every 5 years thereafter, in accordance with 5.2.3.2 through 5.2.3.4.

5.2.3.2 Any cylinder that fails one or more of the criteria in 5.2.3.4 shall not be refilled or continued in service until the condition is corrected.

5.2.3.3 Personnel shall be trained and qualified to perform inspections. Training shall be documented in accordance with Section 4.4.

5.2.3.4 Visual inspection shall be performed in accordance with the following:

- (1) The cylinder is checked for exposure to fire, dents, cuts, digs, gouges, and corrosion according to CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, except that 5.2.1.1(1) of that standard (which requires tare weight verification) shall not be part of the required inspection criteria.
- (2) The cylinder protective collar (where utilized) and the foot ring are intact and are firmly attached.
- (3) The cylinder is painted or coated to minimize corrosion.
- (4) The cylinder pressure relief valve indicates no visible damage, corrosion of operating components, or obstructions.
- (5) There is no leakage from the cylinder or its appurtenances that is detectable without the use of instruments.
- (6) The cylinder is installed on a firm foundation and is not in contact with the soil.
- (7) A cylinder that passes the visual examination is marked with the month and year of the examination followed by

the letter E (e.g., "10-01E," indicating requalification in October 2001 by the external inspection method).

- (8) The results of the visual inspection are documented, and a record of the inspection is retained for a 5-year period.

5.2.4 Container Service Pressure.

5.2.4.1 The service pressure of cylinders shall be in accordance with the regulations published under 49 CFR, "Transportation."

5.2.4.2 The maximum allowable working pressure (MAWP) for ASME containers shall be in accordance with Table 5.2.4.2.

5.2.4.3 In addition to the applicable provisions for horizontal ASME containers, vertical ASME containers over 125 gal (0.5 m³) water capacity shall comply with 5.2.4.3(A) through 5.2.4.3(E).

(A) Containers shall be designed to be self-supporting without the use of guy wires and shall be designed to withstand the wind, seismic (earthquake) forces, and hydrostatic test loads anticipated at the site.

(B) The MAWP (*see Table 5.2.4.2*) 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 in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. 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 other means to lift the container.

5.2.4.4 ASME engine fuel containers shall have a MAWP of 312 psig (2.2 MPag).

Table 5.2.4.2 Maximum Vapor Pressure and Maximum Allowable Working Pressure (MAWP)

Maximum Vapor Pressure		MAWP					
		Current ASME Code ^a		Earlier Codes			
				API-ASME		ASME ^b	
At 100°F (psig)	At 37.8°C (MPag)	psig	MPag	psig	MPag	psig	MPag
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 ^c	250	1.7 ^c	200	1.4
215	1.5	312	2.2 ^c	312	2.2 ^c	—	—

Note: See Annex D for information on earlier ASME or API-ASME codes.

^aASME Code, 1949 edition, paragraphs U-200 and U-201, and all later editions. (*See D.2.1.5.*)

^bAll ASME codes up to the 1946 edition and paragraphs U-68 and U-69 of the 1949 edition. (*See D.2.1.5.*)

^cSee 5.2.4.4 and 5.2.4.5 for required MAWP for ASME engine fuel and mobile containers.

5.2.4.5* ASME mobile containers shall be in accordance with one of the following:

- (1) A MAWP of 312 psig (2.2 MPag) or higher where installed in enclosed spaces of vehicles
- (2) A MAWP of 312 psig (2.2 MPag) where installed outside of passenger vehicles
- (3) A MAWP of 250 psig (1.7 MPag) where installed outside of nonpassenger vehicles

5.2.4.6 Cylinders shall be designed and constructed for at least a 240 psig (1.6 MPag) service pressure.

5.2.5 ASME Container Openings.

5.2.5.1 ASME containers shall be equipped with openings for the service for which the container is to be used.

5.2.5.2 The openings required by 5.2.5.1 shall be located either in the shell, in the heads, or in a manhole cover.

5.2.5.3* ASME containers of more than 30 gal through 2000 gal (0.1 m³ through 7.6 m³) water capacity that are designed to be filled volumetrically shall be equipped for filling into the vapor space.

5.2.5.4* ASME containers of 126 gal through 4000 gal (0.5 m³ through 15.2 m³) water capacity in other than bulk plant and industrial occupancies shall be provided with an opening for an actuated liquid withdrawal excess-flow valve with a connection not smaller than ¾ in. (19 mm) national pipe thread (NPT).

5.2.5.5* ASME containers of more than 4000 gal (15.2 m³) water capacity shall have an opening for a pressure gauge.

5.2.5.6 ASME containers in storage or use shall have pressure relief valve connections that have direct communication with the vapor space of the container.

(A) If the pressure relief valve is located in a well inside the ASME container with piping to the vapor space, the design of the well and piping shall have a flow capacity equal to or greater than that of the pressure relief valve.

(B) An enclosure that protects a pressure relief valve shall be painted, coated, or made from corrosion-resistant materials.

(C) The design of an enclosure that protects a pressure relief valve shall permit inspection of the pressure relief valve.

(D) If the pressure relief valve is 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.

5.2.5.7* ASME containers to be filled on a volumetric basis 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 7.4.2.3.

5.2.6 Portable Container Appurtenance Physical Damage Protection.

5.2.6.1 Cylinders shall incorporate protection against physical damage to cylinder appurtenances and immediate connections to such appurtenances when not in use by any of the following means:

- (1) A ventilated cap
- (2) A ventilated collar
- (3) A cylinder valve providing inherent protection as defined by DOT in 49 CFR 173.301(h)(3)

5.2.6.2 Protection of appurtenances of portable containers, skid tanks, and tanks for use as cargo tanks of more than 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) propane capacity] shall comply with 5.2.6.2(A) through 5.2.6.2(C).

(A) Appurtenance protection from physical damage shall be provided by recessing, by protective housings, or by location on the vehicle.

(B) Appurtenance protection shall comply with the provisions under which the containers are fabricated.

(C) Appurtenance protection shall be secured to the container in accordance with the ASME code under which the container was designed and built.

5.2.7 Containers with Attached Supports.

5.2.7.1 Vertical ASME containers of over 125 gal (0.5 m³) water capacity for use in permanent installations in stationary service shall be designed with steel supports that allow the container to be mounted on and fastened to concrete foundations or supports.

(A) 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.

(B) Steel supports shall be protected against fire exposure with a material having a fire resistance rating of at least 2 hours.

(C) Continuous steel skirts having only one opening of 18 in. (460 mm) or less in diameter shall have 2-hour fire protection applied to the outside of the skirt.

5.2.7.2 ASME containers to be used as portable storage containers, including movable fuel storage tenders for temporary stationary service (normally not more than 12 months duration at any location), shall comply with 5.2.7.2(A) through 5.2.7.2(D).

(A) The legs or supports, or the lugs for the attachment of legs or supports, shall be secured to the container in accordance with the ASME code under which the container was designed and built.

(B) The attachment of a container to either a trailer or semi-trailer running gear, or the attachments to the container to make it a vehicle, so that the unit can be moved by a conventional over-the-road tractor, shall comply with the DOT requirements for cargo tank service.

(C) The unit specified in 5.2.7.2(B) shall be approved for stationary use.

(D) Movable fuel storage tenders shall be secured to the trailer support structure for the service involved.

5.2.7.3 Portable tank design and construction of a full framework, 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 not less than 2 in. (51 mm) or more than 12 in. (300 mm) below the outside bottom of the tank shell.

5.2.8 Container Marking.

5.2.8.1 Cylinders shall be marked as provided in the regulations, rules, or code under which they are fabricated.

(A) 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," "Propane," or "Butane," or shall be marked in accordance with the requirements of 49 CFR, "Transportation."



(B) When being transported, cylinders shall be marked and labeled in accordance with 49 CFR, "Transportation."

5.2.8.2* Cylinders shall be marked with the following information:

- (1) Water capacity of the cylinder in pounds
- (2) Tare weight of the cylinder in pounds, fitted for service

5.2.8.3* 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.

(A) 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.

(B) 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.

(C) Stationary ASME containers shall be marked with the following information:

- (1) Service for which the container is designed (e.g., 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) MAWP in pounds per square inch
- (5) Wording that reads "This container shall not contain a product that has a vapor pressure in excess of ____ psig at 100°F" (see Table 5.2.4.2)
- (6) Outside surface area in square feet
- (7) Year of manufacture
- (8) Shell thickness and head thickness
- (9) OL (overall length), OD (outside diameter), and HD (head design)
- (10) Manufacturer's serial number
- (11) ASME Code symbol
- (12) Minimum design metal temperature ____°F at MAWP ____ psi
- (13) Type of construction "W"
- (14) Degree of radiography "RT-____"

(D) In addition to the markings required by this code, nameplates on cargo tanks shall include the markings required by the ASME Code and the DOT.

5.2.8.4 Warning labels shall meet the following requirements:

- (1) Warning labels shall be applied to all cylinders of 100 lb (45.4 kg) propane capacity or less that are not filled on-site.
- (2) Warning labels shall include information on the potential hazards of LP-Gas.

5.2.8.5 All containers that contain unodorized LP-Gas products shall be marked "NOT ODORIZED".

(A) The marking shall have a contrasting background surrounded by a rectangular border in red letters and red border in the sizes shown in Table 5.2.8.5(A).

(B) The markings shall be on both ends or on both sides of a container or on both sides and the rear of cargo tanks.

5.3 Reserved.

5.4 Reserved.

Table 5.2.8.5(A) "NOT ODORIZED" Label Size

Water Capacity		Letter Height		Border Width	
gal	m ³	in.	cm	in.	cm
≥499	≥1.89	4	10.0	½	1.3
49–498	0.19–1.88	1½	3.7	⅝	0.8
2.6–48	0.01–0.18	¾	1.8	¼	0.6
1–2.5	0.004–0.009	⅜	1.0	⅛	0.2

5.5 Reserved.

5.6 Reserved.

5.7 Container Appurtenances and Regulators.

5.7.1 Materials.

5.7.1.1 Container appurtenances and regulators shall be fabricated of materials that are compatible with LP-Gas and shall be resistant to the action of LP-Gas under service conditions.

(A) The following materials shall not be used:

- (1) Gray cast-iron
- (2) Nonmetallic materials, for bonnets or bodies of valves or regulators

5.7.1.2* Pressure-containing metal parts of appurtenances shall have a minimum melting point of 1500°F (816°C), except for the following:

- (1) Fusible elements
- (2) Approved or listed variable liquid level gauges used in containers of 3500 gal (13.2 m³) water capacity or less

5.7.1.3 Container appurtenances shall have a service pressure of at least 250 psig (1.7 MPag).

5.7.1.4 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas.

(A) Gaskets shall be made of metal or other material confined in metal having a melting point over 1500°F (816°C) or shall be protected against fire exposure.

(B) When a flange is opened, the gasket shall be replaced.

(C) Aluminum O-rings and spiral-wound metal gaskets shall be permitted.

(D) Gaskets for use with approved or listed liquid level gauges for installation on a container of 3500 gal (13.2 m³) water capacity or less shall be exempt from the minimum melting point requirement.

5.7.2 Pressure Relief Devices. See Section 5.13 for hydrostatic relief valves.

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

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

5.7.2.2.1 The rated flow capacity of the pressure relief valve (CG-7) shall meet the requirements for a liquefied gas as defined in CGA S-1.1, *Pressure Relief Device Standards, Part 1 — Cylinders for Compressed Gases*.

5.7.2.3 Cylinders shall not be solely equipped with C-2 or CG-3 fusible plugs as defined in CGAS-1.1, *Pressure Relief Device Standards, Part 1 — Cylinders for Compressed Gases*.

5.7.2.3.1 A composite cylinder shall be permitted to be equipped with a combination device containing a pressure relief valve (CG-7) with 212°F (100°C) fuse metal (CG-3).

