

NFPA®

58

Liquefied
Petroleum
Gas Code



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Liquefied Petroleum Gas Code

2024 Edition



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NFPA® 58

Liquefied Petroleum Gas Code

2024 Edition

This edition of NFPA 58, *Liquefied Petroleum Gas Code*, was prepared by the Technical Committee on Liquefied Petroleum Gases and acted on by the NFPA membership during the 2023 NFPA Technical Meeting held June 22. It was issued by the Standards Council on August 25, 2023, with an effective date of September 14, 2023, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at www.nfpa.org for more information.

This edition of NFPA 58 was approved as an American National Standard on September 14, 2023.

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, 2011, 2014, 2017, and the latest one, in 2020.

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 protected. The requirement that a pressure relief valve be piped vertically upward 7 ft (2.1 m) from the valve was deleted because the technical committee could find no technical reason to justify it. Former railroad tank cars 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 harmonized container requirements for containers with equal to or less than 4000 gal water capacity (w.c.) (15.2 m³) and greater than 4000 gal w.c. (15.2 m³). Bulk plants and industrial plants are defined as facilities that store more than 4000 gal w.c. (15.2 m³), which is the reason for the demarcation point of 4000 gal w.c. (15.2 m³). A new definition was added for *vehicular barrier protection* (VBP). There were many installations where the container and valves were required to be protected from vehicular impact, but no specific information was available as to what constituted such protection. In addition to the definition describing VBP, extensive annex material was incorporated. Prescriptive requirements also were added for VBP of LP-Gas dispensers.

Qualifications of personnel were expanded for clarification in Chapter 4 of the 2014 edition. The requirements, which originated as a Temporary Interim Amendment (TIA) to the 2011 edition, specified which personnel and in which topics they must be trained. New requirements included the covering of tank heaters, and requirements for vaporizers were updated.

The 2014 edition included new requirements to provide cathodic protection for underground metallic piping systems greater than 2 in. (5.08 cm) diameter. Previously, all underground metallic piping was only required to be coated or painted. The new requirements for piping systems were very similar to those for cathodic protection of underground containers.

In previous editions, hot air balloons were not covered under the scope of NFPA 58. The 2017 edition added requirements referencing the current state of federal law regarding their use and construction. The requirements for hot air balloons were included in the corresponding sections for scope, construction, and liquid transfer. The requirements for when a container or piping must be protected from snow loads were altered to allow for calculations and snowfall maps from ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*. The threshold for protecting containers and appurtenances from snow was raised to 100 lb/ft² (488 kgf/m²). Vehicle barrier protection

(VBP) for cylinders protected in a metal cabinet was removed. The VBP requirement for 12,000 lb (53,375 N) protection for vehicle fuel dispensers was also removed.

A new Chapter 12 in the 2017 edition updated the technology available for over-the-road vehicles utilizing LP-Gas. New definitions, construction, transportation, and location requirements were added for skid tanks and porta-pacs. Also, requirements were added in Chapter 6 for the placing of ASME tanks that have been disconnected from use.

Fire extinguisher requirements were centralized to Section 4.7 for basic requirements in the 2017 edition, with individual capacity requirements remaining in the specific application section. The appurtenance requirements in Table 5.9.4.1 (B) were expanded to cover containers, except DOT Spec. 39, less than 2 lb (0.9 kg) propane capacity. Universal tanks were permitted to be filled in the horizontal or vertical orientation as long as the positioning slot was in the correct orientation.

In the 2020 edition, new requirements for fire resistance rating and noncombustible materials were added to specify when materials are required to have a certain fire resistance rating or when they must be noncombustible. Schedule 10 steel piping was allowed for use in aboveground vapor service only and austenitic stainless steel was allowed as a piping material.

Fire extinguisher requirements were revised to specify that fire extinguishers shall not be used for LP-Gas pressure fires unless the source of fuel can be shut off promptly. This was a revision that removed conflict between industry standards and this code when choosing a fire extinguisher for an application.

Requirements were added to require inspection of the face seal on CGA 791 and CGA 793 connections prior to filling because defects in the connection face seal will degrade the effectiveness of the seal; if any defects are found on the face seal, the cylinder is not to be refilled and the valve is to be replaced.

Revisions were made to Chapter 15, Operations and Maintenance, to specifically reference operations and maintenance requirements and to remove a number of unrelated installation requirements. Additionally, the scope of Chapter 15 was revised to exclude systems regulated by the U.S. Department of Transportation because its requirements for operations and maintenance are more stringent.

Several major revisions have been made to the 2024 edition of the code. A new Chapter 16 has been added to cover the installation of LP-Gas systems on food trucks and includes material on piping system construction, container installation, and appliance installation. Installation of horizontal containers has also been revised to more clearly cover the different types of installation of different sizes of horizontal containers based on the container support. Requirements for purging of LP-Gas systems into and out of service have been added to the operations and maintenance chapter as facilities need to have proper procedures and plans when purging LP-Gas systems at facilities.

The application section of the code has also been revised to clarify that containers, piping, and associated equipment that supply manufacturing, plant oil extraction, or liquid fuel blending are under the scope of NFPA 58 while the manufacturing, plant oil extraction, or liquid fuel blending processes themselves are outside the scope.

Requirements for emergency remote shutdown devices have been consolidated into Chapter 4 so that all the requirements for the devices are uniform when an emergency remote shutdown device is required.

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NFPA 58

Liquefied Petroleum Gas Code

2024 Edition

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

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

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

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 for use as a fuel gas
- (2)* Containers, piping, and associated equipment, when supplying LP-Gas for use in a manufacturing, plant oil extraction, or liquid fuel blending process
- (3) Highway transportation of LP-Gas
- (4) 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
- (5)* The design, construction, installation, and operation of pipeline terminals, beginning downstream of the last

pipeline valve or tank manifold inlet, 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

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)
- (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 where NFPA 54 is adopted, used, or enforced
- (7) Transportation by air, 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
- (11) Propane vehicle fuel dispensers located at multiple fuel refueling stations (see NFPA 30A)

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 any portions of this code retroactively.

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. The primary units of measure used in this code shall be U.S. customary units (inch-pound units).

1.6.1 International System (SI) units shall follow inch-pound units in parenthesis.

1.6.2 SI equivalents in this code are approximate and shall not be used to lessen any provision.

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*, 2022 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2022 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2022 edition.

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

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2021 edition.

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

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

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2023 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2021 edition.

NFPA 70®, *National Electrical Code®*, 2023 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2021 edition.

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

NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, 2021 edition.

NFPA 220, *Standard on Types of Building Construction*, 2021 edition.

NFPA 1192, *Standard on Recreational Vehicles*, 2021 edition.

2.3 Other Publications.

2.3.1 API Publications. American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001-5571.

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

API 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*, 2016.

API 620, *Design and Construction of Large, Welded, Low-pressure Storage Tanks*, 2013, with 2014 and 2018 addenda.

API Specification 15S, *Spoolable Reinforced Plastic Line Pipe*, 2019.

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

ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, 2022.

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

ASME B1.20.1, *Pipe Threads, General Purpose, Inch*, 2013, revised 2018.

ASME B16.40, *Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems*, 2019.

ASME B31.3, *Process Piping*, 2020.

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*, 2018.

Boiler and Pressure Vessel Code, 2021.

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

ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings*, 1999, reapproved 2018e1.

ASTM A48/A48M, *Standard Specification for Gray Iron Castings*, 2022.

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2020.

ASTM A106/A106M, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*, 2019a.

ASTM A213/A213M, *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*, 2022a.

ASTM A249/A249M, *Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes*, 2018a.

ASTM A269/A269M, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*, 2015a, reapproved 2019.

ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*, 2019.

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

ASTM A513/A513M, *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing*, 2020a.

ASTM A536, *Standard Specification for Ductile Iron Castings*, 1984, reapproved 2019e1.

ASTM A822/A822M, *Standard Specification for Seamless Cold-Drawn Carbon Steel Tubing for Hydraulic System Service*, 2020.

ASTM B42, *Standard Specification for Seamless Copper Pipe, Standard Sizes*, 2020.

ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*, 2020.

ASTM B75/B75M, *Standard Specification for Seamless Copper Tube*, 2020.

ASTM B86, *Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings*, 2018e1.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, 2020.

ASTM B135/B135M, *Standard Specification for Seamless Brass Tube*, 2017.

ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, 2020.

ASTM B837, *Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems*, 2019.

ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, 2020.

ASTM D2683, *Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing*, 2020.

ASTM D3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*, 2016.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2021a.

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2020.

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, 2019a.

ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, 2018.

ASTM F1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*, 2016a.

ASTM F1733, *Standard Specification for Butt Heat Fusion Polyamide (PA) Plastic Fitting for Polyamide (PA) Plastic Pipe and Tubing*, 2020.

ASTM F1948, *Standard Specification for Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing*, 2020.

ASTM F2145, *Standard Specification for Polyamide 11 (PA11) and Polyamide 12 (PA12) Mechanical Fittings for Use on Outside Diameter Controlled Polyamide 11 and Polyamide 12 Pipe and Tubing*, 2013, reapproved 2018.

ASTM F2509, *Standard Specification for Field-assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene and Polyamide-11 (PA11) Gas Distribution Pipe and Tubing*, 2015, reapproved 2019.

ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings*, 2018.

2.3.5 CGA Publications. Compressed Gas Association, 8484 Westpark Dr., Suite 220, McLean, VA 22102.

CGA C-1, *Methods For Pressure Testing Compressed Gas Cylinders And Tubes*, 2022.

CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, 2019.

CGA C-7, *Guide to Classification and Labeling of Compressed Gases*, 2020.

CGA S-1.1, *Pressure Relief Device Standards, Part 1— Cylinders for Compressed Gases*, 2022.

CGA S-1.3, *Pressure Relief Device Standards, Part 3 — Stationary Storage Containers for Compressed Gases*, 2020.

CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, 2021.

CSA CAN/CGA-8.1-M86, *Elastomeric Composite Hose and Hose Couplings for Conducting Propane and Natural Gas*, 1986, reaffirmed 2011 (withdrawn).

2.3.6 CSA Group Publications. CSA Group, 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada.

ANSI LC 1/CSA 6.26, *Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*, 2019.

ANSI LC 4/CSA 6.32, *Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems*, 2012, revised 2021.

ANSI Z21.11.3, *Gas-Fired Room Heaters, Volume III, Propane-Fired Portable Emergency Use Heater Systems*, 2016.

ANSI Z21.18/CSA 6.3, *Gas Appliance Pressure Regulators*, 2019.

ANSI Z21.24/CSA 6.19, *Connectors for Gas Appliances*, 2015, revised 2020.

ANSI Z21.69/CSA 6.16, *Connectors for Moveable Gas Appliances*, 2015, revised 2020.

ANSI Z21.75/CSA 6.27, *Connectors for Outdoor Gas Appliances and Manufactured Homes*, 2016, revised 2021.

ANSI Z21.80/CSA 6.22, *Line Pressure Regulators*, 2019.

ANSI Z21.81/CSA 6.25, *Cylinder Connection Devices*, 2005, revised 2020.

CSA B149.5, *Installation Code for Propane Fuel Systems and Containers on Motor Vehicles*, 2020.

2.3.7 ISO Publications. International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO/DIS 19825, *Road vehicles — Liquefied petroleum gas (LPG) refuelling connector*, 2018.

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

NBBI NB23, *National Board Inspection Code*, 2021.

2.3.9 SAE Publications. SAE International, Society of Automotive Engineers, 901 15th Street, NW, Suite 520, Washington, DC 20005.

SAE J356, *Welded, Flash-Controlled, Low-Carbon Steel Tubing Normalized for Bending, Double Flaring, Beading, Forming, and Brazing*, 2019.

SAE J512, *Automotive Tube Fitting*, 1997, reaffirmed 2022.

