

# NFPA 58

## Liquefied Petroleum Gas Code

1998 Edition

NFPA Technical Committee  
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## **NFPA 58**

### **Liquefied Petroleum Gas Code**

#### **1998 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 National Fire Protection Association, Inc., at its Annual Meeting held November 17-19, 1997, in Kansas City, MO. It was issued by the Standards Council on January 16, 1998, with an effective date of February 6, 1998, and supersedes all previous editions.

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

This edition of NFPA 58 was approved as an American National Standard on April 2, 1998.

#### **Origin and Development of NFPA 58**

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

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

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

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

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### Foreword

**General Properties of LP-Gas.** Liquefied petroleum gases (LP-Gases), as defined in this code (*see Section 1-6*), are gases at normal room temperature and atmospheric pressure. They liquefy under moderate pressure, readily vaporizing upon release of the pressure. It is this property that permits transportation and storage of LP-Gases in concentrated liquid form, although they normally are used in vapor form. The potential fire hazard of LP-Gas vapor is comparable to that of natural or manufactured gas, except that LP-Gas vapors are heavier than air. The ranges of flammability are considerably narrower and lower than those of natural or manufactured gas. For example, the lower flammable limits of the more commonly used LP-Gases are 2.15 percent for propane and 1.55 percent for butane. These figures represent volumetric percentages of gas in gas-air mixtures.

The boiling point of pure butane is 31°F (-0.6°C), and pure propane has a boiling point of -44°F (-42°C). Both products are liquids at atmospheric pressure at temperatures lower than their boiling points. Vaporization is rapid at temperatures above their boiling points; thus, liquid propane normally does not present a flammable liquid hazard. For additional information on these and other properties of the principal LP-Gases, see Appendix B.

**Federal Regulations.** Regulations of the U.S. Department of Transportation (DOT) are referenced throughout this code. Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission (ICC). The Federal Hazardous Substances Act (15 U.S.C. 1261) requires cautionary labeling of refillable cylinders of liquefied petroleum gases distributed for consumer use. They are typically 40 lb (18 kg) and less, and are used with outdoor cooking appliances, portable lamps, camp stoves, and heaters. The Federal Hazardous Substances Act is administered by the U.S. Consumer Product Safety Commission under regulations codified at 16 CFR 1500.

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

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

Information on referenced publications can be found in Chapter 12 and Appendix J.

All pressures used in this code are gauge pressure unless otherwise indicated.

## Chapter 1 General Provisions

## 1-1 Scope.

**1-1.1\* Liquefied Petroleum Gas.** LP-Gas stored or used in systems within the scope of this code shall not contain ammonia. When such a possibility exists (such as resulting from the dual use of transportation or storage equipment), the LP-Gas shall be tested.

**1-1.2 Application.** This code shall apply to the operation of all LP-Gas systems including the following:

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

*Exception No. 1 to (c): Marine terminals associated with refineries, petrochemicals, and gas plants.*

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

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

*Exception: to (d): Those systems designated by 1-1.3.*

## 1-1.3 Nonapplication of Code.

**1-1.3.1** This code shall not apply to the following:

- (a) Frozen ground containers and underground storage in caverns including associated piping and appurtenances used for the storage of LP-Gas
- (b) Natural gas processing plants, refineries, and petrochemical plants

NOTE: For further information on the storage and handling of LP-Gas at natural gas processing plants, refineries, and petrochemical plants, see API 2510, *Design and Construction of LP-Gas Installations*.

- (c) LP-Gas (including refrigerated storage) at utility gas plants (NFPA 59, *Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants*, shall apply.)

- (d) Chemical plants where specific approval of construction and installation plans, based on substantially similar requirements, is obtained from the authority having jurisdiction
- (e) LP-Gas used with oxygen (NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, and ANSI Z49.1, *Safety in Welding and Cutting*, shall apply.)
- (f) Those portions of LP-Gas systems covered by NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*, where NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*, is adopted, used, or enforced

NOTE: Several types of LP-Gas systems are not covered by the *National Fuel Gas Code* as noted in 1.1.1(b) therein. These include, but are not restricted to, most portable applications; many farm installations; vaporization, mixing, and gas manufacturing; temporary systems, for example, in construction; and systems on vehicles. For those systems within its scope, the *National Fuel Gas Code* is applicable to those portions of a system downstream of the outlet of the final pressure regulator, exclusive of line gas regulators.

- (g) Transportation by air (including use in hot air balloons), rail, or water under the jurisdiction of the U.S. Department of Transportation (DOT)
- (h) Marine fire protection (NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, shall apply.)
- (i) Refrigeration cycle equipment and LP-Gas used as a refrigerant in a closed cycle

**1-1.4 Alternate Materials, Equipment, and Procedures.** The provisions of this code are not intended to prevent the use of any material, method of construction, or installation procedure not specifically prescribed by this code, provided any such use is acceptable to the authority having jurisdiction. (*See definition of Approved in Section 1-6.*) The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claims made regarding the safety of such alternate use.

**1-1.5 Retroactivity.** The provisions of this code are considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosion. They reflect situations and the state of the art prevalent at the time the code was issued.

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

## 1-2 Acceptance of Equipment and Systems.

**1-2.1** Systems, or components assembled to make up systems, shall be approved (*see definition of Approved in Section 1-6*) as specified in Table 1-2.1.



Table 1-2.1 Containers

Containers Used	Capacity Water gal (m <sup>3</sup> )	Approval Applies to
Cylinders	Up to 120 (0.454) (1000 lb, 454 kg)	Container valves and connectors Manifold valve assemblies Regulators and pressure relief devices
ASME containers	2000 (7.6) or less	Container system* including regulator, or container assembly* and regulator separately
ASME containers	Over 2000 (7.6)	Container valves Container excess flow valves, back flow check valves, or alternate means of providing this protection such as remotely controlled manual or automatic internal valves Container gauging devices Regulators and container pressure relief devices

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

**1-2.2** Acceptance applies to the complete system or to the individual components of which it is comprised as specified in Table 1-2.1.

### 1-3 LP-Gas Odorization.

**1-3.1\*** All LP-Gases shall be odorized prior to delivery to a bulk plant by the addition of a warning agent of such character that the gases are detectable, by a distinct odor, to a concentration in air of not over one-fifth the lower limit of flammability.

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

**1-3.2\*** If odorization is required, the presence of the odorant shall be determined by sniff-testing or other means and the results shall be documented:

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

### 1-4 Notification of Installations.

**1-4.1 Stationary Installations.** Plans for stationary installations utilizing storage containers of over 2000 gal (7.6 m<sup>3</sup>) individual water capacity, or with aggregate water capacity exceeding 4000 gal (15.1 m<sup>3</sup>), and all rooftop installations of ASME containers, shall be submitted to the authority having jurisdiction before the installation is started. [See also 3-4.9.1(e).]

**1-4.2 Temporary Installations.** The authority having jurisdiction shall be notified of temporary (not to exceed 6 months) installations of the sizes covered in 1-4.1 before the installation is started.

**1-5 Qualification of Personnel.** Persons who transfer liquid LP-Gas, who are employed to transport LP-Gas, or whose primary duties fall within the scope of this code shall be trained in proper handling procedures. The training shall be documented.

### 1-6 Definitions, Glossary of Terms, and Abbreviations.

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

**AGA.** American Gas Association.

**Anodeless Riser.** A transition assembly where polyethylene pipe or tubing is permitted to be installed and terminated above ground outside of a building. The polyethylene pipe or tubing is piped from at least 12 in. (300 mm) below grade to an aboveground location inside a protective steel casing and terminates in either a factory-assembled transition fitting or a field-assembled service head adapter-type transition fitting. The gas-carrying portion of the anodeless riser after the transition fitting shall be at least Schedule 40 steel pipe.

**ANSI.** American National Standards Institute.

**API.** American Petroleum Institute.

**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 (see Appendix D).

**Approved.\*** Acceptable to the authority having jurisdiction.

**ASME.** American Society of Mechanical Engineers.

**ASME Code.** *The Boiler and Pressure Vessel Code* (Section VIII, "Rules for the Construction of Unfired Pressure Vessels") of the American Society of Mechanical Engineers. Division I of Section VIII of the ASME Code is applicable in this code, except UG-125 through UG-136 shall not apply. Division II is also permitted.

**ASME Container (or Tank).** A container constructed in accordance with the ASME Code. (See Appendix D.)

**ASTM.** American Society for Testing and Materials.

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

**Bulk Plant.** A facility, the primary purpose of which is the distribution of gas, that receives LP-Gas by tank car, tank truck, or piping, distributing this gas to the end user by portable container (package) delivery, by tank truck, or through gas piping. Such plants have bulk storage [2000 gal (7.6 m<sup>3</sup>) water capacity or more] and usually have container-filling and truck-loading facilities on the premises. Normally, no persons other than the plant management or plant employees have access to these facilities. A facility that transfers LP-Gas from tank cars on a private track directly into cargo tanks is also in this category.

**Bureau of Explosives (B of E).** An agency of the Association of American Railroads.

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

**CGA.** Compressed Gas Association, Inc.

**Charging.** See Fill, Filling.

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

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

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

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

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

**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.

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

**Dispenser, Vehicle Fuel.** A device or system designed to measure and transfer volumes of LP-Gas into permanently mounted fuel containers on vehicles. (This serves the same purpose as the gasoline dispenser in a gasoline filling station.)

**Dispensing Station.** Fixed equipment where LP-Gas is stored and dispensed into portable containers. The public can be permitted access to the dispensing station area.

**DOT.** U.S. Department of Transportation.

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

**Excess-Flow Valve (or Excess-Flow Check Valve).** A device designed to close when the liquid or vapor passing through it exceeds a prescribed flow rate as determined by pressure drop.

**Excess-Flow Valve, Internal.** An excess-flow valve constructed and installed so that the seat remains in the container

so that damage to valve parts exterior to the container will not prevent effective seating of the valve.

**Fill, Filling.** Transferring liquid LP-Gas into a container.

**Filling by Volume.** See Volumetric Filling.

**Filling by Weight.** See Weight Filling.

**Fixed Liquid Level Gauge.** A type of liquid level gauge using a relatively small positive shutoff valve and designed to indicate when the liquid level in a container being filled reaches the point at which this gauge or its connecting tube communicates with the interior of the container.

**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.

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

**Flexible Connector.** A short [not exceeding 36 in. (0.91 m) overall length] component of a piping system fabricated of flexible material (such as hose) and equipped with suitable connections on both ends. LP-Gas resistant rubber and fabric (or metal), or a combination of these, or metal only are used. Flexible connectors are used where there is the need for, or the possibility of, greater relative movement between the points connected than is acceptable for rigid pipe.

**Float Gauge.** A gauge constructed with a float inside the container resting on the liquid surface that transmits its position through suitable leverage to a pointer and dial outside the container, indicating the liquid level. Normally the motion is transmitted magnetically through a nonmagnetic plate so that no LP-Gas is released to the atmosphere.

**Gallon.** U.S. Standard. 1 U.S. gal = 0.833 Imperial gal = 231 in.<sup>3</sup> = 3.785 L.

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

**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. The mixture thus created normally is used in industrial or commercial facilities as a substitute for another fuel gas. The mixture can replace another fuel gas completely, or can be mixed to produce similar characteristics and then can be mixed with the basic fuel gas. Any gas-air mixer that is designed to produce a mixture containing more than 85 percent air is not subject to the provisions of this code.

**GPA.** Gas Processors Association.

**ICC.** U.S. Interstate Commerce Commission.

**ICC Cylinder.** See Cylinder.

**Ignition Source.** See Sources of Ignition.

**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.

**Industrial Plant.** An industrial facility that utilizes gas incidental to plant operations, with LP-Gas storage of 2000 gal (7.6 m<sup>3</sup>) water capacity or more, and that receives gas by means of tank car, truck transport, or truck lots. Normally LP-Gas is used through piping systems in the plant but also can be used to fill small containers, such as for engine fuel on industrial trucks (e.g., forklifts). Since only plant employees have access to these filling facilities, they are not considered to be distributing points.

**Internal Valve.** A container primary shutoff valve where the seat and seat disc remain inside the container so that damage to parts exterior to the container or mating flange will not prevent effective seating of the valve. An internal valve has provision for the addition of a means of remote closure. An internal valve closes when flow through the valve exceeds its rated excess-flow capacity or when pump actuation differential pressure drops to a predetermined point.

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

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

**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 identified standards or has been tested and found suitable for a specified purpose.

**Load, Loading.** See Filling.

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

**LPG.** See Liquefied Petroleum Gas.

**LP-Gas.** See Liquefied Petroleum Gas.

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

**Magnetic Gauge.** See Float Gauge.

**Mobile Containers.** Containers that are permanently mounted on a vehicle and are connected for uses other than engine fuel.

**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.

**Movable Fuel Storage Tenders, Including Farm Carts.** Containers not in excess of 1200 gal (4.5 m<sup>3</sup>) water capacity, equipped with wheels to be towed from one location to another. These are basically non-highway vehicles but can occasionally be moved over public roads or highways for short distances for use as fuel supplies for farm tractors, construction machinery, and similar equipment.

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

**NFPA.** National Fire Protection Association.

**NPGA.** National Propane Gas Association.

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

**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.

**Permanent Installation.** See Stationary Installation.

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

**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.

**Portable Container.** A container designed to be moved readily, as distinguished from containers designed for stationary installations. Portable containers, designed for transportation, filled to their maximum filling limit include "cylinders," "cargo tanks," and "portable tanks," all three of which are defined separately. Containers designed to be readily moved from one usage location to another, but substantially empty of product, are "portable storage containers" and are defined separately.

**Portable Storage Container.** A container similar to but distinct from those designed and constructed for stationary installation, designed so that it can be moved readily over the highways, substantially empty of liquid, from one usage location to another. Such containers either have legs or other supports attached, or are mounted on running gear (such as trailer or semitrailer chassis) with suitable supports that can be of the fold-down type, allowing them to be placed or parked in a stable position on a reasonably firm and level surface. For large-volume, limited-duration product usage (such as at construction sites and normally for 12 months or less), portable storage containers function in lieu of permanently installed stationary containers.

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

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

**Pressure Relief Valve.** A type of pressure relief device designed to both open and close to maintain internal fluid pressure. Pressure relief valves are further characterized as follows.

*External Pressure Relief Valve.\** A relief valve that is located entirely outside the container connection except the threaded portion, which is screwed into the container connection, and that has all of its parts exposed to the atmosphere.

*Flush-Type Full Internal Pressure Relief Valve.\** A full internal relief valve in which the wrenching section is also within the container connection, except for pipe thread tolerances on makeup.

*Full Internal Pressure Relief Valve.\** A relief valve in which all working parts are recessed within the container connections, and the spring and guiding mechanism are not exposed to the atmosphere.

*Internal Spring-Type Pressure Relief Valve.\** A relief valve in which only the spring and stem are within the container connection, and the spring and stem are not exposed to the atmosphere. The exposed parts of the relief valve have a low profile.

*Sump-Type Full Internal Pressure Relief Valve.\** A relief valve in which all working parts are recessed within the container connection, but the spring and guiding mechanism are exposed to the atmosphere.

**psi.** Pounds per square inch.

**psig.** Pounds per square inch gauge.

**psia.** Pounds per square inch absolute.

**Quick Connectors.** Devices used for quick connections of the acme thread or lever-cam types. This does not include devices used for cylinder-filling connections.

**Refrigerated LP-Gas.** LP-gas that is maintained as liquid at temperatures at below ambient temperature to reduce the storage pressure. This includes fully refrigerated LP-Gas for pressures near atmospheric pressure but not exceeding 15 psi (103 kPa) and semirefrigerated LP-Gas for pressures above 15 psi (103 kPa).

**Regulator, Automatic Changeover.** An integral two-stage regulator that combines two high pressure regulators and a second-stage regulator into a single unit. It incorporates two inlet connections and a service-reserve indicator and is designed for use with dual or multiple cylinder installations. The system automatically changes the LP-Gas vapor withdrawal from the designated service cylinder(s) when depleted to the designated reserve cylinder(s) without interruption of service. The service reserve indicator gives a visual indication of the cylinder(s) that is supplying the system.

**Regulator, First-Stage.** A pressure regulator for LP-Gas vapor service designed to reduce pressure from the container to 10.0 psi (69 kPa) or less.

**Regulator, High Pressure.** 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 psi (6.9 kPa).

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

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

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

**Rotary Gauge.** A variable liquid level gauge consisting of a small positive shutoff valve located at the outer end of a tube, the bent inner end of which communicates with the container interior. The tube is installed in a fitting designed so that the tube can be rotated with a pointer on the outside to indicate the relative position of the bent inlet end. The length of the tube and the configuration to which it is bent are suitable for the range of liquid levels to be gauged. By means of a suitable outside scale, the level in the container at which the inner end begins to receive liquid can be determined by the pointer position on the scale at which a liquid-vapor mixture is observed to be discharged from the valve.

**Service Head Adapter.** A transition fitting for use with polyethylene pipe or tubing that is recommended by the manufacturer for field assembly and installation at the aboveground termination end of an anodeless riser (*see definition of Anodeless Riser in Section 1-6*). This fitting makes the transition from polyethylene pipe or tubing to a gas-carrying Schedule 40 steel fitting.

**Skid Tank.** See Portable Tank.

**Slip Tube Gauge.** A variable liquid level gauge in which a relatively small positive shutoff valve is located at the outside end of a straight tube, normally installed vertically, that communicates with the container interior. The installation fitting for the tube is designed so that the tube can be slipped in and out of the container and so that the liquid level at the inner end can be determined by observing when the shutoff valve vents a liquid-vapor mixture.

**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.

**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.

Where required in this code, special protection consists of applied insulating coatings, mounding, burial, water spray fixed systems, or fixed monitor nozzles that meet the criteria specified in this code (*see 3-10.3*) or any means listed for this purpose. (*See definition of Listed.*)

**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 place.

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

**UL.** Underwriters Laboratories Inc.

**Universal Cylinder.** A cylinder constructed and fitted with appurtenances in such a manner that it can be connected for service with its longitudinal axis in either the vertical or the horizontal position, and so that its fixed maximum liquid level gauge, pressure relief device(s), and withdrawal appurtenance will function properly in either position.

**Vaporizer.** A device, other than a container, that receives LP-Gas in liquid form and adds sufficient heat to convert the liquid to a gaseous state.

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

**Vaporizer, Electric.** A unit that uses electricity as a source of heat.

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

*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.

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

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

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

**Variable Liquid Level Gauge.** A device that indicates the liquid level in a container throughout a range of levels. (*See definitions of Float, Rotary, and Slip Tube Gauge in Section 1-6.*)

**Volumetric Filling.** Filling a container by determination of the volume of LP-Gas in the container. Unless a container is filled by a fixed maximum liquid level gauge, correction of the volume for liquid temperature is necessary.

**Volumetric Loading.** See Volumetric Filling.

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

**Weight Filling.** Filling containers by weighing the LP-Gas in the container. No temperature determination or correction is required, as a unit of weight is a constant quantity regardless of temperature.

## Chapter 2 LP-Gas Equipment and Appliances

### 2-1 Scope.

**2-1.1** This chapter includes the basic provisions for individual components, or for such components shop-fabricated into subassemblies, container assemblies, or complete container systems.

**2-1.2** The field assembly of components, subassemblies, container assemblies, or complete container systems into complete LP-Gas systems is covered by Chapter 3. (*See definition of LP-Gas System in Section 1-6.*)

### 2-2 Containers.

#### 2-2.1 General.

**2-2.1.1** This section includes design, fabrication, and marking provisions for containers and features normally associated with container fabrication, such as container openings, appurtenances required for these openings to make the containers gastight entities, physical damage protecting devices, and container supports attached to or furnished with the container by the manufacturer.

**2-2.1.2** Refrigerated containers shall comply with Chapter 9.

**2-2.1.3\*** Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT), the ASME *Boiler and Pressure Vessel Code*, "Rules for the Construction of Unfired Pressure Vessels," Section VIII, or the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, whichever is applicable at the date of manufacture. (*See Appendixes C and D.*) The following shall also apply:

- (a) Adherence to applicable ASME *Code Case Interpretations and Addenda* shall be considered as compliance with the ASME Code.
- (b) Containers fabricated to earlier editions of regulations, rules, or codes listed in 2-2.1.3 and the ICC *Rules for Construction of Unfired Pressure Vessels* prior to April 1, 1967, shall be permitted to be continued to be used in accordance with 1-1.5.

**2-2.1.4** A container shall not be filled if the container assembly is not suitable for continued service.

**2-2.1.5** Cylinders subject to the jurisdiction of DOT regulations shall be filled, continued in service, and transported in accordance with those regulations.

**2-2.1.6** Containers that have been involved in a fire and show no distortion shall be requalified for continued service as follows before being used or reinstalled:

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

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

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

- (c) All container appurtenances shall be replaced.

**2-2.1.7** ASME paragraph U-68 or U-69 containers shall be permitted to be continued to be used, installed, reinstalled, or placed back into service. Installation of containers shall be in accordance with all provisions listed in this code. (*See Section 2-2, Tables 2-2.2.2 and 2-3.2.3, and Appendix D.*)

**2-2.1.8** Containers that show serious denting, bulging, gouging, or excessive corrosion shall be removed from service.

**2-2.1.9** Repair or alteration of containers shall comply with the regulations, rules, or code under which the container was fabricated. Other welding shall be permitted only on saddle

plates, lugs, or brackets attached to the container by the container manufacturer.

**2-2.1.10** Containers for general use shall not have individual water capacities greater than 120,000 gal (454 m<sup>3</sup>). Containers in dispensing stations shall have an aggregate water capacity not greater than 30,000 gal (114 m<sup>3</sup>). This capacity restriction shall not apply to LP-Gas bulk plants, industrial plants, or industrial applications.

**2-2.1.11** Heating or cooling coils shall not be installed inside storage containers.

**2-2.2 Container Design or Service Pressure.**

**2-2.2.1** The minimum design or service pressure of cylinders shall be in accordance with the appropriate regulations published under Title 49, *Code of Federal Regulations*.

**2-2.2.2** The minimum design pressure for ASME containers shall be in accordance with Table 2-2.2.2.

**2-2.2.3** In addition to the applicable provisions for horizontal ASME containers, vertical ASME containers over 125 gal (0.5 m<sup>3</sup>) water capacity shall comply with the following:

- (a) Containers shall be designed to be self-supporting without the use of guy wires and shall satisfy proper design criteria taking into account wind, seismic (earthquake) forces, and hydrostatic test loads.
- (b) Design pressure (*see Table 2-2.2.2*) shall be interpreted as the pressure at the top head with allowance made for increased pressure on lower shell sections and bottom head due to the static pressure of the product.
- (c) Wind loading on containers shall be based on wind pressures on the projected area at various height zones above ground in accordance with ASCE 7, *Design Loads for Buildings and Other Structures*. Wind speeds shall be based on a mean occurrence interval of 100 years.
- (d) Seismic loading on containers shall be based on forces recommended in the ICBO *Uniform Building Code*. In those areas identified as zones 3 and 4 on the seismic risk map of the United States — Figures 1, 2, and 3 of Chapter 23 of the *UBC* — a seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction.

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

**2-2.3 ASME Container Openings.**

**2-2.3.1** Containers shall be equipped with openings suitable for the service for which the container is to be used. Such openings shall be permitted to be either in the container proper or in the manhole cover, or partially in each location.

**2-2.3.2** ASME containers of more than 30 gal (0.1 m<sup>3</sup>) through 2000 gal (7.6 m<sup>3</sup>) water capacity designed to be filled volumetrically and manufactured after December 1, 1963, shall be equipped for filling into the vapor space.

**2-2.3.3** ASME containers of 125 gal (0.5 m<sup>3</sup>) through 2000 gal (7.6 m<sup>3</sup>) water capacity manufactured after July 1, 1961, shall be provided with an opening for an actuated liquid withdrawal excess-flow valve with a connection not smaller than 3/4-in. national pipe thread.

**2-2.3.4** ASME containers of more than 2000 gal (7.6 m<sup>3</sup>) water capacity shall be provided with an opening for a pressure gauge.

**2-2.3.5** Connections for pressure relief valves shall be located and installed in such a way so as to have direct communication with the vapor space, whether the ASME container is in storage or in use.

- (a) If located in a well inside the ASME container with piping to the vapor space, then the design of the well and piping shall permit sufficient pressure relief valve relieving capacity.
- (b) If located in a protecting enclosure, the enclosure shall be designed so as to be protected against corrosion and to permit inspection.
- (c) If located in any position other than the uppermost point of the ASME container, then the connection shall be internally piped to the uppermost point practical in the vapor space of the container.

**2-2.3.6** ASME containers to be filled on a volumetric basis and manufactured after December 31, 1965, shall be fabricated so that they can be equipped with a fixed maximum liquid level gauge(s) that is capable of indicating the maximum permitted filling level(s) in accordance with 4-4.2.2.

**Table 2-2.2.2 Vapor Pressures and Design Pressures**

Maximum Vapor Pressure in psi (MPa) at 100°F (37.8°C)	Design Pressure in psi (MPa)		
	Current ASME Code <sup>1</sup>	Earlier Codes	
		API-ASME	ASME <sup>2</sup>
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)	250 (1.7)	200 (1.4)
215 (1.5)	312.5 (2.0) <sup>3</sup>	312.5 (2.2) <sup>3</sup>	—

<sup>1</sup>ASME Code, 1949 edition, Paragraphs U-200 and U-201 and all later editions (*see D-2.1.5*).

<sup>2</sup>All ASME Codes up to the 1946 edition and paragraphs U-68 and U-69 of the 1949 edition (*see D-2.1.5*).

<sup>3</sup>See 8-2.2.1(f) for certain service conditions that require a higher pressure relief valve start-to-leak setting.

<sup>4</sup>See Appendix D for information on earlier ASME or API-ASME Codes.

## 2-2.4 Portable Container Appurtenance Physical Damage Protection.

**2-2.4.1** Cylinders of 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) LP-Gas capacity] or less shall incorporate protection against physical damage to cylinder appurtenances and immediate connections to these when in transit, when in storage, when being moved into position for use, and when in use, except in residential and commercial installations, by the following:

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

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

**2-2.4.2** Portable containers of more than 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) LP-Gas capacity], including skid tanks or for use as cargo containers, shall incorporate protection against physical damage to container appurtenances by recessing, by protective housings, or by location on the vehicle. Such protection shall comply with the provisions under which the tanks are fabricated and shall be designed to withstand static loadings in any direction equal to twice the weight of the container and attachments when filled with LP-Gas, using a safety factor of not less than four, based on the ultimate strength of the material to be used. (See Chapters 3 and 6 for additional provisions applying to the LP-Gas system used.)

## 2-2.5 Containers with Attached Supports.

**2-2.5.1** Horizontal ASME containers of more than 2000 gal (7.6 m<sup>3</sup>) water capacity designed for permanent installation in stationary service shall be permitted to be provided with non-fireproofed structural steel saddles designed to allow mounting of the ASME containers on flat-topped concrete foundations. The total height of the outside bottom of the ASME container shell above the top of the concrete foundation shall not exceed 6 in. (152 mm).

**2-2.5.2** Horizontal ASME containers of 2000 gal (7.6 m<sup>3</sup>) water capacity or less designed for permanent installation in stationary service shall be permitted to be equipped with non-fireproofed structural steel supports and designed to allow mounting on firm foundations in accordance with the following:

(a) For installation on concrete foundations raised above the ground level by more than 12 in. (300 mm), the structural steel supports shall be designed so that the bottoms of the horizontal members are not less than 2 in. (51 mm) nor more than 12 in. (300 mm) below the outside bottom of the container shell.