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

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

(A) The start-to-leak setting of the pressure relief valves specified in 5.7.2.5, in relation to the pressure rating of the container, shall be in accordance with Table 5.7.2.5(A).

Table 5.7.2.5(A) Start-to-Leak Pressure Settings of Pressure Relief Valves in Relation to Container Pressure Rating

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

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

(B) Containers of 40,000 gal (151 m³) or more water capacity shall be equipped with either a spring-loaded pressure relief valve or a pilot-operated pressure relief valve, as follows:

- (1) The pilot-operated relief valve shall be combined with, and controlled by, a self-actuated, direct, spring-loaded pilot valve that complies with Table 5.7.2.5(A).
- (2) The use of a pilot-operated pressure relief valve shall be approved.
- (3) Pilot-operated pressure relief valves shall be inspected and maintained by persons with training and experience and shall be tested for operation at intervals not exceeding 5 years.

5.7.2.6 The minimum rate of discharge of pressure relief valves installed in ASME containers shall be in accordance with Table 5.7.2.6 or shall be calculated using the following formula:

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

where:

F = flow rate (SCFM air)

A = total outside surface area of container (ft²)

5.7.2.7 Relief valves for aboveground ASME containers shall relieve at not less than the flow rate specified in 5.7.2.6 before the pressure exceeds 120 percent of the minimum permitted start-to-

Table 5.7.2.6 Pressure Relief Valve Flow Capacity as Function of Container Surface Area

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

For SI units, 1 ft² = 0.0929 m²; 1 SCFM = 0.0283 m³/min.

Note: Flow rate in SCFM air.

leak pressure setting of the device, excluding the 10 percent tolerance in Table 5.7.2.5(A).

5.7.2.8 The flow capacity of pressure relief valves installed on underground or mounded containers shall be a minimum of 30 percent of the flow specified in Table 5.7.2.6.

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

- (1) Pressure in psig (MPa) at which the valve is set to start-to-leak
- (2) Rated relieving capacity in SCFM (m³/min) air
- (3) Manufacturer's name and catalog number

5.7.2.10 Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold meeting the requirements of 6.7.2.9 is used.

5.7.2.11 Pressure relief valves shall be designed to minimize the possibility of tampering.

5.7.2.12 Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment.



5.7.2.13 Where used on aboveground ASME containers of 1200 gal (4.5 m³) or less water capacity in addition to spring-loaded pressure relief valves, fusible plugs shall meet the following criteria:

- (1) They shall have a yield point between 208°F and 220°F (98°C and 104°C).
- (2) They shall have a total discharge area not exceeding 0.25 in.² (1.6 cm²).
- (3) They shall communicate directly with the vapor space of the container.

5.7.2.14 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 cylinder and every 10 years thereafter.

5.7.3 Overfilling Prevention Devices.

5.7.3.1 Cylinders with 4 lb through 40 lb (1.8 kg through 18 kg) propane capacity for vapor service shall be equipped or fitted with a listed overfilling prevention device that complies with ANSI/UL 2227, *Standard for Overfilling Prevention Devices*, and a fixed maximum liquid level gauge. These devices shall be either separate components or combined in the container valve assembly.

5.7.3.2* Cylinders requalified after September 30, 1998, shall be equipped with a listed overfilling prevention device and a fixed maximum liquid level gauge, sized in accordance with 7.4.3.2(A) or Table 5.7.3.2, prior to being filled.

Table 5.7.3.2 Recommended Dip Tube Lengths for Various Cylinders

Propane Cylinder Size (lb)	Material	Cylinder I.D. (in.)	Cylinder Water Capacity (lb)	Dip Tube Lengths for Various Cylinders (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

For SI units, 1 lb = 0.454 kg; 1 in. = 25 mm.

Note: 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. If the dip tube length that is marked on the cylinder does not appear in Table 5.7.3.2, the next longer dip tube shown in the table should be used.

5.7.3.3 Cylinders required to have an overfilling prevention device (OPD) shall not be filled unless they are equipped with this device and a fixed maximum liquid level gauge. The length of the fixed maximum liquid level gauge dip tube shall be in accordance with 7.4.3.2(A) or Table 5.7.3.2.

5.7.3.4 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 V-1, *Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

5.7.3.5 The following types of cylinders shall be exempt from the requirements of 5.7.3.1 through 5.7.3.4 for installing a listed overfilling prevention device:

- (1) Cylinders used in industrial truck service and cylinders identified and used for industrial welding and cutting gases
- (2) Cylinders manufactured prior to October 1, 1998, and designed for use in the horizontal position and where an overfilling prevention device is not available

5.7.3.6 Exempted horizontal cylinders shall be marked with a label to indicate that they are not equipped with an overfilling prevention device.

5.7.4 Container Valves and Other Appurtenances.

5.7.4.1 Containers of 4000 gal (15.2 m³) water capacity or less shall comply with 5.7.4.1(A) through 5.7.4.1(D).

(A) Underground containers and containers originally equipped with external pressure relief valves shall be permitted to have external pressure relief valves.

(B) ASME containers having a propane capacity not greater than 100 gal (0.45 m³) shall be permitted to have an external pressure relief valve. The external pressure relief valve shall be permitted to be part of a multiple-function valve.

(C) Containers of 2001 gal through 4000 gal (7.6 m³ through 15.2 m³) water capacity in bulk plant and industrial plant service shall be fitted with valves and other appurtenances in accordance with 5.7.4.2.

(D) Containers in other than bulk plant or industrial plant service shall be fitted with valves and other appurtenances in accordance with Table 5.7.4.1(D) and the following:

- (1) Shutoff, filler, check, and excess-flow valves for ASME containers shall comply with ANSI/UL 125, *Standard for Flow Control Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief)*.
- (2) Shutoff valves used on DOT cylinders shall comply with ANSI/UL 1769, *Standard for Cylinder Valves*.
- (3) Containers of 125 gal through 4000 gal (0.5 m³ through 15.2 m³) water capacity shall be provided with an actuated liquid withdrawal excess-flow valve with a connection not smaller than ¾ in. NPT (19 mm), and the container connection shall not be smaller than ¾ in. NPT (19 mm).
- (4) An actuated liquid withdrawal excess-flow valve shall not be required on container connections equipped for liquid withdrawal with 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 connection.
- (5) The actuated liquid withdrawal excess-flow valve shall not be connected for continuous use unless the valve is recommended by the manufacturer for such service.

Table 5.7.4.1(D) Container Connection and Appurtenance Requirements for Containers Used in Other Than Bulk Plants and Industrial Plants

Part	Appurtenance	1	2	3
		Cylinders 2 lb Through 420 lb Propane Capacity	Stationary ASME Containers ≤4000 gal Water Capacity ^a	DOT and ASME Engine Fuel and Mobile Containers
A	Vapor shutoff valve ^b	R (CGA 555 outlet prohibited)	R	R with internal excess-flow valve
B	Liquid shutoff valve ^b	R with CGA 555 outlet and internal excess-flow valve	R with internal excess flow valve	R with internal excess-flow valve
D	Pressure relief valve	R (See 5.7.2.2.)	R ^c [See 5.7.4.1(B).]	R with full internal or flush-type full internal pressure relief valve
E	Fixed maximum liquid level gauge	R (filled by volume) R (filled by weight, ≤40 lb and >100 lb) [See 5.7.4.1(D)(10).]	R	R
F	Overfilling prevention device	R (4 lb through 40 lb) (See 5.7.3.)	NR	R (ASME only) [See 5.7.4.1(D)(6).]
G	Actuated liquid withdrawal excess-flow valve	NR	R (≥125 gal) [See 5.7.4.1(D)(3), (4), and (5).]	NR
H	Float gauge	NR	R (>124 gal only)	NR
I	Filler valve [See 5.7.4.1(D)(7).]	R (for ≥100 lb cylinders that are filled on site at the point of use)	R	R (for ASME containers only)

For SI units, 1 lb = 0.454 kg; 1 gal = 0.0045 m³.

R: Required. NR: Not required.

^aAll ASME container capacities are water capacity.

^bWhere installed.

^cAboveground ASME containers, internal spring-type pressure relief valves only, except as stated in 5.7.4.1(A) and 5.7.4.1(B).

- (6) An overfilling prevention device shall not be required for engine fuel cylinders used on industrial (and fork-lift) trucks powered by LP-Gas or for engine fuel cylinders used on vehicles (including floor maintenance machines) having LP-Gas-powered engines mounted on them.

- (7) A filler valve shall incorporate one of the following:

- Double backflow check valves of the spring-loaded type
- Manual shutoff valve with an internal backflow check valve of the spring-loaded type
- Combination single backflow check valve of the spring-loaded type and an overfilling prevention device designed for containers

- (8) Manual shutoff valves in vapor service shall be equipped with one of the following:

- Orifice between the container contents and the shut-off valve outlet, not exceeding $\frac{5}{16}$ in. (8 mm) in diameter, and an approved regulator directly attached, or attached with a flexible connector, to the manual shut-off valve outlet
- Excess-flow valve

- (9) 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 5.7.3.)

- (10) Cylinders greater than 40 lb through 100 lb (18 kg through 45 kg) propane capacity filled by volume shall have a fixed maximum liquid level gauge.



- (11) Pressure relief valves installed in multiple function valves in single opening cylinders used in industrial truck service shall have the springs and guiding mechanism on the container pressure side of the seats, so that the springs and guiding mechanism shall not be exposed to the atmosphere.
- (12) Multiple function valves installed on single opening cylinders used in industrial truck service shall meet the following requirements:
- When required by 5.7.2.14, the multiple function valve in accordance with 5.7.2.14 shall have the pressure relief valve exchanged with a replacement multiple function valve that incorporates the pressure relief valve described in 5.7.4.1(D)(11).
 - The multiple function valve pressure relief valve shall be permitted to have the means to be replaced without removing the multiple function valve from the cylinder.
 - The multiple function valve shall incorporate an internal excess-flow valve for the liquid or vapor withdrawal service valve outlet.
 - The multiple function valve shall incorporate a weak section on the service valve outlet connection.
 - The multiple function valve shall incorporate an internal excess-flow valve that shall not restrict the flow to the pressure relief valve.
 - The multiple function valve shall be listed.
- 5.7.4.2** ASME containers greater than 4000 gal (15.2 m³) water capacity shall be fitted with valves and other appurtenances in accordance with 5.7.4.2(A) through 5.7.4.2(I) and Table 5.7.4.2.
- (A)** Vapor withdrawal openings shall be equipped with either of the following:
- A positive shutoff valve located as close to the container as practical in combination with an excess-flow valve installed in the container
 - An internal valve
- (B)** Liquid withdrawal openings in new installations shall be equipped with an internal valve that is fitted 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.

Table 5.7.4.2 Connection and Appurtenance Requirements for New and Existing Container Installations in Bulk Plants and Industrial Plants

Service	2001 gal through 4000 gal W.C.* (7.6 m ³ through 15.2 m ³)	Greater Than 4000 gal W.C.* (>15.2 m ³)	Requirements for Containers of Greater Than 4000 gal W.C. (>15.2 m ³) With and Without Internal Valves [†]	
			Without Existing Internal Valves (by 7/1/11)	With Existing Internal Valves
Vapor inlet	Option A, Option B, or Option C	Option A, Option B, or Option C	See Note	See Note
Vapor outlet	Option B or Option C	Option B or Option C	See Note	See Note
Liquid inlet	Option A, Option B, or Option C	Option D or Option E	Option D, Option E, Option F, or Option G	RT
Liquid outlet	Option B or Option C	Option E	Option E or Option H	RT

Option A: Positive shutoff valve installed as close as practical to a backflow check valve installed in the container.

Option B: Positive shutoff valve installed as close as practical to an excess-flow valve installed in the container and sized in accordance with 5.7.8.1(H).

Option C: Internal valve installed in the container or an excess-flow valve in accordance with 5.7.4.2(I).