SAE J513, *Refrigeration Tube Fittings — General Specifications*, 1999.

SAE J1292, *Automobile and Motor Coach Wiring*, 2016.

SAE J2223-1, *Connections for On-Board Road Vehicle Electrical Wiring Harnesses — Part 1: Single-Pole Connectors — Flat Blade Terminals — Dimensional Characteristics and Specific Requirements*, 2011.

SAE J2223-3, *Connections for On-Board Road Vehicle Electrical Wiring Harnesses — Part 3: Multipole Connectors — Flat Blade Terminals — Dimensional Characteristics and Specific Requirements*, 2011.

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

UL 21, *LP-Gas Hose*, 2014, revised 2017.

UL 125, *Flow Control Valves for Anhydrous Ammonia and LP-Gas*, 2020.

UL 132, *Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, 2021.

UL 144, *LP-Gas Regulators*, 2021.

UL 147A, *Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*, 2019.

UL 147B, *Nonrefillable (Disposable) Type Metal Container Assemblies for Butane*, 2019.

UL 495, *Power-Operated Dispensing Devices for LP-Gas*, 2016.

UL 514B, *Conduit, Tubing, and Cable Fittings*, 2020.

UL 567, *Emergency Breakaway Fittings, Swivel Connectors, and Pipe-Connection Fittings for Petroleum Products and LP-Gas*, 2021.

UL 569, *Pigtails and Flexible Hose Connectors for LP-Gas*, 2017.

UL 651, *Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings*, 2011, revised 2020.

UL 723, *Test for Surface Burning Characteristics of Building Materials*, 2018.

UL 1337, *Outline of Investigation for LP-Gas, Natural Gas, and Manufactured Gas Devices for Engine Fuel Systems*, 2020.

UL 1660, *Liquid-Tight Flexible Nonmetallic Conduit*, 2019.

UL 1769, *Cylinder Valves*, 2015, revised 2016.

UL 2061, *Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies*, 2015, revised 2020.

UL 2227, *Overfilling Prevention Devices*, 2007, revised 2019.

2.3.11 United Nations Economic Commission for Europe Publications. UN Economic Commission for Europe Information Services, Palais des Nations, CH-1211 Geneva 10, Switzerland.

ECE R67.01, *Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts Which Can Be Fitted and/or Be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions*, Revision 4, 1998.

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

Interstate Commerce Commission (ICC) *Rules for Construction of Unfired Pressure Vessels*.

Title 49, Code of Federal Regulations, "Transportation."

Title 49, Code of Federal Regulations, Subchapter C, "Hazardous Materials Regulations."

Title 49, Code of Federal Regulations, Part 180, "Continuing Qualification of Maintenance of Packaging."

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

Title 49, Code of Federal Regulations, Part 192.283(b), "Plastic Pipe: Qualifying Joining Procedures — Mechanical Joints."

Title 49, Code of Federal Regulations, Part 192, Appendix D, "Criteria for Cathodic Protection and Determination of Measurements."

Title 49, Code of Federal Regulations, Part 393, "Federal Motor Carrier Safety Regulations — Parts and Accessories Necessary for Safe Operation."

Title 49, Code of Federal Regulations, Part 396, "Federal Motor Carrier Safety Regulations — Inspection, Repair, and Maintenance."

Title 49, Code of Federal Regulations, Part 397, "Federal Motor Carrier Safety Regulations — Transportation of Hazardous Materials; Driving and Parking Rules."

2.3.13 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

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

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

NFPA 101®, *Life Safety Code*®, 2021 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 peri-

odic 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 3.3.81.1.

3.3.2 Anodeless Riser. A transition assembly used between underground polyethylene or polyamide pipe and above-ground metal piping or equipment, and terminating above-ground 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* Assembly Occupancy. An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load. [101, 2021]

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 Cabinet Heater. A portable unvented heater with a self-contained propane supply.

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

3.3.13 CGA. The Compressed Gas Association.

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

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

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

3.3.17 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.

3.3.18 Cylinder. A portable container with a marked water capacity of 1000 lb (454 kg) or less that is designed to transport and store LP-Gas.

3.3.18.1 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 filling and withdrawal appurtenances function properly in either position.

3.3.19 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.

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

3.3.21 Direct Injection. A fuel injection system that delivers LP-Gas fuel through a fuel injector, directly into the combustion chamber at high pressures, as opposed to the injection of fuel into the intake manifold air flow stream, upstream of and prior to the intake valve opening.

3.3.22* Dispenser. An assembly used to transfer LP-Gas into cylinders, portable and mobile containers, and vehicle fuel containers.

N 3.3.22.1* Self-Service Engine Fuel Dispenser. A vehicle fuel dispenser for use by the public for conducting dispensing operations.

3.3.22.2 Vehicle Fuel Dispenser. A dispenser designed to transfer LP-Gas into engine fuel and mobile containers on vehicles.

3.3.23 Dispensing System. An assembly of equipment that includes a dispenser and storage container(s) for storing and transferring LP-Gas from storage to cylinders, portable and mobile containers, and vehicle fuel containers.

3.3.24 DOT. U.S. Department of Transportation.

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

3.3.26 Filling.

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

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

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

3.3.28 Flexible Connector. A fixed piping system component that is fabricated from a flexible material and equipped with connections at both ends.

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

3.3.28.2 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.

3.3.28.3 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.

3.3.29 Fuel Rail. A manifold, pipe, or duct that connects or retains the fuel injection devices for the purpose of providing fuel supply to each injector.

3.3.30 Fuel Switching Device. A component used in some direct injections systems, which is used to switch between fuels of a bifuel powered vehicle.

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

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

3.3.33* 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.

3.3.34 Gauge.

3.3.34.1 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.

3.3.34.2 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.

3.3.34.3 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.

3.3.34.4 Magnetic Gauge. See 3.3.34.3, Float Gauge.

3.3.34.5 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.

3.3.34.6* 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.

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

3.3.35* Ground Snow Load. The snow load established by ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, as the 2 percent annual probability of exceedance or 50-year mean recurrence interval; also known as the “50-year ground snow load.”

3.3.36 ICC. U.S. Interstate Commerce Commission.

3.3.37 Ignition Source. See 3.3.75, Sources of Ignition.

3.3.38 Important Building. A building that is considered not expendable in an exposure fire. [30, 2021] (See A.6.4.1.1.)

3.3.39 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.

3.3.40* 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.

3.3.41 kPa. Absolute pressure in kilo-Pascals.

3.3.42 kPag. Gauge pressure in kilo-Pascals.

3.3.43 Leak Check. An operation performed on a gas piping system to verify that the system does not leak.

3.3.44* 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.

3.3.45* Low-Emission Transfer. A method of transfer of LP-Gas liquid that limits the amount of propane released during the transfer process.

3.3.46 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.

3.3.47 Maximum Allowable Working Pressure (MAWP). The maximum pressure at which a pressure vessel is to operate as described by ASME's *Boiler and Pressure Vessel Code*.

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

N 3.3.49 Mobile Food Facility. A movable commercial or retail food facility.

N 3.3.50 Mobile Storage Vehicle Fuel Tender. A dispensing system installed for temporary service to transfer liquid LP-Gas into vehicles.

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

3.3.52 MPa. Absolute pressure in mega-Pascals.

3.3.53 MPag. Gauge pressure in mega-Pascals.

3.3.54 NFPA. National Fire Protection Association.

3.3.55 NPGA. National Propane Gas Association.

3.3.56 Overfilling Prevention Device (OPD). A device that is designed to provide an automatic means to prevent the filling of a container beyond a predetermined level.

3.3.57 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.

3.3.58 Permanent Installation. See 3.3.78, Stationary Installation (Permanent Installation).

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

3.3.60 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.

3.3.61 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.

3.3.62* Portable Container. A container designed to transport LP-Gas.

3.3.62.1 Cargo Tank. See 3.3.12, Cargo Tank.

3.3.62.2 Cylinder. See 3.3.18, Cylinder.

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

3.3.63* Portable Storage Container. A storage container that is not used to transport LP-Gas.

3.3.63.1 Movable Fuel Storage Tender. A non-DOT specification cargo tank that is used exclusively for agricultural purposes and is commonly known as a “farm cart.”

3.3.63.2 Porta-Pac. An ASME container installed on wheels with retractable landing gear that is used to store LP-Gas in temporary installations and not used to transport LP-Gas.

3.3.63.3 Skid Tank. A container that is designed and fabricated with permanently fastened skids or runners that is not designed to transport LP-Gas.

3.3.64 Power Supply Bushing. A sealed fitting that is installed in a container opening or multifunction valve body that seals conductors passing from the inside to the outside of the pressure vessel for the purposes of supplying electrical signals or operating voltage to electrical/electronic components located inside the pressure containment area of an ASME container.

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

3.3.66 Pressure Test. An operation performed to verify the gastight integrity of gas piping following its installation or modification.

3.3.67 psi. Pounds per square inch.

3.3.68 psia. Pounds per square inch absolute.

3.3.69 psig. Pounds per square inch gauge.

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

3.3.71 Readily Accessible. Capable of being accessed without the use of tools or other equipment.

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

3.3.73 Regulator.

3.3.73.1* Automatic Changeover Regulator. An integral two-stage regulator that combines two inlets on the high-pressure side of the regulator with a single second-stage regulator, thereby forming a single unit for use with multiple cylinder installations.

3.3.73.2 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.

3.3.73.3 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).

3.3.73.4 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.

3.3.73.5 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.

3.3.73.6 Line Pressure Regulator. A pressure regulator with no integral overpressure protection device for LP-Gas vapor service to reduce a nominal inlet pressure.

3.3.73.7 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.

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

3.3.73.9 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).

3.3.73.10 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).

3.3.73.11 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.

3.3.74 SCFM. Standard cubic feet per minute.

3.3.75 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.

3.3.76* 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.

3.3.77 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).

3.3.78 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.

3.3.79 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.

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

3.3.80 UL. Underwriters Laboratories Inc.

3.3.81 Valve.

3.3.81.1 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.

N 3.3.81.2 Backflow Check Valve. A valve designed to close to prevent the backward flow of fluid.

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

3.3.81.4 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.

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

3.3.81.6 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.

Δ 3.3.81.7* Internal Valve. A container primary shutoff valve, capable of being closed remotely, that incorporates an excess-flow capability located within the container designed such that it remains in place should external damage occur to the internal valve.

3.3.81.8 Positive Shutoff Valve. A shutoff valve that, in the closed position, does not allow the flow of LP-Gas in either direction.

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

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

3.3.81.9.2* 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.

3.3.81.9.3* 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.

3.3.81.9.4* 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.

3.3.81.10 Purge Valve. A mechanical or electromechanical device used to permit fuel flow through the engine supply and return lines, generally on fuel injection systems, to ensure all vapor is removed from the lines prior to engine start.

3.3.82 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.

3.3.82.1 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.

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

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

3.3.82.2.2 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.

3.3.82.3 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.

3.3.82.4 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.

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

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

3.3.85 Volumetric Loading. See 3.3.26.1, Volumetric Method Filling.

3.3.86 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.

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 being loaded into a railcar or cargo tank motor vehicle 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 The addition of the odorant shall be documented at the point of odorization.

4.2.3* The presence of the odorant shall be verified by sniff-testing or other means and the results documented prior to final delivery to the end-use customer.

4.2.4 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.

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	≤4000	≤15.2	Container system,* including regulator, or container assembly* and regulator separately
ASME containers	>4000	>15.2	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.

4.3 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 6.23.11.1(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 to transfer 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.

N 4.4.5* Where self-service engine fuel dispensers in accordance with 6.28.5 are available to the public, the requirements of 4.4.1 through 4.4.4 shall not apply.

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.