(b) For installation on paved surfaces or concrete pads within 4 in. (102 mm) of ground level, the structural steel supports shall be permitted to be designed so that the bottoms of the structural members are not more than 24 in. (610 mm) below C. [See 3-2.4.2(a)(4) for installation provisions for such containers, which are customarily used as components of prefabricated container-pump assemblies.]

**2-2.5.3** Vertical ASME containers over 125 gal (0.5 m<sup>3</sup>) water capacity designed for permanent installation in stationary service shall be designed with steel supports that are designed to

allow the container to be mounted on and fastened to concrete foundations or supports. Such steel supports shall be designed to make the container self-supporting without guy wires and shall satisfy proper design criteria, taking into account wind, seismic (earthquake) forces, and hydrostatic test load criteria established in 2-2.2.3.

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

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

**2-2.5.4** ASME containers that are used as portable storage containers (see definition of Portable Container in Section 1-6) for temporary (less than 6 months at any given location) stationary service and are moved only when substantially empty of liquid shall comply with the following (this shall apply to movable fuel storage tenders including farm carts):

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

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

**2-2.5.5** Portable tanks (see definition in Section 1-6) shall comply with DOT portable tank container specifications as to container design and construction, securing of skids or lugs for the attachment of skids, and protection of fittings. In addition, 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 container shell.

**2-2.5.6** Movable fuel storage tenders, including farm carts, shall be secured to the trailer support structure for the service involved.

## 2-2.6 Container Marking.

**2-2.6.1** Containers shall be marked as provided in the regulations, rules, or code under which they are fabricated and shall be in accordance with the following:

(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," "LP-GAS," "Propane," or "Butane." Compliance with marking requirements of Title 49 of the Code of Federal Regulations shall meet this provision.

(b) When being transported, cylinders shall be marked and labeled in accordance with Title 49 of the Code of Federal Regulations.

**2-2.6.2** Cylinders shall be marked with the following information:

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

**2-2.6.3** ASME containers shall be marked in accordance with the following:

- (a) The marking specified shall be on a stainless steel metal nameplate attached to the container, located to remain visible after the container is installed. The nameplate shall be attached in such a way as to minimize corrosion of the nameplate or its fastening means and not contribute to corrosion of the container.

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

- (b) Service for which the container is designed (for example, underground, aboveground, or both)
- (c) Name and address of container supplier or trade name of container
- (d) Water capacity of container in pounds or U.S. gallons
- (e) Design pressure in pounds per square inch
- (f) The wording "This container shall not contain a product that has a vapor pressure in excess of \_\_\_ psi at 100°F" (See Table 2-2.2.2.)
- (g) Outside surface area in square feet
- (h) Year of manufacture
- (i) Shell thickness and head thickness
- (j) OL, OD, HD
- (k) Manufacturer's serial number
- (l) ASME Code symbol

**2-2.6.4** A warning label shall be applied to all cylinders of 100 lb (45.4 kg) LP-Gas capacity or less not filled on site. The label shall include information on the potential hazards of LP-Gas.

**2-2.6.5** Effective January 1, 1996, all ASME containers that contain unodorized LP-Gas products shall be marked NOT ODORIZED in letters 4 in. (10 cm) in height with a contrasting background surrounded by a 1/2-in. (1.3-cm) rectangular border. The markings shall be located on either both sides or both ends of the container.

## 2-3 Container Appurtenances.

### 2-3.1 General.

**2-3.1.1** This section includes fabrication and performance provisions for container appurtenances, such as pressure relief devices, container shutoff valves, backflow check valves, internal valves, excess-flow check valves, plugs, liquid level gauges, and pressure gauges connected directly into the container openings described in 2-2.3. Shop installation of such appurtenances in containers listed as container assemblies or container systems in accordance with Section 1-2 is a responsibility of the fabricator under the listing. Field installation of such appurtenances is covered in Chapters 3 and 8.

**2-3.1.2** Container appurtenances shall be fabricated of materials that are suitable for LP-Gas service and shall be resistant to the action of LP-Gas under service conditions. The following shall also apply:

(a) Pressure-containing metal parts of appurtenances, such as those listed in 2-3.1.1, except fusible elements, shall have a minimum melting point of 1500°F (816°C) such as steel, ductile (nodular) iron, malleable iron, or brass. Ductile iron shall meet the requirements of ASTM A395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or equivalent and malleable iron shall meet the requirements of ASTM A47, *Standard Specification for Ferritic Malleable Iron Castings*, or equivalent.

*Exception: Approved or listed liquid level gauges used in containers of 3500 gal (13.2 m<sup>3</sup>) water capacity or less are exempt from this provision.*

(b) Cast iron shall not be used.

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

**2-3.1.3** Container appurtenances shall have a rated working pressure of at least 250 psi (1.7 MPa).

**2-3.1.4** Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. They shall be made of metal or other suitable material confined in metal having a melting point over 1500°F (816°C) or shall be protected against fire exposure. When a flange is opened, the gasket shall be replaced.

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

**2-3.1.5** Cylinders with 4 lb (1.8 kg) through 40 lb (18 kg) propane capacity for vapor service shall comply with the following:

(a) \* Cylinders fabricated after September 30, 1998, shall be equipped or fitted with a listed overfilling prevention device and a fixed maximum liquid level gauge. These devices shall be part of the container assembly. The length of the fixed maximum liquid level gauge dip tube shall be in accordance with 4-4.3.3(a).

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

(c) Effective April 1, 2002, no cylinder shall be filled unless it is equipped with an overfilling prevention device and a fixed maximum liquid level gauge. The length of the fixed maximum liquid level gauge dip tube shall be in accordance with 4-4.3.3(a).

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

*Exception: All cylinders used in industrial truck service (including forklift truck cylinders) and cylinders identified and used for industrial welding and cutting gases shall be exempt from these requirements.*

**2-3.1.6** Container appurtenances shall be maintained in operating condition.

**2-3.2 Pressure Relief Devices.** See 2-4.7 for hydrostatic relief valves.



**2-3.2.1** Containers shall be equipped with one or more pressure relief devices that, except as otherwise provided for in 2-3.2.2, shall be designed to relieve vapor.

**2-3.2.2** The following shall apply to DOT containers:

- (a) Cylinders that comply with *Code of Federal Regulations*, Title 49, Part 178, Subpart C, shall be equipped with pressure relief valves or fusible plug devices as required by DOT regulations. (See *Appendix E*.)
- (b) If a spring-loaded pressure relief valve(s) is the only relief device, the valve shall comply with the flow capacity requirements of CGA S-1.1, Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases, with the start-to-discharge pressure not less than 75 percent nor more than 100 percent of the minimum required test pressure of the cylinder.
- (c) DOT 2P and 2Q inside nonrefillable metal containers that comply with *Code of Federal Regulations*, Title 49, Part 178, Subpart B, shall be equipped with a pressure relief device(s) or system(s) that will prevent rupture or propulsion of the container when the container is exposed to the action of fire.

**2-3.2.3** ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with applicable requirements of UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, or other equivalent pressure relief valve standards. The start-to-leak setting of such pressure relief valves, with relation to the design pressure of the container, shall be in accordance with Table 2-3.2.3.

*Exception: On containers of 40,000 gal (151 m<sup>3</sup>) water capacity or more, a pilot-operated pressure relief valve in which the relief device is combined with and is controlled by a self-actuated, direct, spring-loaded pilot valve shall be permitted to be used provided it complies with Table 2-3.2.3, is approved (see definition), is inspected and maintained by persons with appropriate training and experience, and is tested for proper operation at intervals not exceeding 5 years.*

**Table 2-3.2.3**

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

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

**2-3.2.4** Pressure relief valves for ASME containers shall also comply with the following:

(a) The minimum rate of discharge of pressure relief valves shall be in accordance with Table 2-3.2.4 or shall be calculated using the following formula:

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

where:

A = total outside surface area of container in square feet

(b) Relief valves for aboveground containers shall relieve at not less than the rate indicated before the pressure exceeds 120 percent of the minimum permitted start-to-leak pressure setting of the device. This does not include the 10 percent reference in the footnote to Table 2-3.2.3. [See 2-3.2.4(e).]

**Table 2-3.2.4 Pressure Relief Valve Flow Capacity as a Function of Tank Surface Area**

Surface Area	Flow Rate	Surface Area	Flow Rate	Surface Area	Flow Rate
Ft <sup>2</sup>	ft <sup>3</sup> /min Air	Ft <sup>2</sup>	ft <sup>3</sup> /min Air	Ft <sup>2</sup>	ft <sup>3</sup> /min Air
20 or less	626	170	3620	600	10170
25	751	175	3700	650	10860
30	872	180	3790	700	11550
35	990	185	3880	750	12220
40	1100	190	3960	800	12880
45	1220	195	4050	850	13540
50	1330	200	4130	900	14190
55	1430	210	4300	950	14830
60	1540	220	4470	1000	15470
65	1640	230	4630	1050	16100
70	1750	240	4800	1100	16720
75	1850	250	4960	1150	17350
80	1950	260	5130	1200	17960
85	2050	270	5290	1250	18570
90	2150	280	5450	1300	19180
95	2240	290	5610	1350	19780
100	2340	300	5760	1400	20380
105	2440	310	5920	1450	20980
110	2530	320	6080	1500	21570
115	2630	330	6230	1550	22160
120	2720	340	6390	1600	22740
125	2810	350	6540	1650	23320
130	2900	360	6690	1700	23900
135	2990	370	6840	1750	24470
140	3080	380	7000	1800	25050
145	3170	390	7150	1850	25620
150	3260	400	7300	1900	26180
155	3350	450	8040	1950	26750
160	3440	500	8760	2000	27310
165	3530	550	9470	—	—

(c) Underground or mounded containers shall be permitted to have pressure relief valve relieving capacities to be as small as 30 percent of those specified in Table 2-3.2.4.

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

1. The pressure in psi at which the valve is set to start-to-leak
2. Rated relieving capacity in cubic feet per minute of air at 60°F (16°C) and 14.7 psia (101 kPa)
3. The manufacturer's name and catalog number

(e) Shutoff valves shall not be located between a pressure relief device and the container.

*Exception to (e): Where the arrangement is such that the relief device relieving capacity flow specified in 2-3.2.4(a) will be achieved through additional pressure relief devices that remain operative.*

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

(g) Fusible plug devices, with a yield point of 208°F (98°C) minimum and 220°F (104°C) maximum, with a total discharge area not exceeding 0.25 in.<sup>2</sup> (1.6 cm<sup>2</sup>), that communicate directly with the vapor space of the container shall be permitted to be used in addition to the spring-loaded pres-

sure relief valves (as specified in Table 2-3.2.3) for above-ground containers of 1200 gal (4.5 m<sup>3</sup>) water capacity or less

**2-3.2.5** All cylinders used in industrial truck service (including forklift truck cylinders) shall have the cylinder's pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the cylinders and every 10 years thereafter.

### 2-3.3 Container Connections and Appurtenances.

**2-3.3.1** Pressure relief devices, container shutoff valves, backflow check valves, internal valves, excess-flow check valves, plugs, liquid level gauges, and overfilling prevention devices that are used individually or in suitable combinations shall comply with 2-3.1.2, 2-3.1.3, and 2-3.1.5, and with the following:

**2-3.3.2** Container appurtenances shall be required as follows:

(a) For containers 2000 gal (7.6 m<sup>3</sup>) water capacity or less, see Table 2-3.3.2(a).

1. The requirement for internal spring-type pressure relief valves that are shown in Table 2-3.3.2(a) for stationary ASME containers up to and including 2000 gal (7.6 m<sup>3</sup>) water capacity shall not apply to underground containers where external pressure relief valves are permitted, or to containers that were originally equipped with external pressure relief valves.

2. Containers of 125 gal (0.5 m<sup>3</sup>) or more water capacity shall be provided with an actuated liquid withdrawal excess-flow valve with a connection not smaller than  $\frac{3}{4}$ -in. national pipe thread. This valve shall not be connected for continuous service unless the valve is recommended by the manufacturer for such service.

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

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

4. Excess-flow protection shall not be required for manual shutoff valves for vapor service where an approved regulator is directly attached or attached with a flexible connector to the outlet of the manual shutoff valve for vapor service and the controlling orifice between the container contents and the shutoff valve outlet does not exceed  $\frac{5}{16}$  in. (8 mm) in diameter.

5. Overfilling prevention devices and fixed maximum liquid level gauges shall be required on cylinders having 4 lb (1.8 kg) through 40 lb (18 kg) propane capacity for vapor service. (See 2-3.1.5.)

(b) For containers over 2000 gal (7.6 m<sup>3</sup>) water capacity.

1. For vapor and liquid withdrawal openings,
  - a. A positive shutoff valve that is located as close to the tank as practical in combination with an excess-flow valve installed in the tank, or
  - b. An internal valve with an integral excess-flow valve or excess-flow protection.
2. For vapor and liquid inlet openings,
  - a. A positive shutoff valve that is located as close to the container as practical, in combination with

either a backflow check valve or excess-flow valve installed in the container, or

b. An internal valve with an integral excess-flow check valve or excess-flow protection.

3. Other required appurtenances include the following:

- a. Internal spring-type, flush-type full internal, or external pressure relief valve (see Appendix E)
- b. Fixed maximum liquid level gauge
- c. Float gauge, rotary gauge, or slip tube gauge, or a combination of these gauges
- d. Pressure gauge
- e. Temperature gauge

**2-3.3.3** The appurtenances specified in Table 2-3.3.2(a) and paragraph 2-3.2.2(c) shall comply with the following:

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

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

*Exception: Excess-flow valves of less than  $\frac{1}{2}$  in. (1.3 cm) NPT shall have a bypass that limits propane vapor flow to 10 scf/hr at 100 psi (690 kPa).*

(c) Backflow check valves, which shall be permitted to be of the spring-loaded or weight-loaded type with in-line or swing operation, shall close when the flow is either stopped or reversed. Both valves of double backflow check valves shall comply with this provision.

(d) Internal valves (see definition), either manually or automatically operated and designed to remain closed except during operating periods, shall be considered positive shutoff valves. [See 6-3.2.1 for special requirements for such valves used on cargo units.]

### 2-3.4 Liquid Level Gauging Devices.

**2-3.4.1** Liquid level gauging devices shall be provided on all containers filled by volume. Fixed maximum liquid level gauges or variable gauges of the slip tube, rotary tube, or float types (or combinations of such gauges) shall be permitted to be used to comply with this provision.

**2-3.4.2** Every container constructed after December 31, 1965, and designed to be filled on a volumetric basis shall be equipped with a fixed maximum liquid level gauge(s) to indicate the maximum filling level(s) for the service(s) in which the container is to be used (see 4-4.3.3). This shall be permitted to be accomplished either by using a dip tube of appropriate length or by the position of the gauging device in the container. The following shall also apply to fixed maximum liquid level gauges:

(a) ASME containers manufactured after December 31, 1969, shall have permanently attached to the container adjacent to the fixed maximum liquid level gauge, or on the container nameplate, markings showing the percentage full that is indicated by that gauge.

(b) Cylinders shall have stamped on the cylinder the letters DT followed by the vertical distance (to the nearest tenth inch) 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. [See 2-3.4.2(c)2 for cylinders designed for loading in either the vertical or horizontal position.]

**Table 2-3.3.2(a) Container Connection and Appurtenance Requirements for Containers Used on Domestic, Commercial, Industrial, Engine Fuel, and Over-the-Road Mobile Applications**

Part	Appurtenances	1. Cylinders, 2-lb-100-lb (0.9-kg-45.4-kg) propane capacity for vapor service	2. Cylinders, 2-lb-100-lb (0.9-kg-45.4-kg) propane capacity for liquid service	3. Cylinders, 2-lb-100-lb (0.9-kg-45.4-kg) propane capacity for liquid and vapor service	4. Cylinders, 100-lb-420-lb (45.4- kg-190-kg) propane capacity filled on site	5. Stationary ASME containers 2000-gal (7.6-m <sup>3</sup> ) water capacity	6. Engine fuel or mobile containers (see Section 1-6, Definitions)	7. ASME engine fuel or mobile containers (see Section 1-6, Definitions)
A.	Manual shutoff valve (CGA 510 outlet) with an overfilling prevention device and an integral external pressure relief valve	R [see 2-3.2.2 and 2-3.3.2(a)5]						
B.	Manual shutoff valve (CGA 555 outlet) with integral external pressure relief valve and excess-flow valve attached to the internal liquid line inside the cylinder		R√ (see 2-3.2.2)					
C.	Manual shutoff valve (CGA 555 outlet) with excess-flow valve for liquid service attached to the internal liquid line inside the cylinder; manual shutoff valve (CGA 510 outlet) with integral external pressure relief valve for vapor service			R√ (see 2-3.2.2)				
D.	Double backflow check filler valve		O√		R√	R√	O	R
E.	Manual shutoff valve for vapor service [see 2-3.3.2(a)4 and 3-4.2.1(b)]				R√	R√		
F.	Fixed maximum liquid level gauge	R√ [see 2-3.3.2(a)5]	O√	O√	R√	R√	R	R
G.	External pressure relief valve (see 2-3.2)				R√			
H.	Internal spring-type pressure relief valve (see 2-3.2)					R [see 2-3.3.2(a)1]		
I.	Float gauge	O√	O√	O√	O	R√	O	O
J.	Backflow check and excess-flow vapor return valve					O√		
K.	Actuated liquid withdrawal excess-flow valve [see 2-3.3.2(a)2]					R		
L.	Manual shutoff liquid or vapor valve with internal excess-flow check valve						R	R
M.	Full internal or flush-type full internal pressure relief valve						R	R
N.	Overfilling prevention device						R [see 2-3.3.2(b)3]	R [see 2-3.3.2(b)3]

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

(c) Each cylinder manufactured after December 31, 1972, that is equipped with a fixed maximum liquid level gauge for which the tube is not welded in place shall be permanently marked adjacent to such gauge as follows:

1. Cylinders designed to be filled in one position shall be marked with the letters DT followed by the vertical distance (to the nearest tenth inch) measured from the top center of the cylinder boss or coupling into which the gauge is installed to the maximum permitted filling level.
2. Universal-type cylinders (*see definition*) shall be marked as follows:
  - a. *Vertical Filling:* With the letters VDT followed by the vertical distance (to the nearest tenth inch) measured from the top center of the cylinder boss or coupling into which the gauge is installed to the maximum permitted filling level.
  - b. *Horizontal Filling:* With the letters HDT followed by the vertical distance (to the nearest tenth inch) measured from the top centerline of the cylinder boss or coupling opening into which the gauge is installed to the inside top of the cylinder when the cylinder is in the horizontal position.

(d) Cargo tanks having several fixed level gauges positioned at different levels shall have stamped adjacent to each gauge the loading percentage (to the nearest  $\frac{2}{10}$  percent) of the container content indicated by that particular gauge.

**2-3.4.3** Variable liquid level gauges shall comply with the following:

- (a) Variable liquid level gauges shall be so marked that the maximum liquid level, in inches or percent of capacity of the container in which they are to be installed, is readily determinable. These markings shall indicate the maximum liquid level for propane, for 50/50 butane-propane mixtures, and for butane at liquid temperatures from 20°F (-6.7°C) to 130°F (54.4°C) and in increments not greater than 20°F (-6.7°C).
- (b) The markings indicating the various liquid levels from empty to full shall be either directly on the system nameplate or on the gauging device or on both.
- (c) Dials of magnetic float or rotary gauges shall indicate whether they are for cylindrical or spherical containers, and whether for aboveground or underground service.
- (d) The dials of gauges for use only on aboveground containers of over 1200 gal (4.5 m<sup>3</sup>) water capacity shall be so marked.

**2-3.4.4** Variable liquid level gauges shall comply with the provisions of 4-4.3.3(b) if they are used for filling containers.

**2-3.4.5** Gauging devices requiring bleeding of product to the atmosphere, such as fixed liquid level, rotary tube, and slip tube gauges, shall be designed so that the bleed valve maximum opening to the atmosphere is not larger than a No. 54 drill size.

### 2-3.5 Pressure Gauges.

**2-3.5.1** Pressure gauges shall comply with 2-3.1.2 and 2-3.1.3.

**2-3.5.2** Pressure gauges shall be attached directly to the container opening or to a valve or fitting that is directly attached

to the container opening. If the effective opening into the container allows a flow greater than that of a No. 54 drill size, then an excess-flow check valve shall be provided.

**2-3.6 Other Container Connections.** Container openings shall be equipped with one of the following:

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

*Exception No. 1: Pressure relief valves in accordance with 2-3.2.*

*Exception No. 2: Connections for flow controls in accordance with 2-3.3.*

*Exception No. 3: Liquid level gauging devices in accordance with 2-3.4.*

*Exception No. 4: Pressure gauges in accordance with 2-3.5.*

**2-3.7 Container Appurtenance Protection.** Container appurtenances other than pressure relief devices shall be installed and protected as follows:

(a) All container openings except those used for pressure relief devices (*see 2-3.2*), liquid level gauging devices (*see 2-3.4*), pressure gauges (*see 2-3.5*), those equipped with double check valves as allowed in Table 2-3.3.2(a), and plugged openings shall be equipped with internal valves [*see 2-3.3.3(d)*] or with positive shutoff valves and either excess-flow or backflow check valves (*see also 2-3.3 for specific application*) as follows:

1. On ASME containers, excess-flow or backflow check valves shall be located between the LP-Gas in the container and the shutoff valves, either inside the container or at a point immediately outside where the line enters or leaves the container. If outside, installation shall be made so that any undue strain beyond the excess-flow or backflow check valve will not cause breakage between the container and the valve. All connections, including couplings, nozzles, flanges, standpipes, and manways, that are listed in the ASME Manufacturers' Data Report for the container shall be considered part of the container.
2. If an excess-flow valve is required on cylinders other than for mobile or engine fuel service, it shall be permitted to be located at the outlet of the cylinder shutoff valve.
3. Shutoff valves shall be located as close to the container as practical. The valves shall be readily accessible for operation and maintenance under normal and emergency conditions, either because of location or by means of permanently installed special provisions. Valves installed in an unobstructed location not more than 6 ft (1.8 m) above ground level shall be considered accessible. Special provisions include, but are not limited to, stairs, ladders, platforms, remote operators, or extension handles.
4. The connections, or line, leading to or from any individual opening shall have greater capacity than the rated flow of the excess-flow valve protecting the opening.

(b) Valves, regulators, gauges, and other container appurtenances shall be protected against physical damage.

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

(d) Connections to ASME containers installed underground shall be located within a substantial dome, housing, or manhole and shall have access thereto protected by a substantial cover. Underground systems shall be installed so that all terminals for connecting hose and any opening through which there can be a flow from pressure relief devices or pressure regulator vents are located above the normal maximum water table. Terminals for connecting hoses, openings for flow from pressure relief devices, and the interior of domes, housing, and manholes shall be kept clean of debris. Such manholes or housings shall be provided with ventilated louvers or their equivalent. The area of such 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.

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

*Exception No. 1: Connections for pressure relief devices.*

*Exception No. 2: Connections for liquid level gauging devices.*

*Exception No. 3: Connections for pressure gauges.*

NOTE: See 3-8.2.5(e) and 8-2.2.7 for requirements for labeling smaller containers used for vehicular installations.

(f) Every ASME storage container of more than 2000 gal (7.6 m<sup>3</sup>) water capacity shall be provided with a pressure gauge.

## 2-4 Piping (Including Hose), Fittings, and Valves.

### 2-4.1 General.

**2-4.1.1** This section includes basic design provisions and material specifications for pipe, tubing, pipe and tubing fittings, valves (including hydrostatic relief valves), hose, hose connections, and flexible connectors used to connect container appurtenances with the balance of the LP-Gas system in accordance with the installation provisions of Chapters 3, 8, and 9.

**2-4.1.2** Piping, pipe and tubing fittings, and valves used to supply utilization equipment within the scope of NFPA 54, *National Fuel Gas Code*, shall comply with that code.

**2-4.1.3** Pipe and tubing shall comply with 2-4.2 and 2-4.3 or shall be of material that has been investigated and tested to determine that it is safe and suitable for the proposed service and is recommended for that service by the manufacturer, and shall be acceptable to the authority having jurisdiction.

**2-4.1.4** Piping that can contain liquid LP-Gas and that can be isolated by valving and that requires hydrostatic relief valves, as specified under 3-2.11, shall have a minimum design pressure of 350 psi (2.4 MPa) or a design pressure that is equivalent to the maximum discharge pressure of any pump or other source

feeding the piping system if it is greater than 350 psi (2.4 MPa).

**2-4.2 Pipe.** Pipe shall be wrought iron or steel (black or galvanized), brass, copper, or polyethylene (*see 3-2.10.8*) and shall comply with the following:

- (a) Wrought-iron pipe — ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*
- (b) Steel pipe — ASTM A53, *Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
- (c) Steel pipe — ASTM A106, *Specification for Seamless Carbon Steel Pipe for High-Temperature Service*
- (d) Brass pipe — ASTM B43, *Specification for Seamless Red Brass Pipe, Standard Sizes*
- (e) Copper pipe — ASTM B42, *Specification for Seamless Copper Pipe, Standard Sizes*
- (f) Polyethylene pipe — ASTM D2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*. Pipe shall be recommended by the manufacturer for use with LP-Gas. Polyethylene pipe shall be marked in full compliance with the product marking requirements of ASTM D2513, and shall include the manufacturer's name or trademark, the standard dimensional ratio of the pipe, the size of the pipe, the designation polyethylene (PE), the date manufactured, and the designation ASTM D2513

**2-4.3 Tubing.** Tubing shall be steel, brass, copper, or polyethylene (*see 3-2.10.8*) and shall comply with the following:

- (a) Steel tubing — ASTM A539, *Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines*
- (b) Brass tubing [*see 3-2.8(d), Exception No. 3*] — ASTM B135, *Specification for Seamless Brass Tube*
- (c) Copper tubing [*see 3-2.8(d), Exception No. 3*]
  - 1. Type K or L — ASTM B88, *Specification for Seamless Copper Water Tube*
  - 2. ASTM B280, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*
- (d) Polyethylene tubing — ASTM D2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*. Tubing shall be recommended by the manufacturer for use with LP-Gas. Polyethylene tubing shall be marked in full compliance with the product marking requirements of ASTM D2513 and shall include the manufacturer's name or trademark, the standard dimensional ratio of the pipe, the size of the pipe, the designation polyethylene (PE), the date manufactured, and the designation ASTM D2513.
- (e) Corrugated stainless steel tubing shall comply with ANSI/AGA LCI.

### 2-4.4 Fittings for Pipe and Tubing.

**2-4.4.1** Fittings shall be steel, brass, copper, malleable iron, ductile (nodular) iron, or polyethylene and shall comply with 2-4.4.1. Cast-iron pipe fittings (ells, tees, crosses, couplings, unions, flanges, and plugs) shall not be used. Thermoplastic fittings fabricated from materials listed in ASTM D2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, used to join polyethylene pipe shall comply with ASTM D2513, and shall be recommended for LP-Gas use by the manufacturer.

(a) Pipe joints in wrought iron, steel, brass, or copper pipe shall be permitted to be screwed, welded, or brazed.

1. Fittings used at pressures higher than container pressure, such as on the discharge of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psi (2.4 MPa).
2. Fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psi (0.9 MPa), shall be suitable for a working pressure of 250 psi (1.7 MPa).