Option D: Positive shutoff valve installed as close as practical to a backflow check valve designed for the intended application and installed in the container.

Option E: Internal valve installed in the container equipped for remote closure and automatic shutoff using thermal (fire) activation within 5 ft (1.5 m) of valve or an excess-flow valve in accordance with 5.7.4.2(I).

Option F: Emergency shutoff valve equipped for remote closure and automatic shutoff using thermal (fire) activation installed in the line upstream as close as practical to an existing positive shutoff valve/excess-flow valve combination.

Option G: Backflow check valve designed for the intended application and installed in the line upstream as close as practical to the existing positive shutoff valve/excess-flow valve combination.

Option H: Emergency shutoff valve equipped for remote closure and automatic shutoff using thermal (fire) activation, installed in the line downstream as close as practical to an existing positive shutoff valve/excess-flow valve combination.

RT: Equipping an existing internal valve for remote closure and automatic shutoff using thermal (fire) actuation within 5 ft (1.5 m) of the internal valve.

Note: Vapor connections on containers installed prior to the effective date of the 2001 edition of NFPA 58 are not required to be modified.

*Applicable to installations constructed on or after the effective date of this code.

[†]Applicable to installations constructed prior to the effective date of this code.

(C) Liquid withdrawal openings in existing installations where the container is equipped with an internal valve that is not fitted for remote closure and automatic shutoff using thermal (fire) actuation shall be equipped for remote and thermal closure by July 1, 2003.

(D) Liquid withdrawal openings in existing installations shall be equipped with either of the following by July 1, 2011:

- (1) An internal valve that is fitted 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
- (2) An emergency shutoff valve that is installed in the line downstream as close as practical to a positive shutoff valve in combination with an excess-flow valve installed in the container

(E) Vapor inlet openings shall be equipped with either of the following:

- (1) A positive shutoff valve that is located as close to the container as practical in combination with either a backflow check valve or an excess-flow valve installed in the container
- (2) An internal valve

(F) Liquid inlet openings in new installations shall be equipped with either of the following:

- (1) An internal valve that is fitted 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
- (2) A positive shutoff valve that is located as close to the container as practical in combination with a backflow check valve that is designed for the intended application and is installed in the container

(G) Liquid inlet openings in existing installations where the container is equipped with an internal valve that is not fitted for remote closure and automatic shutoff using thermal (fire) actuation shall be equipped for remote and thermal closure by July 1, 2003.

(H) Liquid inlet openings in existing installations shall be equipped with any of the following by July 1, 2011:

- (1) An internal valve that is fitted 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
- (2) An emergency shutoff valve that is installed in the line upstream as close as practical to a positive shutoff valve in combination with an excess-flow valve installed in the container
- (3) A positive shutoff valve that is located as close to the container as practical in combination with a backflow check valve that is designed for the intended application and is installed in the container
- (4) A backflow check valve that is designed for the intended application and is installed in the line upstream as close as practical to a positive shutoff valve in combination with an excess-flow valve installed in the container

(I) Container openings that are not compatible with internal valves shall be permitted to utilize both an excess-flow valve installed in the container and a valve complying with API Standard 607, *Fire Test for Quarter-Turn Valves and Valves Equipped with Non-Metallic Seats*, with the following features:

- (1) The valve shall be activated either hydraulically or pneumatically and shall fail in the closed position.

- (2) The valve shall be equipped for remote closure and thermal actuation with a thermal element located within 5 ft (1.5 m) of the valve.

5.7.4.3 ASME containers of 2001 gal through 4000 gal (7.6 m³ through 15.2 m³) water capacity used for bulk plants and industrial plants shall be fitted with valves and other appurtenances in accordance with Table 5.7.4.2.

5.7.4.4 ASME containers over 4000 gal (15.2 m³) water capacity shall also be equipped with the following appurtenances:

- (1) An internal spring-type, flush-type full internal pressure relief valve, or external pressure relief valve (*see Annex 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

5.7.4.5 The appurtenances specified in Table 5.7.4.1(D) and 5.7.4.3 shall comply with the following:

- (1) Manual shutoff valves shall be designed to provide positive closure under service conditions.
- (2) Excess-flow check valves shall be designed to close automatically at the rated flows of vapor or liquid specified by the manufacturer.
- (3) Excess-flow valves shall be designed with a bypass that shall not exceed a No. 60 drill size opening to allow equalization of pressure.
- (4) Excess-flow valves of less than ½ in. NPT (13 mm) shall have a bypass that limits propane vapor flow to 10 scf/hr at 100 psig (690 kPag).
- (5) Backflow check valves shall be of the spring-loaded or weight-loaded type with in-line or swing operation and shall close when the flow is either stopped or reversed.
- (6) Internal valves (*see 3.3.75.6, Internal Valve*), either manually or remotely operated and designed to remain closed except during operating periods, shall be considered positive shutoff valves.

5.7.5 Liquid Level Gauging Devices.

5.7.5.1 Liquid level gauging devices shall be installed on all containers filled by volume.

5.7.5.2 The gauging devices shall be either fixed maximum liquid level gauges or variable gauges of the slip tube, rotary, or float type (or combinations of such gauges).

5.7.5.3* Every container 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 filled or used. (*See 7.4.3.3.*)

5.7.5.4 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.

5.7.5.5 Cylinders shall have the letters DT stamped on them followed by the vertical distance (to the nearest tenth of an 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.

5.7.5.6 Cylinders equipped with a fixed maximum liquid level gauge where the dip tube is not welded to the inside of the cylinder shall be permanently marked adjacent to the gauge.



(A) Cylinders designed to be filled in one position shall be marked as follows:

- (1) The marking shall be the letters DT followed by the dip tube length to the nearest tenth of an inch.
- (2) The dip tube length shall be measured from the top center of the cylinder boss or coupling where the gauge is installed to the maximum permitted filling level.

(B) Universal cylinders, where the dip tube is not welded to the inside of the cylinder and that are permitted to be filled in either the vertical or horizontal position, shall be marked as follows:

- (1) Vertical filling: With the letters VDT followed by the vertical distance (to the nearest tenth of an inch), measured from the top center of the coupling where the gauge is installed to the maximum permitted filling level
- (2) Horizontal filling: With the letters HDT followed by the vertical distance (to the nearest tenth of an inch), measured from the centerline of the coupling opening into which the gauge is installed located at the maximum filling level in the horizontal position, to the inside top of the cylinder

5.7.5.7 Cargo tanks and ASME containers utilizing multiple fixed liquid level gauges shall have the loading percentage (to the nearest $\frac{1}{10}$ percent) stamped adjacent to each gauge.

5.7.5.8 Variable liquid level gauges shall comply with 5.7.5.8(A) through 5.7.5.8(D).

(A) Variable liquid level gauges installed on containers over 1200 gal (4.5 m³) water capacity shall be marked with the maximum liquid level, in inches, metric units, or percent of capacity of the container on which they are to be installed.

(B) If temperature correction markings are provided on variable liquid level gauges on containers greater than 1200 gal (4.5 m³) that will be used for volumetric filling as allowed by 7.4.3.2(A), 7.4.3.2(B), and 7.4.3.3, the markings shall indicate the maximum liquid level at liquid temperatures in accordance with Table 7.4.2.3(b) or Table 7.4.2.3(c). Temperature markings shall be from 20°F to 115°F (−6.7°C to 46°C), with increments not to exceed 20°F (11°C) for propane, for 50/50 butane–propane mixtures, and for butane.

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

(D) The dials of gauges for use only on aboveground containers of over 1200 gal (4.5 m³) water capacity shall be so marked.

5.7.5.9 Variable liquid level gauges shall comply with the provisions of 7.4.3.2(B) if they are used for filling containers.

5.7.5.10 Gauging devices that vent product to the atmosphere when used shall be designed so that the vent valve maximum opening to the atmosphere is not larger than a No. 54 drill size.

5.7.6 Pressure Gauges.

5.7.6.1 Pressure gauges shall be attached directly to the container opening or to a valve or fitting that is directly attached to the container opening.

5.7.6.2 If the cross-sectional area of the opening into the container described in 5.7.6.1 is greater than that of a No. 54 drill

size, an excess-flow check valve shall be provided for the container connection.

5.7.7 Other Container Connections.

5.7.7.1 Other container openings shall be equipped with any of the following:

- (1) Positive shutoff valve in combination with either an excess-flow check valve or a backflow check valve
- (2) Internal valve
- (3) Backflow check valve
- (4) Actuated liquid withdrawal excess-flow valve, normally closed and plugged, with provision to allow for external actuation
- (5) Plug, blind flange, or plugged companion flange

5.7.7.2 Any of the valves listed in 5.7.7.1(1), (2), or (3) that are not connected for service shall be plugged or capped.

5.7.8 Container Appurtenance Installation.

5.7.8.1 All container openings except those used for pressure relief devices, liquid level gauging devices, pressure gauges, filler valves, combination backflow check and excess-flow vapor return valves, actuated liquid withdrawal excess-flow valves, and plugged openings shall be equipped with internal valves or with positive shutoff valves and either excess-flow or backflow check valves.

(A) Valves in ASME containers, where excess-flow or backflow check valves are installed between the LP-Gas in the container and the shutoff valves, shall be installed either inside the container or at a point immediately outside where the line enters or leaves the container.

(B) If excess-flow and backflow check valves are installed outside the container, installation shall be made so that any strain beyond the excess-flow or backflow check valves will not cause breakage between the container and the valve.

(C) All connections that are listed in the ASME Manufacturers' Data Report for the container shall be considered part of the container.

(D) 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.

(E) Shutoff valves shall be located as close to the container as practical.

(F) Shutoff valves shall be readily accessible for operation and maintenance under normal and emergency conditions.

(G) Shutoff valves either shall be located in a readily accessible position less than 6 ft (1.8 m) above ground level; shall have extension handles, stairs, ladders, or platforms for access; or shall be equipped for remote operation.

(H) The connection or line that leads to or from any individual opening shall have a flow capacity greater than the rated flow of the excess-flow valve protecting the opening.

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

5.7.8.3 Valves and other appurtenances that are part of the assembly of portable multicylinder systems shall be arranged so that replacement of cylinders can be made without shutting off the flow of gas in the system.

5.7.8.4 Connections to ASME containers installed underground shall be located within a dome, housing, or manhole and shall have a cover.

(A)* Underground containers shall be installed so that all connections for hose and the point of discharge from pressure relief devices are located above the normal maximum water table.

(B) Such manholes or housings shall be ventilated.

(C) 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.

5.7.8.5 Container inlet and outlet connections on ASME containers of more than 2000 gal (7.6 m³) water capacity shall be labeled either on the container service valve or on the container to designate whether they communicate with the vapor or liquid space.

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

5.7.8.7 Every ASME storage container of more than 2000 gal (7.6 m³) water capacity shall be provided with a pressure gauge.

5.7.9* Container Refurbishment. To prevent the intrusion of foreign matter and physical damage during the container refurbishment process, either of the following shall be required:

- (1) The container appurtenances shall be removed and the container openings shall be protected.
- (2) The container appurtenances shall be protected.

5.8 Regulators and Regulator Vents.

5.8.1 Regulators.

5.8.1.1 Pressure regulators with a maximum rated capacity of 500,000 Btu/hr (147 kW/hr), except for line pressure and appliance regulators, shall comply with ANSI/UL 144, *Standard for LP-Gas Regulators*. Line pressure regulators shall comply with ANSI Z21.80/CSA 6.22, *Standard for Line Pressure Regulators*. Appliance pressure regulators shall comply with ANSI Z21.18/CSA 6.3, *Gas Appliance Regulators*.

5.8.1.2 Regulators over 500,000 Btu/hr (147 kW/hr) capacity shall be recommended by the manufacturer for use with LP-Gas.