4.7* Portable Fire Extinguisher. Where portable fire extinguishers are required, they shall comply with NFPA 10 and the following requirements:

- (1) They shall have a minimum capacity of dry chemical with an A:B:C rating, as specified elsewhere in this code.
- (2) They shall not be used to extinguish an LP-Gas pressure fire unless the source of fuel can be shut off promptly.

4.8 Fire Resistance Rating. Whenever a fire resistance rating is required by this code, it shall be determined in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

4.9* Noncombustible Material.

4.9.1 A material that complies with any of the following shall be considered a noncombustible material:

- (1)* A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat
- (2) A material that is reported as passing ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*
- (3) A material that is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C* [101:4.6.13.1]

N 4.10 Emergency Remote Shutdown Devices. Where emergency remote shutdown devices are required to operate valves or electrical equipment, they shall comply with the following requirements:

- (1) The devices shall be readily accessible.
- (2) The devices shall be located along a path of egress.
- (3) The devices shall be installed not less than 20 ft (6 m) or more than 100 ft (30 m) from the point of transfer controlled by the valve or electrical equipment.
- (4) The devices shall be identified by a sign incorporating the words "[name of the LP-Gas] Emergency Shutoff" in block letters at least 2 in. (51 mm) in height on a background of contrasting color to the letters.
- (5) Where the facility provides a single product or a single emergency shutoff controlling multiple products, the "[name of the LP-Gas]" designation in accordance with 4.10(4) shall not be required.
- (6) The sign required by 4.10(4) shall be located at the device.
- (7) The devices shall be installed outside of buildings except as in 4.10(8).
- (8) The devices shall be permitted to be installed within the structure where the point of transfer is located within a structure complying with Chapter 10.

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.

Δ 5.2.1.1* Containers shall be designed, fabricated, tested, and marked or stamped in accordance with the regulations of the US Department of Transportation (DOT 49 CFR); the Federal Aviation Administration (FAA 14 CFR); Section VIII, "Rules for the Construction of Unfired Pressure Vessels," of ASME's *Boiler and Pressure Vessel Code*; 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 the case interpretations and addenda of the applicable ASME Code that has been adopted and published within 180 calendar days prior to the effective date of this code shall be considered compliance with the ASME Code.

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

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 5.2.4.3, Table 5.9.2.5(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 NBBI 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 Dispensing systems 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 containers designed, constructed, tested, and marked in accordance with 49 CFR, "Transportation," or in accordance with a valid DOT special permit.

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

5.2.2.3 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 at the Point of Use.

5.2.3.1 Cylinders in stationary service that are filled 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 Cylinders shall be designed and constructed for at least a 240 psig (16 bar) service pressure.

5.2.4.3 The maximum allowable working pressure (MAWP) for ASME containers shall be in accordance with Table 5.2.4.3.

5.2.4.4 In addition to the applicable provisions for horizontal ASME containers, vertical ASME containers over 125 gal (0.5 m³) water capacity shall comply with 5.2.4.4(A) through 5.2.4.4(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 5.2.4.3*) 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 LP-Gas.

(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/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. Wind speeds shall be based on a mean occurrence interval of 100 years.

(D) Seismic loading on containers shall be in accordance with ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. A seismic 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.

5.2.4.5 ASME engine fuel containers installed on vehicles shall have a MAWP as required in Chapter 11 or Chapter 12.

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

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

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.

Table 5.2.4.3 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.

5.2.5.2 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 within 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 Portable Storage Containers.

5.2.7.1 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.

5.2.7.2 The attachment of a container to either a trailer or semitrailer 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.

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.

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

- (1) All ASME container nameplate requirements
- (2) Service (i.e., aboveground, underground, or both)
- (3) Water capacity of container in pounds or U.S. gallons
- (4) Wordings that reads “This container shall not contain a product that has a vapor pressure in excess of ____ psig at 100°F” (see Table 5.2.4.3)
- (5) Outside surface area in square feet
- (6) Shell thickness and head thickness
- (7) Overall length (OL), outside diameter (OD), and head design (HD)

(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.

Δ 5.2.8.5 All containers that contain unodorized LP-Gas shall be marked “NOT ODORIZED.”

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

Table 5.2.8.5(A) Size of “NOT ODORIZED” Marking

Water Capacity		Letter Height		Border Width	
gal	m ³	in.	mm	in.	mm
≥499	≥1.89	4	100	½	13
49–498	0.19–1.88	1½	37	⅝ ₁₆	8
2.6–48	0.01–0.18	¾	18	¼	6
1–2.5	0.004–0.009	⅜	10	⅛ ₁₆	2

(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.

5.2.9 Containers for Hot Air Balloons.

5.2.9.1 Containers for hot air balloons shall be marked to demonstrate compliance with FAA regulations.

5.2.9.2 Containers used in hot air balloons shall not be used for any other purpose.

5.3 Reserved.

5.4 Reserved.

5.5 Reserved.

5.6 Containers with Attached Supports.

5.6.1 Vertical ASME Containers. 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 installed on and fastened to concrete foundations or supports.

5.6.1.1 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.

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

Δ 5.6.1.3 Steel Skirts.

N (A) Steel skirts having only one opening that is 18 in. (460 mm) or less in diameter shall be protected in accordance with 5.6.1.3(B).

N (B) The outside of the skirt shall have a fire resistance rating of 2 hours.

5.6.2 Skid Tanks. Skid tanks shall have a secure steel frame to allow transportation of the skid tank when not filled with LP-Gas.

5.6.3 Porta-Pacs.

5.6.3.1 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.

5.6.3.2 The ASME container shall be attached to either of the following:

- (1) A trailer or semitrailer 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.

- (2) A metal frame such that the container can be moved as a trailer if wheels are added, which is approved for stationary use, or on a flat rail car.

5.6.3.3 Protection of appurtenances shall be in accordance with 5.2.6.

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

N 5.6.4 Mobile Storage Vehicle Fuel Tender.

N 5.6.4.1 The legs, supports, or 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.

N 5.6.4.2 The ASME container shall be attached to and supported by noncombustible materials.

N 5.6.4.2.1 The method of support shall be one of the following:

- (1) A trailer running gear, a semitrailer running gear, or the necessary attachments to make the container part of a vehicle
- (2) A metal frame designed to support the container during use as a temporary installation and to support and restrain the container during transportation

N 5.6.4.3 Protection of appurtenances shall be in accordance with 5.2.6.

5.7 Reserved.

5.8 Reserved.

5.9 Container Appurtenances.

5.9.1 Materials.

5.9.1.1 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

5.9.1.2* 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

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

5.9.1.4 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.

5.9.2 Pressure Relief Devices. See Section 5.16 for hydrostatic relief valves.

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

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

5.9.2.2.1 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*.

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

5.9.2.3.1 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).

5.9.2.4 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.

Δ 5.9.2.5 ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with the applicable requirements of UL 132, *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 5.9.2.5, in relation to the pressure rating of the container, shall be in accordance with Table 5.9.2.5(A).

(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) Pilot-operated relief valves shall be combined with, and controlled by, self-actuated, direct, spring-loaded pilot valves that comply with Table 5.9.2.5(A).

Table 5.9.2.5(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.

- (2) Pilot-operated pressure relief valves shall be inspected and maintained by persons with training and experience.
- (3) Pilot-operated pressure relief valves shall be inspected and maintained by persons with training and experience and shall be tested for operation at intervals not exceeding 5 years.

5.9.2.6 The minimum rate of discharge of pressure relief valves installed in ASME containers shall be in accordance with Table 5.9.2.6 or shall be calculated using the following formula:

[5.9.2.6]

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

where:

F = flow rate (SCFM air)

A = total outside surface area of container (ft²)

5.9.2.7 Relief valves for aboveground ASME containers shall relieve at not less than the flow rate specified in 5.9.2.6 before the pressure exceeds 120 percent of the minimum permitted

Table 5.9.2.6 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.

start-to-leak pressure setting of the device, excluding the 10 percent tolerance in Table 5.9.2.5(A).

5.9.2.8 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 5.9.2.6.

5.9.2.9 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

5.9.2.10 Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold meeting the requirements of 6.9.2.8 is used.

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

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

5.9.2.13 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.

5.9.2.14 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 cylinder's date of manufacture and within every 12 years thereafter and if either of the following apply:

- (1) If the cylinder was requalified by a pressure test method with determination of expansion properties as defined in 49 CFR 180, *Continuing Qualification of Maintenance of Packaging*, and CGA Publication C-1, *Methods For Pressure Testing Compressed Gas Cylinders And Tubes*, within every 12 years thereafter
- (2) If the cylinder was requalified by the proof pressure test or visual requalification methods as defined in 49 CFR 180, *Continuing Qualification of Maintenance of Packaging*, and CGA Publications C-1, *Methods For Pressure Testing Compressed Gas Cylinders And Tubes*, or C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, within each 10 years thereafter

5.9.2.15 Multiple function valves installed on single opening cylinders used in industrial truck service shall meet the following requirements:

- (1) Full internal pressure relief valves or flush-type full internal pressure relief valves shall be installed in multiple function valves that are used with single opening cylinders used in industrial truck service.
- (2) Full internal pressure relief valves or flush-type full internal pressure relief valves shall have the springs and guiding mechanism on the container pressure side of the seats, so that the springs and guiding mechanism are not exposed to the atmosphere.

- (3) The multiple function valve with the full internal or flush-type full internal pressure relief valve shall be permitted to have the means to be replaced without removing the multiple function valve from the cylinder.
- (4) The multiple function valve shall incorporate an excess-flow valve installed inside the container for the liquid or vapor withdrawal service valve outlet.
- (5) The multiple function valve shall incorporate a weak section on the service valve outlet connection.
- (6) The multiple function valve shall incorporate an excess-flow valve installed inside the container that shall not restrict the flow to the full internal or flush-type full internal pressure relief valve.
- (7) The multiple function valve shall be listed.

5.9.3 Overfilling Prevention Devices.

▲ 5.9.3.1 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 UL 2227, *Overfilling Prevention Devices*, and a fixed maximum liquid level gauge. These devices shall be either separate components or combined in the container valve assembly.

▲ 5.9.3.2* 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).

5.9.3.3 Cylinders required to have an overfilling prevention device installed shall be equipped with either a CGA connection number 791, CGA connection number 793, or CGA connection number 810 as described in CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

5.9.3.4 The following types of cylinders shall be exempt from the requirements of 5.9.3.1 through 5.9.3.3:

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

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

5.9.4 Container Valves and Other Appurtenances.

5.9.4.1 Containers of 4000 gal (15.2 m³) water capacity or less shall comply with 5.9.4.1(A) through 5.9.4.1(E).

(A) The following containers shall be permitted to be equipped with external pressure relief valves:

- (1) Underground ASME containers
- (2) ASME containers originally equipped with external pressure relief valves
- (3) ASME containers with 125 gal (0.5 m³) water capacity or less, having a pressure relief valve integrated as part of a multiple function valve

(B) Cylinders of less than 2 lb water capacity shall comply with Table 5.9.4.1(B).

▲ (C) Containers 2 lb through 4000 gal water capacity shall be fitted with valves and other appurtenances in accordance with 5.9.8.1, Table 5.9.4.1(B), and the following:

- (1) Shutoff, filler, check, and excess-flow valves for ASME containers shall comply with UL 125, *Flow Control Valves for Anhydrous Ammonia and LP-Gas*.
- (2) Shutoff valves used on cylinders shall comply with UL 1769, *Cylinder Valves*.
- (3) Containers greater than 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 and 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.
- (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.
- (7) A filler valve shall incorporate one of the following:
 - (a) Double backflow check valves of the spring-loaded type
 - (b) Manual shutoff valve with an internal backflow check valve of the spring-loaded type
 - (c) 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:
 - (a) An orifice between the container contents and the shutoff valve outlet, not exceeding ⅝ in. (8 mm) in diameter, and an approved regulator directly attached, or attached with a flexible connector, to the manual shutoff valve outlet
 - (b) An 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 5.9.3.)
- (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.