*Exception: Fittings used at higher pressure as specified in 2-4.4.1(a)1.*

3. Fittings for use with vapor LP-Gas at pressures not exceeding 125 psi (0.9 MPa) shall be suitable for a working pressure of 125 psi (0.9 MPa).
4. Brazing filler material shall have a melting point that exceeds 1000°F (538°C).

(b) Tubing joints in steel, brass, or copper tubing shall be flared, brazed, or made up with approved gas tubing fittings.

1. Fittings used at pressures higher than container pressure, such as on the discharge of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psi (2.4 MPa).
2. Fittings used with liquid LP-Gas or with vapor LP-Gas at operating pressures over 125 psi (0.9 MPa) shall be suitable for a working pressure of 250 psi (1.7 MPa).

*Exception: Fittings used at higher pressure as specified in 2-4.4.1(a)1.*

3. Fittings for use with vapor LP-Gas at pressures not exceeding 125 psi (0.9 MPa) shall be suitable for a working pressure of 125 psi (0.9 MPa).
4. Brazing filler material shall have a melting point exceeding 1000°F (538°C).

(c) Joints in polyethylene pipe and polyethylene tubing shall be made by heat fusion, by compression-type mechanical fittings, or by factory-assembled transition fittings. Heat fusion and factory-assembled transition fittings shall be permitted to be used to make joints in all sizes of polyethylene pipe being used. Mechanical compression-type fittings shall not be used on any polyethylene pipe above 2 in. IPS size. All fittings used to join polyethylene pipe or polyethylene tubing shall be tested and recommended by the manufacturer for use with polyethylene (PE) pipe and shall be installed according to the manufacturer's written procedure. For heat fusion, these instructions shall be specific to the type and grade of polyethylene being joined. Polyethylene pipe shall not be joined by a threaded or miter joint.

1. Polyethylene fusion fittings shall conform to ASTM D2683, *Specification for Socket-type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe*; or ASTM D3261, *Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*; or ASTM F1055, *Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing*, and shall be recommended by the manufacturer for use with LP-Gas.
2. Mechanical fittings shall comply with Category 1 of ASTM D2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, for mechanical joints and shall be tested and shown to be acceptable for use with polyethylene pipe and polyethylene tubing.

- (a) Compression-type mechanical fittings shall include a rigid internal tubular stiffener, other than a split tubular stiffener, to support the pipe. Gasket material in the fitting shall be resistant to the action of LP-Gas and shall be compatible with the polyethylene pipe (PE) material.
- (b) Fittings shall be installed according to the procedure provided by the manufacturer.
3. \*Anodeless risers shall comply with the following:
  - (a) Factory-assembled anodeless risers shall be recommended for LP-Gas use and shall be leak tested by the manufacturer in accordance with written procedures.
  - (b) Field-assembled anodeless risers with service head adapters shall be equipped with moisture seals and shall be recommended for LP-Gas use by the manufacturer and shall be design certified to meet the requirements of Category 1 of ASTM D2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and U.S. Department of Transportation, *Code of Federal Regulations*, Title 49, Part 192.281(e), and the requirements of 3-2.10.8. The manufacturer shall provide the user with qualified installation instructions as prescribed by U.S. Department of Transportation, *Code of Federal Regulations*, Title 49, Part 192.283(b).
4. \*All persons installing polyethylene piping shall be trained in the applicable joining procedure. The training shall be documented.

#### 2-4.5 Valves Other than Container Valves.

**2-4.5.1** Pressure-containing metal parts of valves (except appliance valves), including manual positive shutoff valves, excess-flow check valves, backflow check valves, emergency shutoff valves (*see 2-4.5.4*), and remotely controlled valves (either manually or automatically operated), used in piping systems shall be of steel, ductile (nodular) iron, malleable iron, or brass. Ductile iron shall meet the requirements of ASTM A395, *Specification for Ferritic Ductile Iron Pressure-Related Castings for Use at Elevated Temperatures*, or equivalent and malleable iron shall meet the requirements of ASTM A47, *Specification for Ferritic Malleable Iron Castings*, or equivalent. All materials used, including valve seat discs, packing, seals, and diaphragms, shall be resistant to the action of LP-Gas under service conditions.

**2-4.5.2** Valves shall be suitable for the appropriate working pressure, as follows:

- (a) Valves used at pressures higher than container pressure, such as on the discharge of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psi (2.4 MPa). [400 psi (2.8 MPa) WOG valves comply with this provision.]
- (b) Valves to be used with liquid LP-Gas, or with vapor LP-Gas at pressures in excess of 125 psi (0.9 MPa), but not to exceed 250 psi (1.7 MPa), shall be suitable for a working pressure of at least 250 psi (1.7 MPa).

*Exception: Valves used at higher pressure as specified in 2-4.5.2(a).*

- (c) Valves (except appliance valves) to be used with vapor LP-Gas at pressures not to exceed 125 psi (0.9 MPa) shall be suitable for a working pressure of at least 125 psi (0.9 MPa).

**2-4.5.3** Manual shutoff valves, emergency shutoff valves (*see 2-4.5.4*), excess-flow check valves, and backflow check valves

used in piping systems shall comply with the provisions for container valves. [See 2-3.3.3(a), (b), and (c).]

**2-4.5.4** Emergency shutoff valves shall be approved and shall incorporate all of the following means of closing (see 3-2.10.12, 3-3.3.7, and 3-3.3.8):

- (a) Automatic shutoff through thermal (fire) actuation. Where fusible elements are used, they shall have a melting point not exceeding 250°F (121°C).
- (b) Manual shutoff from a remote location
- (c) Manual shutoff at the installed location

**2-4.6 Hose, Quick Connectors, Hose Connections, and Flexible Connectors.**

**2-4.6.1** Hose, hose connections, and flexible connectors (see definition) shall be fabricated of materials that are resistant to the action of LP-Gas both as liquid and vapor. If wire braid is used for reinforcement, it shall be of corrosion-resistant material such as stainless steel.

**2-4.6.2** Hose and quick connectors shall be approved.

**2-4.6.3** Hose, hose connections, and flexible connectors used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psi (34 kPa), and as provided in Section 3-4 regardless of the pressure, shall comply with the following:

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

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

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

(b) Hose assemblies, after the application of connections, shall have a design capability of withstanding a pressure of not less than 700 psi (4.8 MPa). If a test is performed, such assemblies shall not be leak tested at pressures higher than the working pressure [350 psi (2.4 MPa) minimum] of the hose.

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

**2-4.6.4** Hoses or flexible connectors used to supply LP-Gas to utilization equipment or appliances shall be installed in accordance with the provisions of 3-2.10.10 and 3-2.10.12.

**2-4.7 Hydrostatic Relief Valves.** Hydrostatic relief valves designed to relieve the hydrostatic pressure that might develop in sections of liquid piping between closed shutoff valves shall have pressure settings not less than 400 psi (2.8 MPa) or more than 500 psi (3.5 MPa) unless installed in systems designed to operate above 350 psi (2.4 MPa). Hydrostatic relief valves for use in systems designed to operate above 350 psi (2.4 MPa) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

**2-5 Equipment.**

**2-5.1 General.**

**2-5.1.1** This section includes fabrication and performance provisions for the pressure-containing metal parts of LP-Gas equipment such as pumps, compressors, vaporizers, strainers, meters, sight flow glasses, and regulators. Containers shall not be subject to the provisions of this section.

**2-5.1.2** The design pressure of equipment shall be selected as follows:

- (a) Equipment to be used at pressures higher than container pressure shall be designed for the maximum anticipated pressure but shall be not less than 350 psi (2.4 MPa).
- (b) Equipment to be used with liquid LP-Gas, or vapor LP-Gas at pressures over 125 psi (0.9 MPa) but not to exceed 250 psi (1.7 MPa), shall be designed for a working pressure of at least 250 psi (1.7 MPa).
- (c) Equipment to be used with vapor LP-Gas at pressures over 20 psi (138 kPa), but not to exceed 125 psi (0.9 MPa), shall be designed for a working pressure of at least 125 psi (0.9 MPa).
- (d) Equipment to be used with vapor LP-Gas at pressures of 20 psi (138 kPa) or less shall be designed for the maximum anticipated pressure.

**2-5.1.3** Equipment shall be fabricated of materials resistant to deterioration by LP-Gas under service conditions.

The following shall also apply:

(a) Pressure-containing metal parts shall be of steel, ductile (nodular) iron (ASTM A395 or A536 Grade 60-40-18 or 65-45-12), malleable iron (ASTM A47), higher strength gray iron (ASTM A48, Class 40B), brass, or the equivalent.

(b) Cast iron shall not be used for strainers or flow indicators that shall comply with provisions for materials for construction of valves (see 2-4.5.1).

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

(d) Aluminum or zinc shall be permitted to be used for approved regulators. Zinc used for regulators shall comply with ASTM B86, *Specification for Zinc-Alloy Die Casting*.

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

**2-5.1.4** Engines used to drive portable pumps and compressors shall be equipped with exhaust system spark arresters and shielded ignition systems.

**2-5.2 Pumps.** Pumps shall be designed for LP-Gas service.

**2-5.3 Compressors.**

**2-5.3.1** Compressors shall be designed for LP-Gas service.

**2-5.3.2** Means shall be provided to limit the suction pressure to the maximum for which the compressor is designed.

**2-5.3.3** Means shall be provided to prevent the entrance of LP-Gas liquid into the compressor suction, either integral with the compressor or installed externally in the suction piping [see 3-2.15.2(b)].

*Exception: Portable compressors used with temporary connections.*

**2-5.4 Vaporizers, Tank Heaters, Vaporizing Burners, and Gas-Air Mixers.**

**2-5.4.1** Vaporizers shall be permitted to be of the indirect type (utilizing steam, hot water, or other heating medium) or direct fired. (This subsection does not apply to engine fuel vaporizers or to integral vaporizer-burners such as those used with weed burners or tar kettles.)

**2-5.4.2** Indirect vaporizers shall comply with the following.

(a) Indirect vaporizers shall be constructed in accordance with the applicable provision of the ASME Code for a design

pressure of 250 psi (1.7 MPa) and shall be permanently and legibly marked with the following:

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

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

(b) Indirect vaporizers shall be provided with a suitable automatic means to prevent the passage of liquid through the vaporizer to the vapor discharge piping. This means shall be permitted to be integral with the vaporizer or otherwise provided in the external piping.

(c) Indirect vaporizers, including atmospheric-type vaporizers using heat from the surrounding air or the ground, and of more than 1-qt (0.9-L) capacity shall be equipped at or near the discharge with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 2-5.4.5. Fusible plug devices shall not be used.

(d) Indirect atmospheric-type vaporizers of less than 1-qt (0.9-L) capacity shall not be required to be equipped with pressure relief valves but shall be installed in accordance with 3-6.2.7.

#### 2-5.4.3 Direct-fired vaporizers shall comply as follows.

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

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

(b) Direct-fired vaporizers shall be equipped at or near the discharge with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 2-5.4.5. The relief valve shall be located so as not to be subject to temperatures in excess of 140°F (60°C). Fusible plug devices shall not be used.

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

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

(e) Direct-fired vaporizers shall be equipped with an automatic safety device to shut off the flow of gas to the main burner if the pilot light is extinguished. If the pilot flow exceeds 2000 Btu/hr (2 MJ/h), the safety device shall also shut off the flow of gas to the pilot.

(f) Direct-fired vaporizers shall be equipped with a limit control to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, and to prevent raising the pressure within the storage container above the pressure specified in the first column of Table 2-2.2.2 that corresponds with the design pressure of the

container (or its ASME Code equivalent). (See notes to Table 2-2.2.2.)

#### 2-5.4.4 Waterbath vaporizers shall comply with the following.

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

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

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

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

(c) Heat exchangers for waterbath vaporizers shall be equipped at or near the discharge with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 2-5.4.5. Fusible plug devices shall not be used.

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

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

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

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

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

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

#### 2-5.4.5 The minimum rate of discharge in cubic feet of air per minute for pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct-fired, shall be determined as follows:

- (a) Based on conservative heat transfer calculations (assuming that the vaporizing chamber is liquid full), the maximum vapor generating capacity (rate) shall be determined when maximum heat is available. That vapor rate shall be converted to an equivalent air rate.
- (b) If the vaporizer is direct fired or if a substantial exterior surface is in contact with the LP-Gas, the sum of the vaporizer surface and the LP-Gas wetted exterior surface shall be permitted to be used in conjunction with Table 2-3.2.4 to determine the required relief valve capacity.



**2-5.4.6** Direct gas-fired tank heaters shall be designed exclusively for outdoor aboveground use and so that there is no direct flame impingement upon the container. The following shall also apply.

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

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

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

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

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

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

(f) Direct gas-fired tank heaters shall be equipped with a limit control to prevent the heater from raising the pressure in the storage container to more than 75 percent of the pressure shown in the first column of Table 2-2.2.2 that corresponds with the design pressure of the container (or its ASME *Boiler and Pressure Vessel Code* equivalent).

**2-5.4.7** Vaporizing burners shall be constructed with a minimum design pressure of 250 psi (1.7 MPa) with a safety factor of 5 and shall comply with the following.

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

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

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

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

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

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

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

NOTE: See NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*, for ignition and combustion controls applicable to vaporizing burners associated with grain dryers.

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

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

**2-5.4.8** Gas-air mixers shall comply with the following:

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

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

(c) In addition to the interlocks provided for in 2-5.4.8(b), a method shall be provided to prevent air from accidentally entering gas distribution lines without LP-Gas being present. Check valves shall be installed in the air and LP-Gas supply lines close to the mixer to minimize the possibility of backflow of gas into the air supply lines or of air into the LP-Gas system. Gas-mixing control valves in the LP-Gas and air supply lines that are arranged to fail closed when actuated by safety interlock trip devices are acceptable shutdown devices.

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

(e) Gas-air mixers that utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere, and are so designed that maximum air entrained is less than 85 percent of the mixture, shall be exempt from the interlock provisions in 2-5.4.8(b), (c), and (d), but shall be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down. Gas-air mixers of this type receiving air from a blower, compressor, or any source of air other than directly from the atmosphere shall include a method of preventing air without LP-Gas, or mixtures of air and LP-Gas within the flammable range, from entering the gas distribution system accidentally.

**2-5.5 Strainers.** Strainers shall be designed to minimize the possibility of particulate materials clogging lines and damaging pumps, compressors, meters, or regulators. The strainer element shall be accessible for cleaning.

**2-5.6 Meters.**

**2-5.6.1** Vapor meters of the tin or brass case type of soldered construction shall not be used at pressures in excess of 1 psi (7 kPa).

**2-5.6.2** Vapor meters of the die cast or iron case type shall be permitted to be used at any pressure equal to or less than the working pressure for which they are designed and marked.

### 2-5.7 Regulators.

**2-5.7.1** Single-stage regulators shall have a maximum outlet pressure setting of 1.0 psi (7 kPa) and shall be equipped with one of the following [see 3-2.7.4 for required protection from the elements]:

(a) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*.

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

**2-5.7.2** Second-stage regulators and integral two-stage regulators shall have a maximum outlet pressure setting of 14 in. (4.0 kPa) w.c. and shall be equipped with one of the following (see 3-2.7.4 for required protection from the elements):

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

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

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

**2-5.7.3** Integral two-stage regulators shall be provided with a means to determine the outlet pressure of the high pressure regulator portion of the integral two-stage regulator.

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

**2-5.7.4** Integral two-stage regulators shall not incorporate an integral pressure relief valve in the high pressure regulator portion of the unit.

**2-5.7.5** First-stage regulators shall incorporate an integral pressure relief valve having a start-to-discharge setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*.

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

**2-5.7.6** High pressure regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) where permitted to be used in two-stage systems shall incorporate an integral relief valve or shall have a separate relief valve.

**2-5.7.7** First-stage regulators shall have an outlet pressure setting up to 10.0 psi (69 kPa) in accordance with UL 144, *Standard for LP-Gas Regulators*.

**2-5.7.8** Regulators shall be designed so as to drain all condensate from the regulator spring case when the vent is directed down vertically.

**2-5.8 Sight Flow Glasses.** Flow indicators, either of the simple observation type or those combined with a backflow check valve, shall be permitted to be used in applications in which the observation of liquid flow through the piping is desirable or necessary.

### 2-6 Appliances.

#### 2-6.1 Approved Appliances.

**2-6.1.1** This section includes basic construction and performance provisions for LP-Gas consuming appliances.

**2-6.1.2** New residential, commercial, and industrial LP-Gas consuming appliances shall be approved.

*Exception: For an appliance, class of appliance, or appliance accessory for which no applicable standard has been developed, approval of the authority having jurisdiction shall be permitted to be required before installation is made.*

#### 2-6.2 Provisions for Appliances.

**2-6.2.1** Any appliance originally manufactured for operation with a gaseous fuel other than LP-Gas and in good condition shall be permitted to be used with LP-Gas provided it is properly converted, adapted, and tested for performance with LP-Gas before being placed into use.

**2-6.2.2** Unattended heaters used inside buildings for animal or poultry production or care shall be equipped with approved automatic devices to shut off the flow of gas to the main burners, and pilots if used, in the event of flame extinguishment or combustion failure.

*Exception: Heaters as provided in 3-5.1.3.*

**2-6.2.3** Appliances using vaporizing burners shall comply with 2-5.4.7.

**2-6.2.4** Appliances used in mobile homes and recreational vehicles shall be approved for such service.

**2-6.2.5** LP-Gas appliances used on commercial vehicles (see Section 3-8) shall be approved for the service (see 2-6.1) and shall comply with the following:

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

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

(c) Gas-fired heating appliances and water heaters to be used in vehicles intended for human occupancy shall make provisions for complete separation of the combustion system and the living space. If this separation is not integral with the appliance, it shall be provided otherwise by the method of installation (see 3-8.4.2). See NFPA 501C, *Standard on Recreational Vehicles*, for additional requirements where used on recreational vehicles.

## Chapter 3 Installation of LP-Gas Systems

### 3-1 General.

**3-1.1** This chapter applies to the location and field installation of LP-Gas systems that use components, subassemblies, container assemblies, and container systems that are fabricated in accordance with Chapter 2.

*Exception: Refrigerated containers shall be installed in accordance with Chapter 9.*

NOTE: Section 3-2 includes general provisions that are applicable to most stationary systems. Sections 3-3 through 3-8 extend and modify Section 3-2 for systems installed for specific purposes.

**3-1.2** Installation of systems used in the highway transportation of LP-Gas shall be in accordance with Chapter 6.

**3-1.3** LP-Gas systems shall be installed in accordance with this code and other national standards or regulations that apply. These include the following:

- (a) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
- (b) NFPA 54, *National Fuel Gas Code (ANSI Z223.1)*
- (c) NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*
- (d) NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*
- (e) NFPA 86, *Standard for Ovens and Furnaces*
- (f) NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*
- (g) NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*
- (h) NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*
- (i) NFPA 501C, *Standard on Recreational Vehicles*
- (j) U.S. DOT Regulations, 49 CFR 191 and 192, for LP-Gas pipeline systems subject to DOT

### 3-2 General Provisions.

**3-2.1 Scope.** This section includes criteria for the location of containers and liquid transfer systems, the installation of container appurtenances and regulators, piping service limitations, the installation of piping (including flexible connectors and hose), hydrostatic relief valves and equipment (other than vaporizers) (see Section 3-6), and the testing of piping systems.

#### 3-2.2 Location of Containers.

**3-2.2.1** LP-Gas containers shall be located outside of buildings.

*Exception No. 1: Cylinders as specifically provided for in Section 3-4.*

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

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

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

*Exception No. 5: Containers used with LP-Gas fueled industrial trucks complying with 8-3.6.*

*Exception No. 6: Containers on LP-Gas fueled vehicles garaged in accordance with Section 8-6.*

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

**3-2.2.2** Containers installed outside of buildings, whether of the portable type replaced on a cylinder exchange basis or

permanently installed and refilled at the installation, shall be located with respect to the nearest container, important building, group of buildings, or line of adjoining property that can be built upon, in accordance with the following and Tables 3-2.2.2, 3-2.2.4, and 3-2.2.7(f).

NOTE: See 3-2.3.2, 3-2.3.3, and 3-3.4.3 for minimum distances to buildings as outlined in or referenced by these respective sections.

(a) At a consumer site, if the aggregate water capacity of a multicontainer installation comprised of individual containers having a water capacity of less than 125 gal (0.5 m<sup>3</sup>) is 501 gal (1.9+ m<sup>3</sup>) or more, the minimum distance shall comply with the appropriate portion of Table 3-2.2.2, applying the aggregate capacity rather than the capacity per container. If more than one such installation is made, each installation shall be separated from any other installation by at least 25 ft (7.6 m). The minimum distances between containers shall not be applied to such installations.

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

(c) The distance measured horizontally from the point of discharge of a container pressure relief valve to any building opening below the level of such discharge shall be in accordance with Table 3-2.2.2(d).

(d) The distance measured in any direction from the point of discharge of a container pressure relief valve, the vent of a fixed maximum liquid level gauge on a container, or the installed location of the filling connection of a container to any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes shall be in accordance with Table 3-2.2.2(d).

(e) The 25-ft (7.6-m) distance from aboveground containers of 501 gal to 2000 gal (1.9 m<sup>3</sup> to 7.6 m<sup>3</sup>) capacity to buildings, group of buildings, or line of adjoining property that can be built upon shall be permitted to be reduced to not less than 10 ft (3 m) for a single container of 1200 gal (4.5 m<sup>3</sup>) water capacity or less provided such container is at least 25 ft (7.6 m) from any other LP-Gas container of more than 125 gal (0.5 m<sup>3</sup>) water capacity.

(f) Minimum distances for underground or mounded ASME containers of 2001 gal through 30,000 gal (7.6 m<sup>3</sup> through 114 m<sup>3</sup>) water capacity incorporating all the provisions of Section 3-11 shall be permitted to be reduced to 10 ft (3 m). Distances for all underground and mounded ASME containers shall be measured from the relief valve and the filling connection. No part of an underground ASME container shall be less than 10 ft (3 m) from a building or line of adjoining property that can be built upon, and no part of a mounded ASME container that is installed above grade shall be less than 5 ft (1.5 m) from a building or line of adjoining property that can be built upon.

Table 3-2.2.2

Water Capacity per Container gallons (m <sup>3</sup> )	Mounded or Underground Containers [see 3-2.2.2(f)]	Minimum Distances ft (m)	
		Aboveground Containers [see 3-2.2.2(h)]	Between Containers [see 3-2.2.2(g)]
Less than 125 (0.5) [see 3-2.2.2(a)]	10 (3)	None [see 3-2.2.2(b), (c), and (d)]	None
125 to 250 (0.5 to 1.0)	10 (3)	10 (3)	None
251 to 500 (1.0+ to 1.9)	10 (3)	10 (3)	3 (1)
501 to 2000 (1.9+ to 7.6)	10 (3)	25 (7.6) [see 3-2.2.2(e)]	3 (1)
2001 to 30,000 (7.6+ to 114)	50 (15)	50 (15)	5 (1.5)  1/4 of sum of diameters of adjacent containers
30,001 to 70,000 (114+ to 265)	50 (15)	75 (23)	
70,001 to 90,000 (265+ to 341)	50 (15)	100 (30)	
90,001 to 120,000 (341+ to 454)	50 (15)	125 (38)	
120,001 to 200,000 (454 to 757)	50 (15)	200 (61)	
200,001 to 1,000,000 (757 to 3785)	50 (15)	300 (91)	
Over 1,000,000 (3785)	50 (15)	400 (122)	

Table 3-2.2.2(d)

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

(g) Where underground multicontainer installations are made of individual containers having a water capacity of 125 gal (0.5 m<sup>3</sup>) or more, such containers shall be installed so as to permit access at their ends or sides to facilitate working with cranes or hoists.

(h) In applying the distance between buildings and ASME containers of 125 gal (0.5 m<sup>3</sup>) or more water capacity, a minimum of 50 percent of this horizontal distance shall also apply to all portions of the building that project more than 5 ft (1.5 m) from the building wall and that are higher than the relief valve discharge outlet. This horizontal distance shall be measured from a point determined by projecting the outside edge of such overhanging structure vertically downward to grade or other level upon which the container is installed. Under no condition shall the distances to the building wall be less than those specified except when the provisions of 3-11.3 and 3-11.4 are met. These distances shall be permitted to be reduced by one-half for ASME containers of 2001 gal through

30,000 gal (7.6 m<sup>3</sup> through 114 m<sup>3</sup>) water capacity used in systems complying with Section 3-11.

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

**3-2.2.3** Where storage containers having an aggregate water capacity of more than 4000 gal (15.1 m<sup>3</sup>) are located in heavily populated or congested areas, the siting provisions of 3-2.2.2 and Table 3-2.2.2 shall be permitted to be modified as indicated by the fire safety analysis described in 3-10.2.3.

**3-2.2.4** Aboveground multicontainer installations comprised of containers having an individual water capacity of 12,000 gal (45 m<sup>3</sup>) or more installed for use in a single location shall be limited to the number of containers in one group, and with each group separated from the next group in accordance with the degree of fire protection provided in Table 3-2.2.4.

The separation distance between groups of ASME containers protected by hose stream only shall be permitted to be reduced by one-half when the provisions of 3-11.3 and 3-11.4 are met.

**3-2.2.5** Underground or mounded containers shall be located outside of any buildings. Buildings shall not be constructed over any underground or mounded containers. Sides of adjacent containers shall be separated in accordance with Table 3-2.2.2 but not less than 3 ft (1 m).

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

**3-2.2.6** In the case of buildings of other than wood-frame construction devoted exclusively to gas manufacturing and distribution operations, the distances specified in Table 3-2.2.2 shall be permitted to be reduced provided that containers having a water capacity exceeding 500 gal (1.9 m<sup>3</sup>) shall not be located closer than 10 ft (3 m) to such gas manufacturing and distributing buildings.

Table 3-2.2.4

Fire Protection Provided by	Maximum Number of Containers in One Group	Minimum Separation between Groups ft (m)
Hose streams only (see 3-2.2.4 and 3-10.2.3)	6	50 (15)
Fixed monitor nozzles per 3-10.3.5	6	25 (7.6)
Fixed water spray per 3-10.3.4	9	25 (7.6)
Insulation per 3-10.3.1	9	25 (7.6)

3-2.2.7 The following provisions shall also apply.

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

(b) Loose or piled combustible material and weeds and long dry grass shall not be permitted within 10 ft (3.0 m) of any container.

(c) Means shall be used to prevent the accumulation or flow of liquids having flash points below 200°F (93.4°C) under adjacent LP-Gas containers such as by dikes, diversion curbs, or grading.

NOTE: For information on determination of flash points see NFPA 30, *Flammable and Combustible Liquids Code*.

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

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

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

(f) The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with Table 3-2.2.7(f).

*Exception:* Shorter distances shall be permitted 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. The location and arrangement of such structures shall minimize the problems cited in the note to 3-2.2.9.

NOTE: Also see NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites*, and NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, for oxygen systems and NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, for gaseous hydrogen systems.

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

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

(i) Where LP-Gas containers are to be stored or used in the same area with other compressed gases, the containers shall be marked to identify their content in accordance with ANSI/CGA C-4, *Method of Marking Portable Compressed Gas Containers to Identify the Material Contained*.

(j) No part of an aboveground LP-Gas container shall be located in the area 6 ft (1.8 m) horizontally from a vertical plane beneath overhead electric power lines that are over 600 volts, nominal.