5.8.1.3 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 6.8.1.4 for required protection from the elements*):

- (1) Integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in ANSI/UL 144, *Standard for LP-Gas Regulators*
- (2) 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 ANSI/UL 144, *Standard for LP-Gas Regulators*, and does not open to allow flow of gas until it has been manually reset

5.8.1.4 Second-stage regulators and integral two-stage regulators shall be equipped with one of the following (*see 6.8.1.4 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 ANSI/UL 144, *Standard for LP-Gas Regulators*, that limits the outlet pressure of the second-stage

regulator to 2.0 psig (14 kPag) or less when the regulator seat disc is removed and the inlet pressure to the regulator is 15.0 psig (103.5 kPag), as specified in ANSI/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 ANSI/UL 144, *Standard for LP-Gas Regulators*, and does not open to allow flow of gas until it has been manually reset

5.8.1.5 Second-stage regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) shall either comply with ANSI/UL 144, *Standard for LP-Gas Regulators*, with respect to an integral pressure relief device or an overpressure shutoff device, or shall have a separate overpressure protection device complying with 5.9.2 of NFPA 54, *National Fuel Gas Code* (ANSI Z223.1). The overpressure protection devices shall limit the outlet pressure of the regulator to 2.0 psig (14 kPag) or less when the regulator seat disc is removed and the inlet pressure to the regulator is 15.0 psig (103.5 kPag).

5.8.1.6 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.

5.8.1.7 Automatic changeover regulators shall be exempt from the requirement in 5.8.1.6.

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

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

5.8.1.10 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 pressure relief valve or shall have a separate relief valve.

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

5.8.1.12 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.

5.8.1.13 Regulators shall be designed to drain condensate from the regulator spring case when the vent is directed vertically down.

5.8.1.14 Two psig service regulators and integral 2 psi regulators shall have a maximum outlet pressure setting of 2.5 psi (17 kPag) and shall be equipped with one of the following:

- (1) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in ANSI/UL 144, *Standard for LP-Gas Regulators*. This relief device shall limit the outlet pressure of the 2 psig service regulator to 5.0 psig when the seat disc is removed and the inlet pressure of the regulator is 15.0 psig (103 kPag) as specified in ANSI/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 ANSI/UL 144, *Standard for LP-Gas Regulators*. Such a device shall not open to permit the flow of LP-Gas vapor until it has been manually reset.



5.8.2 Pressure Regulators. (Reserved)**5.8.3* Pipe for Regulator Venting.**

5.8.3.1 Pipe or tubing used to vent regulators shall be one of the following:

- (1) Metal pipe and tubing in accordance with 5.9.3
- (2) PVC conduit meeting the requirements of ANSI/UL 651, *Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings*
- (3) Flexible conduit meeting the requirements of ANSI/UL 1660, *Standard for Liquid-Tight Flexible Nonmetallic Conduit*, with nonmetallic fittings meeting the requirements of ANSI/UL 514B, *Standard for Conduit, Tubing, and Cable Fittings*
- (4) Flexible conduit meeting the requirement of ANSI/UL 1660, *Standard for Liquid-Tight Flexible Nonmetallic Conduit*, with metallic or nonmetallic fittings as part of a manufactured assembly

5.8.3.2 Other PVC piping materials and polyethylene and polyamide pipe and tubing shall not be permitted to be used to vent regulators.

5.9 Piping (Including Hose), Fittings, and Valves.**5.9.1 General.**

5.9.1.1 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 Section 5.9.

5.9.1.2 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.

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

- (1) Pipe and tubing shall comply with 5.9.3.
- (2) Pipe and tubing shall be recommended for that service by the manufacturer and shall be approved.

5.9.1.4 Piping that can contain liquid LP-Gas and that can be isolated by valving and that requires hydrostatic relief valves, as specified under Section 6.13, shall have an operating pressure of 350 psig (2.4 MPa) or a pressure that is equivalent to the maximum discharge pressure of any pump or other source feeding the fixed piping system if it is greater than 350 psig (2.4 MPa).

5.9.2 Reserved.**5.9.3 Pipe and Tubing.**

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

- (1) Wrought iron: ASME B36.10M, *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*

- (6) Polyamide pipe: ASTM D 2513-09, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and shall be recommended by the manufacturer for use with LP-Gas

- (7) Polyethylene pipe: ASTM D 2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, and shall be recommended by the manufacturer for use with LP-Gas

5.9.3.2 Tubing shall be steel, stainless steel, brass, copper, polyamide, or polyethylene (see 6.9.4) and shall comply with the following:

- (1) Brass tubing: ASTM B 135, *Standard Specification for Seamless Brass Tube*
- (2) Copper tubing:
 - (a) Type K or L: ASTM B 88, *Standard Specification for Seamless Copper Water Tube*
 - (b) ASTM B 280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*
- (3) Polyamide tubing: ASTM D 2513-09, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and shall be recommended by the manufacturer for use with LP-Gas
- (4) Polyethylene tubing: ASTM D 2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, and shall be recommended by the manufacturer for use with LP-Gas
- (5) Corrugated stainless steel tubing: ANSI/CSA 6.26 (LC1), *Interior Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*

5.9.4 Fittings for Metallic Pipe and Tubing.

5.9.4.1 Fittings shall be steel, brass, copper, malleable iron, or ductile (nodular) iron.

5.9.4.2 Pipe fittings shall have a minimum pressure rating as specified in Table 5.9.4.2 and shall comply with the following:

- (1) Cast-iron pipe fittings shall not be used.
- (2) Brazing filler material shall have a melting point that exceeds 1000°F (538°C).

5.9.4.3 Metal tube fittings shall have a minimum pressure rating as specified in Table 5.9.4.2.

Table 5.9.4.2 Service Pressure Rating of Pipe, Tube Fittings, and Valves

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

5.9.5 Fittings for Polyethylene and Polyamide Pipe and Tubing.

5.9.5.1* Joints in polyamide and polyethylene pipe and polyethylene tubing shall be made by heat fusion, by compression-type mechanical fittings, or by factory-assembled transition fittings.

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

5.9.5.3 Polyamide and polyethylene fusion fittings shall be recommended by the manufacturer for use with LP-Gas and shall conform to one of the following:

- (1) ASTM D 2683, *Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing*
- (2) ASTM D 3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*
- (3) ASTM F 1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*
- (4) ASTM F 1733, *Standard Specification for Butt Heat Fusion Polyamide (PA) Plastic Fitting for Polyamide (PA) Plastic Pipe and Tubing*

5.9.5.4 Installation instructions specific to the type and grade of polyethylene being joined shall be provided with heat fusion fittings.

5.9.5.5* Mechanical fittings shall comply with Category 1 of ASTM D 2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings*, and 5.9.5.5(A) through 5.9.5.5(C).

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

(B) Compression-type mechanical fittings shall include a rigid internal tubular stiffener, other than a split tubular stiffener, to support the pipe.

(C) Gasket material in the fitting shall be resistant to the action of LP-Gas and shall be compatible with the polyamide or polyethylene pipe material.

5.9.5.6 Anodeless risers shall comply with 5.9.5.6(A) through 5.9.5.6(E).

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

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

(C) 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.

(D) Field assembled anodeless risers shall be design certified to meet the requirements of Category 1 of ASTM D 2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings*; U.S. Department of Transportation, 49 CFR 192.281(e), "Transportation"; and 6.9.4.3 and 6.9.4.4.

(E) The manufacturer shall provide the user qualified installation instructions as prescribed by U.S. Department of Transportation, 49 CFR 192.283(b).

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

5.9.6.1 Hose, hose connections, and flexible connectors (*see 3.3.25, Flexible Connector*) shall be fabricated of materials that are resistant to the action of LP-Gas both as liquid and vapor.

5.9.6.2 When wire braid is used for reinforcement, it shall be of corrosion-resistant material such as stainless steel.

5.9.6.3 Hose and quick connectors shall be approved.

5.9.6.4 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 6.20 regardless of the pressure, shall comply with 5.9.6.4(A) through 5.9.6.4(E).

(A) Hose shall be designed for a working pressure of at least 350 psig (2.4 MPag), with a safety factor of 5 to 1 and comply with ANSI/UL 569, *Standard for Pigtailed and Flexible Hose Connectors for LP-Gas*, or ANSI/UL 21, *Standard for LP-Gas Hose*.

(B) Hose shall be continuously marked to provide at least the following information:

- (1) LP-GAS HOSE or LPG HOSE
- (2) Maximum working pressure
- (3) Manufacturers' name or coded designation
- (4) Month or quarter and year of manufacture
- (5) Product identification

(C) Hose assemblies, after the application of couplings, shall have a design capability of not less than 700 psig (4.8 MPag).

(D) If a pressure test is performed, such assemblies shall be pressure tested at 120 percent of the maximum working pressure [350 psig (2.4 MPag) minimum] of the hose.

(E) Hose assemblies shall be leak tested at the time of installation at not less than the operating pressure of the system in which they are installed.

5.9.6.5 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.

5.9.6.6 Hoses or flexible connectors used to supply LP-Gas to utilization equipment or appliances shall be installed in accordance with the provisions of 6.9.6 and 6.21.3.

5.10 Reserved.

5.11 Internal Valves. (Reserved)

5.12 Valves Other Than Container Valves.

5.12.1 Materials.

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

5.12.1.2 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.

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

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



5.12.2 Valves in Piping Systems.

5.12.2.1 Valves shall have a service pressure rating as specified in Table 5.9.4.2.

5.12.2.2 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 5.7.4.)

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

- (1) Automatic shutoff through thermal (fire) actuation
- (2) Manual shutoff from a remote location
- (3) Manual shutoff at the installed location

5.12.2.4 Where fusible elements are used, they shall have a melting point not exceeding 250°F (121°C).

5.12.2.5 Valves in polyethylene piping systems shall be manufactured from thermoplastic materials listed in ASTM D 2513, *Standard Specification for Polyethylene (PE) 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.

5.12.2.6 Valves in polyamide piping systems shall be manufactured from polyamide material as defined in ASTM D 2513-09, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*.

5.12.2.7 Metallic valves in polyethylene and polyamide piping systems shall be protected to minimize corrosion in accordance with Section 6.17.

5.12.2.8 Valves shall be recommended for LP-Gas service by the manufacturer.

5.13 Hydrostatic Relief Valves.

5.13.1 Hydrostatic relief valves designed to relieve the hydrostatic pressure that can develop in sections of liquid piping between closed shutoff valves shall have pressure settings not less than 400 psig (2.8 MPa) or more than 500 psig (3.5 MPa), unless installed in systems designed to operate above 350 psig (2.4 MPa).

5.13.2 Hydrostatic relief valves for use in systems designed to operate above 350 psig (2.4 MPa) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

5.14 Reserved.

5.15 Reserved.

5.16 Reserved.

5.17 Equipment.**5.17.1 Pressure-Containing Metal Parts.**

5.17.1.1 This section shall apply to pressure-containing metal parts of LP-Gas equipment.

5.17.1.2 The service pressure rating of equipment shall be in accordance with Table 5.17.1.2.

5.17.1.3 Equipment shall be fabricated of materials that are compatible with LP-Gas under service conditions and shall be in accordance with Table 5.17.1.3.

(A) Pressure-containing metal parts shall be made from the following materials:

- (1) Steel

Table 5.17.1.2 Service Pressure Rating

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

- (2) Ductile (nodular) iron (ASTM A 395, *Standard Specification for Ferritic 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 Ferritic 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 5.17.1.3(A)(1) through 5.17.1.3(A)(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 used only for cylinders, gaskets, regulators, approved meters, and indirect electric vaporizers.

(D) Zinc shall be used for approved regulators only, complying with ASTM B 86, *Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings*.

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

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

5.17.2.1 The maximum design pressure rating for pumps shall be based upon the maximum differential pressure produced and shall be in accordance with Table 5.17.2.1.