▲ (D) Containers used in stationary service having water capacities greater than 1000 gal (3.8 m³) but equal to or less than 4000 gal (15.2 m³) and using a liquid withdrawal opening for liquid service shall be equipped with one of the following:

- (1) An internal valve fitted for remote closure and automatic shutoff equipped with thermal activation
- (2) An emergency shutoff valve fitted for remote closure and automatic shutoff, equipped with thermal activation, and installed in a line downstream close to a positive shutoff valve and an excess-flow valve installed in the container

Table 5.9.4.1(B) Container Connection and Appurtenance Requirements for Containers Used in Other Than Bulk Plants and Industrial Plants

Part	Appurtenance	1	2	3
		≤420 lb propane capacity (except DOT Spec. 39)	Stationary ASME containers ≤4000 gal water capacity ^a	DOT and ASME engine fuel and mobile containers installed on vehicles
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
C	Pressure relief valve	R (See 5.9.2.2.)	R ^c [See 5.9.4.1(A).]	R With full internal or flush-type full internal pressure relief valve
D	Fixed maximum liquid level gauge	R (filled by volume)	R [See 5.9.4.1(C)(10).]	R (ASME only)
E	Overfilling prevention device	R (4 lb through 40 lb) (See 5.9.3.)	NR	R (ASME only) [See 5.9.4.1(C)(6).]
F	Actuated liquid withdrawal excess- flow valve	NR	R (≥125 gal) [See 5.9.4.1(C)(3), (4), and (5).]	NR
G	Float gauge	NR	R (>124 gal only)	NR
H	Filler valve [See 5.9.4.1(C)(7).]	R (≥100 lb cylinders that are filled at the point of use)	R	R (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 can be used. See 5.9.4.1(A), 5.9.4.1(B), and 5.9.4.1(C).

(3) Both an excess-flow valve installed at the container and a valve complying with the following requirements:

- The valve shall comply with API 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*.
- The valve shall be designed to fail in the closed position.
- The valve shall be fitted for remote closure and equipped with thermal actuation with a thermal element located within 5 ft (1.5 m) of the valve.
- At least one remote emergency shutdown device in accordance with Section 4.10 shall be installed.

(E) Existing installations shall comply with the requirements of 5.9.4.1(D) within 3 years of the first adoption of the 2023 or later edition of this code.

5.9.4.2 Openings in ASME containers greater than 4000 gal (15.2 m³) water capacity shall be fitted with valves and other appurtenances in accordance with 5.9.4.2(A) through 5.9.4.2(I) and Table 5.9.4.2.

(A) Vapor withdrawal openings shall be equipped with either of the following:

- A positive shutoff valve located as close to the container as practical and an excess-flow valve installed in the container
- An internal valve

Table 5.9.4.2 Connection and Appurtenance Requirements for New and Existing Container Installations in Bulk Plants and Industrial Plants

Service	>4000 gal w.c. (>15.2 m ³) ^{a,b}	Requirements for Containers of >4000 gal w.c. (>15.2 m ³) With and Without Internal Valves ^c	
		Without Existing Internal Valves (by 7/1/11)	With Existing Internal Valves
Vapor inlet	Option A, Option B, or Option C	See Note.	See Note.
Vapor outlet	Option B or Option C	See Note.	See Note.
Liquid inlet	Option D or Option E	Option D, Option E, Option F, or Option G	RT
Liquid outlet	Option E	Option E or Option H	RT

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

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 5.15.2.4.

Option C: Internal valve installed in the container or an excess-flow valve in accordance with 5.9.4.2(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 (i.e., fire) activation within 5 ft (1.5 m) of valve or an excess-flow valve in accordance with 5.9.4.2(I).

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

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

^aApplicable to installations constructed on or after the effective date of the current edition of this code.

^bApplicable to installations constructed prior to the effective date of the current edition of this code.

^cSee also 5.9.4.2.

(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 (i.e., fire) actuation where the thermal element is located within 5 ft (1.5 m) of the internal valve.

(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 (i.e., 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 (i.e., 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 and 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 and either a backflow check valve or an excess-flow valve installed in the container
- (2) An internal valve

Δ (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 (i.e., 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 and a backflow check valve that is designed for the intended application and 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 (i.e.,

fire) actuation shall be equipped for remote and thermal closure by July 1, 2003.

Δ (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 (i.e., 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 and an excess-flow valve installed in the container
- (3) A positive shutoff valve that is located as close to the container as practical and a backflow check valve that is designed for the intended application and installed in the container
- (4) A backflow check valve that is designed for the intended application and installed in the line upstream as close as practical to a positive shutoff valve and an excess-flow valve installed in the container

Δ (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 the following requirements:

- (1) The valve shall comply with API 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*.
- (2) The valve shall be designed to fail in the closed position.
- (3) The valve shall be fitted for remote closure and equipped with thermal actuation with a thermal (i.e., fire) element located within 5 ft (1.5 m) of the valve.
- (4) At least one remote emergency shutdown device in accordance with Section 4.10 shall be installed.

N (J)* Liquid outlet openings and vapor openings on new ASME containers greater than 4000 gal (15.2 m³) water capacity and used for liquid transfer only shall be fitted with internal valves.

5.9.4.3* ASME containers over 4000 gal (15.2 m³) water capacity shall also be equipped with the following appurtenances and shall comply with Table 5.9.4.2:

- (1) A fixed maximum liquid level gauge
- (2) A variable liquid level gauge
- (3) A pressure gauge
- (4) A temperature gauge for aboveground containers only

5.9.4.4 The appurtenances specified in Table 5.9.4.1(B) shall comply with the following:

- (1) Manual shutoff valves shall be designed to provide positive closure under service conditions.
- (2) Excess-flow 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 3.3.81.7, *Internal Valve*), either manually or remotely operated and designed to remain

closed except during operating periods, shall be considered positive shutoff valves.

5.9.5 Liquid Level Gauging Devices.

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

5.9.5.2 The gauging devices shall be either fixed maximum liquid level gauges or variable liquid level gauges, or a combination of such devices.

5.9.5.3* 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 7.4.3.2.)

5.9.5.4 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.

5.9.5.5 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.

5.9.5.6 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 on the cylinder collar 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.

(A) Cylinders 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.

5.9.5.7 Cargo tanks and ASME containers utilizing multiple fixed liquid level gauges shall have the loading percentage (to the nearest 0.2 percent) stamped adjacent to each gauge.

5.9.5.8 Variable liquid level gauges shall comply with 5.9.5.8(A) through 5.9.5.8(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) water capacity 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.

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

5.9.5.10 Gauging devices that vent LP-Gas 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.

5.9.6 Pressure Gauges.

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

5.9.6.2 If the cross-sectional area of the opening into the container described in 5.9.6.1 is greater than that of a No. 54 drill size, an excess-flow check valve shall be provided for the container connection.

5.9.7 Other Container Connections.

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

- (1) Positive shutoff valve and 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

5.9.7.2 Any of the valves listed in 5.9.7.1(1), 5.9.7.1(2), or 5.9.7.1(3) that are not connected for service shall be plugged or capped.

5.9.8 Container Appurtenance Installation.

5.9.8.1 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.

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

5.9.8.3 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.

5.9.8.4 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.

5.9.8.5 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.

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

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

5.9.9* 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.

5.10 Regulators and Regulator Vents.

5.10.1 Regulators.

Δ 5.10.1.1 Pressure regulators, except for line pressure and appliance regulators, with a maximum rated capacity of 500,000 Btu/hr (147 kW) shall be listed in accordance with UL 144, *LP-Gas Regulators*.

N 5.10.1.1.1 Line pressure regulators shall comply with the requirements of ANSI Z21.80/CSA 6.22, *Line Pressure Regulators*.

N 5.10.1.1.2 Appliance pressure regulators shall comply with the requirements of ANSI Z21.18/CSA 6.3, *Gas Appliance Pressure Regulators*.

Δ 5.10.1.2 Regulators over 500,000 Btu/hr (147 kW) capacity shall be recommended by the manufacturer for use with LP-Gas.

Δ 5.10.1.3 Single-stage regulators shall have a maximum outlet pressure setting of 1.0 psig (7 kPag).

Δ 5.10.1.4 Second-stage regulators with a rated capacity of more than 500,000 Btu/hr (147 kW) shall either comply with UL 144, *LP-Gas Regulators*, or have a separate overpressure protection device complying with 5.9.2 of NFPA 54 that limits 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).

5.10.1.5 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.

5.10.1.6 Automatic changeover regulators shall be exempt from the requirement in 5.10.1.5.

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

Δ 5.10.1.8 First-stage regulators with a rated capacity of more than 500,000 Btu/hr (147 kW) shall either incorporate an integral pressure relief valve or have an external pressure relief valve with a start-to-discharge setting within the limits specified in UL 144, *LP-Gas Regulators*.

Δ 5.10.1.9 High-pressure regulators with a rated capacity of more than 500,000 Btu/hr (147 kW) where permitted to be used in two-stage systems shall incorporate an integral pressure relief valve or shall have a separate relief valve.

Δ 5.10.1.10 First-stage regulators shall have a maximum outlet pressure setting of 10.0 psig (69 kPag).

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

Δ 5.10.1.12 Two psig (14 kPag) service regulators and integral 2 psig (14 kPag) regulators shall have a maximum outlet pressure setting of 2.5 psi (17 kPag).

N 5.10.1.13 Two psig (14 kPag) service regulators and integral 2 psig (14 kPag) regulators with a rated capacity of more than 500,000 Btu/hr (174 kW) shall either incorporate an integral pressure relief valve or have an external pressure relief valve with a start-to-discharge setting within the limits specified in UL 144, *LP-Gas Regulators*.

5.10.2 Pressure Regulators. (Reserved)

5.10.3* Pipe for Regulator Venting.

Δ 5.10.3.1 Pipe or tubing used to vent regulators shall be one of the following:

- (1) Metal pipe and tubing in accordance with 5.11.3
- (2) PVC conduit meeting the requirements of UL 651, *Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings*
- (3) Flexible conduit meeting the requirements of UL 1660, *Liquid-Tight Flexible Nonmetallic Conduit*, with nonmetallic

fittings meeting the requirements of UL 514B, *Conduit, Tubing, and Cable Fittings*

- (4) Flexible conduit meeting the requirement of UL 1660, *Liquid-Tight Flexible Nonmetallic Conduit*, with metallic or nonmetallic fittings as part of a manufactured assembly

5.10.3.2 Other PVC piping materials and polyethylene, polyamide, and reinforced thermoplastic pipe and tubing shall not be permitted to be used to vent regulators.

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

5.11.1 General.

5.11.1.1 Material specifications for piping, tubing, fittings, valves (including hydrostatic relief valves), hose, hose connections, and flexible connectors shall be in accordance with Section 5.11.

5.11.1.2 Piping, tubing, fittings, and valves used to supply equipment and appliances within the scope of NFPA 54 shall comply with that code.

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

- (1) Pipe and tubing shall comply with 5.11.3.
- (2) Pipe and tubing shall be recommended for that service by the manufacturer and shall be approved.

5.11.1.4 Piping that can contain liquid LP-Gas and that can be isolated by valving and that requires hydrostatic relief valves, as specified under Section 6.16, 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).

5.11.2 Reserved.

5.11.3 Pipe and Tubing.

Δ 5.11.3.1* Pipe shall be steel (black or galvanized), brass, copper, copper alloy, polyamide, polyethylene, reinforced thermoplastic pipe, or austenitic stainless steel.