3-2.2.8 Impoundment in accordance with Section 9-2 shall be installed around refrigerated LP-Gas containers.

NOTE: Because of the anticipated flash of nonrefrigerated LP-Gas when it is released to the atmosphere, dikes normally serve no useful purpose for nonrefrigerated installations.

Table 3-2.2.7(f)

LP-Gas Containers Aggregate Water Capacity gal (m <sup>3</sup> )	Separation from Oxygen Containers Aggregate Capacity			Separation from Gaseous Hydrogen Containers Aggregate Capacity		
	400 ft <sup>3</sup> (11 m <sup>3</sup> )* or less	More than 400 ft <sup>3</sup> (11 m <sup>3</sup> )* to 20,000 ft <sup>3</sup> (566 m <sup>3</sup> )* including unconnected reserves ft (m)	More than 20,000 ft <sup>3</sup> (566 m <sup>3</sup> )* including unconnected reserves ft (m)	Less than 400 ft <sup>3</sup> (11 m <sup>3</sup> )*	400 ft <sup>3</sup> (11 m <sup>3</sup> )* to 3000 ft <sup>3</sup> (85 m <sup>3</sup> )* ft (m)	More than 3000 ft <sup>3</sup> (85 m <sup>3</sup> )* ft (m)
1200 (4.5) or less	None	20 (6)	25 (7.6)	—	—	—
Over 1200 (4.5)	None	20 (6)	50 (15)	—	—	—
500 (1.9) or less	—	—	—	None	10 (3)	25 (7.6)
Over 500 (1.9)	—	—	—	None	25 (7.6)	50 (15)

\*Cubic feet (m<sup>3</sup>) measured at 70°F (21°C) and atmospheric pressure.

**3-2.2.9** Structures such as fire walls, fences, earth or concrete barriers, and other similar structures, shall be avoided around or over installed nonrefrigerated containers.

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

*Exception No. 2:* Structures used to prevent flammable or combustible liquid accumulation or flow shall be permitted in accordance with 3-2.2.7(c).

*Exception No. 3:* Structures between LP-Gas containers and gaseous hydrogen containers shall be permitted in accordance with 3-2.2.7(f).

*Exception No. 4:* Fences shall be permitted in accordance with 3-3.6.

**NOTE:** The presence of such structures can create significant hazards, for example, pocketing of escaping gas, interference with application of cooling water by fire departments, redirection of flames against containers, and impeding egress of personnel in an emergency.

**3-2.3 Location of Transfer Operations.**

**3-2.3.1** Liquid shall be transferred into containers, including containers mounted on vehicles, only outdoors or in structures specially designed for the purpose.

- (a) The transfer of liquid into containers mounted on vehicles shall not take place within a building but shall be permitted to take place under a weather shelter or canopy (see 3-9.3.2).
- (b) Structures housing transfer operations or converted for such use after December 31, 1972, shall comply with Chapter 7.
- (c) The transfer of liquid into containers on the roofs of structures shall be permitted, provided that the installation conforms to the requirements contained in 3-2.5 and 3-4.9.
- (d) The transfer hose shall not be routed in or through any building except those specified in 3-2.3.1(b).

**3-2.3.2** Containers located outdoors in stationary installations (see definition) in accordance with 3-2.2 and with the point of transfer located at the container shall be permitted to be filled at that location. If the point of transfer (see definition) is not located at the container, it shall be located in accordance with 3-2.3.3.

**3-2.3.3** Containers not located in stationary installations (see definition) shall be filled at a location determined by the point of transfer (see definition) in accordance with Table 3-2.3.3.

- (a) If the point of transfer is a component of a system covered by Section 3-8 or Chapter 8 or part of a system installed in accordance with standards referenced in 3-1.3, parts 1, 2, and 3 of Table 3-2.3.3 shall not apply to the structure containing the point of transfer.
- (b) If LP-Gas is vented to the atmosphere under the conditions stipulated in 4-3.1, Exception No. 4, the distances in Table 3-2.3.3 shall be doubled.
- (c) If the point of transfer is housed in a structure complying with Chapter 7, the distances in Table 3-2.3.3 shall be permitted to be reduced provided either the exposing wall(s) or the exposed wall(s) complies with 7-3.1(a).

**Table 3-2.3.3 Distance Between Point of Transfer and Exposures**

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

\*See 3-2.3.3(d).  
<sup>1</sup>Buildings, for the purpose of the table, also include structures such as tents and box trailers at construction sites.  
<sup>2</sup>Walls constructed of noncombustible materials having, as erected, a fire resistance rating of at least 1 hour as determined by NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*.  
<sup>3</sup>Not applicable to driveways and points of transfer at vehicle fuel dispensers.  
<sup>4</sup>Not applicable to filling connections at the storage container or to dispensing vehicle fuel dispenser units of 2000 gal (7.6 m<sup>3</sup>) water capacity or less when used for filling containers not mounted on vehicles.  
<sup>5</sup>NFPA 30, *Flammable and Combustible Liquids Code*, defines these as follows: Flammable liquids include those having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lb psia (an absolute pressure of 2.068 mm Hg) at 100°F (37.8°C). Class II combustible liquids include those having a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

- (d) The distances in Table 3-2.3.3, Parts B, C, D, E, F(b), and J shall be permitted to be reduced by one-half where the system employs the provisions of low emission transfer as provided in 3-11.5.

**3-2.4 Installation of Containers.**

**3-2.4.1** Containers shall be installed in accordance with the following:

- (a) Cylinders shall be installed only aboveground, and shall be set upon a firm foundation or be otherwise firmly secured. Flexibility shall be provided in the connecting piping. (See 3-2.10.6 and 3-2.10.10.)

(b) All containers shall be positioned so that the pressure relief valve is in direct communication with the vapor space of the container.

(c) Where physical damage to LP-Gas containers, or systems of which they are a part, from vehicles is a possibility, precautions shall be taken against such damage.

(d) The installation position of ASME containers shall make all container appurtenances accessible for their normally intended use.

(e) Field welding on containers shall be limited to attachments to nonpressure parts such as saddle plates, wear plates, or brackets applied by the container manufacturer. Welding to container proper shall comply with 2-2.1.9.

(f) \*Aboveground containers shall be kept properly painted.

**3-2.4.2** Horizontal ASME containers designed for permanent installation in stationary service above ground shall be placed on masonry or other noncombustible structural supports. Such supports shall be placed on concrete or masonry foundations with the containers supported as follows.

(a) Horizontal ASME containers shall be mounted on saddles in such a manner as to allow expansion and contraction and to prevent an excessive concentration of stresses. Structural steel supports shall be permitted to be used if in compliance with 3-2.4.2(b) or as follows:

*Exception No. 1: Temporary use as provided in 3-2.4.2(a)3.b.*

*Exception No. 2: Isolated locations as provided in 3-2.4.2(b).*

1. ASME containers that have liquid interconnections shall be installed so that the maximum permitted filling level of each vessel is at the same elevation.
2. Containers of more than 2000 gal (7.6 m<sup>3</sup>) water capacity shall be provided with concrete or masonry foundations formed to fit the container contour or, if furnished with saddles in compliance with 2-2.5.1, shall be permitted to be placed on flat-topped foundations.
3. Containers of 2000 gal (7.6 m<sup>3</sup>) water capacity or less shall be permitted to be installed on concrete or masonry foundations formed to fit the container contour or, if equipped with attached supports complying with 2-2.5.2(a), shall be permitted to be installed as follows:
  - a. If the bottoms of the horizontal members of the container saddles, runners, or skids are to be more than 12 in. (300 mm) above grade, fire-resistive foundations shall be provided. A container shall not be mounted with the outside bottom of the container shell more than 5 ft (1.5 m) above the surface of the ground.
  - b. For temporary use of no more than 6 months at a given location, fire-resistive foundations or saddles shall not be required provided that the outside bottom of the container shell is not more than 5 ft (1.5 m) above the ground and that flexibility in the connecting piping is provided. (See 2-4.6.3.)
4. Containers or container-pump assemblies mounted on a common base complying with 2-2.5.2(b) shall be permitted to be placed on paved surfaces or on concrete pads at ground level within 4 in. (102 mm) of ground level.
  - (b) Single containers complying with 2-2.5.1 or 2-2.5.2 shall be permitted to be installed in isolated locations with nonfireproofed steel supports resting on concrete pads or footings provided the outside bottom of the container shell is not more than 5 ft (1.5 m) above the ground level, with the approval of the authority having jurisdiction.

(c) Means of preventing corrosion shall be provided on that part of the container in contact with the saddles or foundations or on that part of the container in contact with masonry.

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

1. A stake or other marking shall be installed higher than the highest anticipated snow cover up to a height of 15 ft (4.6 m).
2. The installation shall prevent moving of the container by the forces anticipated as a result of snow accumulation.

**3-2.4.3** Vertical ASME containers over 125-gal (0.5-m<sup>3</sup>) water capacity designed for permanent installation in stationary service above ground shall be installed on reinforced concrete or steel structural supports on reinforced concrete foundations that are designed to meet the loading provisions established in 2-2.2.3.

(a) Steel supports shall be protected against fire exposure with a material that has a fire resistance rating of at least 2 hours. Continuous steel skirts that have only one opening that is 18 in. (457 mm) or less in diameter shall be permitted to have such fire protection applied only to the outside of the skirts.

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

**3-2.4.4** Single containers constructed as portable storage containers (*see definition*) for temporary stationary service in accordance with 2-2.5.4(a) shall be placed on concrete pads, paved surfaces, or firm earth for such temporary service (not more than 6 months at a given location) and shall meet the following requirements:

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

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

(c) If such containers are to be set with the bottoms of the skids or runners above the ground, then nonfireproofed structural supports shall be permitted to be used for isolated locations with the approval of the authority having jurisdiction and provided the height of the outside bottom of the container shell above the ground does not exceed 5 ft (1.5 m). Otherwise, fire-resistive supports shall be provided.

**3-2.4.5** If the container is mounted on or is part of a vehicle as provided in 2-2.5.4(b), the unit shall be parked in compliance with the provisions of 3-2.2.2 for the location of a container of that capacity for normal stationary service and shall be in accordance with the following:

(a) The surface shall be substantially level and, if not paved, shall be suitable for heavy vehicular use and shall be cleared (and kept cleared) of dry grass and weeds and other combustible material within 10 ft (3 m) of the container.

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

**3-2.4.6** Portable containers of 2000 gal (7.6 m<sup>3</sup>) water capacity or less that complies with 2-2.5.5 shall be permitted to be installed for stationary service as provided in 3-2.4.2(a)3 for stationary containers.

**3-2.4.7** Mounded containers shall be installed as follows:

(a) Mounding material shall be earth, sand, or other non-combustible, noncorrosive materials such as vermiculite or perlite and shall provide minimum thickness of cover for the container of at least 1 ft (0.3 m).

(b) Unless inherently resistant to erosion, a suitable protective cover shall be provided.

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

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

2. Bottom connections shall be permitted on mounded tanks where they extend beyond the mound. The connection shall be part of the ASME tank or shall be installed in compliance with the ASME Code, and shall be designed for the forces that can act on the connection.

(d) \*Mounded containers shall be protected against corrosion in accordance with good engineering practice.

**3-2.4.8** ASME container assemblies listed for underground installation, including interchangeable aboveground-underground container assemblies, shall be permitted to be installed underground as follows:

(a) The container shell shall be placed at least 6 in. (150 cm) below grade unless the container might be subject to abrasive action or physical damage from vehicular traffic within a parking lot area, driveway, or similar area. In such a case, a noninterchangeable underground container shall be used and the container shell placed at least 18 in. (460 cm) below grade [see 3-2.4.8(c)] or equivalent protection shall be otherwise provided, such as the use of a concrete slab, to prevent imposing the weight of a vehicle directly on the container shell. Protection of the fitting housing, housing cover, tank connections, and piping shall be provided to protect against vehicular damage.

(b) Where containers are installed underground within 10 ft (3 m) of where vehicular traffic can be reasonably expected, such as driveways and streets or within a utility easement subject to vehicular traffic, protection of the fitting housing, housing cover, tank connections, and piping shall be provided to protect against vehicular damage.

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

(d) Any party involved in construction or excavation in the vicinity of a buried container shall be responsible for determining the location of and providing protection for the container and piping against their physical damage from vehicular traffic.

(e) The portion of the container to which the fitting cover or other connections are attached shall be permitted to be covered. The discharge of the regulator vent shall be above the highest probable water level.

(f) \*Containers shall be protected against corrosion for the soil conditions at the container site by a method in accordance with good engineering practice. Precaution shall be taken to prevent damage to the coating during handling. Any damage to the coating shall be repaired before backfilling.

(g) Containers shall be set substantially level on a firm foundation and shall be surrounded by earth or sand firmly tamped in place. Backfill shall be free of rocks or similar abrasives.

NOTE: Firm earth can be used.

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

1. As much liquid LP-Gas as possible shall be removed through the container liquid withdrawal connection.
2. \*As much of the remaining LP-Gas vapor as possible shall be removed by venting it through a vapor connection, either by burning the vapor or venting it to the open air at a safe location. The vapor shall not be vented at such a rapid rate as to exceed the vaporization rate of any residual liquid LP-Gas that remains after the liquid removal procedure of 3-2.4.8(h)1.
3. Where only vapor LP-Gas at atmospheric pressure remains in the container, the container shall be filled with water, sand, or foamed plastic or shall be purged with an inert gas. The displaced vapor shall be permitted to be burned or vented to the open air at a safe location.

**3-2.4.9** Partially underground, unmounted ASME containers shall be installed as follows:

(a) The portion of the container below the surface, and for a vertical distance of at least 3 in. (75 mm) above the surface, shall be protected to resist corrosion as required for underground containers. [See 3-2.4.8(f).]

(b) Containers shall be set substantially level on a firm foundation, with backfilling to be as required for underground containers. [See 3-2.4.8(g).]

(c) Spacing provisions shall be as specified for aboveground containers in 3-2.2.2 and Table 3-2.2.2.

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

**3-2.5 Installation of Containers on Roofs of Buildings.**

**3-2.5.1** With the prior approval of the authority having jurisdiction, buildings complying with Type I, 443 or 332, or Type II, 222 construction as specified in NFPA 220, *Standard on Types of Building Construction*, shall be permitted to have ASME containers installed, filled, and used on roofs in accordance with the following.

**3-2.5.2** LP-Gas containers installed on roofs or terraces shall be 2000 gal (7.6 m<sup>3</sup>) water capacity or less. The aggregate water capacity of LP-Gas tanks installed on the roof or terrace of one building shall not exceed 4000 gal (15.1 m<sup>3</sup>).

*Exception:* Additional installations shall be permitted where located 50 ft (15.2 m) apart.

**3-2.5.3** 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.

**3-2.5.4** The fire department shall be advised of each installation of propane tanks on a roof.

**3-2.5.5** Containers shall be installed in external locations only. Where a fill line to the container is required, it shall be located entirely outside the building. The fill connection shall be located entirely outside the building. The fill connection shall be located at least 8 ft (2.4 m) above ground level.



**3-2.5.6** Containers shall be installed on a level location.

**3-2.5.7** The container shall be secured to the building structure. The support of the container shall be designed to the same seismic criteria as the building.

**3-2.5.8** 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 established by the applicable construction codes.

**3-2.5.9** Containers shall be located in areas where there is free air circulation, at least 10 ft (3.0 m) from building openings (such as windows and doors), and at least 20 ft (6.1 m) from air intakes of air conditioning and ventilating systems.

**3-2.5.10** Location shall permit the easy access to all valves and controls and shall have enough area to permit the required maintenance.

**3-2.5.11** The location of the container shall have fixed stairs or another safe method to reach it.

**3-2.5.12** If the installation requires the use of more than one container, the distances between containers of Table 3-2.2.2 shall apply.

**3-2.5.13** If the container location is higher than 23 ft (7 m) from the ground, or the filling hose cannot be observed by the operators in its entire length, the container shall have a filling line constructed to withstand liquid transfer, and it shall have the following appurtenances: filling valve, cap, two control valves, hydrostatic relief, venting line with control valve.

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

### **3-2.6 Installation of Container Appurtenances.**

**3-2.6.1** Pressure relief devices shall be installed on containers in accordance with this section and positioned so that the relief device is in direct communication with the vapor space of the container.

**3-2.6.2** Pressure relief devices on cylinders shall be installed to minimize the possibility of relief device(s) discharge(s) impingement on the cylinder.

**3-2.6.3** Pressure relief devices on ASME containers of 125 gal (0.5 m<sup>3</sup>) water capacity or more that are permanently installed in stationary service, portable storage containers (*see definition*), portable containers (tanks) of nominal 120 gal (0.5 m<sup>3</sup>) water capacity or more, or cargo tanks shall be installed so that any gas released is vented away from the container upward and unobstructed to the open air. The following provisions shall also apply.

(a) Means such as rain caps shall be provided to minimize the possibility of the entrance of water or other extraneous matter (which might render the relief device inoperative or restrict its capacity) into the relief device or any discharge piping. If necessary, provision shall be made for drainage. The rain cap or other protector shall be designed to remain in place, except when the relief device operates, and shall permit the relief device to operate at sufficient relieving capacity.

(b) On each aboveground container of more than 2000 gal (7.6 m<sup>3</sup>) water capacity, the relief device discharge shall be installed vertically upward and shall be unobstructed to the open air at a point at least 7 ft (2 m) above the top of the container. The following also shall apply:

1. Relief device discharge piping shall comply with 3-2.6.3(f).
2. In providing for drainage in accordance with 3-2.6.3(a) the design of the relief device discharge(s) and attached piping shall

- a. Protect the container against flame impingement that might result from ignited product escaping from the drain opening.
- b. Be directed so that a container(s), piping, or equipment that might be installed adjacent to the container on which the relief device is installed is not subjected to flame impingement.

(c) On underground containers of 2000 gal (7.6 m<sup>3</sup>) or less water capacity, the relief device shall be permitted to discharge into the manhole or housing, provided such manhole or housing is equipped with ventilated louvers, or their equivalent, as specified in 2-3.7(d).

*Exception: Pressure relief devices installed in dispensing stations covered in the exception to 3-2.6.3(d).*

(d) On underground containers of more than 2000 gal (7.6 m<sup>3</sup>) water capacity, the discharge from relief devices shall be piped vertically and directly upward to a point at least 7 ft (2 m) above the ground. Relief device discharge piping shall comply with 3-2.6.3(f).

*Exception: On underground containers in dispensing stations the relief device discharge shall be piped vertically and directly upward to a point at least 10 ft (3.0 m) above the ground. Discharge piping shall comply with 3-2.6.3(f) and shall be adequately supported and protected against physical damage.*

(e) The discharge terminals from relief devices shall be located to provide protection against physical damage. The discharge piping shall be sized to provide the rate of flow specified in 2-3.2.4(a). Such piping shall be metallic and have a melting point over 1500°F (816°C). Discharge piping shall be designed so that excessive force applied to the discharge piping will result in breakage on the discharge side of the valve rather than on the inlet side without impairing the function of the valve. Return bends and restrictive pipe or tubing fittings shall not be used.

(f) Shutoff valves shall not be installed between relief devices and the container, or between the relief devices and the discharge piping.

*Exception: Specially designed relief device/shutoff valve combinations covered by 2-3.2.4(e), or where two or more separate relief devices are installed, each with an individual shutoff valve, and the shutoff valve stems are mechanically interconnected in a manner that will allow the rated relieving capacity required for the container from the relief device or devices that remain in communication with the container.*

**3-2.6.4** Pressure relief devices on portable storage containers (constructed and installed in accordance with 2-2.5.4 and 3-2.4.4, respectively) used temporarily in stationary-type service shall be installed in accordance with the applicable provisions of 3-2.6.3.

**3-2.6.5** Additional provisions (over and above the applicable provision in 3-2.6.2 and 3-2.6.3) apply to the installation of pressure relief devices in containers used in connection with vehicles as follows:

- (a) For containers installed on vehicles in accordance with Section 3-8 and Chapter 8
- (b) For cargo containers (tanks) installed on cargo vehicles in accordance with Section 6-3 (*see 6-3.2.1*)

### 3-2.7 Regulator Installation.

**3-2.7.1** A two-stage regulator system or an integral two-stage regulator shall be required on all fixed piping systems that serve 1/2 psi (3.4 kPa) appliance systems [normally operated at 11 in. w.c. (2.7 kPa) pressure]. The regulators utilized in these systems shall meet the requirements of 2-5.7. This requirement includes fixed piping systems for appliances on RVs (recreational vehicles), mobile home installations, manufactured home installations, catering vehicles, and food service vehicle installations. Single-stage regulators shall not be installed in fixed piping systems after June 30, 1997.

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

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

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

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

**3-2.7.2** First-stage or high-pressure regulators shall be directly attached or attached by flexible connectors to the vapor service valve of a container or to a vaporizer outlet. The regulators also shall be permitted to be installed with flexibility in the interconnecting piping of manifolded containers or vaporizers.

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

**3-2.7.3** First-stage and high-pressure regulators shall be installed outside of buildings.

*Exception No. 1: Regulators on portable containers installed indoors in accordance with Section 3-4.*

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

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

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

*Exception No. 5: Regulators on containers used with LP-Gas fueled industrial trucks complying with 8-3.6.*

*Exception No. 6: Regulators on containers on LP-Gas fueled vehicles garaged in accordance with Section 8-6.*

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

**3-2.7.4** All regulators for outdoor installations shall be designed, installed, or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud, or debris). This protection shall be permitted to be integral with the regulator.

*Exception: Regulators used for portable industrial applications.*

**3-2.7.5** The point of discharge from the required pressure relief device on regulating equipment installed outside of buildings in fixed piping systems shall be located not less than 3 ft (1 m) horizontally away from any building opening below the level of such discharge, and not beneath any building unless this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter. The point of discharge shall also be located not less than 5 ft (1.5 m) in any direction away from any source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

*Exception: This requirement shall not apply to vaporizers.*

**3-2.7.6** The discharge from the required pressure relief device on regulating equipment installed inside of buildings in fixed piping systems shall be vented with properly sized and supported piping to the outside air with the discharge outlet located not less than 3 ft (1 m) horizontally away from any building opening below the level of such discharge. The discharge outlet shall also be located not less than 5 ft (1.5 m) in any direction away from any source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

*Exception No. 1: This provision shall not apply to appliance regulators otherwise protected, or to regulators used in connection with containers in buildings as provided for in 3-2.2.1, Exception Nos. 1, 2, 4, 5, and 6.*

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

**3-2.7.7** Single-stage regulators shall be permitted to be used only on small portable appliances and outdoor cooking appliances with input ratings of 100,000 Btu/hr (29 kW) maximum.

**3-2.8 Piping System Service Limitations.** This subsection describes the physical state (vapor or liquid) and pressure at which LP-Gas shall be permitted to be transmitted through piping systems under various circumstances.

(a) LP-Gas liquid or vapor shall be permitted to be piped at all normal operating pressures outside of buildings.

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

1. Vapor service not exceeding 30 psi (208 kPa)
2. Installation outdoors and underground (see 3-2.10.8)

(c) LP-Gas vapor at pressures not exceeding 20 psi (138 kPa) shall be permitted to be piped into any building.

(d) LP-Gas vapor at pressures exceeding 20 psi (138 kPa) or LP-Gas liquid shall not be piped into any building.

*Exception No. 1: C in accordance with Chapter 7 and used exclusively to house the following:*

- (a) Equipment for vaporization, pressure reduction, gas mixing, gas manufacturing, or distribution
- (b) Internal combustion engines, industrial processes, research and experimental laboratories, or equipment or processing having a similar hazard

NOTE: Complete compliance with Chapter 7 for buildings or separate areas of buildings housing industrial processes and other occupancies cited in 3-2.8(d), Exception No. 1(b), is not always necessary depending on the prevailing conditions. Construction of buildings or separate areas of buildings housing certain internal combustion engines is covered in NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*.

*Exception No. 2: Buildings or structures under construction or undergoing major renovation, provided the temporary piping meets the provisions of 3-4.2 and 3-4.10.2.*

*Exception No. 3: In buildings or structures other than those covered by 3-2.8(d), Exception Nos. 1 and 2, in which liquid feed systems are used, liquid piping shall be permitted to enter the building or structure to connect to a vaporizer provided heavy walled seamless brass or copper tubing not exceeding  $3/32$ -in. (2.4-mm) internal diameter and with a wall thickness not less than  $3/64$  in. (1.2 mm) is used.*

(e) Corrugated stainless steel piping systems shall be limited to vapor service not exceeding 5 psi (34 kPa).

### 3-2.9 Sizing of LP-Gas Vapor Piping Systems.

**3-2.9.1** LP-Gas vapor piping systems downstream of the first-stage pressure shall be sized so that all appliances operate within their manufacturer's specifications.

**3-2.9.2** The size of gas piping shall be in accordance with acceptable engineering practices or the tables in Chapter 11.

### 3-2.10 Installation of Pipe, Tubing, Pipe and Tubing Fittings, Valves, and Hose.

**3-2.10.1** All metallic LP-Gas piping shall be designed and installed in accordance with ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*. All welding and brazing of metallic piping shall be in accordance with ASME *Boiler and Pressure Vessel Code*, Section IX.

**3-2.10.2** Metallic piping shall comply with the following:

- Piping used at pressures higher than container pressure, such as on the discharge side of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psi (2.4 MPa).
- Vapor LP-Gas piping with operating pressures in excess of 125 psi (0.9 MPa) and liquid piping not covered by 3-2.9.2(a) shall be suitable for a working pressure of at least 250 psi (1.7 MPa).
- Vapor LP-Gas piping subject to pressures of not more than 125 psi (0.9 MPa) shall be suitable for a working pressure of at least 125 psi (0.9 MPa).

*Exception: Safety relief discharge piping (see 3-2.5.3).*

**3-2.10.3** Metallic pipe joints shall be permitted to be threaded, flanged, welded, or brazed using pipe and fittings that comply with 2-4.2 and 2-4.4 as follows.

(a) When joints are threaded or threaded and back welded,

- For LP-Gas vapor at pressures in excess of 125 psi (0.9 MPa) or for LP-Gas liquid the pipe and nipples shall be Schedule 80.
- For LP-Gas vapor at pressures of 125 psi (0.9 MPa) or less, the pipe and nipples shall be Schedule 40 or heavier.

(b) Where joints are welded or brazed the pipe shall be Schedule 40 or heavier. The fittings or flanges shall be suitable for the service for which they are to be used. Brazed joints shall be made with a brazing material having a melting point exceeding 1000°F (538°C).

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

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

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

**3-2.10.4** Metallic tubing joints shall be permitted to be flared or brazed using tubing and fittings and brazing material that complies with 2-4.3 and 2-4.4.

**3-2.10.5** Piping in systems shall be run as directly as is practical from one point to another, and with as few restrictions, such as ells and bends, as conditions will permit, giving consideration to provisions of 3-2.10.6.

Where condensation of vapor can occur, metallic and non-metallic piping shall be pitched back to the container or suitable means provided for revaporizing the condensate.

**3-2.10.6** Provision shall be made in piping including interconnecting of permanently installed containers, to compensate for expansion, contraction, jarring and vibration, and for settling. Where necessary, flexible connectors complying with 2-4.6 shall be permitted to be used (*see 3-2.10.11*). The use of nonmetallic pipe, tubing, or hose for permanently interconnecting such containers shall be prohibited.