5.17.2.2 Pumps that produce a differential pressure greater than 125 psi (0.9 MPa) shall be marked to indicate that a bypass valve is required in the piping system. (See 6.18.2.3.)

5.17.3 Bypass Valves. Bypass valves shall have a maximum design pressure in accordance with Table 5.17.2.1.

5.17.3.1 If a bypass valve is installed in the system, it shall have a flow capacity equal to or greater than the pump in the system at the specified differential pressure.

5.17.4 Compressors.

5.17.4.1 Compressors shall be designed for LP-Gas service.

Table 5.17.1.3 Materials for Equipment Used in LP-Gas Service

Equipment Material	Service Condition
Steel	
Ductile (nodular) iron (ASTM A 395, <i>Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures</i> , or ASTM A 536, <i>Standard Specification for Ductile Iron Castings</i> , Grade 60–40–18 or 65–45–12)	Pressure-containing metal parts
Malleable iron (ASTM A 47, <i>Standard Specification for Ferritic Malleable Iron Castings</i>)	
Higher strength gray iron (ASTM A 48, <i>Standard Specification for Gray Iron Castings</i> , Class 40B)	
Brass	
Materials equivalent to 5.17.1.3(A)(1) through 5.17.1.3(A)(5) in melting point, corrosion resistance, toughness, and strength	
Cast iron	Not to be used as a material of construction for strainers or flow indicators
Aluminum	For approved meters, approved regulators, and indirect vaporizers
Zinc (ASTM B 86, <i>Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings</i>)	For approved regulators
Nonmetallic materials	Not to be used for upper or lower casings of regulators

Table 5.17.2.1 Maximum Allowable Working Pressure for Pumps and Bypass Valves

Maximum Differential Pressure Produced (psi)	Equipment Design Pressure Rating (psig)
≤125	350
>125 and ≤150	375
>150 and ≤200	400
>200	200 + maximum differential pressure

For SI units, 1 psi = 6.895 kPa.

5.17.4.2 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.

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

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

5.17.5 Reserved.

5.17.6 Meters.

5.17.6.1 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).

5.17.6.2 Vapor meters of the die cast or iron case type shall not be used at any pressure higher than the working pressure for which they are designed and marked.

5.17.6.3 Liquid meters shall be installed so that the meter housing is not subject to excessive strains from the connecting piping. Where used to provide flexibility in the fixed piping system, flexible connectors shall not exceed 36 in. (1 m) in total length.

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

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

5.18 Reserved.

5.19 Reserved.

5.20 Appliances.

5.20.1 New residential, commercial, and industrial LP-Gas consuming appliances shall be approved.

5.20.2 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.

5.20.3 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.

5.20.4 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.

5.20.5 Appliances using vaporizing burners shall comply with 5.21.5.

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

5.20.7* LP-Gas appliances used on commercial vehicles shall be approved for the service.

(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.

(D) If the separation between the combustion system and the living space is not integral with the appliance, it shall be provided in accordance with installation requirements in 6.24.7.5.

5.21 Vaporizers, Tank Heaters, Vaporizing Burners, and Gas-Air Mixers.

5.21.1 Reserved.

5.21.2 Indirect Vaporizers.

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

- (1) Marking required by the ASME Code
- (2) Maximum allowable working pressure and temperature for which designed
- (3) Name of the manufacturer

5.21.2.2 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 MAWP of 250 psig (1.7 MPa).

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

5.21.2.4 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 5.21.9. Fusible plug devices shall not be used.

5.21.2.5 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 6.22.2.11.

5.21.3 Direct-Fired Vaporizers.

5.21.3.1 Design and construction of direct-fired vaporizers 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) Markings required by the ASME Code
- (2) Maximum vaporizing capacity in gallons per hour
- (3) Rated heat input in British thermal units per hour
- (4) Name or symbol of the manufacturer

5.21.3.2 Direct-fired vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 5.21.9.

5.21.3.3 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.

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

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

5.21.3.6 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.

5.21.3.7 If the pilot flow exceeds 2000 Btu/hr (2 MJ/hr), the safety device shall also shut off the flow of gas to the pilot.

5.21.3.8 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 5.2.4.2 that corresponds with the design pressure of the container (or its ASME Code equivalent). (*See notes to Table 5.2.4.2.*)

5.21.4 Tank Heaters.

5.21.4.1 Tank heaters shall be approved for the application and shall be used according to the manufacturer's instructions.

5.21.4.2 Tank heaters shall be approved and shall be permanently and legibly marked with the following:

- (1) Rated input to the burner in British thermal units per hour
- (2) Maximum vaporizing capacity in gallons per hour
- (3) Name or symbol of the manufacturer

5.21.4.3 Manufacturer's instructions for tank heaters shall provide direction for their use for heating LP-Gas containers.

5.21.4.4 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 5.2.4.2 that corresponds with the MAWP of the container (or its ASME *Boiler and Pressure Vessel Code* equivalent).

5.21.4.5 Tank heaters of the electric immersion type shall be automatically de-energized when the liquid level falls below the top of the heater.

5.21.4.6 Devices that cannot apply a temperature in excess of 90°F (32°C) shall not be required to comply with 5.21.4.4 and 5.21.4.5.

5.21.4.7 Direct-type tank heaters shall be designed such that the heater can be removed for inspection of the entire container.

5.21.4.8 Direct gas-fired tank heaters shall be designed exclusively for outdoor aboveground use.

5.21.4.9 Direct gas-fired tank heaters shall be designed such that there is no direct flame impingement upon the container.

5.21.4.10 Fuel gas supply connections to direct gas-fired tank heaters originating in the vapor space of the container shall be provided with a manually operated shutoff valve at the heater.

5.21.4.11 Heater control systems 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.

5.21.4.12 Where installed on containers exceeding 1000 gal (3.8 m³) 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.

5.21.5 Vaporizing Burners.

5.21.5.1 Section 5.21 shall not apply to engine fuel vaporizers or to integral vaporizer burners, such as those used with weed burning equipment and tar kettles.

5.21.5.2 Vaporizing burners shall be constructed with a pressure rating of 250 psig (1.7 MPa), with a safety factor of 5 to 1.

5.21.5.3 The vaporizing burner or the appliance in which it is installed shall be permanently and legibly marked with the following:

- (1) Maximum burner input in British thermal units per hour
- (2) Name or symbol of the manufacturer

5.21.5.4 Vaporizing coils or jackets shall be made of ferrous metals or high-temperature alloys.

5.21.5.5 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 MPa).

5.21.5.6 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.

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

5.21.5.8 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.

5.21.5.9* 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 airflow.

5.21.5.10 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.

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

5.21.6 Waterbath Vaporizers.

5.21.6.1 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 MAWP of 250 psig (1.7 MPa) and shall be permanently and legibly marked with the following:

- (1) Marking required by the ASME Code
- (2) MAWP and temperature for which the heat exchanger is designed
- (3) Name or symbol of the manufacturer

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

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

5.21.6.4 Heat exchangers for waterbath vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 5.21.9. Fusible plug devices shall not be used.

5.21.6.5 Waterbath sections of waterbath vaporizers shall be designed to prevent pressure from exceeding the design pressure.

5.21.6.6 The immersion heater that provides heat to the waterbath shall be installed so as not to contact the heat exchanger.

5.21.6.7 A control to limit the temperature of the waterbath shall be provided.

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

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

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

5.21.7 Reserved.

5.21.8 Gas-Air Mixers.

5.21.8.1 Gas-air mixers shall be designed for the air, vapor, and mixture pressures to which they are subjected.

5.21.8.2 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.

5.21.8.3 In addition to the interlocks required in 5.21.8.2, 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.

5.21.8.4 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.

5.21.8.5 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) They shall be exempt from the interlock provisions in 5.21.8.2 through 5.21.8.4.
- (2) They shall be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down.

5.21.8.6 Gas-air mixers of the type specified in 5.21.8.5 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.



5.21.9 Vaporizer Pressure Relief Valve.

5.21.9.1 The minimum rate of discharge in cubic feet of air per minute for pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct-fired type, shall comply with 5.21.9.2 through 5.21.9.4.

5.21.9.2 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.

5.21.9.3 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 5.7.2.6 to determine the required relief valve capacity.

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

5.22 Vehicle Fuel Dispensers.

5.22.1 The dispenser shall have a maximum design pressure rating equal to or greater than the maximum discharge pressure from the pump and bypass valve, if provided.

5.22.2 The maximum design pressure and all equipment downstream from the pump shall be in accordance with Table 5.17.2.1.

Chapter 6 Installation of LP-Gas Systems

6.1 Scope.

6.1.1* Application. This chapter applies to the following:

- (1) Location and field installation of LP-Gas systems that use components, subassemblies, container assemblies, and container systems that are fabricated in accordance with Chapter 5
- (2) Location of containers and liquid transfer systems
- (3) Installation of container appurtenances and regulators
- (4) Installation of piping (including flexible connectors and hose), hydrostatic relief valves, and piping service limitations
- (5) Installation of equipment
- (6) Testing of piping systems

6.1.2 Nonapplication. This chapter does not apply to the following:

- (1) Refrigerated containers
- (2) Installation of systems used in the highway transportation of LP-Gas

6.1.3* Additional Features. For any purpose or application addressed within the scope of this chapter, if the requirements of the chapter are met, any or all additional features or components of equipment not prohibited by the chapter shall be permitted to be used.

6.2 Location of Containers.

6.2.1 LP-Gas containers shall be located outside of buildings unless they are specifically allowed to be located inside of buildings.

6.2.2 LP-Gas containers shall be allowed in buildings only for the following applications:

- (1) Cylinders as specifically provided for in Section 6.20

- (2) Containers of less than 125 gal (0.5 m³) water capacity for the purposes of being filled in buildings or structures complying with Chapter 10
- (3) Containers on LP-Gas vehicles complying with, and parked or garaged in accordance with, Chapter 9
- (4) Containers used with LP-Gas portable engine fuel systems complying with 11.15.1
- (5) Containers used with LP-Gas stationary engine fuel systems complying with 6.26
- (6) Containers used with LP-Gas-fueled industrial trucks complying with 11.13.4
- (7) Containers on LP-Gas-fueled vehicles garaged in accordance with Section 11.16
- (8) Cylinders awaiting use, resale, or exchange when stored in accordance with Chapter 8

6.3 Container Separation Distances.

6.3.1 Aboveground Containers.

6.3.1.1* 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 Table 6.3.1.1, Table 6.4.1.2, 6.3.1.2 through 6.3.1.3, 6.3.3, 6.3.4.1 through 6.3.4.4, and 6.4.4.6 through 6.4.4.11.

6.3.1.2 When the provisions of 6.28.3 through 6.28.5 are met, the minimum distance from an ASME container to a building shall be reduced by one-half for ASME containers of 2001 gal through 30,000 gal (7.6 m³ through 114 m³) water capacity.

6.3.1.3 The 25 ft (7.6 m) minimum distance from aboveground ASME containers of 501 gal through 2000 gal (1.9 m³ through 7.6 m³) 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 ASME container of 1200 gal (4.5 m³) 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 m³) water capacity.

6.3.2 Underground or Mounded ASME Containers.

6.3.2.1 Minimum distances for underground or mounded ASME containers of 2001 gal through 30,000 gal (7.6 m³ through 114 m³) water capacity, incorporating all the provisions of Section 6.28, shall be reduced to 10 ft (3 m).

6.3.2.2 Distances for all underground and mounded ASME containers shall be measured from the container surface.

6.3.2.3 No part of an underground or mounded ASME container shall be less than 10 ft (3 m) from a building or line of adjoining property that can be built upon.

6.3.3 Minimum Separation Distances for ASME Containers.

6.3.3.1 The minimum separation distances specified in Table 6.3.1.1 between containers and buildings of other than woodframe construction devoted exclusively to gas manufacturing and distribution operations shall be reduced to 10 ft (3 m).