N 5.11.3.1.1 Pipe shall comply with the applicable standard as follows:

- (1) Steel pipe shall comply with ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*.
- (2) Steel pipe shall comply with ASTM A106/A106M, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*.
- (3) Brass pipe shall comply with ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*.
- (4) Copper pipe shall comply with ASTM B42, *Standard Specification for Seamless Copper Pipe, Standard Sizes*.
- (5) Polyamide pipe shall comply with ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings*, and be recommended by the manufacturer for use with LP-Gas.
- (6) Polyethylene pipe shall comply with ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, and be recommended by the manufacturer for use with LP-Gas.

- (7) Reinforced thermoplastic pipe shall comply with API Specification 15S, *Spoolable Reinforced Plastic Line Pipe*, have a polyamide liner, and be recommended by the manufacturer for use with LP-Gas.
- (8) Stainless pipe shall comply with ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*.

N 5.11.3.1.2 Furnace butt welded piping shall not be used for piping that meets ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*.

Δ 5.11.3.2 Tubing shall be steel, stainless steel, brass, copper, copper alloy, polyamide, polyethylene, or reinforced thermoplastic.

Δ 5.11.3.2.1 Tubing shall comply with the applicable standard as follows:

- (1) Brass tubing shall comply with ASTM B135/B135M, *Standard Specification for Seamless Brass Tube*.
- (2) Copper tubing shall comply with one of the following:
 - (a) For Type K or Type L, ASTM B88, *Standard Specification for Seamless Copper Water Tube*
 - (b) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*
 - (c) ASTM B837, *Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems*
- (3) Polyamide tubing shall comply with ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings*, and be recommended by the manufacturer for use with LP-Gas.
- (4) Polyethylene tubing shall comply with ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, and be recommended by the manufacturer for use with LP-Gas.
- (5) Reinforced thermoplastic tubing shall comply with API Specification 15S, *Spoolable Reinforced Plastic Line Pipe*, have a polyamide liner, and be recommended by the manufacturer for use with LP-Gas.
- (6) Corrugated stainless steel tubing shall comply with ANSI LC 1/CSA 6.26, *Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*.
- (7) Stainless steel tubing shall comply with one of the following:
 - (a) ASTM A213/A213M, *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*
 - (b) ASTM A249/A249M, *Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes*
 - (c) ASTM A269/A269M, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*
- (8) Steel tubing shall comply with one of the following:
 - (a) SAE J356, *Welded, Flash-Controlled, Low-Carbon Steel Tubing Normalized for Bending, Double Flaring, Beading, Forming, and Brazing*
 - (b) ASTM A822/A822M, *Standard Specification for Seamless Cold-Drawn Carbon Steel Tubing for Hydraulic System Service*

5.11.4 Fittings for Metallic Pipe and Tubing.

5.11.4.1* Fittings shall be steel, austenitic stainless steel, brass, copper, malleable iron, or ductile (nodular) iron.

Δ 5.11.4.2 Pipe fittings shall have a minimum pressure rating as specified in Table 5.11.4.2.

N 5.11.4.3 Pipe fittings shall comply with the following:

- (1) Gray cast-iron pipe fittings shall not be used.
- (2) Brazing filler material shall have a melting point that exceeds 1000°F (538°C).
- (3) Brass flare fittings shall meet the specifications of SAE J512, *Automotive Tube Fitting*, or SAE J513, *Refrigeration Tube Fittings — General Specifications*.

N 5.11.4.4 Metal tube fittings shall have a minimum pressure rating as specified in Table 5.11.4.2.

5.11.5 Fittings for Polyethylene, Polyamide, and Reinforced Thermoplastic Pipe and Tubing.

5.11.5.1* 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, except as required in 5.11.5.2.

N 5.11.5.2 Reinforced thermoplastic pipe and tubing shall not be joined using heat fusion.

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

5.11.5.4 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 D2683, *Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing*
- (2) ASTM D3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*
- (3) ASTM F1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*

Table 5.11.4.2 Service Pressure Rating of Pipe, Tube Fittings, and Valves

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

- (4) ASTM F1733, *Standard Specification for Butt Heat Fusion Polyamide (PA) Plastic Fitting for Polyamide (PA) Plastic Pipe and Tubing*

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

5.11.5.6* Mechanical fittings for polyethylene gas piping shall comply with Category 1 of ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, or ASTM F1948, *Standard Specification for Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing*, and 5.11.5.6(A) through 5.11.5.6(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.

5.11.5.7 Mechanical fittings for ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings*, PA11 gas piping shall comply with Category 1 of ASTM F2145, *Standard Specification for Polyamide 11 (PA11) and Polyamide 12 (PA12) Mechanical Fittings for Use on Outside Diameter Controlled Polyamide 11 and Polyamide 12 Pipe and Tubing*, or ASTM F1948, *Standard Specification for Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing*.

N 5.11.5.8 Mechanical fittings for reinforced thermoplastic pipe shall comply with API Specification 15S, *Spoolable Reinforced Plastic Line Pipe*, and be installed according to the manufacturer's instructions.

5.11.5.9 Anodeless risers shall comply with 5.11.5.9(A) through 5.11.5.9(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 adapter transition fittings shall be equipped with moisture seals and shall be recommended for LP-Gas use by the manufacturer for installation at the aboveground termination of the riser.

(D) Polyethylene and Polyamide 11 field-assembled anodeless risers shall be design certified to meet the requirements of ASTM F2509, *Standard Specification for Field-assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene and Polyamide-11 (PA11) Gas Distribution Pipe and Tubing*.

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

N 5.11.6 Reserved.

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

5.11.7.1 Hose, hose connections, and flexible connectors (*see* 3.3.28, *Flexible Connector*) shall be fabricated of materials that are resistant to the action of LP-Gas both as liquid and vapor.

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

5.11.7.3 Hose and quick connectors conveying LP-Gas at pressures of 5 psig (34 kPag) and less shall be approved.

5.11.7.4 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 6.23 regardless of the pressure, shall comply with 5.11.7.4(A) through 5.11.7.4(E).

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

(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 MPa) 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.

5.11.7.5 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.

5.11.7.6 Hoses or flexible connectors used to supply LP-Gas to equipment or appliances shall be installed in accordance with the provisions of 6.11.7 and 6.24.4.

5.12 Reserved.

5.13 Internal Valves. (Reserved)

N 5.14 Reserved.

5.15 Valves Other Than Container Valves.

5.15.1 Materials.

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

5.15.1.2 Ductile iron shall meet the requirements of ASTM A395/A395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or equivalent.

5.15.1.3 Malleable iron shall meet the requirements of ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings*, or equivalent.

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

5.15.2 Valves in Piping Systems.

5.15.2.1 Valves shall have a service pressure rating as specified in Table 5.11.4.2.

5.15.2.2 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 5.9.4.)

5.15.2.3 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

5.15.2.4* Where required by this code, excess-flow valves shall be sized and installed in accordance with the manufacturer's recommendations.

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

5.15.2.6 Plastic valves in polyethylene piping systems shall be manufactured from thermoplastic materials listed in ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, and shall comply with ASTM D2513 and ASME B16.40, *Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems*.

5.15.2.7 Valves in polyamide piping systems shall be manufactured from thermoplastic materials listed in ASTM F2945, *Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings*, which have been shown to be resistant to the action of LP-Gas and comply with ASME B16.40, *Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems*.

5.15.2.8 Metallic valves in polyethylene and polyamide piping systems shall be protected to minimize corrosion in accordance with Section 6.20.

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

5.16 Hydrostatic Relief Valves.

5.16.1 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 MPag) or more than 500 psig (3.5 MPag), unless installed in systems designed to operate above 350 psig (2.4 MPag).

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

5.17 Reserved.

5.18 Reserved.

5.19 Reserved.

5.20 Reserved.

5.21 Equipment.

5.21.1 Pressure-Containing Metal Parts.

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

5.21.1.2 The service pressure rating of equipment shall be in accordance with Table 5.21.1.2.

5.21.1.3 Equipment shall be fabricated of materials that are compatible with LP-Gas under service conditions and shall be in accordance with Table 5.21.1.3.

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

- (1) Steel
- (2) Ductile (nodular) iron (ASTM A395/A395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or ASTM A536, *Standard Specification for Ductile Iron Castings*, Grade 60-40-18 or 65-45-12)
- (3) Malleable iron (ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings*)
- (4) Seamless red brass, (ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*)
- (5) Forged, wrought, or cast copper alloy products
- (6) Materials equivalent to 5.21.1.3(A)(1) through 5.21.1.3(A)(4) in melting point, corrosion resistance, toughness, and strength

(B) Gray 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, meters, and indirect electric vaporizers.

Table 5.21.1.2 Service Pressure Rating

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

Table 5.21.1.3 Materials for Equipment Used in LP-Gas Service

Equipment Material	Service Condition
Steel	Pressure-containing metal parts
Ductile (nodular) iron (ASTM A395/A395M, <i>Standard Specification for Ferritic Ductile Iron Pressure- Retaining Castings for Use at Elevated Temperatures</i> , or ASTM A536, <i>Standard Specification for Ductile Iron Castings</i> , Grade 60–40–18 or 65–45–12)	Pressure-containing metal parts
Malleable iron (ASTM A47/ A47M, <i>Standard Specification for Ferritic Malleable Iron Castings</i>)	Pressure-containing metal parts
Higher strength gray iron (ASTM A48/A48M, <i>Standard Specification for Gray Iron Castings</i> , Class 40B)	Pressure-containing metal parts
Brass	Pressure-containing metal parts
Materials equivalent to 5.21.1.3(A)(1) through 5.21.1.3(A)(5) in melting point, corrosion resistance, toughness, and strength	Pressure-containing metal parts
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 B86, <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

(D) Zinc shall be used for approved regulators only, and comply with ASTM B86, *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.

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

5.21.2.1 The maximum design pressure rating for pumps shall be based upon the maximum differential pressure produced and shall be in accordance with Table 5.21.2.1.

5.21.2.2 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 6.21.2.3.)

Table 5.21.2.1 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.

5.21.3 Bypass Valves.

5.21.3.1 Bypass valves shall have a maximum design pressure in accordance with Table 5.21.2.1.

5.21.3.2 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.

5.21.4 Compressors.

5.21.4.1 Compressors shall be designed for LP-Gas service.

5.21.4.2 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.

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

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

5.21.5 Reserved.

5.21.6 Meters.

5.21.6.1 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).

5.21.6.2 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.

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

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

5.22 Reserved.

5.23 Reserved.

5.24 Appliances.

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

5.24.2 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.

N 5.24.3 Cabinet heaters shall be listed and meet the requirements of 5.24.3.1 through 5.24.3.8.

N 5.24.3.1 Cabinet heaters shall have a maximum propane input rating of 15,000 Btu/hr (4,396 W) and be listed in accordance with ANSI Z21.11.3, *Gas-Fired Room Heaters, Volume III, Propane-Fired Portable Emergency Use Heater Systems*.

N 5.24.3.2 Cabinet heaters shall be supplied with propane only from listed composite cylinders.

N 5.24.3.2.1 Cabinet heaters shall use a cylinder valve that complies with UL 1769, *Cylinder Valves*.

N 5.24.3.3 Composite cylinders used with cabinet heaters shall have a maximum weight capacity of 19 lb (8.7 kg) of propane [nominal 43 lb (19 kg) water capacity].

N 5.24.3.4 The composite cylinder shall be located in a separate compartment from the heating element.

N 5.24.3.5 Cabinet heaters shall use a listed integral two-stage regulator that complies with UL 144, *LP-Gas Regulators*, and operates with a maximum outlet pressure setting that does not exceed a nominal gauge pressure of 2 psig (14 kPag).

N 5.24.3.6 Cabinet heater integral two-stage regulators shall not be equipped with a pressure relief valve in either stage.