**3-2.10.7** Aboveground piping shall be supported and protected against physical damage. The portion of aboveground piping in contact with a support or a corrosion causing substance shall be protected against corrosion. Where underground piping is beneath driveways, roads, or streets, possible damage by vehicles shall be taken into account.

**3-2.10.8** Polyethylene pipe and tubing and thermoplastic compression-type mechanical fittings shall be installed outside underground with a minimum 18 in. (460 mm) of cover. The cover shall be permitted to be reduced to 12 in. (300 mm) if external damage to the pipe or tubing is not likely to result. If a minimum 12 in. (300 mm) of cover cannot be maintained, the piping shall be installed in conduit or shall be bridged (shielded).

(a) Underground polyethylene piping systems shall require assembled anodeless risers to terminate above ground. The horizontal portion of risers shall be buried at least 12 in. (300 mm) below grade and the casing material used for the risers shall be protected against corrosion in accordance with 3-2.14.

(b) The aboveground portion of the riser casing shall either be provided with a plastic sleeve inside the riser casing or shall utilize other methods to center the polyethylene pipe or tubing in order to provide an annular air space around the pipe or tubing.

(c) The factory-assembled riser shall be sealed and leak tested by the manufacturer. The field-assembled riser shall be supplied only in kit form with all necessary hardware for installation. They shall be sealed and pressure tested by the installer. Field-assembled riser kits shall be design certified. They shall be assembled and installed in accordance with the riser manufacturer's instructions.

(d) The casing of the riser shall be constructed of ASTM A53 Schedule 40 steel pipe, ASTM A513 mechanical steel tubing with a minimum wall thickness of 0.073 in. (1.9 mm), or a flexible metal tubing with a minimum crush strength of 1000 lb (453.6 kg) and a tensile strength of 300 lb (136 kg) including the transition connection as tested by the manufacturer.

(e) An electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape shall be buried with the

polyethylene pipe to facilitate locating. One end shall be brought aboveground at a building wall or riser. The wire or tape shall not be in direct contact with the polyethylene pipe.

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

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

NOTE: Polyethylene will expand or contract 1 in. (25 mm) for every 10°F temperature change for every 100 ft (30.5 m) of pipe.

(h) Polyethylene pipe shall be permitted to be inserted into an existing steel pipe only if done in a manner that will protect the polyethylene from being damaged during the insertion process. The leading end of the polyethylene being inserted shall also be closed prior to insertion.

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

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

(j) Valve installation in polyethylene pipe shall be designed so as to protect the pipe against excessive torsional or shearing loads when the valve is being operated. Valve boxes shall be installed so as to avoid transmitting external loads to the valve or pipe. Valves shall be manufactured from thermoplastic materials fabricated from materials listed in ASTM D2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, that have been shown to be resistant to the action of LP-Gas and comply with ASTM D2513, or from metals protected to minimize corrosion in accordance with 3-2.10.9. Valves shall be recommended for LP-Gas service by the manufacturer.

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

**3-2.10.9** Underground metallic piping shall be protected against corrosion as warranted by soil conditions (*see 3-2.14*).

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

**3-2.10.10** Flexible components used in piping systems shall comply with 2-4.6 for the service for which they are to be used, shall be installed in accordance with the manufacturer's instructions, and shall also comply with the following:

(a) \*Flexible connectors in lengths up to 36 in. (1 m) (*see 2-4.6.3 and 2-4.6.4*) shall be permitted to be used for liquid or vapor piping on portable or stationary tanks to compensate for expansion, contraction, jarring, vibration, and settling.

(b) Hose shall be permitted to be installed if flexibility is required for liquid or vapor transfer. The use of wet hose is recommended for liquid.

**3-2.10.11** On new installations and, by December 31, 1980, on existing installations, stationary single-container systems of over 4000 gal (15.1 m<sup>3</sup>) water capacity, or stationary multiple-container systems with an aggregate water capacity of more than 4000 gal (15.1 m<sup>3</sup>) utilizing a common or manifolded liq-

uid transfer line, or railroad tank car transfer systems to fill trucks with no stationary storage involved shall comply with the following:

(a) Where a hose or swivel-type piping 1 1/2 in. (38 mm) or larger is used for liquid transfer or a 1 1/4-in. (32-mm) or larger vapor hose or swivel-type piping is used in this service, an emergency shutoff valve complying with 2-4.5.4 shall be installed in the fixed piping of the transfer system within 20 ft (6 m) of lineal pipe from the nearest end of the hose or swivel-type piping to which the hose or swivel-type piping is connected. Where either a liquid or vapor line has two or more hose or swivel-type piping of the sizes designated, an emergency shutoff valve or a backflow check valve shall be installed in each leg of the piping.

*Exception: Where the flow is only in one direction into the container, a backflow check valve shall be permitted to be used in lieu of an emergency shutoff valve if installed in the fixed piping downstream of the hose or swivel-type piping, provided the backflow check valve has a metal-to-metal seat or a primary resilient seat with a secondary metal seat not hinged with combustible material.*

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

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

(d) The emergency shutoff valve(s) or backflow check valve(s) specified in 3-2.10.11(a) shall be installed in the plant piping so that any break resulting from a pull will occur on the hose or swivel-type piping side of the connection while retaining intact the valves and piping on the plant side of the connection. Provisions for anchorage and breakaway shall be provided on the cargo tank side for transfer from a railroad tank car directly into a cargo tank.

*Exception: Such anchorage shall not be required for tank car side.*

NOTE: This can be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting.

(e) Emergency shutoff valves shall be maintained in working order.

(f) Emergency shutoff valves and check valves required in this section shall be tested annually for proper operation. The results of the tests shall be documented.

(g) All new installations and, by March 31, 1999, existing installations shall have at least one clearly identified and easily accessible manually operated remote emergency shutoff device. The device shall be located not less than 20 ft (6.1 m) nor more than 100 ft (30.5 m) in the path of egress from the emergency shutoff valve.

**3-2.10.12** Hose shall be permitted to be used on the low-pressure side of regulators to connect to other than domestic and commercial appliances as follows:

(a) The appliance connected shall be of a portable type.

(b) For use inside buildings, the hose shall be of a minimum length, not exceeding 6 ft (1.8 m) [except as provided in 3-4.2.3(b)], and shall not extend from one room to another nor pass through any partitions, walls, ceilings, or floors

(except as provided in 3-4.3.7). It shall not be concealed from view or used in concealed locations. For use outside buildings, hose length shall be permitted to exceed 6 ft (1.8 m) but shall be kept as short as practical.

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

(d) A shutoff valve shall be provided in the piping immediately upstream of the inlet connection of the hose. Where more than one such appliance shutoff is located near another, precautions shall be taken to prevent operation of the wrong valve.

(e) Hose used for connecting appliances to wall or other outlets shall be protected against physical damage.

**3-2.11 Hydrostatic Relief Valve Installation.** A hydrostatic relief valve that complies with 2-4.7 or a device providing pressure-relieving protection shall be installed in each section of piping (including hose) in which liquid LP-Gas can be isolated between shutoff valves so as to relieve the pressure that could develop from the trapped liquid to a safe atmosphere or product-retaining section.

**3-2.12 Testing Piping Systems.** After assembly, piping systems (including hose) shall be tested and proven free of leaks at not less than the normal operating pressure. Piping within the scope of NFPA 54, *National Fuel Gas Code [see 1-1.3.1(f)]*, shall be pressure tested in accordance with that code. Tests shall not be made with a flame.

**3-2.13 Areas of Heavy Snowfall.** In areas where heavy snowfall can be expected, piping, regulators, meters, and other equipment installed in the piping system shall be protected from the forces anticipated as a result of accumulated snow.

**3-2.14 Corrosion Protection.** All metallic equipment and components that are buried, mounded, or otherwise considered to be in the ground shall be protected and maintained to minimize corrosion.

NOTE: For information on protection of underground components see NACE RP-0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*.

Corrosion protection of all other materials shall be in accordance with accepted engineering practice.

### 3-2.15 Equipment Installation.

**3-2.15.1** Pumps shall be installed as recommended by the manufacturer and in accordance with the following:

(a) Installation shall be made so that the pump casing shall not be subjected to excessive strains transmitted to it by the suction and discharge piping. This shall be accomplished by piping design, the use of flexible connectors or expansion loops, or by other effective methods, in accordance with good engineering practice.

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

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

shall be designed or installed so that it cannot be rendered inoperative and shall discharge either into a storage container or into the pump inlet.

(c) A pump operating control or disconnect switch shall be located near the pump. Remote control points shall be provided as necessary for other plant operations such as container filling, loading or unloading of cargo vehicles and tank cars, or operation of engine fuel dispensers. (*See 3-9.3.10 for vehicle fuel dispensers and dispensing stations.*)

**3-2.15.2** Compressors shall be installed as recommended by the manufacturer and shall be in accordance with the following:

(a) Installation shall be made so that the compressor housing shall not be subjected to excessive strains transmitted to it by the suction and discharge piping. Flexible connectors shall be permitted to be used where necessary to accomplish this.

(b) If the compressor is not equipped with an integral means to prevent the LP-Gas liquid from entering the suction (*see 2-5.3.3*), a suitable liquid trap shall be installed in the suction piping as close to the compressor as practical.

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

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

**3-2.15.3** Strainers shall be installed so that the strainer element can be serviced.

**3-2.15.4** Liquid or vapor meters shall be installed as recommended by the manufacturer and shall be in compliance with the following applicable provisions:

(a) Liquid meters shall be securely mounted and shall be installed so that the meter housing is not subject to excessive strains from the connecting piping. If not provided in the piping design, flexible connectors shall be permitted to be used where necessary to accomplish this.

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

### 3-3 Bulk Plant and Industrial LP-Gas Systems.

**3-3.1 Application.** This section includes provisions for LP-Gas systems installed at bulk plants and industrial plants.

**3-3.2 General.** The location and installation of storage containers and the installation of container appurtenances, piping, and equipment shall comply with Section 3-2.

#### 3-3.3 Installation of Liquid Transfer Facilities.

**3-3.3.1** Points of transfer (*see definition*) or the nearest part of a structure housing transfer operations shall be located in accordance with 3-2.3.2 and 3-2.3.3.

**3-3.3.2** Buildings used exclusively for housing pumps or vapor compressors shall be located in accordance with 3-2.3.3 considering the building as one that houses a point of transfer.

**3-3.3.3** The track of the railroad siding or the roadway surface at the transfer points shall be relatively level. Adequate clearances from buildings, structures, or stationary containers shall be provided for the siding or roadway approaches to the unloading or loading points to prevent the rail car or cargo vehicle from contacting buildings, structures, or stationary containers. Barriers shall be provided at the ends of railroad sidings.

**3-3.3.4** Liquid transfer shall be permitted to be accomplished by pressure differential, by gravity, or by the use of pumps or compressors complying with Section 2-5.

**3-3.3.5** Compressors used for liquid transfer normally shall take suction from the vapor space of the container being filled and discharge into the vapor space of the container from which the withdrawal is being made.

**3-3.3.6** Pumps and compressors shall be provided with an operating control or disconnect switch located nearby. Remote shutoff controls shall be provided as necessary in other liquid transfer systems.

**3-3.3.7** Safeguards shall be provided to prevent the uncontrolled discharge of LP-Gas in the event of failure in the hose or swivel-type piping. The provisions of 3-2.10.11 shall apply. For all other LP-Gas systems the following shall apply:

(a) The connection or connecting piping larger than 1/2-in. (12-mm) internal diameter into which the liquid or vapor is being transferred shall be equipped with one of the following:

1. A backflow check valve
2. An emergency shutoff valve complying with 2-4.5.4
3. An excess-flow valve properly sized in accordance with 2-3.7(a)4

(b) The connection or connecting piping larger than 1/2-in. (12-mm) internal diameter from which the liquid or vapor is being withdrawn shall be equipped with one of the following:

1. An emergency shutoff valve complying with 2-4.5.4
2. An excess-flow valve properly sized in accordance with 2-3.7(a)4

**3-3.3.8** Where a hose or swivel-type piping is used for loading or unloading railroad tank cars, an emergency shutoff valve complying with 2-4.5.4 shall be used at the tank car end of the hose or swivel-type piping.

**3-3.3.9** Transfer hose larger than 1/2-in. (12-mm) internal diameter shall not be used for making connections to individual containers being filled indoors.

**3-3.3.10** If gas is to be discharged from containers inside a building, the provisions of 4-3.2.1 shall apply.

### **3-3.4 Installation of Gas Distribution Facilities.**

**3-3.4.1** This subsection applies to the installation of facilities used for gas manufacturing, gas storage, gas-air mixing and vaporization, and compressors not associated with liquid transfer.

**3-3.4.2** Separate buildings and attachments to or rooms within other buildings housing gas distribution facilities, constructed or converted to such use after December 31, 1972, shall comply with Chapter 7.

*Exception No. 1: Facilities for vaporizing LP-Gas and gas-air mixing shall be designed, located, and installed in accordance with Section 3-6.*

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

**3-3.4.3** Separate buildings used for housing vapor compressors shall be located in accordance with 3-2.3.3 considering the building as one that houses a point of transfer.

**3-3.4.4** The use of pits to house gas distribution facilities shall be permitted where automatic flammable vapor detecting systems are installed in the pit. Drains or blow-off lines shall not be directed into or in proximity of sewer systems.

**3-3.4.5** If gas is to be discharged from containers inside a building, the installation provisions of 4-3.2 shall apply.

**3-3.5 Installation of Electrical Equipment.** Installation of electrical equipment shall comply with Section 3-7.

**3-3.6 Protection against Tampering for Section 3-3 and Section 3-9 Systems.** To minimize the possibilities for trespassing and tampering the area that includes container appurtenances, pumping equipment, loading and unloading facilities, and container filling facilities shall be protected by one of the following methods:

(a) Enclosure with at least a 6-ft (1.8-m) high industrial-type fence, unless otherwise adequately protected. There shall be at least two means of emergency access from the fenced or other enclosure. Clearance shall be provided to allow maintenance to be performed, and a clearance of at least 3 ft (1.0 m) shall be provided to allow emergency access to the required means of egress. If guard service is provided, it shall be extended to the LP-Gas installation. Guard personnel shall be properly trained. (See Section 1-5.)

*Exception: If a fenced or otherwise enclosed area is not over 100 ft<sup>2</sup> (9 m<sup>2</sup>) in area, the point of transfer is within 3 ft (1.0 m) of a gate, and containers being filled are not located within the enclosure, a second gate shall not be required.*

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

**3-3.7 Lighting.** If operations are normally conducted during other than daylight hours, lighting shall be provided to illuminate storage containers, containers being loaded, control valves, and other equipment.

**3-3.8 Ignition Source Control.** Ignition source control shall comply with Section 3-7.

### **3-4 LP-Gas Systems in Buildings or on Building Roofs or Exterior Balconies.**

#### **3-4.1 Application.**

**3-4.1.1** This section includes installation and operating provisions for LP-Gas systems containing liquid LP-Gas located inside of or on the roofs or exterior balconies of buildings or structures. Systems covered include those utilizing cylinders inside of or on the roofs or exterior balconies of buildings and those in which the liquid is piped from outside containers into buildings or onto the roof. These systems shall be permitted only under the conditions specified in this paragraph and in accordance with 3-4.1 and 3-4.2. Cylinders in use shall mean connected for use.

(a) The use of cylinders indoors shall be only for the purposes specified in 3-4.3 through 3-4.8. Such use shall be limited to those conditions where operational requirements make use of cylinders necessary and location outside is impractical.

(b) Installations using cylinders on roofs shall be as specified in 3-4.9.1. Such use shall be limited to those conditions where operational requirements make use of cylinders neces-

sary and location not on roofs of buildings or structures is impractical.

(c) Installations using cylinders on exterior balconies shall be as specified in 3-4.9.2.

(d) Liquid LP-Gas shall be piped into buildings or structures only for the purposes specified in 3-2.8(d).

**3-4.1.2** Storage of cylinders awaiting use shall be in accordance with Chapter 5.

**3-4.1.3** Transportation of cylinders within a building shall be in accordance with 3-4.2.7.

**3-4.1.4** These provisions shall be required in addition to those specified in Section 3-2.

**3-4.1.5** Liquid transfer systems shall be in accordance with Chapter 4.

**3-4.1.6** Engine fuel systems used inside buildings shall be in accordance with Chapter 8.

**3-4.1.7** LP-Gas transport or cargo vehicles stored, serviced, or repaired in buildings shall be in accordance with Chapter 6.

**3-4.2 General Provisions for Cylinders, Equipment, Piping, and Appliances.**

**3-4.2.1** Cylinders shall comply with DOT cylinder specifications (see 2-2.1.3 and 2-2.2.1), shall not exceed 245 lb (111 kg) water capacity [nominal 100 lb (45 kg) LP-Gas capacity] each, shall comply with other applicable provisions of Section 2-2, and shall be equipped as provided in Section 2-3 [see 2-3.3 and Table 2-3.3.2(a)]. They shall also comply with the following:

(a) Cylinders shall be marked as provided in 2-2.6.1 and 2-2.6.2.

(b) Cylinders with propane capacities greater than 2 lb (0.9 kg) shall be equipped as provided in Table 2-3.3.2(a). Excess-flow valve protection shall be provided for vapor service.

(c) Valves on cylinders shall be protected in accordance with 2-2.4.1.

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

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

**3-4.2.2** Regulators, if used, shall be suitable for use with LP-Gas. Manifolds and fittings connecting cylinders to pressure regulator inlets shall be designed for at least 250-psi (1.7-MPa) service pressure.

**3-4.2.3** Piping including pipe, tubing, fittings, valves, and hose shall comply with Section 2-4, except that a minimum working pressure of 250 psi (1.7 MPa) shall apply to all components. The following also shall apply:

(a) Piping shall be installed in accordance with the provisions of 3-2.10 for liquid piping or for vapor piping for pressures above 125 psi (0.9 MPa). [See 3-2.10.2(b).]

(b) Hose, hose connections, and flexible connectors used shall be designed for a working pressure of at least 350 psi (2.4 MPa), shall comply with 2-4.6, and shall be installed in accordance with 3-2.10.12. Hose length shall be permitted to

exceed that specified by 3-2.10.12(b) but shall be as short as practical, although long enough to permit compliance with the spacing requirements (see 3-4.3.3 and 3-4.3.4) without kinking or straining hose or causing it to be close enough to a burner to be damaged by heat. (See 3-4.9 for permanent roof installations.)

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

**3-4.2.4** Cylinders, regulating equipment, manifolds, pipe, tubing, and hose shall be located to minimize exposure to abnormally high temperatures (such as might result from exposure to convection and radiation from heating equipment or installation in confined spaces), physical damage, or tampering by unauthorized persons.

**3-4.2.5** Heat-producing equipment shall be located and used to minimize the possibility of the ignition of combustibles.

**3-4.2.6** Where cylinders are located on a floor, roof, or balcony, provisions shall be made to minimize the possibility of cylinders falling over the edge.

**3-4.2.7** Transportation (movement) of cylinders within a building shall comply with the following:

(a) Containers having water capacities greater than 2.7 lb (1.2 kg) within a building shall be restricted to movement directly associated with the uses covered by 3-4.3 through 3-4.9 and shall be conducted in accordance with these provisions and 3-4.2.7(b) through (d).

(b) Valve outlets on cylinders having water capacities greater than 2.7 lb (1.2 kg) shall be tightly plugged or capped and shall comply with the provisions of 2-2.4.1.

(c) Only emergency stairways not generally used by the public shall be used, and precautions shall be taken to prevent the cylinder from falling down the stairs.

(d) Freight or passenger elevators shall be permitted to be used when occupied only by those engaged in moving the cylinder.

**3-4.2.8** Portable heaters, including salamanders, shall be equipped with an approved automatic device to shut off the flow of gas to the main burner and to the pilot, if used, in the event of flame extinguishment or combustion failure. Such portable heaters shall be self-supporting unless designed for cylinder mounting (see 3-4.3.4). Cylinder valves, connectors, regulators, manifolds, piping, or tubing shall not be used as structural supports. The following shall also apply.

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

(a) A pilot that must be lighted and proved before the main burner can be turned on

(b) An approved electric ignition system

*Exception:* The provisions of 3-4.2.8 shall not be applicable to the following:

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

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

### 3-4.3 Buildings Under Construction or Undergoing Major Renovation.

**3-4.3.1** Cylinders shall be permitted to be used and transported in buildings or structures under construction or undergoing major renovation where such buildings are not occupied by the public or, if partially occupied by the public, cylinders shall be permitted to be used and transported in the unoccupied portions with the prior approval of the authority having jurisdiction. Such use shall be in accordance with 3-4.3.2 through 3-4.3.8.

**3-4.3.2** Cylinders, equipment, piping, and appliances shall comply with 3-4.2.

**3-4.3.3** For temporary heating, such as curing concrete, drying plaster, and similar applications, heaters (other than integral heater-container units covered in 3-4.3.4) shall be located at least 6 ft (1.8 m) from any cylinder.

**3-4.3.4** Integral heater-cylinder units specifically designed for the attachment of the heater to the cylinder, or to a supporting standard attached to the cylinder, shall be permitted to be used, provided they are designed and installed to prevent direct or radiant heat application to the cylinder. Blower-type and radiant-type units shall not be directed toward any cylinder within 20 ft (6.1 m).

**3-4.3.5** If two or more heater-cylinder units of either the integral or nonintegral type are located in an unpartitioned area on the same floor, the cylinder(s) of each such unit shall be separated from the cylinder(s) of any other such unit by at least 20 ft (6.1 m).

**3-4.3.6** If heaters are connected to cylinders manifolded together for use in an unpartitioned area on the same floor, the total water capacity of cylinders manifolded together serving any one heater shall not be greater than 735 lb (333 kg) [nominal 300 lb (136 kg) LP-Gas capacity] and, if there is more than one such manifold, it shall be separated from any other by at least 20 ft (6.1 m).

**3-4.3.7** On floors on which no heaters are connected for use, cylinders shall be permitted to be manifolded together for connection to a heater or heaters on another floor, provided the following:

- (a) The total water capacity of the cylinders connected to any one manifold is not greater than 2450 lb (1111 kg) [nominal 1000 lb (454 kg) LP-Gas capacity], and
- (b) Manifolds of more than 735 lb (333 kg) water capacity [nominal 300 lb (136 kg) LP-Gas capacity], if located in the same unpartitioned area, shall be separated from each other by at least 50 ft (15 m).

**3-4.3.8** The provisions of 3-4.3.5, 3-4.3.6, and 3-4.3.7 shall be permitted to be altered by the authority having jurisdiction if compliance is impractical.

**3-4.4 Buildings Undergoing Minor Renovation When Frequented by the Public.** Cylinders shall be permitted to be used and transported for repair or minor renovation in buildings frequented by the public as follows:

(a) During the hours the public normally occupies the building, the following shall apply:

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

exceed the number of workers assigned to the use of the LP-Gas.

2. Cylinders having a water capacity greater than 2.7 lb (1.2 kg) shall not be left unattended.

(b) During the hours the building is not open to the public, cylinders shall be permitted to be used and transported within the building for repair or minor renovation in accordance with 3-4.2 and 3-4.3, provided that cylinders with a greater water capacity than 2.7 lb (1.2 kg) shall not be left unattended.

### 3-4.5 Buildings Housing Industrial Occupancies.

**3-4.5.1** Cylinders shall be permitted to be used in buildings housing industrial occupancies for processing, research, or experimental purposes as follows:

(a) Cylinders, equipment, and piping used shall comply with 3-4.2.

(b) If cylinders are manifolded together, the total water capacity of the connected cylinders shall be not more than 735 lb (333 kg) [nominal 300 lb (136 kg) LP-Gas capacity]. If there is more than one such manifold in a room, it shall be separated from any other by at least 20 ft (6.1 m).

(c) The amount of LP-Gas in cylinders for research and experimental use in the building shall be limited to the smallest practical quantity.

**3-4.5.2** Cylinders shall be permitted to be used to supply fuel for temporary heating in buildings housing industrial occupancies with essentially noncombustible contents, if portable equipment for space heating is essential and a permanent heating installation is not practical, provided cylinders and heaters comply with and are used in accordance with 3-4.3.

**3-4.6 Buildings Housing Educational and Institutional Occupancies.** Cylinders shall be permitted to be used in buildings housing educational and institutional laboratory occupancies for research and experimental purposes, but not in classrooms, as follows:

(a) The maximum water capacity of individual cylinders used shall be 50 lb (23 kg) [nominal 20 lb (9.1 kg) LP-Gas capacity] if used in educational occupancies and 12 lb (5.4 kg) [nominal 5 lb (2 kg) LP-Gas capacity] if used in institutional occupancies.

(b) If more than one such cylinder is located in the same room, the cylinders shall be separated by at least 20 ft (6.1 m).

(c) Cylinders not connected for use shall be stored in accordance with Chapter 5.

*Exception: Cylinders shall not be stored in a laboratory room.*

### 3-4.7 Temporary Heating and Food Service Appliances in Buildings in Emergencies.

**3-4.7.1** Cylinders shall be permitted to be used in buildings for temporary emergency heating purposes if necessary to prevent damage to the buildings or contents, and if the permanent heating system is temporarily out of service, provided the cylinders and heaters comply with and are used and transported in accordance with 3-4.2 and 3-4.3 and the temporary heating equipment is not left unattended.

**3-4.7.2** When a public emergency has been declared and gas, fuel, or electrical service has been interrupted, portable listed LP-Gas commercial food service appliances meeting the requirements of 3-4.8.4 shall be permitted to be temporarily



used inside affected buildings. The portable appliances used shall be discontinued and removed from the building at the time the permanently installed appliances are placed back in operation.

### 3-4.8 Use in Buildings for Demonstrations or Training, or Use in Small Containers.

**3-4.8.1** Cylinders having a maximum water capacity of 12 lb (5.4 kg) [nominal 5 lb (2 kg) LP-Gas capacity] shall be permitted to be used temporarily inside buildings for public exhibitions or demonstrations, including use in classroom demonstrations. If more than one such cylinder is located in a room, the cylinders shall be separated by at least 20 ft (6.1 m).

**3-4.8.2** Cylinders shall be permitted to be used temporarily in buildings for training purposes related to the installation and use of LP-Gas systems, provided the following conditions are met:

- (a) The maximum water capacity of individual cylinders shall be 245 lb (111 kg) [nominal 100 lb (45 kg) LP-Gas capacity], but not more than 20 lb (9.1 kg) of LP-Gas shall be placed in a single cylinder.
- (b) If more than one such cylinder is located in the same room, the cylinders shall be separated by at least 20 ft (6.1 m).
- (c) The training location shall be acceptable to the authority having jurisdiction.
- (d) Cylinders shall be promptly removed from the building when the training class has terminated.

**3-4.8.3\*** Cylinders complying with UL 147A, *Standard for Non-refillable (Disposable) Type Fuel Gas Cylinder Assemblies*, and having a maximum water capacity of 2.7 lb (1.2 kg) shall be permitted to be used in buildings as part of approved self-contained torch assemblies or similar appliances.

**3-4.8.4** Listed and approved LP-Gas commercial food service appliances shall be permitted to be used inside restaurants and in attended commercial food catering operations provided that no commercial food service appliances shall have more than two 10-oz (296-ml) nonrefillable butane gas containers complying with UL 147B, *Standard for Nonrefillable (Disposable) Type Metal Container Assemblies for Butane*, having a maximum water capacity of 1.08 lb (0.490 kg) per container connected directly to the appliance at any time and the containers shall not be manifolded. The appliance fuel container(s) shall be an integral part of the listed, approved, commercial food service device and shall be connected without the use of a rubber hose. Butane containers shall be listed. Storage of containers shall be in accordance with 5-3.1.