6.3.3.2 If the aggregate water capacity of a multicontainer installation is 501 gal (1.9 m³) or more and the installation is comprised of individual containers, each with a water capacity of less than 125 gal (0.5 m³), the minimum distance shall comply with Table 6.3.1.1 and 6.3.3.2(A) through 6.3.3.2(C).

(A) The aggregate capacity shall be used rather than the capacity per container.

Table 6.3.1.1 Separation Distances Between Containers, Important Buildings, and Line of Adjoining Property That Can Be Built Upon

Water Capacity per Container		Minimum Distances					
		Mounded or Underground Containers ^a		Aboveground Containers		Between Containers ^b	
		ft	m	ft	m	ft	m
gal	m ³						
<125 ^c	<0.5 ^c	10	3	0 ^d	0 ^d	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
501–2,000	>1.9–7.6	10	3	25 ^c	7.6	3	1
2,001–30,000	>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	¼ of sum of	
90,001–120,000	>341–454	50	15	125	38	diameters of	
120,001–200,000	>454–757	50	15	200	61	adjacent	
200,001–1,000,000	>757–3,785	50	15	300	91	containers	
>1,000,000	>3,785	50	15	400	122		

^aSee 6.3.2.1.^bSee 6.3.4.5.^cSee 6.3.4.4.^dSee 6.3.4.1, 6.3.4.2, 6.3.4.3, and 6.3.4.4.^eSee 6.3.1.3.

(B) 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).

(C) The minimum distances between containers shall not be applied to installations covered by 6.3.3.2.

6.3.4 Separation Distance Between Container Pressure Relief Valve and Building Openings.

6.3.4.1 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.

6.3.4.2 ASME containers of less than 125 gal (0.5 m³) water capacity shall be located and installed so that the discharge from pressure relief devices shall not terminate in or beneath any building.

6.3.4.3* 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 6.3.4.3.

6.3.4.4 The distance measured in any direction from the point of discharge of a container pressure relief valve, vent of a fixed maximum liquid level gauge on a container, and the container filling connection to exterior sources of ignition, openings into direct-vent (sealed combustion system) appliances, and mechanical ventilation air intakes shall be in accordance with Table 6.3.4.3.

6.3.4.5 Access at the ends or sides of individual underground containers having a water capacity of 125 gal (0.5 m³) or more shall be provided in multicontainer installations to facilitate working with cranes or hoists.

Table 6.3.4.3 Separation Distance Between Container Pressure Relief Valve and Building Openings

Container Type	Exchange or Filled on Site at Point of Use	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, and Mechanical Ventilation Air Intakes	
		ft	m	ft	m
Cylinder	Exchange	3	0.9	5	1.5
Cylinder	Filled on site at the point of use	3	0.9	10	3.0
ASME	Filled on site at the point of use	5	1.5	10	3.0



6.4 Other Container Location Requirements.

6.4.1 ASME Multicontainer Requirements.

6.4.1.1 Where storage containers having an aggregate water capacity of more than 4000 gal (15.2 m³) are located in heavily populated or congested areas, the siting provisions of 6.3.1.1 and Table 6.3.1.1 shall be permitted to be modified as indicated by the fire safety analysis described in 6.27.3.

6.4.1.2 Aboveground multicontainer installations comprised of ASME containers having an individual water capacity of 12,000 gal (45 m³) 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 6.4.1.2.

Table 6.4.1.2 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 (<i>see</i> 6.4.1.2 and 6.27.3.1)	6	50	15
Fixed monitor nozzles per 6.27.6.3	6	25	7.6
Fixed water spray per 6.27.6.1	9	25	7.6
Insulation per 6.27.5.1	9	25	7.6

6.4.1.3 Where the provisions of 6.28.3 and 6.28.4 are met, the minimum separation distance between groups of ASME containers protected by hose stream only shall be one-half the distances required in Table 6.4.1.2.

6.4.2 Underground and Mounded ASME Containers.

6.4.2.1 Underground or mounded ASME containers shall be located in accordance with 6.4.2.2 and 6.4.2.3.

6.4.2.2 Underground or mounded containers shall be located outside of any buildings.

6.4.2.3 Buildings shall not be constructed over any underground or mounded containers.

6.4.3 General Requirements.

6.4.3.1 The sides of adjacent containers shall be separated in accordance with Table 6.3.1.1 but shall not be separated by less than 3 ft (1 m).

6.4.3.2 Where containers are installed parallel with ends in line, the number of containers in one group shall not be limited.

6.4.3.3 Where more than one row of containers is installed, the adjacent ends of the containers in each row shall be separated by not less than 10 ft (3 m).

6.4.4 Additional Container Installation Requirements.

6.4.4.1 Additional container installation requirements shall comply with 6.4.4.2 through 6.4.4.14 and 6.4.5.

6.4.4.2 Containers shall not be stacked one above the other.

6.4.4.3* Combustible materials shall not accumulate or be stored within 10 ft (3 m) of a container.

6.4.4.4* 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.

6.4.4.5 LP-Gas containers shall be located at least 10 ft (3 m) from the centerline of the wall of diked areas containing flammable or combustible liquids.

6.4.4.6 The minimum horizontal separation between aboveground LP-Gas containers and aboveground tanks containing liquids having flash points below 200°F (93.4°C) shall be 20 ft (6 m).

6.4.4.7 The requirements of 6.4.4.6 shall not apply where LP-Gas containers of 125 gal (0.5 m³) or less water capacity are installed adjacent to fuel oil supply tanks of 660 gal (2.5 m³) or less capacity.

6.4.4.8 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*.

6.4.4.9* The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with NFPA 55, *Compressed Gases and Cryogenic Fluids Code*.

6.4.4.10 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.

6.4.4.11 The minimum separation between LP-Gas containers and liquefied hydrogen containers shall be in accordance with NFPA 55, *Compressed Gases and Cryogenic Fluids Code*.

6.4.4.12 Where LP-Gas cylinders are to be stored or used in the same area with other compressed gases, the cylinders 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*.

6.4.4.13 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.

6.4.4.14* Refrigerated LP-Gas containers shall be located within an impoundment in accordance with Section 12.5.

6.4.5* Structure Requirements.

6.4.5.1 Structures such as fire walls, fences, earth or concrete barriers, and other similar structures shall not be permitted around or over installed nonrefrigerated containers unless specifically allowed.

6.4.5.2 Structures partially enclosing containers shall be permitted if designed in accordance with a sound fire protection analysis.

6.4.5.3 Structures used to prevent flammable or combustible liquid accumulation or flow shall be permitted in accordance with 6.4.4.4.

6.4.5.4 Structures between LP-Gas containers and gaseous hydrogen containers shall be permitted in accordance with 6.4.4.10.

6.4.5.5 Structures such as fences shall be permitted in accordance with 6.19.4.

6.5 Location of Transfer Operations.

6.5.1 Transfer of Liquids.

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

6.5.1.2 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 6.25.3.3.)

6.5.1.3 Structures housing transfer operations or converted for such use after December 31, 1972, shall comply with Chapter 10.

6.5.1.4 The transfer of liquid into containers on the roofs of structures shall be permitted, provided that the installation conforms to the requirements specified in 6.6.7 and 6.20.11.

6.5.1.5 The transfer hose shall not be routed in or through any buildings except those specified in 6.5.1.3.

6.5.1.6 Filling of containers located outdoors in stationary installations in accordance with Section 6.3 shall be permitted to be filled at that location.

6.5.2 Container Point of Transfer Location Requirements.

6.5.2.1 If the point of transfer of containers located outdoors in stationary installations is not located at the container, it shall be located in accordance with Table 6.5.2.1.

6.5.2.2 Containers not located in stationary installations shall be filled at a location determined by the point of transfer in accordance with Table 6.5.2.1.

6.5.3 Separation Distance from Point of Transfer.

6.5.3.1 If the point of transfer is a component of a system covered by Section 6.24 or Chapter 11, the requirements of parts A, B, and C of Table 6.5.2.1 shall not apply to the structure containing the point of transfer.

6.5.3.2 If LP-Gas is vented to the atmosphere under the conditions stipulated in 7.3.1(5), the distances in Table 6.5.2.1 shall be doubled.

6.5.3.3 If the point of transfer is housed in a structure complying with Chapter 10, and the common walls comply with 10.2.1, separation distances in Table 6.5.2.1 shall not be required where the common walls comply with 10.3.1.3.

6.5.3.4 The distances in Table 6.5.2.1, parts B, C, D, E, F(2), and J, shall be reduced by one-half where the system incorporates the provisions of low emission transfer as provided in 6.28.5.

Table 6.5.2.1 Distance Between Point of Transfer and Exposures

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

^aFor the purpose of the table, buildings also include structures such as tents and box trailers at construction sites.

^bSee ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests for Building Construction and Materials*.

^cSee 6.5.3.4.

^dNot applicable to driveways and points of transfer at vehicle fuel dispensers.

^eNot applicable to filling connections at the storage container or to dispensing vehicle fuel dispenser units of 4000 gal (15.2 m³) water capacity or less when used for filling containers not mounted on vehicles.

^fNFPA 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 (276 kPa) 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).



6.6 Installation of Containers.

6.6.1 General Requirements.

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

6.6.1.2 LP-Gas containers or systems of which they are a part that are installed within 10 ft (3 m) of public vehicular thoroughfares shall be provided with a means of vehicular barrier protection.

6.6.1.3 Field welding on containers shall be limited to non-pressure parts such as saddle plates, wear plates, or brackets installed by the container manufacturer.

6.6.1.4* Aboveground containers shall be painted.

6.6.1.5 Containers shall be installed so that all container operating appurtenances are accessible.

6.6.1.6 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.

6.6.2 Installation of Cylinders.

6.6.2.1 Cylinders shall be installed only aboveground and shall be set upon a firm foundation or otherwise be firmly secured. (See 6.6.2.2.)

6.6.2.2 The cylinder shall not be in contact with the soil.

6.6.2.3 Flexibility shall be provided in the connecting piping. (See 6.6.2.4.)

6.6.2.4 Where flexible connectors are used, they shall comply with 6.9.6.

6.6.3 Installation of Horizontal Aboveground ASME Containers.

6.6.3.1 Horizontal ASME containers designed for permanent installation in stationary aboveground service shall be placed on masonry or other noncombustible structural supports located on concrete or masonry foundations with the container supports.

(A) Where saddles are used to support the container, 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 6.6.3.3.

(C) Containers of more than 2000 gal (7.6 m³) 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 6.6.3.3(A), shall be placed on flat-topped foundations.

(D) Containers of 2000 gal (7.6 m³) water capacity or less shall be installed either on concrete or masonry foundations formed to fit the container contour or in accordance with 6.6.3.1(E).

(E) Containers of 2000 gal (7.6 m³) water capacity or less and equipped with attached supports complying with Table 6.6.3.3(A) shall be installed on a fire-resistive foundation if the bottoms of the horizontal members of the container saddles, runners, or skids are more than 12 in. (300 mm) above grade.

(F) Containers of 2000 gal (7.6 m³) water capacity or less 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.

(G) Containers of 4000 gal (15.2 m³) water capacity or less installed with combined container-pump assemblies on a common base complying with Table 6.6.3.3(A) shall be placed either on paved surfaces or on concrete pads at ground level within 4 in. (100 mm) of ground level.

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

6.6.3.3 Support of horizontal ASME containers shall comply with 6.6.3.3(A) through 6.6.3.3(D).

(A) Horizontal ASME containers with attached supports and designed for permanent installation in stationary service shall be installed in accordance with Table 6.6.3.3(A).