N 5.24.3.7 Cabinet heater integral two-stage regulators shall use separate vent-limiting features on each stage that comply with ANSI Z21.18/CSA 6.3, *Gas Appliance Pressure Regulators*.

N 5.24.3.8 Cabinet heaters shall use a CGA 793 appliance-side connection that complies with CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, and is listed to UL 2061, *Adapters and Cylinder Connection Devices for Portable LP-Gas Cylinder Assemblies*, or ANSI Z21.81/CSA 6.25, *Cylinder Connection Devices*.

5.24.4 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.

5.24.5 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.

5.24.6 Appliances using vaporizing burners shall comply with 5.25.5.

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

5.24.8* 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 6.27.7.5.

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

5.25.1 Reserved.

5.25.2 Indirect Vaporizers.

Δ 5.25.2.1 Indirect vaporizers shall be constructed in accordance with the applicable provision of the ASME Boiler and Pressure Vessel Code Section VIII with a MAWP as specified in Table 5.2.4.3 and 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

5.25.2.2 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 MPag).

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

5.25.2.4 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 5.25.9. Fusible plug devices shall not be used.

5.25.2.5 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 6.25.2.11.

5.25.3 Direct-Fired Vaporizers.

Δ 5.25.3.1 Design and construction of direct-fired vaporizers shall be in accordance with the applicable requirements of Section VIII of ASME's *Boiler and Pressure Vessel Code* and be legibly marked with the maximum vaporizing rate in gallons per hour and the rated heat input in Btus per hour, or metric equivalents.

5.25.3.2 Direct-fired vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 5.25.9.

5.25.3.3 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.

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

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

5.25.3.6 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.

5.25.3.7 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.

5.25.3.8 Direct-fired vaporizers shall be equipped with a limit control to prevent the heater from raising the LP-Gas 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 5.2.4.3 that corresponds with the design pressure of the container (or its ASME Code equivalent). (See notes to Table 5.2.4.3.)

5.25.4 Tank Heaters.

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

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

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

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

5.25.4.4 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 5.2.4.3 that corresponds with the MAWP of the container (or its ASME Boiler and Pressure Vessel Code equivalent).

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

5.25.4.6 Devices that cannot apply a temperature in excess of 90°F (32°C) shall not be required to comply with 5.25.4.4 and 5.25.4.5.

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

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

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

5.25.4.10 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.

5.25.4.11 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.

5.25.4.12 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.

5.25.5 Vaporizing Burners.

5.25.5.1 Section 5.25 shall not apply to engine fuel vaporizers or to integral vaporizer burners, such as those used with weed burning equipment and tar kettles.

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

5.25.5.3 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 Btus per hour
- (2) Name or symbol of the manufacturer

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

5.25.5.5 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).

5.25.5.6 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.

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

5.25.5.8 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.

5.25.5.9* 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.

5.25.5.10 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.

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

5.25.6 Waterbath Vaporizers.

5.25.6.1 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 with a MAWP as specified in Table 5.2.4.3 and 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

5.25.6.2 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.

5.25.6.3 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.

5.25.6.4 Heat exchangers for waterbath vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 5.25.9. Fusible plug devices shall not be used.

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

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

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

5.25.6.8 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.

5.25.6.9 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.

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

5.25.7 Reserved.

5.25.8 Gas-Air Mixers.

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

5.25.8.2 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.

5.25.8.3 In addition to the interlocks required in 5.25.8.2, 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.

5.25.8.4 Backflow 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.

5.25.8.5 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 5.25.8.2 through 5.25.8.4.
- (2) They shall be equipped with a backflow check valve at the air intake to prevent the escape of gas to atmosphere when shut down.

5.25.8.6 Gas-air mixers of the type specified in 5.25.8.5 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.

5.25.9 Vaporizer Pressure Relief Valve.

5.25.9.1 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 5.25.9.2 through 5.25.9.4.

5.25.9.2 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.

5.25.9.3 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 5.9.2.6 to determine the required relief valve capacity.

5.25.9.4 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.

5.26 Reserved.

5.27 Reserved.

5.28 Vehicle Fuel Dispensers.

5.28.1 Vehicle fuel dispensers shall have a maximum design pressure rating equal to or greater than the maximum discharge pressure from the pump and bypass valve, if provided.

5.28.2 The maximum design pressure and all equipment downstream from the pump shall be in accordance with Table 5.21.2.1.

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
- (7) Location of containers not connected for use

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 6.23
- (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 11.13.1
- (5) Containers used with LP-Gas stationary engine fuel systems complying with Section 6.29
- (6) Containers used with LP-Gas-fueled industrial trucks complying with 11.11.4
- (7) Containers on LP-Gas-fueled vehicles garaged in accordance with Section 11.14
- (8) Cylinders awaiting use, resale, or exchange when stored in accordance with Sections 8.2 and 8.3

6.3 Location of Containers Not Connected for Use.

6.3.1 Cylinders awaiting use, resale, or exchange shall be stored in accordance with Chapter 8.

6.3.2 ASME containers of 4,000 gal (15.2 m³) or less that have been removed from service but that contain LP-Gas shall be stored outside of buildings in accordance with either (1) or (2):

- (1) Containers shall be located either at a bulk plant or in an approved area.
- (2) Containers not complying with (1) shall comply with the following:
 - (a) Containers shall be located in a manner that will minimize exposure to physical damage.
 - (b) Containers shall be oriented so that the pressure relief valve remains in communication with the vapor space.
 - (c) Containers shall not be located on roofs of buildings.
 - (d) Valve outlets on ASME containers shall be plugged or capped.
 - (e) Where screw-on-type caps or collars are utilized on ASME containers, they shall be in place whenever this type of container is stored regardless of the fill level of the container.
 - (f) The location of ASME containers shall comply with the "Aboveground Containers" column and the "Between Containers" column of Table 6.4.1.1 with respect to important buildings and lines of adjoining property that can be built upon.
 - (g) Where the provisions of (f) are impractical, alternative storage locations for containers shall be approved by the authority having jurisdiction.

6.4 Container Separation Distances.

6.4.1 Aboveground Containers.

6.4.1.1* 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 6.4.1.1, Table 6.5.1.2, 6.4.1.2 through 6.4.1.3, 6.4.3, 6.4.4.1 through 6.4.4.4, and 6.5.3.6 through 6.5.3.11.

6.4.1.2 When the provisions of 6.31.3 through 6.31.5 are met, the minimum distance from an ASME container to a building or adjoining property line that can be built upon shall be reduced by one-half for ASME containers of 2001 gal through 30,000 gal (7.6 m³ through 114 m³) water capacity.

6.4.1.3 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.

6.4.2 Underground or Mounded ASME Containers.

6.4.2.1 Minimum distances from important buildings and the line of adjoining property that can be built upon for underground or mounded ASME containers larger than 2000 gal (7.6 m³) water capacity incorporating all the provisions of Section 6.31, shall be reduced to 10 ft (3 m).

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

6.4.2.3 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.

6.4.3 Multiple Containers Less Than 125 gal (0.5 m³) Individual Water Capacity. Multiple containers, each having a water capacity less than 125 gal (0.5 m³) and installed in an aboveground group as a manifolded single service or as individual services, shall comply with the following:

- (1) Where the aggregate water capacity of all containers in any group is 500 gal (1.9 m³) or less, the minimum separation distances required by Table 6.4.1.1 for each container shall be 0 ft (0 m) for each container in the group from an important building or line of adjoining property that can be built upon.
- (2) Where the aggregate water capacity of all containers in the group is greater than 500 gal (1.9 m³), the minimum separation distances in Table 6.4.1.1 for each container shall be based on the aggregate capacity.
- (3) There shall be no separation required between individual containers within the group.
- (4)* For the application of 6.4.3(1) and 6.4.3(2), the number of containers in a single group is determined by the number of containers that are less than 10 ft (3 m) from any other container in the group.

Table 6.4.1.1 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
<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 ^c	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 diameters of adjacent containers	
90,001–120,000	>341–454	50	15	125	38		
120,001–200,000	>454–757	50	15	200	61		
200,001–1,000,000	>757–3,785	50	15	300	91		
>1,000,000	>3,785	50	15	400	122		

^aSee 6.4.2.1.

^bSee 6.4.4.5.

^cSee 6.4.4.4.

^dSee 6.4.4.1, 6.4.4.2, 6.4.4.3, and 6.4.4.4.

^eSee 6.4.1.3.

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

6.4.4.1 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.

6.4.4.2 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.

6.4.4.3* 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 6.4.4.3.

6.4.4.4 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 6.4.4.3.

6.4.4.5 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.

6.5 Other Container Location Requirements.

6.5.1 ASME Multicontainer Requirements.

6.5.1.1 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 6.4.1.1 and Table 6.4.1.1 shall be permitted to be modified as indicated by the fire safety analysis described in 6.30.3.

Table 6.4.4.3 Separation Distance Between Container Pressure Relief Valve and Building Openings

Container Type	Exchange or Filled 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 at the point of use	3	0.9	10	3.0
ASME	Filled at the point of use	5	1.5	10	3.0

6.5.1.2 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 6.5.1.2.

Table 6.5.1.2 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> 6.5.1.2 and 6.30.3.1)	6	50	15
Fixed monitor nozzles per 6.30.6.3	6	25	7.6
Fixed water spray per 6.30.6.1	9	25	7.6
Insulation per 6.30.5.1	9	25	7.6

6.5.1.3 Where the provisions of 6.31.3 and 6.31.4 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 6.5.1.2.

6.5.2 Underground and Mounded ASME Containers.

6.5.2.1 Underground or mounded ASME containers shall be located in accordance with 6.5.2.2 and 6.5.2.3.

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

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

6.5.2.4 The sides of adjacent containers shall be separated in accordance with Table 6.4.1.1 but shall not be separated by less than 3 ft (1 m).

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

6.5.2.6 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).

6.5.3 Additional Container Installation Requirements.

6.5.3.1 Additional container installation requirements shall comply with 6.5.3.2 through 6.5.3.13 and 6.5.4.

6.5.3.2 Containers shall not be stacked one above the other.

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

6.5.3.4* 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.

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

6.5.3.6 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).

6.5.3.7 The requirements of 6.5.3.6 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.

6.5.3.8 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.

6.5.3.9* The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with NFPA 55.

6.5.3.10 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.

6.5.3.11 The minimum separation between LP-Gas containers and liquefied hydrogen containers shall be in accordance with NFPA 55.

6.5.3.12 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 CGA C-7, *Guide to Classification and Labeling of Compressed Gases*.

6.5.3.13 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.

6.5.3.14 The minimum separation distances specified in Table 6.4.1.1 between containers and buildings of noncombustible construction devoted exclusively to gas manufacturing and distribution operations shall be reduced to 10 ft (3 m).

6.5.4* Structure Requirements.

6.5.4.1 Structures such as fire walls, fences, earth or concrete barriers, and other similar structures shall be permitted around installed nonrefrigerated containers in accordance with all of the following:

- (1) Clearance shall be provided around the container for inspection and maintenance.
- (2) The structure shall be open on at least one side that includes the longest dimension of the container.
- (3) The top of the container shall be capable of being wetted by an emergency response hose stream.

6.5.4.2 Structures used to prevent flammable or combustible liquid accumulation or flow shall be permitted in accordance with 6.5.3.4.

6.5.4.3 Structures between LP-Gas containers and gaseous hydrogen containers shall be permitted in accordance with 6.5.3.10.

6.5.4.4 Structures such as fences shall be permitted in accordance with 6.22.4.

6.6 Installation of Containers with Attached Supports.

6.6.1 Installation of Vertical Containers. Installation of portable storage containers shall be in accordance with 6.6.3.

6.6.2 Installation of Skid Tanks. Permanent installation of skid tanks shall be in accordance with 6.8.3, except that the maximum elevation of a skid tank with non-fireproofed steel supports above the concrete foundation is 18 in. (460 mm).