### 3-4.9 Cylinders on Roofs or Exterior Balconies.

**3-4.9.1** Cylinders shall be permitted to be permanently installed on roofs of buildings of fire-resistive construction, or noncombustible construction having essentially noncombustible contents, or of other construction or contents that are protected with automatic sprinklers (*see NFPA 220, Standard on Types of Building Construction*) in accordance with 3-4.2 and the following:

(a) The total water capacity of cylinders connected to any one manifold shall be not greater than 980 lb (445 kg) [nominal 400 lb (181 kg) LP-Gas capacity]. If more than one manifold is located on the roof, it shall be separated from any other by at least 50 ft (15 m).

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

(c) Cylinders shall not be located on roofs that are entirely enclosed by parapets more than 18 in. (457 mm) high unless the parapets are breached with low-level ventilation openings no more than 20 ft (6.1 m) apart or all openings communicating with the interior of the building are at or above the top of the parapets.

(d) Piping shall be in accordance with 3-4.2.3. Hose shall not be used for connection to cylinders.

(e) The fire department shall be advised of each such installation.

**3-4.9.2** Cylinders having water capacities greater than 2½ lb (1 kg) [nominal 1 lb (0.5 kg)] LP-Gas capacity shall not be located on balconies above the first floor that are attached to a multiple family dwelling of three or more living units located one above the other.

*Exception:* Where such balconies are served by outside stairways and where only such stairways are used to transport the cylinder.

### 3-4.10 Liquid Piped into Buildings or Structures.

**3-4.10.1** Liquid LP-Gas piped into buildings in accordance with 3-2.8(d), Exception No. 1, shall comply with 3-2.10.

**3-4.10.2** Liquid LP-Gas piped into buildings in accordance with 3-2.8(d), Exception No. 2, from containers located and installed outside the building or structure in accordance with 3-2.2 and 3-2.3 shall comply with the following:

(a) Liquid piping shall not exceed ¾ in. IPS and shall comply with 3-2.8 and 3-2.10. If approved by the authority having jurisdiction, copper tubing complying with 2-4.3c(1) and with a maximum outside diameter of ¾ in. shall be permitted to be used. Liquid piping in buildings shall be kept to a minimum and shall be protected against construction hazards by the following methods:

1. Securely fastening it to walls or other surfaces to provide protection against breakage
2. Locating it so as to avoid exposure to high ambient temperatures

(b) A readily accessible shutoff valve shall be located at each intermediate branch line where it leaves the main line. A second shutoff valve shall be located at the appliance end of the branch and upstream of any flexible appliance connector.

(c) Excess-flow valves complying with 2-3.3.3(b) shall be installed in the container outlet supply line, downstream of each shutoff valve, and at any point in the piping system where the pipe size is reduced. They shall be sized for the reduced size piping.

(d) Hose shall not be used to carry liquid between the container and building and shall not be used at any point in the liquid line except as the appliance connector. Such connectors shall be as short as practical and shall comply with 2-4.6, 3-2.10.10, and 3-2.10.12.

(e) Hydrostatic relief valves shall be installed in accordance with 3-2.11.

(f) Provision shall be made so that the release of fuel when any section of piping or appliances is disconnected shall be minimized by use of one of the following methods:

1. An approved automatic quick-closing coupling that shuts off the gas on both sides when uncoupled
2. Closing the shutoff valve closest to the point to be disconnected and allowing the appliance or appliances on that line to operate until the fuel in the line is consumed

### 3-5 Installation of Appliances.

#### 3-5.1 Application.

**3-5.1.1** This section includes installation provisions for LP-Gas appliances fabricated in accordance with Section 2-6.

**3-5.1.2** Installation of appliances on commercial vehicles shall be in accordance with Section 3-8.

**3-5.1.3** With the approval of the authority having jurisdiction, unattended heaters used for the purpose of animal or poultry production inside structures without enclosing walls shall not be required to be equipped with an automatic device designed to shut off the flow of gas to the main burners and to the pilot, if used, in the event of flame extinguishment or combustion failure.

**3-5.2 Referenced Standards.** LP-Gas appliances shall be installed in accordance with this code and other national standards that apply. These include the following:

- (a) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
- (b) NFPA 54, *National Fuel Gas Code* (ANSI Z223.1)
- (c) NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*
- (d) NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*
- (e) NFPA 86, *Standard for Ovens and Furnaces*
- (f) NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*
- (g) NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*
- (h) NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*
- (i) NFPA 501C, *Standard on Recreational Vehicles* (ANSI A119.2)

#### 3-6 Vaporizer Installation.

**3-6.1 Application.** This section shall apply to the installation of vaporizing devices covered in 2-5.4. It shall not apply to engine fuel vaporizers or to integral vaporizing burners such as those used for weed burners or tar kettles.

#### 3-6.2 Installation of Indirect-Fired Vaporizers.

**3-6.2.1** Indirect-fired vaporizers shall comply with 2-5.4.2, and shall be installed as provided in this section.

**3-6.2.2** Where an indirect-fired vaporizer is installed in a building or structure, the building or structure shall comply with the following:

- (a) Separate buildings or structures shall comply with Section 7-2.
- (b) Attached structures or rooms shall comply with Section 7-3.
- (c) The building or structure shall not have any unprotected drains to sewers or sump pits. Pressure relief valves on vaporizers within buildings in industrial or gas manufacturing plants shall be piped to a point outside the building or structure and shall discharge vertically upward.

**3-6.2.3** If the heat source of an indirect vaporizer is gas fired and is located within 15 ft (4.6 m) of the vaporizer, the vaporizer and its heat source shall be considered to be a direct-fired vaporizer and subject to the requirements of 3-6.3.

**3-6.2.4** The installation of a heat source serving an indirect vaporizer that utilizes a flammable or combustible heat transfer fluid shall comply with one of the following:

- (a) It shall be located outdoors.
- (b) If installed within a structure, the structure shall comply with Section 7-2.
- (c) If installed within structures attached to, or rooms within, buildings, the structures or rooms shall comply with Section 7-3.

**3-6.2.5** Gas-fired heating systems supplying heat for vaporization purposes shall be equipped with automatic safety devices to shut off gas to the main burners if ignition fails to occur.

**3-6.2.6** The installation of a heat source serving an indirect vaporizer that utilizes a noncombustible heat transfer fluid, such as steam, water, or a water-glycol mixture, shall be installed outdoors or shall comply with the following:

- (a) A source of heat for an indirect vaporizer shall be permitted to be installed in an industrial occupancy (*see definition*) complying with Chapter 28 of NFPA 101®, *Life Safety Code*®, and Section 6.3 of NFPA 54, *National Fuel Gas Code* (ANSI Z223.1), where the heat transfer fluid is steam or hot water and is not recirculated and a back-flow preventer is installed between the vaporizer and the heat source.
- (b) If the heat transfer fluid is recirculated after leaving the vaporizer, the heat source shall be installed in accordance with 3-6.2.4 and a phase separator shall be installed with the gas vented to a safe location.

**3-6.2.7** Vaporizers employing heat from the atmosphere shall be installed outdoors and shall be located in accordance with Table 3-6.3.5.

*Exception:* Atmospheric vaporizers of less than 1-qt (0.9-L) capacity shall be permitted to be installed inside an industrial building close to the point of entry of the supply line.

#### 3-6.3 Installation of Direct-Fired Vaporizers.

**3-6.3.1** Direct-fired vaporizers shall comply with 2-5.4.3 and shall be installed as provided in this section.

**3-6.3.2** Direct-fired vaporizers shall be permitted to be installed outdoors or in separate structures constructed in accordance with Chapter 7.

**3-6.3.3** The housing for direct-fired vaporizers shall not have any drains to a sewer or a sump pit that is shared with any other structure or to a sewer. Pressure relief valve discharges on direct-fired vaporizers shall be piped to a point outside the structure or building.

**3-6.3.4** Direct-fired vaporizers shall be permitted to be connected to the liquid space or to both the liquid or vapor space of the container, but in any case there shall be a manually operated shutoff valve in each connection at the container.

**3-6.3.5** Direct-fired vaporizers of any capacity shall be located in accordance with Table 3-6.3.5

Table 3-6.3.5

Exposure	Minimum Distance Required ft (m)
Container	10 (3.0)
Container shutoff valves	15 (4.6)
Point of transfer	15 (4.6)
Nearest important buildings or group of buildings or line of adjoining property that can be built upon (except buildings in which vaporizer is installed) (see 3-6.3.2 and 3-6.3.3)	25 (7.6)
Chapter 7 building or room housing gas-air mixer	10 (3.0)
Cabinet housing gas-air mixer outdoors	0 (0)

### 3-6.4 Installation of Tank Heaters.

**3-6.4.1** Gas-fired tank heaters shall comply with 2-5.4.6 and shall be installed in accordance with this section.

**3-6.4.2** Tank heaters shall be installed only on aboveground containers and shall be located in accordance with Table 3-6.4.2 with respect to the nearest important building, group of buildings, or line of adjoining property that can be built upon.

Table 3-6.4.2

Container Water Capacity gal (m <sup>3</sup> )	Minimum Distance Required ft (m)
500 or less (1.9 or less)	10 (3.0)
501 – 2000 (1.9 – 7.6)	25 (7.6)
2001 – 30,000 (7.6 – 114)	50 (15)
30,001 – 70,000 (114 – 265)	75 (23)
70,001 – 90,000 (265 – 341)	100 (30.5)
90,001 – 120,000 (341 – 454)	125 (38.1)

**3-6.4.3** If the tank heater is gas fired, an automatic shutoff shall be provided on the fuel supply (including the pilot) that will operate if the container pressure exceeds 75 percent of the maximum design pressure specified in Table 2-2.2.2 or if the liquid level in the container falls below the top of the tank heater.

**3-6.4.4** If the tank heater is of the electric immersion type, the heater shall be automatically de-energized when the pressure or level conditions specified in 3-6.4.3 are reached.

**3-6.4.5** If the tank heater is similar in operation to an indirect vaporizer, the flow of the heat transfer fluid shall be automatically interrupted under the pressure or temperature conditions specified in 3-6.4.3 and the heat source shall comply with 3-6.2.6 and 3-6.2.7.

**3-6.4.6** If a point of transfer is located within 15 ft (4.6 m) of a direct gas-fired tank heater, the heater burner and pilot shall be shut off during the product transfer and a caution notice shall be displayed immediately adjacent to the filling connections that reads:

"A gas-fired device that contains a source of ignition is connected to this container. Burner and pilot must be shut off before filling tank."

**3-6.5 Installation of Vaporizing Burners.** Vaporizing burners shall comply with 2-5.4.7 and shall be installed as follows:

- Vaporizing burners shall be installed outside of buildings. The minimum distance between any container and a vaporizing-burner shall be in accordance with Table 3-6.5.
- Manually operated positive shutoff valves shall be located at the containers to shut off all flow to the vaporizing burners.

Table 3-6.5

Container Water Capacity gal (m <sup>3</sup> )	Minimum Distance Required ft (m)
500 or less (1.9 or less)	10 (3.0)
501 – 2000 (1.9 – 7.6)	25 (7.6)
Over 2000 (over 7.6)	50 (15)

**3-6.6 Installation of Waterbath Vaporizers.** Waterbath vaporizers shall comply with 2-5.4.4 and shall be installed as follows:

- If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class 1, Group D, locations, the unit shall be treated as indirect-fired and shall be installed in accordance with 3-6.2.
- All others shall be treated as direct-fired vaporizers and shall be installed in accordance with 3-6.3.

**3-6.7 Installation of Electric Vaporizers.** Electric vaporizers, whether direct immersion or indirect immersion, shall be treated as indirect-fired and shall be installed in accordance with 3-6.2.

**3-6.8 Installation of Gas-air Mixers.** Gas-air mixing equipment shall comply with 2-5.4.8 and shall be installed in accordance with this section. Piping and equipment installed with gas-air mixers shall comply with 3-2.6, 3-2.7, and 3-2.10.

(a) Where used without a vaporizer(s), a mixer(s) shall be permitted to be installed outdoors or in buildings complying with Chapter 7.

(b) Where used with an indirect-heated vaporizer(s), a mixer(s) shall be permitted to be installed outdoors, or in the same compartment or room with the vaporizer(s), in a building(s) complying with Chapter 7, or the mixer(s) shall be permitted to be installed remotely from the vaporizer(s) and shall be located in accordance with 3-6.2.

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

- Listed or approved and installed in a common cabinet with the vaporizer(s) outdoors in accordance with 3-6.3.5
- Installed outdoors on a common skid with the vaporizer(s) in accordance with 3-6.3
- Installed adjacent to the vaporizer(s) to which it is connected in accordance with 3-6.3
- Installed in a building complying with Chapter 7 without any direct-fired vaporizer in the same room

### 3-7 Ignition Source Control.

#### 3-7.1 Application.

**3-7.1.1** This section includes provisions for minimizing the possibility of ignition of flammable LP-Gas-air mixtures resulting from the normal or accidental release of nominal quantities of liquid or vapor from LP-Gas systems installed and operated in accordance with this code.

**3-7.1.2** The installation of lightning protection equipment shall not be required on LP-Gas storage containers.

NOTE: For information on lightning protection, see NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

**3-7.1.3** Grounding and bonding shall not be required on LP-Gas systems.

NOTE: Because liquefied petroleum gas is contained in a closed system of piping and equipment, the system need not be electrically conductive or electrically bonded for protection against static electricity. For information on grounding and bonding for protection against static electricity, see NFPA 77, *Recommended Practice on Static Electricity*.

**3-7.2 Electrical Equipment.**

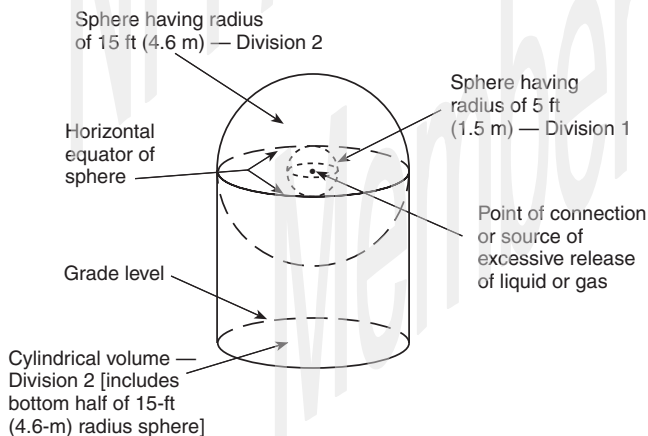
**3-7.2.1** Electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with NFPA 70, *National Electrical Code*®, for ordinary locations.

*Exception: Fixed electrical equipment in classified areas shall comply with 3-7.2.2.*

**3-7.2.2\*** Fixed electrical equipment and wiring installed within classified areas specified in Table 3-7.2.2 shall comply with Table 3-7.2.2 and shall be installed in accordance with NFPA 70, *National Electrical Code*. This provision shall not apply to fixed electrical equipment at residential or commercial installations of LP-Gas systems or to systems covered by Section 3-8. The provision shall apply to vehicle fuel operations.

Fired vaporizers, calorimeters with open flames, and other areas where open flames are present either intermittently or constantly shall not be considered electrically classified areas.

**3-7.2.3** Electrical equipment installed on LP-Gas cargo vehicles shall comply with 6-1.1.4.



**Figure 3-7.2.2** Extent of electrically classified area. (See Table 3-7.2.2.)

**3-7.3 Other Sources of Ignition.**

**3-7.3.1** Open flames or other sources of ignition shall not be permitted in pump houses, cylinder filling rooms, or other

similar locations. Direct-fired vaporizers or indirect-fired vaporizers attached or installed adjacent to gas-fired heat sources shall not be permitted in pump houses or cylinder filling rooms.

**3-7.3.2** Open flames (except as provided in Section 3-6), cutting or welding, portable electric tools, and extension lights capable of igniting LP-Gas shall not be permitted within classified areas specified in Table 3-7.2.2 unless the LP-Gas facilities have been freed of all liquid and vapor or special precautions have been taken under carefully controlled conditions.

**3-8 LP-Gas Systems on Vehicles (Other than Engine Fuel Systems).**

**3-8.1 Application.**

**3-8.1.1** This section applies to nonengine fuel systems on commercial, industrial, construction, and public service vehicles such as trucks, semitrailers, trailers, portable tar kettles, road surface heating equipment, mobile laboratories, clinics, and mobile cooking units (such as catering and canteen vehicles). LP-Gas systems on such vehicles shall be permitted to be either vapor-withdrawal or liquid-withdrawal type. Included are provisions for installations served by exchangeable (removable) cylinder systems and by permanently mounted containers.

**3-8.1.2** This section shall not apply to the following:

- (a) Systems installed on mobile homes
- (b) Systems installed on recreational vehicles [see 3-1.3(i)]
- (c) Tank trucks, truck transports (trailers and semitrailers), and similar units used to transport LP-Gas as cargo, which are covered by Chapter 6
- (d) LP-Gas engine fuel systems on the vehicles covered by Section 3-8 and those cited in 3-8.1.2, which are covered by Chapter 8

**3-8.2 Construction, Location, Mounting, and Protection of Containers and Systems.**

**3-8.2.1** Containers shall comply with Section 2-2, and appurtenances used to equip them for service shall comply with Section 2-3. In addition, the following shall apply:

- (a) ASME containers shall be constructed for a minimum 250 psi (1.7 MPa) design pressure.
- (b) Containers installed in enclosed spaces on vehicles (including recesses or cabinets covered in 3-8.2.2) shall be constructed as follows:
  1. Cylinders shall be designed and constructed for at least a 240-psi (1.6-MPa) service pressure.
  2. ASME containers shall be constructed for at least a 312.5-psi (2.2-MPa) design pressure.
- (c) Cylinders shall comply with 2-2.4.
- (d) Permanently mounted containers shall comply with 3-8.2.3(c).
- (e) LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200 gal (0.8 m<sup>3</sup>) aggregate water capacity.

Table 3-7.2.2

Part	Location	Extent of Classified Area <sup>1</sup>	Equipment Shall Be Suitable for <i>National Electrical Code, Class 1, Group D</i> <sup>2</sup>
A	Unrefrigerated containers other than cylinders and ASME vertical containers of less than 1000 lb water capacity	Within 15 ft in all directions from connections, except connections otherwise covered in Table 3-7.2.2	Division 2
B	Refrigerated storage containers	Within 15 ft in all directions from connections otherwise covered in Table 3-7.2.2	Division 2
		Area inside dike to the level of the top of the dike	Division 2
C	Tank vehicle and tank car loading and unloading	Within 5 ft in all directions from connections regularly made or disconnected for product transfer	Division 1
		Beyond 5 ft but within 15 ft in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and grade ( <i>see Figure 3-7.2.2</i> )	Division 2
D	Gauge vent openings other than those on cylinders and ASME vertical containers of less than 1000 lb water capacity	Within 5 ft in all directions from point of discharge	Division 1
		Beyond 5 ft but within 15 ft in all directions from point of discharge	Division 2
E	Relief device discharge other than those on cylinders and ASME vertical containers of less than 1000 lb water capacity and vaporizers	Within direct path of discharge	Division 1 Note: Fixed electrical equipment should preferably not be installed.
F	Pumps, vapor compressors, gas-air mixers and Vaporizers (other than direct-fired or indirect-fired with an attached or adjacent gas-fired heat source)		
	Indoors without ventilation	Entire room and any adjacent room not separated by a gastight partition	Division 1
		Within 15 ft of the exterior side of any exterior wall or roof that is not vaportight or within 15 ft of any exterior opening	Division 2
	Indoors with ventilation	Entire room and any adjacent room not separated by a gastight partition	Division 2
	Outdoors in open air at or above grade	Within 15 ft in all directions from this equipment and within the cylindrical volume between the horizontal equator of the sphere and grade ( <i>see Figure 3-7.2.2</i> )	Division 2
G	Vehicle fuel dispenser	Entire space within dispenser enclosure, and 18 in. horizontally from enclosure exterior up to an elevation 4 ft above dispenser base; entire pit or open space beneath dispenser	Division 1
		Up to 18 in. above ground within 20 ft horizontally from any edge of enclosure (Note: For pits within this area, see Part H of this table.)	Division 2
H	Pits or trenches containing or located beneath LP-Gas valves, pumps, vapor compressors, regulators, and similar equipment		
	Without mechanical ventilation	Entire pit or trench	Division 1
		Entire room and any adjacent room not separated by a gastight partition	Division 2
		Within 15 ft in all directions from pit or trench when located outdoors	Division 2
	With mechanical ventilation	Entire pit or trench	Division 2
		Entire room and any adjacent room not separated by a gastight partition	Division 2
		Within 15 ft in all directions from pit or trench when located outdoors	Division 2
I	Special buildings or rooms for storage of cylinders	Entire room	Division 2
J	Pipelines and connections containing operational bleeds, drips, vents, or drains	Within 5 ft in all directions from point of discharge	Division 1
		Beyond 5 ft from point of discharge, same as Part F of this table	

Table 3-7.2.2 (Continued)

Part	Location	Extent of Classified Area <sup>1</sup>	Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D <sup>2</sup>	
K	Cylinder filling	Indoors with ventilation	Within 5 ft in all directions from a point of transfer	Division 1
			Beyond 5 ft and entire room	Division 2
	Outdoors in open air		Within 5 ft in all directions from a point of transfer	Division 1
			Beyond 5 ft but within 15 ft in all directions from point of transfer and within the cylindrical volume between the horizontal equator of the sphere and grade (see Figure 3-7.2.2)	Division 2

For SI units: 18 in. = 256 mm; 4 ft = 1.2 m; 5 ft = 1.5 m; 15 ft = 4.6 m; 20 ft = 6.1 m; 1000 lb = 454 kg

<sup>1</sup>The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

<sup>2</sup>See Article 500 Hazardous (Classified) Locations in 70 National Electrical Code (ANSI), for definitions of Classes, Groups, and Divisions.

(f) Individual LP-Gas containers used on other than passenger-carrying vehicles normally operating on the highway shall not exceed 300 gal (1.1 m<sup>3</sup>) water capacity. This shall not be construed as applying to the use of LP-Gas from the cargo tanks of vehicles covered by Chapter 6.

*Exception: ASME Containers on road surface heating equipment shall not exceed 1000 gal (3.8 m<sup>3</sup>) water capacity.*

(g) Containers designed for stationary service only and not in compliance with 2-2.4 shall not be used.

**3-8.2.2** ASME containers and cylinders utilized for the purposes covered by this section shall not be installed, transported, or stored (even temporarily) inside any vehicle covered by Section 3-8, except as provided in 3-8.2.3(d), Chapter 6, or as provided by applicable DOT regulations. The LP-Gas supply system, including the containers, shall be permitted to be installed on the outside of the vehicle or in a recess or cabinet vaportight to the inside of the vehicle but accessible from and vented to the outside, with the vents located near the top and bottom of the enclosure, and 3 ft (1 m) horizontally away from any opening into the vehicle below the level of the vents.

**3-8.2.3** Containers shall be mounted securely on the vehicle, or within the enclosing recess or cabinet, and shall be located and installed so as to minimize the possibility of damage to containers, their appurtenances, or contents as follows:

(a) Containers shall be installed with road clearance in accordance with 8-2.6.5.

(b) Fuel containers shall be mounted securely to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand, without permanent visible deformation, static loading in any direction equal to four times the weight of the container filled with fuel. Where containers are mounted within a vehicle housing, the securing of the housing to the vehicle shall comply with this provision. Any hoods, domes, or removable portions of the housing or cabinet shall be provided with means to keep them firmly in place in transit. Field welding shall comply with 3-2.4.1(e).

(c) All container valves, appurtenances, and connections shall be adequately protected to prevent damage from accidental contacts with stationary objects, from loose objects, stones, mud, or ice thrown up from the ground or floor, and from damage due to overturn or similar vehicular accident. In the case of permanently mounted ASME containers, this

provision shall be met by the location on the vehicle, with parts of the vehicle furnishing the protection. On cylinders, the protection for cylinder valves and connections shall be attached permanently to the cylinder (see 2-2.4.1 and 2-2.4.2). Such weather protection necessary to ensure safe operation shall be provided for cylinders and systems mounted on the outside of vehicles.

(d) Containers mounted on the interior of passenger-carrying vehicles shall be installed in compliance with 8-2.7. Pressure relief valve installations for such containers shall comply with 8-2.6.9.

**3-8.2.4** Cylinders installed on portable tar kettles alongside the kettle, on the vehicle frame, or on road surface heating equipment shall be protected from radiant or convected heat from open flame or other burners by the use of a heat shield or by the location of the cylinder(s) on the vehicle to prevent the temperature of the fuel in the cylinder from becoming abnormally high. In addition, the following shall apply:

- (a) Cylinder location, mounting, and protection shall comply with 3-8.2.3(a), (b), and (c) except that the protection for cylinder valves shall not be required to be attached to the cylinder permanently; however, the protection shall comply with 2-2.4.1(a) and (b).
- (b) Piping shall comply with 3-8.2.7(a), (b), (d), (e), (g), (h), and (i).
- (c) Flexible connections shall comply with 2-4.6.1, 2-4.6.2, and 2-4.6.3.
- (d) Container valves shall be closed when burner is not in use.
- (e) Containers shall not be refilled while burners are in use as provided in 4-2.3.2(b).

**3-8.2.5** Container appurtenances shall be installed in accordance with the following.

(a) ASME container pressure relief devices shall be located and installed as follows:

1. On ASME containers mounted in the interior of vehicles complying with 8-2.7, the pressure relief valve installation shall comply with 8-2.6.9.
2. Pressure relief valve installations on ASME containers installed on the outside of vehicles shall comply with 8-2.6.9 and 3-8.2.2.

(b) Connections and appurtenances on containers shall be in compliance with 2-3.3.1 through 2-3.3.3 and Table 2-3.3.2(a).

(c) Main shutoff valves on containers for liquid and vapor shall be readily accessible.

(d) Containers to be filled volumetrically shall be equipped with fixed maximum liquid level gauging devices as provided in 2-3.4. Cylinders shall be permitted to be designed, constructed, and fitted for filling in either the vertical or horizontal position or, if of the universal type [see 2-3.4.2(c)2], in either position. The cylinder shall be in the appropriate position when filled or, if of the universal type, shall be permitted to be loaded in either position, provided the following:

1. The fixed maximum liquid level gauge indicates correctly the maximum permitted filling level in either position.
2. The pressure relief devices are located in or connected to the vapor space in either position.

(e) All container inlets and outlets, except pressure relief devices and gauging devices, shall be labeled to designate whether they communicate with the vapor or liquid space. Labels shall be permitted to be affixed to valves.

(f) Containers from which only vapor is to be withdrawn shall be installed and equipped with connections to minimize the possibility of the accidental withdrawal of liquid.

**3-8.2.6** Regulators shall comply with 2-5.1.3(d) and (e) and 2-5.7 and shall be installed in accordance with 3-2.7. If the regulators are installed in an enclosed space, the discharge from the required pressure relief device shall be vented to the outside air in accordance with 3-8.2.2.