Table 6.6.3.3(A) Installation of Permanently Installed Horizontal ASME Containers with Attached Supports

Container Size		Attached Support	Height of Container Bottom
gal	m ³		
≥4000	≥15.2	Non-fireproofed steel on flat-topped concrete foundations	6 in. (150 mm) maximum above concrete foundations
≤4000	≤15.2	Non-fireproofed steel on masonry or concrete foundations more than 12 in. (300 mm) above the ground	2 in. to 12 in. (51 mm to 300 mm) above concrete foundation
≤4000	≤15.2	Non-fireproofed 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
≤4000	≤15.2	Foundations or supports for horizontal LP-Gas containers per 6.6.3.3(B)	24 in. (610 mm) maximum above paved surface

(B) Steel supports shall be protected against fire exposure with a material having a fire resistance rating of at least 2 hours if the height limits specified in Table 6.6.3.3(A) are exceeded.

(C) The test to determine the fire resistance rating shall be ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

(D) Horizontal ASME containers of 2000 gal (7.6 m³) or less, on foundations in their installed condition, shall meet the following conditions:

- (1) Structurally support the containers when subject to deteriorating environmental effects including, but not limited to, ambient temperature of -40°F to 150°F (-40°C to 66°C) or local conditions if outside this range, ultraviolet rays, radiant heat from fires, and moisture
- (2) Be of either noncombustible or self-extinguishing material (per the definition in NFPA 99, *Health Care Facilities Code*, 3.3.163)

6.6.3.4 Where a single ASME container complying with Table 6.6.3.3(A) is installed in isolated locations with non-fireproofed 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.

6.6.3.5 The part of an ASME container in contact with saddles, foundations, or masonry shall be coated or protected to minimize corrosion.

6.6.3.6 In locations where the monthly maximum depth of snow accumulation, as determined from the National Weather Service or other published statistics, is more than the height of aboveground containers, excluding the dome cover, the following requirements shall apply:

- (1) A stake or other marking shall be installed higher than the average snow cover depths, up to a height of 15 ft (4.6 m).
- (2) The container shall be installed to prevent its movement resulting from snow accumulation.

6.6.3.7 If the container is mounted on or is part of a vehicle in accordance with 5.2.7.2(B), the unit shall be located in accordance with 6.3.1.1.

(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, weeds, and other combustible material within 10 ft (3 m) of the container.

(B) Flexibility shall be provided in the connecting piping in accordance with 6.9.6.

6.6.3.8 Portable tanks of 2000 gal (7.6 m³) water capacity or less that comply with 5.2.7.3 shall be installed in accordance with 6.6.3.1(E).

6.6.4 Installation of Vertical ASME Containers.

6.6.4.1 Vertical ASME containers of over 125 gal (0.5 m³) water capacity designed for permanent installation in stationary aboveground service shall be installed on reinforced concrete or steel structural supports on reinforced concrete foundations that are designed to meet the loading provisions established in 5.2.4.3.

6.6.4.2 The requirements in 6.6.4.3 through 6.6.4.5 shall also apply to the installation of vertical ASME containers.

6.6.4.3 Steel supports shall be protected against fire exposure with a material that has a fire resistance rating of at least 2 hours, except that continuous steel skirts that have only one opening that is 18 in. (460 mm) or less in diameter shall have fire protection applied to the outside of the skirts.

6.6.4.4 Vertical ASME containers used in liquid service shall not be manifolded to horizontal ASME containers.

6.6.4.5 Vertical ASME containers of different dimensions shall not be manifolded together.

6.6.5 Temporary Container Installations.

6.6.5.1 Single containers constructed as portable storage containers for temporary stationary service in accordance with 5.2.7.2 shall be placed on concrete pads, paved surfaces, or firm earth for such temporary service (not more than 12 months at a given location).

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

6.6.5.3 Flexibility shall be provided in the connecting piping in accordance with 6.9.6.

6.6.5.4 Where portable storage containers are installed at isolated locations with the bottoms of the skids or runners above the ground, either fire-resistive supports shall be provided or non-fire-resistive supports shall be permitted when all the following conditions are met:

- (1) The height of the outside bottom of the container does not exceed 5 ft (1.5 m) above the ground.
- (2) The approval of the authority having jurisdiction is obtained.

6.6.6 Installation of Underground and Mounded Containers.

6.6.6.1* ASME container assemblies intended for underground installation, including interchangeable aboveground-underground container assemblies, shall be installed underground in accordance with 6.6.6.1(A) through 6.6.6.1(M).

(A) Containers installed in areas with no vehicular traffic shall be installed at least 6 in. (150 mm) below grade.

(B) At installations within 10 ft (3 m) of a public vehicular thoroughfare or designated parking location, a noninterchangeable underground container shall be installed 18 in. (460 mm) below grade or vehicular barrier protection shall be provided.

(C) Installations within 10 ft (3 m) of a public vehicular thoroughfare or designated parking location shall be provided with vehicular barrier protection for the container's fitting housing, housing cover, container connections, and piping.

(D) Approved interchangeable aboveground-underground container assemblies installed underground shall not be placed with the container shell more than 12 in. (300 mm) below grade.

(E) The installation of a buried container shall include protection for the container and piping against physical damage from vehicular traffic.

(F) Prior to digging, the location of underground and mounded containers and piping in the vicinity of construction and excavation activities shall be determined and the installation shall be protected from damage.



(G) 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.
- (3) The vapor shall be either recovered, burned, or vented to the atmosphere.
- (4) 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.
- (5) If purged, the displaced vapor shall be either recovered, burned, or vented to the atmosphere.

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

(I)* A corrosion protection system shall be installed on new installations of underground steel containers, unless technical justification is provided to and is approved by the authority having jurisdiction. The corrosion protection system shall include the following:

- (1) A container coating complying with 5.2.1.11
- (2) A cathodic protection system that consists of a sacrificial anode(s) or an impressed current anode
- (3) A means to test the performance of the cathodic protection system in accordance with 6.17.3

(J) Prior to burial, the container shall be visually examined for damage to the coating. Damaged areas shall be repaired with a coating recommended for underground service and compatible with the existing coating.

(K)* Containers shall be set level and shall be surrounded by earth or sand firmly tamped in place.

(L)* Where electrical isolation is provided between buried metallic piping and an underground container, the dielectric connection shall comply with the applicable requirements of Section 5.9 or shall be listed.

(M) Backfill shall be free of rocks and abrasives.

6.6.6.2 Partially underground, unmounded ASME containers shall be installed in accordance with 6.6.6.2(A) through 6.6.6.2(F).

(A) The portion of the container below the surface of the ground, and for a vertical distance of at least 3 in. (75 mm) above that surface, shall comply with the corrosion protection requirements of 6.6.6.1(I) through (J).

(B) The aboveground portion of the container shall be painted to comply with 6.6.1.4.

(C) Containers shall be set level and shall be surrounded by earth or sand firmly tamped in place.

(D) Backfill shall be free of rocks and abrasives.

(E) Spacing provisions shall be as specified for aboveground containers in 6.3.1.1 and Table 6.3.1.1.

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

6.6.6.3 Mounded containers shall be installed in accordance with 6.6.6.3(A) through 6.6.6.3(F).

(A)* Mounding material shall be earth, sand, or other noncombustible, noncorrosive materials and shall provide a minimum thickness of cover for the container of 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.

(D) 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.

(E) 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.

(F) Mounded containers shall comply with the corrosion protection requirements of 6.6.6.1(I) and 6.6.6.1(J).

6.6.7 Installation of Containers on Roofs of Buildings.

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

6.6.7.2 Where the authority having jurisdiction and the fire department have approved an installation of a container, it shall comply with 6.6.7.2(A) through 6.6.7.2(S).

(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 of 2000 gal (7.6 m³) water capacity or less.

(C) The aggregate water capacity of LP-Gas containers installed on the roof or terrace of a building shall meet the following criteria:

- (1) It shall not exceed 4000 gal (15.2 m³) in one location.
- (2) Additional installations on the same roof or terrace shall be located at least 50 ft (15 m) apart.

(D) 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.

(E) Containers shall be installed in external locations only.

(F) Where a fill line to the container is required, it shall be located entirely outside the building.

(G) The fill connection shall be located entirely outside the building.

(H) The fill connection shall be located at least 8 ft (2.4 m) above ground level.

(I) Containers shall be installed on a level surface.

(J) The container shall be secured to the building structure.

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

(L) 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.

(M) Containers shall be located in areas that have free air circulation, are at least 10 ft (3 m) from building openings (such as windows and doors), and are at least 20 ft (6.1 m) from air intakes of air-conditioning and ventilating systems.

(N) The location of containers shall allow access to all valves and controls and shall have enough surrounding area to allow the required maintenance.

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

(P) If the installation requires the use of more than one container, the distances between containers from Table 6.3.1.1 shall apply.

(Q) If the container location is higher than 23 ft (7 m) from the ground, or if 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:

- (1) Filler valve [see 5.7.4.1(D)]
- (2) Filler valve cap
- (3) Two control valves
- (4) Hydrostatic relief valve
- (5) Venting line

(R) The liquid fill and vapor connections shall be conspicuously marked or labeled.

(S) A fire safety analysis shall be prepared in accordance with 6.27.3.

6.7 Installation of Container Appurtenances.

6.7.1 Reserved.

6.7.2 Installation of Pressure Relief Devices.

6.7.2.1 Pressure relief devices shall be installed so that the relief device is in direct communication with the vapor space of the container.

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

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

- (1) Containers of 125 gal (0.5 m³) or more water capacity installed in stationary service
- (2) Portable storage containers
- (3) Portable tanks
- (4) Cargo tanks

6.7.2.4 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.

6.7.2.5 The rain cap or other protector shall be designed to remain in place, except during pressure relief device operation, and shall not restrict pressure relief device flow.

6.7.2.6 The design of the pressure relief valve drain opening shall provide the following:

- (1) Protection of the container against flame impingement resulting from ignited product escaping from the drain opening
- (2) Direction of the pressure relief valve drain opening so that an adjacent container, piping, or equipment is not subjected to flame impingement

6.7.2.7 Pressure relief valve discharge on each container of more than 2000 gal (7.6 m³) water capacity shall be directed vertically upward and unobstructed to the open air.

6.7.2.8 Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold meeting the requirements of 6.7.2.9 is used.

6.7.2.9 Listed pressure relief valve manifolds shall be exempt from the requirements of 6.7.2.8 when the following conditions are met:

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

6.7.2.10 Shutoff valves shall not be installed at the outlet of a pressure relief device or at the outlet of the discharge piping where discharge piping is installed.

6.7.2.11 The pressure relief valve discharge piping from underground containers of 2000 gal (7.6 m³) or less water capacity shall extend beyond the manhole or housing or shall discharge into the manhole or housing, where the manhole or housing is equipped with ventilated louvers or their equivalent, in accordance with 5.7.8.4.

6.7.2.12 Pressure relief valve discharge on underground containers of more than 2000 gal (7.6 m³) water capacity shall be piped vertically and directly upward to a point at least 7 ft (2.1 m) above the ground. (See 6.7.2.13.)

6.7.2.13 Pressure relief devices installed in underground containers in dispensing stations shall be piped vertically upward to a point at least 10 ft (3 m) above the ground.

6.7.2.14 Where installed, the discharge piping shall comply with 6.7.2.14(A) through 6.7.2.14(F).

(A) Piping shall be supported and protected against physical damage.

(B) Piping from aboveground containers shall be sized to provide the rate of flow specified in Table 5.7.2.6.

(C) Piping from underground containers shall be sized to provide the rate of flow specified in 5.7.2.8.

(D) Piping shall be metallic and have a melting point over 1500°F (816°C).

(E) Discharge piping shall be so designed that excessive force applied to the discharge piping results in breakage on the discharge side of the valve, rather than on the inlet side, without impairing the function of the valve.

(F) Return bends and restrictive pipe or tubing fittings shall not be used.

6.7.3 Reserved.

6.7.4 Reserved.

6.7.5 Reserved.

6.7.6 Reserved.

6.7.7 Reserved.

6.7.8 Reserved.

6.7.9 Reserved.



6.8 Regulators.

6.8.1 Regulator Installation.

6.8.1.1 First-stage, high-pressure, automatic changeover, integral 2 psi service, integral two-stage, and single-stage regulators where allowed shall be installed in accordance with 6.8.1.1(A) through 6.8.1.1(D).