6.6.3 Installation of Porta-Pacs. 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.

N 6.6.4 Installation of Mobile Storage Vehicle Fuel Tenders.

N 6.6.4.1 Mobile storage vehicle fuel tenders shall be placed on level concrete pads, paved surfaces, or firm earth for temporary service.

N 6.6.4.2 The container shall be located in accordance with Table 6.4.1.1.

N 6.6.4.3 Combustible materials not part of the mobile storage vehicle fuel tender shall not accumulate or be stored within 10 ft (3 m) of a container.

N 6.6.4.4 Flexibility shall be provided in the connecting piping in accordance with 6.11.7.

N 6.6.4.5 Where mobile storage vehicle fuel tenders are installed at isolated locations with the bottoms of the skids, runners, or base above ground, the supports shall be fabricated of noncombustible materials.

N 6.6.4.6* Mobile storage vehicle fuel tenders shall comply with Row G of Table 6.26.2.2.

N 6.6.4.7 Mobile storage vehicle fuel tenders shall comply with Section 6.28.

6.7 Location of Transfer Operations.

6.7.1 Transfer of Liquids.

6.7.1.1* Liquid shall be transferred into containers, including containers mounted on vehicles, only outdoors, under weather canopies, or in structures in accordance with Chapter 10.

6.7.1.2 The transfer of liquid into containers on the roofs of structures shall be permitted, provided that the installation conforms to the requirements specified in 6.8.9 and 6.23.11.

6.7.1.3 The transfer hose shall not be routed in or through any buildings except those specified in 6.7.1.1.

6.7.1.4 Filling of containers located outdoors in stationary installations in accordance with Section 6.4 shall be permitted to be filled at that location.

6.7.2 Container Point of Transfer Location Requirements.

6.7.2.1* 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 6.7.2.1.

6.7.2.2 Containers not located in stationary installations shall be filled at a location determined by the point of transfer in accordance with Table 6.7.2.1.

6.7.3 Separation Distance from Point of Transfer.

6.7.3.1 If the point of transfer is a component of a system covered by Section 6.27 or Chapter 11, the requirements of parts A, B, and C of Table 6.7.2.1 shall not apply to the structure containing the point of transfer.

6.7.3.2 If LP-Gas is vented to the atmosphere under the conditions stipulated in 7.3.1.1(4), the distances in Table 6.7.2.1 shall be doubled.

6.7.3.3 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 6.7.2.1 shall not be required where the common walls comply with 10.3.1.3.

6.7.3.4 The distances in Table 6.7.2.1, 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 6.31.5.

6.8 Installation of Containers.

6.8.1 General Requirements.

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

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

6.8.1.3 Field welding on containers shall be limited to nonpressure parts such as saddle plates, wear plates, or brackets installed by the container manufacturer.

6.8.1.4* Aboveground containers shall be painted.

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

6.8.1.6 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.

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

6.8.2 Installation of Cylinders.

6.8.2.1 Cylinders shall be installed only above ground and shall be set upon a firm foundation or otherwise be firmly secured.

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

6.8.2.3 Flexibility shall be provided in the connecting piping. (See 6.8.2.4.)

6.8.2.4 Where flexible connectors are used, they shall comply with 6.11.7.

Table 6.7.2.1 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	10	3.1
B	Buildings ^a with other than at least 1-hour fire-rated walls	25 ^b	7.6 ^b
C	Building wall openings or pits at or below the level of the point of transfer	25 ^b	7.6 ^b
D	Line of adjoining property that can be built upon	25 ^b	7.6 ^b
E	Outdoor places of public assembly, including schoolyards, athletic fields, and playgrounds	50 ^b	15 ^b
F	Public ways, including public streets, highways, thoroughfares, and sidewalks		
	(1) From points of transfer of LP-Gas dispensing systems	10	3.1
	(2) From other points of transfer	25 ^b	7.6 ^b
G	Driveways ^c	5	1.5
H	Mainline railroad track centerlines	25	7.6
I	Containers ^d other than those being filled	10	3.1
J	Flammable and Class II combustible liquid ^e dispensers and the fill connections of containers	10 ^b	3.1 ^b
K	Flammable and Class II combustible liquid ^e aboveground containers and filling connections of underground containers	20	6.1
L	Stored or accumulated combustible materials	10	3.1

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

^bSee 6.7.3.4.

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

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

^eNFPA 30 defines Class I flammable liquids as including 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). NFPA 30 defines Class II combustible liquids as including those having a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

N 6.8.3 Installation of Horizontal Aboveground ASME Containers Greater Than 4000 gal (15.2 m³).

N 6.8.3.1 Containers greater than 4000 gal (15.2 m³) without attached supports shall be placed in steel, concrete, or masonry saddles formed to fit the contour of the container.

N 6.8.3.2 Containers greater than 4000 gal (15.2 m³) without attached supports shall be protected in accordance with the following conditions:

- (1) The portion of the container in contact with the saddle is coated to minimize corrosion, or inert material is used to prevent contact between the container and the saddle.
- (2) The saddle is installed on flat-topped masonry blocks, concrete pads, or concrete foundations.
- (3) The saddle allows for expansion and contraction and prevents an excessive concentration of stress.

N 6.8.3.3 Containers greater than 4000 gal (15.2 m³) with attached supports shall be installed in accordance with the following conditions:

- (1) The attached supports are placed on flat-topped masonry blocks, concrete pads, or concrete foundations.
- (2)* The bottoms of the attached supports are located no more than 12 in. (300 mm) above grade unless they are installed on concrete or masonry foundations, or the specific installation is approved.

N 6.8.3.4 Where approved, a single ASME container at an isolated location shall be permitted to be installed with the outside bottom of the container shell no more than 5 ft (1.5 m) above the ground.

N 6.8.4 Installation of ASME Horizontal Aboveground Containers Less Than or Equal to 4000 gal (15.2 m³).

N 6.8.4.1 ASME containers less than or equal to 4000 gal (15.2 m³) shall be installed on self-extinguishing non-metallic structural supports in accordance with 6.8.4.4 or masonry or concrete foundations.

N 6.8.4.2 ASME containers less than or equal to 4000 gal (15.2 m³) with non-insulated steel supports shall be installed with the bottom of the container no more than 36 in. (0.91 m) above grade.

N 6.8.4.3 ASME containers less than or equal to 4000 gal (15.2 m³) with insulated steel supports having a fire resistance rating of at least 2 hours shall not be limited in height above-grade.

N 6.8.4.4 Where horizontal ASME containers less than or equal to 4000 gal (15.2 m³) are supported with nonmetallic supports, the supports shall be as follows:

- (1) Structurally support the container 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 such that, once the source of ignition is removed, the flame is quickly extinguished without the fuel or oxidizer being exhausted

N 6.8.4.5 Portable tanks of 4000 gal (15.2 m³) water capacity or less that comply with 5.2.7.3 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.

N 6.8.5 Installation in Heavy Snow Areas. In locations where the snow depth, based on the ground snow load, is more than the height of aboveground containers, excluding the dome cover, both of the following requirements shall apply:

- (1) A stake or other marking shall be installed higher than the snow depth based on the ground snow load.
- (2) The container shall be installed to prevent its movement resulting from snow accumulation.

6.8.5.1* Snow depth (ft), based on the ground snow load (lb/ft²) and snow density (lb/ft³), shall be determined as follows:

[6.8.5.1a]

$$\text{Snow depth} = (\text{ground snow load}) / (\text{snow density})$$

[6.8.5.1b]

$$\text{Snow density} = (0.13 \times \text{ground snow load}) + 14$$

6.8.5.2 Where the calculation in Equation 6.8.5.1b results in a value greater than 30 lb/ft³ (481 kg/m³), 30 lb/ft³ (481 kg/m³) shall be used in Equation 6.8.5.1a.

6.8.6 Installation of Vertical ASME Containers.

6.8.6.1 Vertical ASME containers of 125 gal (0.5 m³) water capacity or less shall be installed in accordance with 6.8.2.

6.8.6.2 Vertical ASME containers of 125 gal (0.5 m³) water capacity or less shall not be in contact with the soil.

6.8.6.3 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 5.2.4.4.

6.8.6.4 The requirements in 6.8.6.5 through 6.8.6.7 shall also apply to the installation of vertical ASME containers greater than 125 gal (0.5 m³) water capacity.

6.8.6.5 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.

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

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

6.8.7 Installation of Underground and Mounded Containers.

6.8.7.1* ASME container assemblies intended for underground installation, including interchangeable aboveground-underground container assemblies, shall be installed underground in accordance with 6.8.7.1(A) through 6.8.7.1(M).

(A) The shell of 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, the shell of 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) **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 6.20.3

(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 5.11 or shall be listed.

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

6.8.7.2 Partially underground, unmounted ASME containers shall be installed in accordance with 6.8.7.2(A) through 6.8.7.2(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 6.8.7.1(I) through 6.8.7.1(J).

(B) The aboveground portion of the container shall be painted to comply with 6.8.1.4.

(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 6.4.1.1 and Table 6.4.1.1.

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

6.8.7.3 Mounded containers shall be installed in accordance with 6.8.7.3(A) through 6.8.7.3(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 6.8.7.1(I) and 6.8.7.1(J).

6.8.8 Temporary Container Installations.

6.8.8.1 Single containers constructed as portable storage containers for temporary stationary service in accordance with 5.2.7 shall be placed on concrete pads, paved surfaces, or firm earth for such temporary service (not more than 12 months at a given location).

6.8.8.2 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.

6.8.8.3 Flexibility shall be provided in the connecting piping in accordance with 6.11.7.

6.8.8.4 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.

6.8.9 Installation of Containers on Roofs of Buildings.

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

6.8.9.2 Where the authority having jurisdiction and the fire department have approved an installation of a container, it shall comply with 6.8.9.2(A) through 6.8.9.2(S).

(A) The building shall be of Type I, 443 or 332, or Type II, 222, construction as specified in NFPA 220.

(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 6.4.1.1 shall apply.

Δ (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 have the following appurtenances:

- (1) Filler valve [see 5.9.4.1(C)]
- (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 6.30.3.

N 6.8.10 Temporary Installation of Horizontal Aboveground Containers.

N 6.8.10.1 Temporarily installed horizontal aboveground containers shall be level and located on concrete foundations, concrete pads, paved surfaces, firm earth, or crushed stone.

N 6.8.10.2 Flexibility in piping connecting horizontal aboveground containers shall be provided in accordance with 6.11.7.

N 6.8.11* **Installation of Containers Where Interior Has Been Exposed to Atmosphere.** New or reconditioned containers, or containers that have had their interiors exposed to the atmosphere, shall be purged prior to being filled with LP-Gas.

6.9 Installation of Container Appurtenances.

6.9.1 Reserved.

6.9.2 Installation of Pressure Relief Devices.

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

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

6.9.2.3 Pressure relief devices on the following ASME containers shall be installed so that any gas released is vented upward and away from the container to prevent deflection toward the container:

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

6.9.2.4 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.

6.9.2.5 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.

Δ 6.9.2.6 The orientation of the pressure relief valve drain opening shall provide protection of the container, piping, and equipment against flame impingement resulting from ignited LP-Gas escaping from the drain opening.

6.9.2.7 Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold meeting the requirements of 6.9.2.8 is used.

6.9.2.8 Listed pressure relief valve manifolds shall be exempt from the requirements of 6.9.2.7 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.

6.9.2.9 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.

6.9.2.10 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 5.9.8.4.

6.9.2.11 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 6.9.2.12.)

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

6.9.2.13 Where installed, the discharge piping shall comply with 6.9.2.13(A) through 6.9.2.13(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 5.9.2.6.

(C) Piping from underground containers shall be sized to provide the rate of flow specified in 5.9.2.8.