(a) A two-stage regulator system or an integral two-stage regulator is required for vapor withdrawal systems in accordance with 3-2.7.1 and protected from the elements in accordance with 3-2.7.4. The regulator shall be installed with the pressure relief vent opening pointing vertically downward to allow for drainage of moisture collected on the diaphragm of the regulator. Regulators not installed in compartments shall be equipped with a durable cover designed to protect the regulator vent opening from sleet, snow, freezing rain, ice, mud, and wheel spray.

(b) If a vehicle-mounted regulator(s) is installed at or below the floor level, it shall be installed in a compartment that provides protection against the weather and wheel spray. The compartment shall be of sufficient size to allow tool operation for connection to and replacement of the regulator(s), shall be vaportight to the interior of the vehicle, shall have a 1-in.<sup>2</sup> (650-mm<sup>2</sup>) minimum vent opening to the exterior located within 1 in. (25 mm) of the bottom of the compartment, and shall not contain flame- or spark-producing equipment. A regulator vent outlet shall be at least 2 in. (51 mm) above the compartment vent opening.

**3-8.2.7** Piping shall comply with Section 2-4, and the following requirements with respect to material and design and shall be installed in accordance with 3-2.10. The following shall also apply to piping systems on vehicles covered by Section 3-8.

*Exception: Steel tubing shall have a minimum wall thickness of 0.049 in. (1.2 mm).*

- (a) A flexible connector or a tubing loop shall be installed between the regulator outlet and the piping system to protect against expansion, contraction, jarring, and vibration strains.
- (b) In the case of cylinders, flexibility shall be provided in the piping between the cylinder and the gas piping system or regulator.

(c) Flexible connectors shall comply with 2-4.6 and shall be installed in accordance with 3-2.10.10(a). Flexible connectors of more than 36 in. (91 cm) overall length, or fuel lines that essentially are made completely of hose, shall be used only with the approval of the authority having jurisdiction.

(d) The piping system shall be designed, installed, supported, and secured in such a manner as to minimize the possibility of damage due to vibration, strains, or wear, and to preclude any loosening while in transit.

(e) Piping, including hose, shall be installed in a protected location. If outside, piping shall be under the vehicle and below any insulation or false bottom. Fastening or other protection shall be installed to prevent damage due to vibration or abrasion. At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chafing.

(f) Gas piping shall be installed to enter the vehicle through the floor directly beneath or adjacent to the appliance served. If a branch line is required, the tee connection shall be located in the main gas line under the floor and outside the vehicle.

(g) Exposed parts of the piping system shall be either of corrosion-resistant material or adequately protected against exterior corrosion.

(h) Hydrostatic relief valves complying with 2-4.7 shall be installed in isolated sections of liquid piping as provided in 3-2.11.

(i) Piping systems, including hose, shall be tested and proven free of leaks in accordance with 3-2.12.

(j) There shall be no fuel connection between a tractor and trailer or other vehicle units.

**3-8.3 Equipment Installation.** Equipment for installation on vehicles shall comply with Section 2-5 with respect to design and construction and shall be installed in accordance with 3-2.15 and the following:

- (a) Installation shall be made in accordance with the manufacturer's recommendations and, in the case of listed or approved equipment, as provided in the listing or approval.
- (b) Equipment installed on vehicles shall be considered as part of the LP-Gas system on the vehicle and shall be protected against vehicular damage as provided for container appurtenances and connections in 3-8.2.3(c).

### **3-8.4 Appliance Installation.**

**3-8.4.1** The term *appliances* as used in this subsection shall include any commercial or industrial gas-consuming device except engines.

**3-8.4.2** All gas-consuming devices (appliances) other than engines installed on vehicles shall be approved as provided in 2-6.1, shall comply with 2-6.2, and shall be installed as follows.

(a) Wherever the device or appliance is of a type designed to be in operation while the vehicle is in transit, such as a cargo heater or cooler, suitable means to stop the flow of gas in the event of a line break, such as an excess-flow valve, shall be installed. Excess-flow valves shall comply with 2-3.3.3(b).

(b) All gas-fired heating appliances shall be equipped with safety shutoffs in accordance with 2-6.2.5(a) except those covered in 3-4.2.8(b).

(c) For installations on vehicles intended for human occupancy, all gas-fired heating appliances, except ranges and illuminating appliances, shall be designed or installed to provide for a complete separation of the combustion system from the atmosphere inside the vehicle. Combustion air inlets and flue gas outlets shall be listed as components of the appliance.

(d) For installations on vehicles not intended for human occupancy, unvented-type gas-fired heating appliances shall be permitted to be used to protect the cargo. Provision shall be made to provide air for combustion [see 3-8.4.2(f)] and to dispose of the products of combustion to the outside.

(e) Appliances installed within vehicles shall comply with the following:

1. If in the cargo space, they shall be readily accessible whether the vehicle is loaded or empty.
2. Appliances shall be constructed or otherwise protected to minimize possible damage or impaired operation due to cargo shifting or handling.
3. Appliances shall be located so that a fire at any appliance will not block egress of persons from the vehicle.

(f) Provision shall be made in all appliance installations for a supply of outside air for complete combustion.

(g) A permanent caution plate shall be provided, affixed to either the appliance or the vehicle outside of any enclosure and adjacent to the container(s), and shall include the following items:

#### CAUTION

1. Be sure all appliance valves are closed before opening container valve.
2. Connections at the appliances, regulators, and containers shall be checked periodically for leaks with soapy water or its equivalent.
3. Never use a match or flame to check for leaks.
4. Container valves shall be closed when equipment is not in use.

#### 3-8.5 General Precautions.

**3-8.5.1** Containers on vehicles shall be filled or refilled as provided by 4-2.2. Requalification requirements for continued use and reinstallation of containers shall be in accordance with 2-2.1.5.

**3-8.5.2** Mobile units containing hotplates and other cooking equipment, including mobile kitchens and catering vehicles, shall be provided with at least one approved portable fire extinguisher rated in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*, at not less than 10-B:C.

**3-8.6 Parking, Servicing, and Repair.** Vehicles with LP-Gas fuel systems mounted on them for purposes other than propulsion shall be permitted to be parked, serviced, or repaired inside buildings, in accordance with the following:

- (a) The fuel system shall be leak-free, and the container(s) shall not be filled beyond the limits specified in Chapter 4.
- (b) The container shutoff valve shall be closed except when fuel is required for test or repair.
- (c) The vehicle shall not be parked near sources of heat, open flames, or similar sources of ignition, or near unventilated pits.

- (d) Vehicles having containers with water capacities larger than 300 gal (1.1 m<sup>3</sup>) shall comply with the requirements of Section 6-6.

#### 3-9 Vehicle Fuel Dispenser and Dispensing Stations.

**3-9.1 Application.** This section includes location, installation, and operating provisions for vehicle fuel dispensers and dispensing stations. The general provisions of Section 3-2 shall apply unless specifically modified in this section.

##### 3-9.2 Location.

**3-9.2.1** Location shall be in accordance with Table 3-2.3.3.

**3-9.2.2** Vehicle fuel dispensers and dispensing stations shall be located away from pits in accordance with Table 3-2.3.3 with no drains or blow-offs from the unit directed toward or within 15 ft (4.6 m) of a sewer systems opening.

##### 3-9.3 General Installation Provisions.

**3-9.3.1** Vehicle fuel dispensers and dispensing stations shall be installed as recommended by the manufacturer.

**3-9.3.2** Installation shall not be within a building but shall be permitted to be under weather shelter or canopy, provided this area is adequately ventilated and is not enclosed for more than 50 percent of its perimeter.

**3-9.3.3** Control for the pump used to transfer LP-Gas through the unit into containers shall be provided at the device in order to minimize the possibility of leakage or accidental discharge.

**3-9.3.4** An excess-flow check valve complying with 2-3.3.3(b) or an emergency shutoff valve complying with 2-4.5.4 shall be installed in or on the dispenser at the point at which the dispenser hose is connected to the liquid piping. A differential back pressure valve shall be considered as meeting this provision.

**3-9.3.5** Piping and the dispensing hose shall be provided with hydrostatic relief valves as specified in 3-2.11.

**3-9.3.6** Protection against trespassing and tampering shall be in accordance with 3-3.6.

**3-9.3.7** A manual shutoff valve and an excess-flow check valve of suitable capacity shall be located in the liquid line between the pump and dispenser inlet where the dispensing device is installed at a remote location and is not part of a complete storage and dispensing unit mounted on a common base.

**3-9.3.8** All dispensers shall either be installed on a concrete foundation or be part of a complete storage and dispensing unit mounted on a common base and installed in accordance with 3-2.4.2(a)4 and 2-2.5.2(a) and (b). Protection shall be provided against physical damage.

**3-9.3.9** A listed quick-acting shutoff valve shall be installed at the discharge end of the transfer hose.

**3-9.3.10** A clearly identified and an easily accessible switch(es) or circuit breaker(s) shall be provided at a location not less than 20 ft (6.1 m) nor more than 100 ft (30.5 m) from the dispensing device(s) to shut off the power in the event of a fire, accident, or other emergency. The marking for the switch(es) or breaker(s) shall be visible at the point of liquid transfer.

##### 3-9.4 Installation of Vehicle Fuel Dispensers.

**3-9.4.1** Hose length shall not exceed 18 ft (5.5 m). All hose shall be listed. When not in use, hose shall be secured to protect it from damage.



*Exception:* Hoses longer than 18 ft (5.5 m) shall be permitted where approved by the authority having jurisdiction.

**3-9.4.2** A listed emergency breakaway device complying with UL 567, *Standard Pipe Connectors for Flammable and Combustible Liquids and LP-Gas*, and designed to retain liquid on both sides of the breakaway point, or other devices affording equivalent protection approved by the authority having jurisdiction, shall be installed.

**3-9.4.3** Dispensing devices for liquefied petroleum gas shall be located at least 10 ft (3.0 m) for conventional systems and at least 3 ft (1 m) for low emission transfer systems in accordance with Section 3-11 from any dispensing device for Class I liquids.

### 3-10 Fire Protection.

**3-10.1 Application.** This section contains provisions for fire protection to augment the leak control and ignition source control provisions in this code.

#### 3-10.2 General.

**3-10.2.1** The wide range in size, arrangement, and location of LP-Gas installations covered by this code precludes the inclusion of detailed fire protection provisions completely applicable to all installations. Provisions in this section are subject to verification or modification through analysis of local conditions.

**3-10.2.2\*** The planning for effective measures for control of inadvertent LP-Gas release or fire shall be coordinated with local emergency handling agencies such as fire and police departments. Such measures require specialized knowledge and training not commonly present in the training programs of emergency handling agencies. Planning shall consider the safety of emergency personnel.

**3-10.2.3\*** Fire protection shall be provided for installations having storage containers with an aggregate water capacity of more than 4000 gal (15.1 m<sup>3</sup>) subject to exposure from a single fire. The mode of such protection shall be determined through a competent fire safety analysis.

The first consideration in any such analysis shall be an evaluation of the total product control system including emergency shutoff and internal valves having remote and thermal shutoff capability and pullaway protection, and the optional requirements of Section 3-11, if used.

*Exception No. 1:* If the analysis specified in 3-10.2.3 indicates a serious hazard does not exist, the fire protection provisions of 3-10.2.3 shall not apply.

*Exception No. 2:* If the analysis specified in 3-10.2.3 indicates that a serious hazard exists and the provisions of 3-10.2.3 cannot be met, special protection (see definition) shall be provided in accordance with 3-10.3.

**3-10.2.4** Suitable roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

**3-10.2.5** Each industrial plant, bulk plant, and distributing point shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (8.2 kg) of dry chemical with a B:C rating. (Also see NFPA 10, *Standard for Portable Fire Extinguishers*.)

**3-10.2.6** LP-Gas fires shall not normally be extinguished until the source of the burning gas has been shut off or can be shut off.

**3-10.2.7** Emergency controls shall be conspicuously marked, and the controls shall be located so as to be readily accessible in emergencies.

#### 3-10.3 Special Protection.

**3-10.3.1\*** If insulation is used, it shall be capable of limiting the container temperature to not over 800°F (427°C) for a minimum of 50 minutes as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate. The insulation system shall be inherently resistant to weathering and the action of hose streams. (See Appendix H.)

**3-10.3.2** If mounding is utilized, the provisions of 3-2.4.7 shall be required.

**3-10.3.3** If burial is utilized, the provisions of 3-2.4.8 shall be required.

**3-10.3.4** If water spray fixed systems are used, they shall comply with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*. Such systems shall be automatically actuated by fire responsive devices and shall also have a capability for manual actuation.

**3-10.3.5** If monitor nozzles are used, they shall be located and arranged so that all container surfaces likely to be exposed to fire will be wetted. Such systems shall otherwise comply with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and shall be automatically actuated by fire responsive devices and shall also have a capability for manual actuation.

### 3-11 Alternate Provisions for Installation of ASME Containers.

**3-11.1 Application.** This section provides alternate provisions for the location and installation of ASME containers that incorporate the use of redundant fail-safe product control measures and low emission transfer concepts for the purpose of enhancing safety and to mitigate distance and special protection requirements.

**3-11.2 Spacing Requirements.** Minimum distances for underground and mounded ASME containers of 2001 through 30,000 gal (7.6 m<sup>3</sup>) water capacity incorporating all the provisions of this section shall be permitted to be reduced to 10 ft (3.0 m). Distances for all underground and mounded ASME containers shall be measured from the relief valve and the filling connection. No part of an underground ASME container shall be less than 10 ft (3.0 m) from a building or line of adjoining property that is permitted to be built upon, and no part of a mounded ASME container that is installed above grade shall be less than 5 ft (1.5 m) from a building or line of adjoining property that is permitted to be built upon.

**3-11.3 ASME Container Appurtenances.** The following provisions shall be required for ASME containers of 2001 gal through 30,000 gal (7.6 m<sup>3</sup> through 114 m<sup>3</sup>) water capacity referenced in this section:

(a) All liquid withdrawal openings and all vapor withdrawal openings that are 1<sup>1</sup>/<sub>4</sub> in. (3.2 cm) or larger shall be equipped with an internal valve with an integral excess flow valve or excess flow protection. The internal valves shall remain closed except during periods of operation. As required, the internal valves shall be equipped for remote closure and automatic shutoff through thermal (fire) actuation.

(b) In addition, a positive manual shutoff valve shall be installed as close as practical to each internal valve.

(c) All liquid and vapor inlet openings shall be equipped in accordance with (a) and (b) or shall be equipped with a backflow check valve and a positive manual shutoff valve installed as close as practical to the backflow check valve.

**3-11.4 Facility Piping Requirements.** The following redundant fail-safe product control measures shall be required for systems covered in this section.

(a) At cargo tank and railroad tank car transfer points, protection shall be provided in accordance with 3-2.10.11 using approved emergency shutoff valves or backflow check valves or a combination of the two.

(b) Automatic system shutdown of all primary valves (internal valves and emergency shutoff valves) shall be provided through thermal (fire) actuation and in the event of a hose pull-away.

(c) Remote shutdown capability, including power supply for the transfer equipment and all primary valves (internal and emergency shutoff), shall be provided as follows:

1. A remote shutdown station shall be installed within 15 ft (4.6 m) of the point of transfer.
2. At least one additional remote shutdown station shall be installed not less than 25 ft (7.6 m) nor more than 100 ft (30.5 m) from the transfer point.
3. Emergency remote shutdown stations shall be identified as such by a sign incorporating the words "Propane" and "Emergency Shutoff" in block letters of not less than 2 in. (5.1 cm) in height on a background of contrasting color to the letters. The sign shall be visible from the point of transfer.

### 3-11.5 Low Emission Transfer.

**3-11.5.1** With the application of the following provisions, the transfer distance requirements of Table 3-2.3.3 and 3-9.4.3 shall be permitted to be reduced by one-half.

**3-11.5.2** Transfer into cylinders and ASME containers on vehicles shall meet the following provisions:

(a) The delivery valve and nozzle combination shall mate with the filler valve in the receiving container in such a manner that, when they are uncoupled following a transfer of product, not more than 4 cc (0.24 in.<sup>3</sup>) of product (liquid equivalent) shall be released to the atmosphere.

(b) Fixed maximum liquid level gauges shall not be used to determine the maximum permitted filling limit at a low emission transfer site. The maximum permitted filling limit shall be determined by an overfilling prevention device or other approved means. Where fixed maximum liquid level gauges are installed, a label shall be placed near the gauge providing the following instructions: **"Do not use this fixed maximum liquid level gauge at low emission transfer stations."**

**3-11.5.3** Transfer into stationary ASME containers shall meet the following provisions:

(a) Where transfer is made through a hose of nominal 1-in. (2.5-cm) size or smaller, the delivery valve and nozzle combination shall not contain an interstitial volume greater than 4 cc (0.24 in.<sup>3</sup>).

(b) Where transfer is made through hose larger than 1 in. (2.5 cm) nominal size, no more than 15 cc (0.91 in.<sup>3</sup>) of LP-Gas (liquid equivalent) shall be released to the atmosphere during the transfer operation. This includes uncoupling the transfer hose.

(c) Fixed maximum liquid level gauges on low emission transfer systems shall be installed and used to verify the (function) accuracy of liquid level gauges or other liquid level gauging devices. Fixed maximum liquid level gauges shall not be used in the routine filling of low emission transfer systems. The use of a float gauge or other approved nonventing device for containers of 2001 gal (7.6 m<sup>3</sup>) w.c. or larger shall be permitted to be the sole means for determining the maximum filling limit. The maximum filling limit for containers of less than 2001 gal (7.6 m<sup>3</sup>) w.c. in low emission transfer systems shall be controlled through the use of an overfilling prevention device or other device approved for this service.

## Chapter 4 LP-Gas Liquid Transfer

### 4-1 Scope.

#### 4-1.1 Application.

**4-1.1.1** This chapter covers transfers of liquid LP-Gas from one container to another wherever this transfer involves connections and disconnections in the transfer system, or the venting of LP-Gas to the atmosphere. Included are provisions covering operational safety and methods for determining the quantity of LP-Gas permitted in containers.

**4-1.1.2** Provisions for ignition source control at transfer locations are covered in Section 3-7. Fire protection shall be in accordance with Section 3-10.

### 4-2 Operational Safety.

#### 4-2.1 Transfer Personnel.

**4-2.1.1** Transfer operations shall be conducted by qualified personnel meeting the provisions of Section 1-5. At least one qualified person shall remain in attendance at the transfer operation from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

**4-2.1.2** Transfer personnel shall exercise precaution to ensure that the LP-Gases transferred are those for which the transfer system and the containers to be filled are designed.

#### 4-2.2 Containers to Be Filled or Evacuated.

**4-2.2.1** In the interest of safety, transfer of LP-Gas to and from a container shall be accomplished only by qualified persons trained in proper handling and operating procedures meeting the requirements of Section 1-5 and in emergency response procedures. Such persons shall notify the container owner and user in writing when noncompliance with Sections 2-2 and 2-3 is found.

**4-2.2.2** Injection of compressed air, oxygen, or any oxidizing gas into containers to transfer LP-Gas liquid shall not be permitted.

When evacuating a container owned by others, the qualified person(s) performing the transfer shall not inject any material other than LP-Gas into the container.

**4-2.2.3** Valve outlets on cylinders of 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) propane capacity] or less shall be equipped with an effective seal such as a plug, cap, listed quick-closing coupling, or a listed quick-connect coupling. This seal shall be in place whenever the cylinder is not connected for use.

*Exception: Nonrefillable (disposable) and new unused cylinders shall not be required to comply.*

**4-2.2.4** Containers shall be filled only after determination that they comply with the design, fabrication, inspection, marking, and requalification provisions of this code. (See 2-2.1.3 through 2-2.1.6.)

**4-2.2.5** Cylinders authorized as "single trip," "nonrefillable," or "disposable" cylinders shall not be refilled with LP-Gas.

**4-2.2.6** Containers into which LP-Gas is to be transferred shall comply with the following with regard to service or design pressure in relation to the vapor pressure of the LP-Gas:

(a) For cylinders, the service pressure marked on the cylinder shall be not less than 80 percent of the vapor pressure of the LP-Gas at 130°F (54.4°C). For example, if the vapor pressure of a commercial propane is 300 psi (2.0 MPa) at 130°F (54.4°C), the service pressure must be at least 80 percent of 300, or 240 psi (1.6 MPa).

(b) For ASME containers, the minimum design pressure shall comply with Table 2-2.2.2 in relation to the vapor pressure of the LP-Gas.

### 4-2.3 Arrangement and Operation of Transfer Systems.

**4-2.3.1** Public access to areas where LP-Gas is stored and transferred shall be prohibited except where necessary for the conduct of normal business activities.

**4-2.3.2** Sources of ignition shall be controlled during transfer operations, while connections or disconnections are made, or while LP-Gas is being vented to the atmosphere.

(a) Internal combustion engines within 15 ft (4.6 m) of a point of transfer shall be shut down while such transfer operations are in progress, except as follows:

1. Engines of LP-Gas cargo vehicles constructed and operated in compliance with Chapter 6 while such engines are driving transfer pumps or compressors on these vehicles to load containers as provided in 3-2.3.2
2. Engines installed in buildings as provided in Section 8-3

(b) Smoking, open flame, metal cutting or welding, portable electrical tools, and extension lights capable of igniting LP-Gas shall not be permitted within 25 ft (7.6 m) of a point of transfer while filling operations are in progress. Care shall be taken to ensure that materials that have been heated have cooled before that transfer is started.

(c) Sources of ignition, such as pilot lights, electric ignition devices, burners, electrical appliances, and engines located on the vehicle being refueled shall be turned off during the filling of any LP-Gas container on the vehicle.

**4-2.3.3** Cargo vehicles (see Section 6-3) unloading into storage containers shall be at least 10 ft (3.0 m) from the container and so positioned that the shutoff valves on both the truck and the container are readily accessible. The cargo vehicle shall not transfer LP-Gas into dispensing station storage while parked on a public way.

**4-2.3.4** Transfers to containers serving agricultural or industrial equipment requiring refueling in the field shall comply with the following:

- (a) Air-moving equipment, such as large blowers on crop dryers or on space heaters, shall be shut down while containers are being refilled, unless the point of transfer is at least 50 ft (15 m) from the air intake of the blower.

- (b) Equipment employing open flames, or equipment with integral containers such as flame cultivators, weed burners, tractors, large blower-type space heaters, or tar kettles shall be shut down while refueling.

**4-2.3.5** During the time tank cars are on sidings for loading or unloading, the following shall apply:

(a) A caution sign, with wording such as "STOP. TANK CAR CONNECTED," shall be placed at the active end(s) of the siding while the car is connected as required by DOT regulations.

(b) Wheel chocks shall be placed to prevent movement of the car in either direction.

**4-2.3.6** Where a hose or swivel-type piping is used for loading or unloading railroad tank cars, an emergency shutoff valve complying with 2-4.5.4 shall be used at the tank car end of the hose or swivel-type piping.

**4-2.3.7** Transfer hoses larger than 1/2-in. (12-mm) internal diameter shall not be used for making connections to individual cylinders being filled indoors.

**4-2.3.8** Cargo tanks shall be permitted to be filled directly from railroad tank cars on a private track with nonstationary storage tanks involved, provided the following requirements are met. Such operation shall be considered a bulk plant (see definition).

- (a) Transfer protection shall be provided in accordance with 3-2.10.11.
- (b) Compressors, if used, shall comply with 2-5.3 and 3-2.15.2.
- (c) Installations of liquid transfer facilities shall comply with 3-3.3.
- (d) Protection against tampering for the compressor, fixed piping, and hose shall be provided in accordance with 3-3.6.
- (e) Lighting shall be provided in accordance with 3-3.7, if operations are conducted during other than daylight hours.
- (f) Ignition source control shall be in accordance with Section 3-7.
- (g) Control of ignition sources during transfer shall be provided in accordance with 4-2.3.
- (h) Fire extinguishers shall be provided in accordance with 3-10.2.5.
  - (i) Transfer personnel shall meet the provisions of 4-2.1.
  - (j) Cargo tanks shall meet the requirements of 4-2.2.4.
- (k) Arrangement and operation of the transfer system shall be in accordance with 4-2.3.
- (l) The points of transfer (see definition) shall be located in accordance with Table 3-2.3.3 with respect to exposures.

**4-2.4 Inspection.** Hose assemblies shall be visually inspected for leakage or damage that will impair their integrity. Such hose shall be immediately repaired or removed from service.

### 4-3 Venting LP-Gas to the Atmosphere.

**4-3.1 General.** LP-Gas, in either liquid or vapor form, shall not be vented to the atmosphere.

*Exception No. 1: Venting for the operation of fixed liquid level, rotary, or slip tube gauges, provided the maximum flow does not exceed that from a No. 54 drill orifice.*

*Exception No. 2: Venting of LP-Gas between shutoff valves before disconnecting the liquid transfer line from the container. Where necessary, suitable bleeder valves shall be used.*

*Exception No. 3: LP-Gas shall be permitted to be vented for the purposes described in Exceptions No. 1 and 2 within structures designed for container filling as provided in 3-2.3.1 and Chapter 7.*

*Exception No. 4: Venting vapor from listed liquid transfer pumps using such vapor as a source of energy, provided the rate of discharge does not exceed that from a No. 31 drill size orifice. (See 3-2.3.3 for location of such transfer operations.)*

*Exception No. 5: Purging as permitted in 4-3.2.*

*Exception No. 6: Emergency venting as permitted in 4-3.3.*

**4-3.2 Purging.**

**4-3.2.1** Venting of gas from containers for purging or for other purposes shall be accomplished as follows.

(a) If indoors, cylinders shall be permitted to be vented only in structures designed and constructed for cylinder filling in accordance with 3-2.3.1 and Chapter 7 and with the following provisions:

1. Piping shall be provided to carry the vented product outside and to a point at least 3 ft (1 m) above the highest point of any building within 25 ft (7.6 m).
2. Only vapors shall be exhausted to the atmosphere.
3. If a vent manifold is used to allow for the venting of more than one cylinder at a time, each connection to the vent manifold shall be equipped with a backflow check valve.

(b) Where located outdoors, container venting shall be performed under conditions that will result in rapid dispersion of the product being released. Consideration shall be given to such factors as distance to buildings, terrain, wind direction and velocity, and use of a vent stack so that a flammable mixture will not reach a point of ignition.

(c) If conditions are such that venting into the atmosphere cannot be accomplished safely, LP-Gas shall be permitted to be burned off, providing such burning is done under controlled conditions at a distance of 25 ft (7.6 m) from combustibles or a hazardous atmosphere.

**4-3.3 Emergency Venting.** The procedure to be followed for the disposal of LP-Gas in an emergency will be dictated by the conditions present, requiring individual judgment in each case and using, where practical, the provisions of this code.

**4-4 Quantity of LP-Gas in Containers.**

**4-4.1 Application.** This section includes provisions covering the maximum permissible LP-Gas content of containers and the methods of verifying this quantity.

**4-4.2 LP-Gas Capacity of Containers** (see Appendix F).

**4-4.2.1\*** The maximum LP-Gas content of any container shall be that quantity that equals the maximum permitted filling limit provided in Table 4-4.2.1. (See Appendix F.)

**4-4.2.2** The compliance of the LP-Gas content of a container with Table 4-4.2.1 shall be determined either by weight or by volume in accordance with 4-4.3. If by volume, the volume having a weight equal to the maximum permitted filling limit shall be calculated using the formula in 4-4.2.2(b). These equivalent volumes are shown in Tables 4-4.2.2(a), (b), and (c).

(a) The maximum liquid LP-Gas content of any container depends upon the size of the container, whether it is installed above ground or underground, the maximum permitted filling limit, and the temperature of the liquid. [See Tables 4-4.2.2(a), (b), and (c).]