(A) Regulators connected to single container permanent installations shall be installed with one of the following methods:

- (1) Directly attached to the vapor service valve
- (2) Attached to the vapor service valve with a flexible metallic connector

(B) Regulators connected to cylinders in other than stationary installations shall be installed with one of the following methods:

- (1) Directly attached to the vapor service valve
- (2) Attached to the vapor service valve with a flexible metallic connector
- (3) Attached to the vapor service valve with a flexible hose connector

(C) Regulators connected to manifolded containers shall be installed with the following methods:

- (1) Installations shall comply with 6.9.3.8.
- (2) The regulator shall be directly attached or attached with a flexible metallic connector to the vapor service manifold piping outlet.
- (3) The connection between the container service valve outlet and the inlet side of the manifold piping shall be installed with one of the following methods:
 - (a) Directly attached
 - (b) Attached with a flexible metallic connector
 - (c) Attached with a flexible hose connector connected to a cylinder in other than stationary installations

(D) Regulators installed on vaporizer outlets shall be installed with one of the following methods:

- (1) Directly attached
- (2) Attached with a flexible metallic connector

(E) Regulators connected to underground or mounded containers shall be permitted to be attached to the vapor service valve with a flexible hose connector providing electrical isolation between the container and metallic piping system that complies with ANSI/UL 569, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas*, and is recommended by the manufacturer for underground service.

6.8.1.2 First-stage regulators installed downstream of high-pressure regulators shall be exempt from the requirement of 6.8.1.1.

6.8.1.3* First-stage and high-pressure regulators shall be installed outside of buildings, except as follows:

- (1) Regulators on cylinders installed indoors in accordance with Section 6.20
- (2) Regulators on containers of less than 125 gal (0.5 m³) water capacity for the purpose of being filled or in structures complying with Chapter 10
- (3) Regulators on containers on LP-Gas vehicles complying with, and parked or garaged in accordance with, Chapter 11
- (4) Regulators on containers used with LP-Gas stationary or portable engine fuel systems complying with Chapter 11

- (5) Regulators on containers used with LP-Gas-fueled industrial trucks complying with 11.13.4
- (6) Regulators on containers on LP-Gas-fueled vehicles garaged in accordance with Section 11.16
- (7) Regulators on cylinders awaiting use, resale, or exchange when stored in accordance with Chapter 8

6.8.1.4 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).

(A) This protection shall be permitted to be integral with the regulator.

(B) Regulators used for portable industrial applications shall be exempt from the requirements of 6.8.1.4.

6.8.1.5 The point of discharge from the required pressure relief device on regulated equipment installed outside of buildings or occupiable structures in fixed piping systems shall be located not less than 3 ft (1 m) horizontally away from any building or occupiable structure opening below the level of discharge, and not beneath or inside any building or occupiable structure unless this space is not enclosed for more than 50 percent of its perimeter.

6.8.1.6 The point of discharge shall also be located not less than 5 ft (1.5 m) in any direction from any source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

6.8.1.7 The discharge from the required pressure relief device of a second-stage regulator, other than a line pressure regulator, installed inside of buildings in fixed piping systems shall comply with the following:

- (1) The discharge shall be directly vented with supported piping to the outside air.
- (2) The vent line shall be at least the same nominal pipe size as the regulator vent connection pipe size.
- (3) Where there is more than one regulator at a location, either each regulator 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.
- (4) The material of the vent line shall comply with 5.8.3.
- (5) 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.
- (6) The discharge outlet shall also be located not less than 5 ft (1.5 m) in any direction from any source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes.
- (7) 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.

6.8.1.8 The requirement in 6.8.1.7 shall not apply to appliance regulators otherwise protected, to 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 6.2.2(1), 6.2.2(2), 6.2.2(4), 6.2.2(5), and 6.2.2(6).

6.8.1.9 The requirement in 6.8.1.7 shall not apply to vaporizers.

6.8.1.10 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.

6.8.1.11 Line pressure regulators shall be installed in accordance with the requirements of NFPA 54, *National Fuel Gas Code*.

6.8.2 Selection of Pressure Regulators.

6.8.2.1 A two-stage regulator system, an integral two-stage regulator, or a 2 psi regulator system shall be required on all fixed piping systems that serve ½ psig (3.4 kPag) appliance systems [normally operated at 11 in. water column (2.7 kPag) pressure].

6.8.2.2 The requirement for two-stage regulation shall include fixed piping systems for appliances on recreational vehicles, mobile home installations, manufactured home installations, catering vehicles, and food service vehicle installations.

6.8.2.3 Single-stage regulators shall not be installed in fixed piping systems after June 30, 1997, except for installations covered in 6.8.2.4.

6.8.2.4 Single-stage regulators shall be permitted on small portable appliances and outdoor cooking appliances with input ratings of 100,000 Btu/hr (29 kW) or less.

6.8.2.5 Gas distribution systems utilizing multiple second-stage regulators shall be permitted to use a high-pressure regulator installed at the container, provided that a first-stage regulator is installed downstream of the high-pressure regulator and ahead of the second-stage regulators.

6.8.2.6 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.

6.8.2.7 The overpressure protection device described in 6.8.2.6 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.

6.8.2.8 Systems consisting of listed components that provide an equivalent level of overpressure protection shall be exempt from the requirements of 6.8.2.6 and 6.8.2.7.

6.8.2.9 A 2 psi regulator system shall consist of a first-stage regulator and a 2 psi service regulator in compliance with the requirements of 5.8.1.14 in conjunction with a line pressure regulator that is in compliance with ANSI Z21.80/CSA 6.22, *Standard for Line Pressure Regulators*.

6.9 Piping Systems.

6.9.1 Piping System Service Limitations.

6.9.1.1 The physical state (vapor or liquid) and pressure at which LP-Gas is transmitted through piping systems shall be in accordance with 6.9.1.1(A) through 6.9.1.1(E).

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

(B) Outdoor underground LP-Gas liquid or vapor polyamide piping systems shall have pressure limitations as defined by the design pressure of the piping being installed.

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

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

(D)* LP-Gas vapor at pressures exceeding 20 psig (138 kPag) or LP-Gas liquid shall not be piped into any building unless the installation is in accordance with one of the following:

- (1) The buildings or structures are under construction or undergoing major renovation, and the temporary piping systems are in accordance with 6.20.2 and 6.20.12.
- (2) The buildings or separate areas of the buildings are constructed in accordance with Chapter 10 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
 - (c) Engine-mounted fuel vaporizers
- (3) Industrial occupancies are in accordance with 6.9.1.2.

(E)* Corrugated stainless steel piping systems shall be limited to vapor service not exceeding the listed pressure rating of the product.

6.9.1.2* LP-Gas vapor fixed piping systems at pressures of 20 psig through 50 psig (138 kPag through 345 kPag) in industrial occupancies shall be approved and shall comply with 6.9.1.2(A) through 6.9.1.2(D).

(A) The industrial equipment shall require inlet pressures greater than 20 psig (138 kPag).

(B) Pressure relief valve protection shall be provided for the vapor piping system that will limit any overpressure in the piping system to not more than 10 percent of the design pressure of the system.

(C) Pressure relief valve discharge shall be vented directly to the outdoors.

(D) A low-temperature control system shall positively shut off the flow of LP-Gas into the vapor piping system when the temperature of the LP-Gas vapor is reduced to its condensation point at the maximum design operating pressure of the system.

6.9.1.3 Liquid piping systems in buildings or structures feeding a vaporizer other than those covered by 6.9.1.1(D) shall comply with the material requirements of Chapters 5 and 6.

6.9.2 Sizing of LP-Gas Vapor Piping Systems.

6.9.2.1 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.

6.9.2.2 LP-Gas vapor piping systems shall be sized and installed to provide a supply of gas to meet the maximum demand of all gas utilization equipment using Table 15.1(a) through Table 15.1(q) or engineering methods.

6.9.3 Installation of Metallic Pipe, Tubing, and Fittings.

6.9.3.1* All metallic LP-Gas piping shall be installed in accordance with ASME B31.3, *Process Piping*, for normal fluid service, or in accordance with Section 6.9.

6.9.3.2 All welding and brazing of metallic piping shall be in accordance with ASME *Boiler and Pressure Vessel Code*, Section IX.

6.9.3.3 Metallic piping shall comply with 6.9.3.3(A) through 6.9.3.3(C).

(A) Piping used at pressures higher than container pressure, such as on the discharge side of liquid transfer pumps, shall be designed for a pressure rating of at least 350 psig (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 6.9.3.3(A) shall be designed 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 designed for a pressure rating of at least 125 psig (0.9 MPag).

6.9.3.4 Pressure relief valve discharge piping shall be exempt from the requirement of 6.9.3.3(C).

6.9.3.5 Metallic pipe joints shall be permitted to be threaded, flanged, welded, or brazed using pipe and fittings that comply with 5.9.3, 5.9.4, and 6.9.3.5(A) through 6.9.3.5(H).

(A) Metallic threaded, welded, and brazed pipe joints shall be in accordance with Table 6.9.3.5(A).

Table 6.9.3.5(A) Types of Metallic Pipe Joints in LP-Gas Service

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

(B) Fittings and flanges shall be designed for a pressure rating 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.

(E) Gaskets 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.

(F) When a flange is opened, the gasket shall be replaced.

(G) Aluminum O-rings and spiral-wound metal gaskets shall be permitted to be used.

(H) Nonmetallic gaskets used in insulating fittings shall be permitted to be used.

6.9.3.6 Metallic tubing joints shall be flared or brazed using tubing and fittings in accordance with 5.9.3 and 5.9.4.

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

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

6.9.3.9 Piping systems, including the interconnection of permanently installed containers, shall compensate for expansion, contraction, jarring, vibration, and settling.

(A) Flexible metallic connectors shall be permitted to be used.

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

6.9.3.10 Aboveground piping shall be supported and protected against physical damage by vehicles.

6.9.3.11 The portion of aboveground piping in contact with a support or a corrosion-causing substance shall be protected against corrosion.

6.9.3.12 Buried metallic pipe and tubing shall be installed underground with a minimum 12 in. (300 mm) of cover.

(A) The minimum cover shall be increased to 18 in. (460 mm) if external damage to the pipe or tubing from external forces is likely to result.

(B) If a minimum 12 in. (300 mm) of cover cannot be maintained, the piping shall be installed in conduit or shall be bridged (shielded).

6.9.3.13 Where underground piping is beneath driveways, roads, or streets, possible damage by vehicles shall be taken into account.

6.9.3.14 Metallic piping shall be protected against corrosion in accordance with 6.9.3.14(A) through 6.9.3.14(C).

(A) Piping and tubing of 1 in. (25 mm) nominal diameter or smaller shall be protected in accordance with 6.17.1 or 6.17.2.

(B) Piping and tubing larger than 1 in. (25 mm) nominal diameter and installed above ground shall be protected in accordance with 6.17.1.

(C) Steel piping larger than 1 in. (25 mm) nominal diameter installed underground shall have a cathodic protection system in accordance with 6.17.2(C) unless technical justification is approved by the authority having jurisdiction.

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

6.9.3.16 Underground metallic piping, tubing, or both that convey LP-Gas from a gas storage container shall be provided with dielectric fittings installed above ground and outdoors at the building to electrically isolate it from the aboveground portion of the fixed piping system that enters a building.

6.9.4 Installation of Polyamide and Polyethylene Pipe, Tubing, and Fittings.

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

6.9.4.2 Polyethylene and polyamide pipe and tubing shall be buried as follows:

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

6.9.4.3 Assembled anodeless risers shall be used to terminate underground polyamide and polyethylene fixed piping systems above ground.

(A) 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 Section 6.17.