(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.

6.10 Regulators.

6.10.1 Regulator Installation.

6.10.1.1 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 6.10.1.1(A) through 6.10.1.1(D).

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

- (1) Attached to the vapor service valve using metallic pipe, tubing, fittings, or adapters that do not exceed 5 ft (1.5 m) in total length
- (2) Attached to the vapor service valve with a single flexible metallic connector

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

- (1) Attached to the vapor service valve using metallic pipe, tubing, fittings, or adapters that do not exceed 5 ft (1.5 m) in total length
- (2) Attached to the vapor service valve with a single flexible metallic connector
- (3) Attached to the vapor service valve with a single flexible hose connector

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

- (1) Installations shall comply with 6.11.3.8.
- (2) The regulator shall be attached with pipe or a single 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) Attached with a metallic fitting
 - (b) Attached with a single flexible metallic connector
 - (c) Attached with a flexible hose connector connected to a cylinder in other than stationary installations
 - (d) Attached with pipe

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

- (1) Attached using metallic pipe, tubing, fittings, or adapters that do not exceed 5 ft (1.5 m) in total length
- (2) Attached with a single flexible metallic connector

Δ (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 UL 569, *Pigtails and Flexible Hose Connectors for LP-Gas*, and is recommended by the manufacturer for underground service.

6.10.1.2 First-stage regulators installed downstream of high-pressure regulators shall be exempt from the requirement of 6.10.1.1.

6.10.1.3* 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 6.23

- (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 11.11.4
- (6) Regulators on containers on LP-Gas-fueled vehicles garaged in accordance with Section 11.14
- (7) Regulators on cylinders awaiting use, resale, or exchange when stored in accordance with Chapter 8

6.10.1.4 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 6.10.1.4.

6.10.1.5 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.

6.10.1.6 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.

6.10.1.7 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 5.10.3.
- (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.

Δ 6.10.1.8 The requirement in 6.10.1.7 shall not apply to appliance regulators otherwise protected, to line pressure regulators listed as complying with ANSI Z21.80/CSA 6.22, *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).

6.10.1.9 The requirement in 6.10.1.7 shall not apply to vaporizers.

6.10.1.10 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.

6.10.1.11 Line pressure regulators shall be installed in accordance with the requirements of NFPA 54.

6.10.2 Selection of Pressure Regulators.

6.10.2.1 A two-stage regulator system, an integral two-stage regulator system, or a 2.0 psi (14 kPa) regulator system shall be installed on all fixed piping systems and mobile food facilities that serve ½ psig (3.4 kPa) appliance systems [normally operated at 11 in. water column (2.7 kPa) pressure].

6.10.2.2 Single-stage regulators shall not be installed in fixed piping systems after June 30, 1997, except for installations covered in 6.10.2.3.

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

6.10.2.4 Gas distribution systems using multiple second-stage regulators shall be permitted to use a high-pressure regulator installed at the container where a first-stage regulator is installed downstream of the high-pressure regulator and ahead of the second-stage regulators.

6.10.2.5 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.

6.10.2.6 The overpressure protection device described in 6.10.2.5 shall limit the outlet pressure of the second-stage regulator to 2.0 psig (14 kPa) when the regulator seat disc is removed and have an inlet pressure equivalent to the maximum outlet pressure setting of the high-pressure regulator.

6.10.2.7 Systems consisting of listed components that provide an equivalent level of overpressure protection shall be exempt from the requirements of 6.10.2.5 and 6.10.2.6.

Δ 6.10.2.8 A 2.0 psi (14 kPa) regulator system shall consist of a first-stage regulator and a 2.0 psi (14 kPa) service regulator complying with the requirements of 5.10.1.12 in conjunction with a line pressure regulator complying with ANSI Z21.80/CSA 6.22, *Line Pressure Regulators*.

6.11 Piping Systems.

6.11.1 Piping System Service Limitations.

6.11.1.1 The physical state (vapor or liquid) and pressure at which LP-Gas is transmitted through piping systems shall be in accordance with 6.11.1.1(A) through 6.11.1.1(F).

(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 kPa)
- (2) Installation outdoors and underground

N (D) Reinforced thermoplastic pipe shall be installed outdoors and underground.

Δ (E)* LP-Gas vapor at pressures exceeding 20 psig (138 kPa) 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 6.23.2 and 6.23.12.
- (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 fuel vaporizers
- (3) Industrial occupancies are in accordance with 6.11.1.2.

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

6.11.1.2* LP-Gas vapor fixed piping systems at pressures of 20 psig through 50 psig (138 kPa through 345 kPa) in industrial occupancies shall be approved and shall comply with 6.11.1.2(A) through 6.11.1.2(D).

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

(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.

6.11.1.3 Liquid piping systems in buildings or structures feeding a vaporizer other than those covered by 6.11.1.1(E) shall comply with the material requirements of Chapters 5 and 6.

6.11.2 Sizing of LP-Gas Vapor Piping Systems.

6.11.2.1 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.

6.11.2.2 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 17.1(a) through Table 17.1(n), engineering methods, or sizing tables

included in a piping system manufacturer's installation instructions.

6.11.3 Installation of Metallic Pipe, Tubing, and Fittings.

6.11.3.1* 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 6.11.

▲ 6.11.3.2 All welding and brazing of metallic piping shall be in accordance with **Section IX of ASME's** *Boiler and Pressure Vessel Code*.

6.11.3.3 Metallic piping shall comply with 6.11.3.3(A) through 6.11.3.3(D).

(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 MPa) and liquid piping not covered by 6.11.3.3(A) shall be designed for a working pressure of at least 250 psig (1.7 MPa).

(C) Vapor LP-Gas piping subject to pressures of not more than 125 psig (0.9 MPa) shall be designed for a pressure rating of at least 125 psig (0.9 MPa).

(D) Schedule 10 steel piping shall be installed above ground and used for vapor service only.

6.11.3.4 Pressure relief valve discharge piping shall be exempt from the requirement of 6.11.3.3(C).

6.11.3.5 Metallic pipe joints shall be permitted to be threaded, flanged, welded, press-connected, or brazed using pipe and fittings that comply with 5.11.3, 5.11.4, and 6.11.3.5(A) through 6.11.3.5(H).

(A) Metallic threaded, welded, press-connected, and brazed pipe joints shall be in accordance with Table 6.11.3.5(A).

(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) Press-connected joints shall comply with ANSI **LC 4/CSA** 6.32, *Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems*.

(E) Gaskets used to retain LP-Gas in flanged connections in piping shall be resistant to the action of LP-Gas.

(F) 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.

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

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

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

6.11.3.6 Metallic tubing joints shall be flared or brazed using tubing and fittings in accordance with 5.11.3 and 5.11.4.

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

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

6.11.3.9 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.

6.11.3.10 Aboveground piping shall be supported to ensure integrity of the piping.

6.11.3.11 Aboveground piping shall be protected against physical damage by vehicles.

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

6.11.3.13 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).

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

6.11.3.15 Metallic piping shall be protected against corrosion in accordance with 6.11.3.15(A) through 6.11.3.15(C).

▲ Table 6.11.3.5(A) Types of Metallic Pipe Joints in LP-Gas Service

Service	Schedule 10	Schedule 40	Schedule 80
Liquid	NP	Welded or brazed	Threaded, welded, or brazed
Vapor, ≤125 psig (≤0.9 MPa)	Welded, press-connected, or brazed	Threaded, welded, press-connected, or brazed	Threaded, welded, press-connected, or brazed
Vapor, >125 psig (>0.9 MPa)	NP	Welded or brazed	Threaded, welded, or brazed

NP: Not permitted.

Shaded text = Revisions. ▲ = Text deletions and figure/table revisions. • = Section deletions. N = New material



(A) Piping and tubing of 1 in. (25 mm) nominal diameter or smaller shall be protected in accordance with 6.20.1 or 6.20.2.

(B) Piping and tubing larger than 1 in. (25 mm) nominal diameter and installed above ground shall be protected in accordance with 6.20.1.

(C) Steel piping installed underground shall have a cathodic protection system in accordance with 6.20.2(C) unless technical justification is approved by the authority having jurisdiction.

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

Δ 6.11.3.17* Underground metallic piping shall be provided with a dielectric fitting installed at building penetrations.

N 6.11.3.18 Dielectric fittings shall not be installed underground.

N 6.11.4 Reserved.

6.11.5 Installation of Polyamide, Polyethylene, and Reinforced Thermoplastic Pipe, Tubing, and Fittings.

6.11.5.1 Polyethylene, polyamide, and reinforced thermoplastic pipe, tubing, and fittings shall be installed outdoors underground only.

6.11.5.2 Polyethylene, polyamide, and reinforced thermoplastic 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

6.11.5.3 Assembled anodeless risers shall be used to terminate underground polyamide, polyethylene, and reinforced thermoplastic 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 6.20.

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

(C) Factory-assembled risers shall be sealed and leak tested by the manufacturer.

6.11.5.4 Field-assembled risers shall be supplied only in kit form with all necessary hardware for installation.

(A) Field-assembled risers shall comply with the following:

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

(B) The casing of the riser shall be constructed of one of the following materials:

- (1) ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, Schedule 40 steel pipe
- (2) ASTM A513/A513M, *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing*,

mechanical steel tubing with a minimum wall thickness of 0.073 in. (1.9 mm)

- (3) Flexible metal tubing with a minimum crush strength of 1000 lb (453.6 kg) and a tensile strength of 300 lb (136 kg), including the transition connection as tested by the manufacturer

N 6.11.5.5 Reinforced thermoplastic piping shall comply with 6.11.5.3 or shall transition to aboveground piping in accordance with the manufacturer's recommendation.

6.11.5.6* Polyamide, polyethylene, and reinforced thermoplastic piping shall be designed to sustain and minimize the thrust forces caused by contraction or expansion of the piping or by anticipated external or internal loading.

6.11.5.7 An electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape shall be buried with the polyamide, polyethylene, or reinforced thermoplastic pipe to facilitate locating the pipe.

(A) One end of the tracer wire shall be brought above ground at a building wall or riser.

(B) The tracer wire or tape shall not be in direct contact with the polyamide or polyethylene pipe.

6.11.5.8 Polyamide, polyethylene, and reinforced thermoplastic piping that is installed in a vault, the dome of an underground container, or any other belowground enclosure shall be completely encased in one of the following:

- (1) Gastight metal pipe and fittings that are protected from corrosion
- (2) An anodeless riser

6.11.5.9 Polyamide, polyethylene, and reinforced thermoplastic piping shall be installed in accordance with the manufacturer's installation instructions.

6.11.5.10 Where polyamide, polyethylene, or reinforced thermoplastic pipe or tubing is inserted into an existing steel pipe, it shall comply with 6.11.5.10(A) and 6.11.5.10(B).

(A) The polyamide, polyethylene, or reinforced thermoplastic pipe or tubing shall be protected from being damaged during the insertion process.

(B) The leading end of the polyamide, polyethylene, or reinforced thermoplastic pipe or tubing being inserted shall also be closed prior to insertion.

6.11.5.11 Polyamide, polyethylene, and reinforced thermoplastic pipe that is not encased shall have a minimum wall thickness of 0.090 in. (2.3 mm).

6.11.5.12 Polyamide or polyethylene pipe with an outside diameter of 0.875 in. (22.2 mm) or less shall be permitted to have a minimum wall thickness of 0.062 in. (1.6 mm).

6.11.5.13 Each imperfection or damaged piece of polyamide or polyethylene pipe shall be removed and replaced using fusion joints or mechanical fittings.

N 6.11.5.14 Each imperfection or damaged piece of reinforced thermoplastic pipe shall be removed and replaced by using mechanical fittings.

6.11.5.15 Repair clamps shall not be used to cover damaged or leaking sections.