(b) The maximum volume,  $V_t$  (in percent of container capacity) of an LP-Gas at temperature,  $t$ , having a specific gravity,  $G$ , and a filling limit of  $L$ , shall be computed by using the formula (see F-5.1.2 for example):

$$V_t = \frac{L}{G} \div F$$

or

$$V_t = \frac{L}{G \times F}$$

where:

$V_t$  = maximum liquid volume (percent)

$L$  = filling limit from Table 4-4.2.1

$G$  = specific gravity of particular LP-Gas

$F$  = correction factor to correct volume at temperature,  $t$ , to 60°F (16°C) from Table 4-4.2.2(a)

**Table 4-4.2.1 Maximum Permitted Filling Limit (percent of marked water capacity in pounds)**

Specific Gravity at 60°F (15.6°C)	Aboveground Containers		
	0 to 1200 U.S. gal (0 to 4.5 m <sup>3</sup> ) Total Water Capacities	Over 1200 U.S. gal (0 to 4.5 m <sup>3</sup> ) Total Water Capacities	Underground Containers All Capacities
0.496-0.503	41%	44%	45%
0.504-0.510	42	45	46
0.511-0.519	43	46	47
0.520-0.527	44	47	48
0.528-0.536	45	48	49
0.537-0.544	46	49	50
0.545-0.552	47	50	51
0.553-0.560	48	51	52
0.561-0.568	49	52	53
0.569-0.576	50	53	54
0.577-0.584	51	54	55
0.585-0.592	52	55	56
0.593-0.600	53	56	57

Table 4.4.2.2(a) Maximum Permitted Liquid Volume (percent of total water capacity): Aboveground Containers 0 to 1200 Gal (0 to 4.5 m<sup>3</sup>)

Liquid Temperature °F (°C)	Specific Gravity												
	0.496 to 0.503	0.504 to 0.510	0.511 to 0.519	0.520 to 0.527	0.528 to 0.536	0.537 to 0.544	0.545 to 0.552	0.553 to 0.560	0.561 to 0.568	0.569 to 0.576	0.577 to 0.584	0.585 to 0.592	0.593 to 0.600
-50 (-45.6)	70	71	72	73	74	75	75	76	77	78	79	79	80
-45 (-42.8)	71	72	73	73	74	75	76	77	77	78	79	80	80
-40 (-40)	71	72	73	74	75	75	76	77	78	79	79	80	81
-35 (-37.2)	71	72	73	74	75	76	77	77	78	79	80	80	81
-30 (-34.4)	72	73	74	75	76	76	77	78	78	79	80	81	81
-25 (-31.5)	72	73	74	75	76	77	77	78	79	80	80	81	82
-20 (-28.9)	73	74	75	76	76	77	78	79	79	80	81	81	82
-15 (-26.1)	73	74	75	76	77	77	78	79	80	80	81	82	83
-10 (-23.3)	74	75	76	76	77	78	79	79	80	81	81	82	83
-5 (-20.6)	74	75	76	77	78	78	79	80	80	81	82	82	83
0 (-17.8)	75	76	76	77	78	79	79	80	81	81	82	83	84
5 (-15)	75	76	77	78	78	79	80	81	81	82	83	83	84
10 (-12.2)	76	77	77	78	79	80	80	81	82	82	83	84	84
15 (-9.4)	76	77	78	79	80	80	81	81	82	83	83	84	85
20 (-6.7)	77	78	78	79	80	80	81	82	83	84	84	84	85
25 (-3.9)	77	78	79	80	80	81	82	82	83	84	84	85	85
30 (-1.1)	78	79	79	80	81	81	82	83	83	84	85	85	86
35 (1.7)	78	79	80	81	81	82	83	83	84	85	85	86	86
*40 (4.4)	79	80	81	81	82	82	83	84	84	85	86	86	87
45 (7.8)	80	80	81	82	82	83	84	84	85	85	86	87	87
50 (10)	80	81	82	82	83	83	84	85	85	86	86	87	88
55 (12.8)	81	82	82	83	84	84	85	85	86	86	87	87	88
60 (15.6)	82	82	83	84	84	85	85	86	86	87	87	88	88
65 (18.3)	82	83	84	84	85	85	86	86	87	87	88	88	89
70 (21.1)	83	84	84	85	85	86	86	87	87	88	88	89	89
75 (23.9)	84	85	85	85	86	86	87	87	88	88	89	89	90
80 (26.7)	85	85	86	86	87	87	87	88	88	89	89	90	90
85 (29.4)	85	86	87	87	88	88	88	89	89	89	90	90	91
90 (32.2)	86	87	87	88	88	88	89	89	90	90	90	91	91
95 (35)	87	88	88	88	89	89	89	90	90	91	91	91	92
100 (37.8)	88	89	89	89	89	90	90	90	91	91	92	92	92
105 (40.4)	89	89	90	90	90	90	91	91	91	92	92	92	93
110 (43)	90	90	91	91	91	91	92	92	92	92	93	93	93
115 (46)	91	91	92	92	92	92	92	92	93	93	93	94	94
120 (49)	92	92	93	93	93	93	93	93	93	94	94	94	94
125 (51.5)	93	94	94	94	94	94	94	94	94	94	94	95	95
130 (54)	94	95	95	95	95	95	95	95	95	95	95	95	95

\*See 4.4.3.3(a).

**Table 4-4.2.2(b) Maximum Permitted Liquid Volume (percent of total water capacity): Aboveground Containers Over 1200 Gal (0 to 4.5 m<sup>3</sup>)**

Liquid Temperature °F (°C)	Specific Gravity												
	0.496 to 0.503	0.504 to 0.510	0.511 to 0.519	0.520 to 0.527	0.528 to 0.536	0.537 to 0.544	0.545 to 0.552	0.553 to 0.560	0.561 to 0.568	0.569 to 0.576	0.577 to 0.584	0.585 to 0.592	0.593 to 0.600
-50 (-45.6)	75	76	77	78	79	80	80	81	82	83	83	84	85
-45 (-42.8)	76	77	78	78	79	80	81	81	82	83	84	84	85
-40 (-40)	76	77	78	79	80	80	81	82	83	83	84	85	85
-35 (-37.2)	77	78	78	79	80	81	82	82	83	84	84	85	86
-30 (-34.4)	77	78	79	80	80	81	82	83	83	84	85	85	86
-25 (-31.5)	78	79	79	80	81	82	82	83	84	84	85	86	86
-20 (-28.9)	78	79	80	81	81	82	83	83	84	85	85	86	87
-15 (-26.1)	79	79	80	81	82	82	83	84	85	85	86	87	87
-10 (-23.3)	79	80	81	82	82	83	84	84	85	86	86	87	87
-5 (-20.6)	80	81	81	82	83	83	84	85	85	86	87	87	88
0 (-17.8)	80	81	82	82	83	84	84	85	86	86	87	88	88
5 (-15)	81	82	82	83	84	84	85	86	86	87	87	88	89
10 (-12.2)	81	82	83	83	84	85	85	86	87	87	88	88	89
15 (-9.4)	82	83	83	84	85	85	86	87	87	88	88	89	90
20 (-6.7)	82	83	84	85	85	86	86	87	88	88	89	89	90
25 (-3.9)	83	84	84	85	86	86	87	88	88	89	89	90	90
30 (-1.1)	83	84	85	86	86	87	87	88	89	89	90	90	91
35 (1.7)	84	85	86	86	87	87	88	89	89	90	90	91	91
*40 (4.4)	85	86	86	87	87	88	88	89	90	90	91	91	92
45 (7.8)	85	86	87	87	88	88	89	89	90	91	91	92	92
50 (10)	86	87	87	88	88	89	90	90	91	91	92	92	92
55 (12.8)	87	88	88	89	89	90	90	91	91	92	92	92	93
60 (15.6)	88	88	89	89	90	90	91	91	92	92	93	93	93
65 (18.3)	88	89	90	90	91	91	91	92	92	93	93	93	94
70 (21.1)	89	90	90	91	91	91	92	92	93	93	94	94	94
75 (23.9)	90	91	91	91	92	92	92	93	93	94	94	94	95
80 (26.7)	91	91	92	92	92	93	93	93	94	94	95	95	95
85 (29.4)	92	92	93	93	93	93	94	94	95	95	95	96	96
90 (32.2)	93	93	93	94	94	94	95	95	95	95	96	96	96
95 (35)	94	94	94	95	95	95	95	96	96	96	96	97	97
100 (37.8)	94	95	95	95	95	96	96	96	96	97	97	97	98
105 (40.4)	96	96	96	96	96	97	97	97	97	97	98	98	98
110 (43)	97	97	97	97	97	97	97	98	98	98	98	98	99
115 (46)	98	98	98	98	98	98	98	98	98	99	99	99	99

\*See 4-4.3.3(a).

**4-4.3 Compliance with Maximum Permitted Filling Limit Provisions.**

**4-4.3.1** The maximum permitted filling limit for any container shall be determined by weight or by the volumetric filling method in accordance with 4-4.3.2, 4-4.3.3, and 4-4.3.4.

**4-4.3.2** The volumetric method shall be permitted to be used for the following containers if designed and equipped for filling by volume:

- (a) Cylinders of less than 200 lb (91 kg) water capacity that

are not subject to DOT jurisdiction (such as, but not limited to, engine fuel cylinders on vehicles not in interstate commerce or cylinders filled at the installation)

- (b) Cylinders of 200 lb (91 kg) water capacity or more (*See DOT regulations requiring spot weight checks.*)
- (c) Cargo tanks or portable tank containers complying with DOT specifications MC-330, MC-331, or DOT 51
- (d) ASME and API-ASME containers complying with 2-2.1.3 or 2-2.2.2

Table 4-4.2.2(c) Maximum Permitted Liquid Volume (percent of total water capacity): All Underground Containers

Liquid Temperature °F (°C)	Specific Gravity													
	0.496 to 0.503	0.504 to 0.510	0.511 to 0.519	0.520 to 0.527	0.528 to 0.536	0.537 to 0.544	0.545 to 0.552	0.553 to 0.560	0.561 to 0.568	0.569 to 0.576	0.577 to 0.584	0.585 to 0.592	0.593 to 0.600	
-50 (-45.6)	77	78	79	80	80	81	82	83	83	84	85	85	86	
-45 (-42.8)	77	78	79	80	81	82	82	83	84	84	85	86	87	
-40 (-40)	78	79	80	81	81	82	83	83	84	85	86	86	87	
-35 (-37.2)	78	79	80	81	82	82	83	84	85	85	86	87	87	
-30 (-34.4)	79	80	81	81	82	83	84	84	85	86	86	87	88	
-25 (-31.5)	79	80	81	82	83	83	84	85	85	86	87	87	88	
-20 (-28.9)	80	81	82	82	83	84	84	85	86	86	87	88	88	
-15 (-26.1)	80	81	82	83	84	84	85	86	86	87	87	88	89	
-10 (-23.3)	81	82	83	83	84	85	85	86	87	87	88	88	89	
-5 (-20.6)	81	82	83	84	84	85	86	86	87	88	88	89	89	
0 (-17.8)	82	83	84	84	85	85	86	87	87	88	89	89	90	
5 (-15)	82	83	84	85	85	86	87	87	88	88	89	90	90	
10 (-12.2)	83	84	85	85	86	86	87	88	88	89	90	90	91	
15 (-9.4)	84	84	85	86	86	87	88	88	89	89	90	91	91	
20 (-6.7)	84	85	86	86	87	88	88	89	89	90	90	91	91	
25 (-3.9)	85	86	86	87	87	88	89	89	90	90	91	91	92	
30 (-1.1)	85	86	87	87	88	89	89	90	90	91	91	92	92	
35 (1.7)	86	87	87	88	88	89	90	90	91	91	92	92	93	
40 (4.4)	87	87	88	88	89	90	90	91	91	92	92	93	93	
45 (7.8)	87	88	89	89	90	90	91	91	92	92	93	93	94	
*50 (10)	88	89	89	90	90	91	91	92	92	93	93	94	94	
55 (12.8)	89	89	90	91	91	91	92	92	93	93	94	94	95	
60 (15.6)	90	90	91	91	92	92	92	93	93	94	94	95	95	
65 (18.3)	90	91	91	92	92	93	93	94	94	94	95	95	96	
70 (21.1)	91	91	92	93	93	93	94	94	94	95	95	96	96	
75 (23.9)	92	93	93	93	94	94	94	95	95	95	96	96	97	
80 (26.7)	93	93	94	94	94	95	95	95	96	96	96	97	97	
85 (29.4)	94	94	95	95	95	95	96	96	96	97	97	97	98	
90 (32.2)	95	95	95	95	96	96	96	97	97	97	98	98	98	
95 (35)	96	96	96	96	97	97	97	97	98	98	98	98	99	
100 (37.8)	97	97	97	97	97	98	98	98	98	99	99	99	99	
105 (40.4)	98	98	98	98	98	98	98	99	99	99	99	99	99	

\*See 4-4.3.3(a).

**4-4.3.3** Where used, the volumetric method shall be in accordance with the following:

- (a) If a fixed maximum liquid level gauge or a variable liquid level gauge without liquid volume temperature correction is used, the liquid level indicated by these gauges shall be computed based on the maximum permitted filling limit when the liquid is at 40°F (4°C) for above-ground containers or at 50°F (10°C) for underground containers.
- (b) When a variable liquid level gauge is used and the liquid volume is corrected for temperature, the maximum per-

mitted liquid level shall be in accordance with Tables 4-4.2.2(a), (b), and (c).

- (c) ASME containers with a water capacity of 2000 gal (7.6 m) or less filled by the volumetric method shall be gauged in accordance with 4-4.3.3(a), utilizing the fixed maximum liquid level gauge.

*Exception: Containers fabricated on or before December 31, 1965, shall be exempt from this provision.*

**4-4.3.4** Where containers are to be filled volumetrically by a variable liquid level gauge in accordance with 4-4.3.3(b), provisions shall be made for determining the liquid temperature.

## Chapter 5 Storage of Cylinders Awaiting Use, Resale, or Exchange

### 5-1 Scope.

#### 5-1.1 Application.

**5-1.1.1** The provisions of this chapter are applicable to the storage of cylinders of 1000 lb (454 kg) water capacity, or less, whether filled, partially filled, or empty (if they have been in LP-Gas service) as follows:

- (a) At consumer sites or dispensing stations, where not connected for use
- (b) In storage for resale or exchange by dealer or reseller

**5-1.1.2** The provisions of this chapter shall not apply to cylinders stored at bulk plants.

### 5-2 General Provisions.

#### 5-2.1 General Location of Cylinders.

**5-2.1.1** Cylinders in storage shall be located to minimize exposure to excessive temperature rise, physical damage, or tampering.

**5-2.1.2** Cylinders in storage having individual water capacity greater than 2.5 lb (1.1 kg) [nominal 1 lb (0.45 kg)] LP-Gas capacity shall be positioned such that the pressure relief valve is in direct communication with the vapor space of the cylinder.

**5-2.1.3** Cylinders stored in buildings in accordance with Section 5-3 shall not be located near exits, stairways, or in areas normally used, or intended to be used, for the safe egress of occupants.

**5-2.1.4** If empty cylinders that have been in LP-Gas service are stored indoors, they shall be considered as full cylinders for the purposes of determining the maximum quantities of LP-Gas permitted in 5-3.1, 5-3.2.1, and 5-3.3.1.

**5-2.1.5** Cylinders that are not connected for use shall not be stored on roofs.

#### 5-2.2 Protection of Valves on Cylinders in Storage.

**5-2.2.1** Cylinder valves shall be protected as required by 2-2.4.1. Screw-on-type caps or collars shall be securely in place on all cylinders stored, regardless of whether they are full, partially full, or empty, and cylinder outlet valves shall be closed and plugged or capped. The provisions of 4-2.2.3 for valve outlet plugs and caps shall apply.

### 5-3 Storage within Buildings.

**5-3.1 Storage within Buildings Frequented by the Public.** Cylinders with a maximum water capacity of 2.5 lb (1.1 kg) [nominal 1 lb (0.45 kg)] LP-Gas capacity, used with completely self-contained hand torches and similar applications, shall be permitted to be stored or displayed in a building frequented by the public. The quantity of LP-Gas shall not exceed 200 lb (91 kg).

*Exception No. 1: Storage in restaurants and at food service locations of 10-oz (283-g) butane nonrefillable containers shall be limited to no more than 24 containers.*

*Exception No. 2: An additional twenty-four 10-oz (283-g) butane nonrefillable containers shall be permitted to be stored in another location within the building, provided that the storage area is constructed with at least a 2-hour fire wall protection.*

### 5-3.2 Storage within Buildings Not Frequented by the Public (Such as Industrial Buildings).

**5-3.2.1** The maximum quantity allowed in one storage location shall not exceed 735 lb (334 kg) water capacity [nominal 300 lb (136 kg) LP-Gas]. If additional storage locations are required on the same floor within the same building, they shall be separated by a minimum of 300 ft (91.4 m). Storage beyond these limitations shall comply with 5-3.3.

**5-3.2.2** Cylinders carried as part of the service equipment on highway mobile vehicles shall not be considered part of the total storage capacity in the requirements of 5-3.2.1, provided such vehicles are stored in private garages and carry no more than 3 cylinders with a total aggregate capacity per vehicle not exceeding 100 lb (45.4 kg) of LP-Gas. Cylinder valves shall be closed when not in use.

### 5-3.3 Storage within Special Buildings or Rooms.

**5-3.3.1** The maximum quantity of LP-Gas stored in special buildings or rooms shall be 10,000 lb (4540 kg).

**5-3.3.2** Special buildings or rooms for storing LP-Gas cylinders shall not be located adjoining the line of property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering.

**5-3.3.3** The construction of all such special buildings, and rooms within, or attached to, other buildings, shall comply with Chapter 7 and the following:

- (a) Adequate vents, to the outside only, shall be provided at both top and bottom and shall be located at least 5 ft (1.5 m) from any building opening.
- (b) The entire area shall be classified for purposes of ignition source control in accordance with Section 3-7.

**5-3.4 Storage within Residential Buildings.** Storage of cylinders within a residential building, including the basement or any storage area in a common basement storage area in multiple family buildings and attached garages, shall be limited to two cylinders each with a maximum water capacity of 2.7 lb (1.2 kg) and shall not exceed 5.4 lb (2.4 kg) total water capacity for smaller cylinders per each living space unit. Each cylinder shall meet DOT specifications.

### 5-4 Storage Outside of Buildings.

**5-4.1\* Location of Storage Outside of Buildings.** Storage outside of buildings for cylinders awaiting use, resale, or part of a cylinder exchange point shall be located at least 20 ft (6.1 m) from any doorway or opening in a building frequented by the public; 20 ft (6.1 m) from any automotive service station fuel dispenser; and in accordance with Table 5-4.1 with respect to

- (a) Nearest important building or group of buildings
- (b) Line of adjoining property that may be built upon
- (c) Busy thoroughfares or sidewalks
- (d) Line of adjoining property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering
- (e) Dispensing station

*Exception: Cylinders in the filling process shall not be considered to be in storage.*



Table 5-4.1

Quantity of LP-Gas Stored lb (kg)	Horizontal Distance in ft (m) to		
	(a) and (b)	(c) and (d)	(e)
720 (227) or less	0	0	5 (1.5)
721 to 2500 (227+ to 1134)	0	10 (3)	10 (3)
2501 to 6000 (1134+ to 2721)	10 (3)	10 (3)	10 (3)
6001 to 10,000 (2721+ to 4540)	20 (6.1)	20 (6.1)	20 (6.1)
Over 10,000 (4540)	25 (7.6)	25 (7.6)	25 (7.6)

## 5-4.2 Protection of Cylinders.

**5-4.2.1** Cylinders at a location open to the public shall be protected by either:

- (a) An enclosure in accordance with 3-3.6(a), or
- (b) A lockable ventilated metal locker or rack that prevents tampering with valves and pilferage of the cylinder

**5-4.2.2** Protection against vehicle impact shall be provided in accordance with good engineering practice where vehicle traffic normally is expected at the location.

**5-4.3 Alternate Location and Protection of Storage.** Where the provisions of 5-4.1 and 5-4.2.1 are impractical at construction sites, or at buildings or structures undergoing major renovation or repairs, the storage of cylinders shall be acceptable to the authority having jurisdiction.

**5-5 Fire Protection.** Storage locations, other than supply depots at separate locations apart from those of the dealer, reseller, or user's establishments, shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (8.2 kg) dry chemical with a B:C rating. (Also see NFPA 10, Standard for Portable Fire Extinguishers.)

## Chapter 6 Vehicular Transportation of LP-Gas

### 6-1 Scope.

#### 6-1.1 Application.

**6-1.1.1** This chapter includes provisions that apply to containers, container appurtenances, piping, valves, equipment, and vehicles used in the transportation of LP-Gas, as follows:

- (a) Transportation of cylinders.

*Exception:* The provisions of this chapter shall not apply to cylinders and related equipment incident to their use on vehicles as covered in Section 3-8 and Chapter 8.

- (b) Transportation in cargo vehicles, whether fabricated by mounting cargo tanks on conventional truck or trailer chassis, or constructed as integral cargo units in which the container constitutes in whole, or in part, the stress member of the vehicle frame. Transfer equipment and piping, and the protection of such equipment and the container appurtenances against overturn, collision, or other vehicular accidents, are also included.

- (c) Vehicles and procedures under the jurisdiction of DOT shall comply with DOT regulations.

**NOTE:** Most truck transportation of LP-Gas is subject to regulation by the U.S. Department of Transportation. Many of the provisions of this chapter are identical or similar to DOT regulations and are intended to extend these provisions to areas not subject to DOT regulation.

**6-1.1.2** The provisions of this chapter shall not be applicable to the transportation of LP-Gas on vehicles incident to its use on these vehicles as covered in Sections 3-8, 8-5, and 8-6.

**6-1.1.3** If LP-Gas is used for engine fuel, the supply piping and regulating, vaporizing, gas-air mixing, and carburetion equipment shall be designed, constructed, and installed in accordance with Chapter 8. Fuel systems (including fuel containers) shall be constructed and installed in accordance with Section 3-8. Fuel shall be used from the cargo tank of tank trucks or engine fuel containers installed in accordance with 8-2.6. Fuel shall not be used from cargo tanks on trailers or semitrailers.

**6-1.1.4** No artificial light other than electrical shall be used with the vehicles covered by this chapter. All wiring used shall provide mechanical strength and current-carrying capacity necessary to safely function for its intended use. Wiring shall be insulated and protected from physical damage.

### 6-2 Transportation in Portable Containers.

**6-2.1 Application.** This section applies to the vehicular transportation of portable containers filled with LP-Gas delivered as "packages," including containers built to DOT cylinder specifications and other portable containers (such as DOT portable tank containers and skid tanks). The design and construction of these containers is covered in Chapter 2.

#### 6-2.2 Transportation of Cylinders.

**6-2.2.1** Portable containers having an individual water capacity not exceeding 1000 lb (454 kg) [nominal 420 lb (191 kg) LP-Gas capacity], when filled with LP-Gas, shall be transported in accordance with the requirements of this section.

**6-2.2.2** Cylinders shall be constructed as provided in Section 2-2 and equipped in accordance with Section 2-3 for transportation as cylinders.

**6-2.2.3** The quantity of LP-Gas in containers shall be in accordance with Chapter 4.

**6-2.2.4** Valves of cylinders shall be protected in accordance with 2-2.4.1. Screw-on-type protecting caps or collars shall be secured in place. The provisions of 4-2.2.3 shall apply.

**6-2.2.5** The cargo space of the vehicle shall be isolated from the driver's compartment, the engine, and its exhaust system. Open-bodied vehicles shall be considered to be in compliance with this provision. Closed-bodied vehicles having separate cargo, driver's, and engine compartments shall also be considered to be in compliance with this provision.

*Exception:* Closed-bodied vehicles such as passenger cars, vans, and station wagons shall not be used for transporting more than 215 lb (98 kg) water capacity [nominal 90 lb (41 kg) LP-Gas capacity] but not more than 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) LP-Gas capacity] per cylinder (see 6-2.2.6 and 6-2.2.7), unless the driver's and engine compartments are separated from the cargo space by a vaportight partition that contains no means of access to the cargo space.

**6-2.2.6** Cylinders and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Cylinders shall be loaded into vehicles with substantially flat floors or equipped with suitable racks for holding cylinders. Cylinders shall be securely fastened in position to minimize the possibility of movement, tipping, or physical damage.

**6-2.2.7** Cylinders having an individual water capacity not exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas capac-

ity] transported in open vehicles and cylinders having an individual water capacity not exceeding 10 lb (4.5 kg) [nominal 4.2 lb (2 kg) LP-Gas capacity] transported in enclosed spaces of the vehicle shall be permitted to be transported in other than the upright position. Cylinders having an individual water capacity exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas capacity] transported in open vehicles and cylinders having an individual water capacity exceeding 10 lb (4.5 kg) [nominal 4.2 lb (1.9 kg) LP-Gas capacity] transported in enclosed spaces shall be transported with the relief device in direct communication with the vapor space.

**6-2.2.8** Vehicles transporting more than 1000 lb (454 kg) of LP-Gas, including the weight of the cylinders, shall be placarded as required by DOT regulations or state law.

### **6-2.3 Transportation of Portable Containers of More than 1000 lb (454 kg) Water Capacity.**

**6-2.3.1** Portable containers having an individual water capacity exceeding 1000 lb (454 kg) [nominal 420 lb (191 kg) LP-Gas capacity] when filled with LP-Gas shall be transported in compliance with the requirements of this section.

**6-2.3.2** Containers shall be constructed in accordance with Section 2-2 and equipped in accordance with Section 2-3 for portable use or shall comply with DOT portable tank container specifications for LP-Gas service.

**6-2.3.3** The quantity of LP-Gas put into containers shall be in accordance with Chapter 4.

**6-2.3.4** Valves and other container appurtenances shall be protected in accordance with 2-2.4.2.

**6-2.3.5** Containers and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Containers shall be transported in a suitable rack or frame or on a flat surface. Containers shall be fastened securely in a position to minimize the possibility of movement, tipping, or physical damage, relative to each other or to the supporting structure, while in transit.

**6-2.3.6** Containers shall be transported with relief devices in communication with the vapor space.

**6-2.3.7** Vehicles carrying more than 1000 lb (454 kg) of LP-Gas, including the weight of the containers, shall be placarded as required by DOT regulations or state law.

**6-2.3.8** Where portable containers complying with the requirements of this section are mounted permanently or semipermanently on vehicles to serve as cargo tanks, so that the assembled vehicular unit can be used for making liquid deliveries to other containers at points of use, the provisions of Section 6-3 shall apply.

**6-2.4 Fire Extinguishers.** Each truck or trailer transporting portable containers as provided by 6-2.2 or 6-2.3 shall be equipped with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (8.2 kg) dry chemical with a B:C rating. (Also see NFPA 10, *Standard for Portable Fire Extinguishers*.)

## **6-3 Transportation in Cargo Vehicles.**

### **6-3.1 Application.**

**6-3.1.1** This section includes provisions for cargo vehicles used for the transportation of LP-Gas as liquid cargo, normally loaded into the cargo container at the bulk plant or manufacturing point and transferred into other containers at the point

of delivery. Transfer shall be permitted to be made by a pump or compressor mounted on the vehicle or by a transfer means at the delivery point.

**6-3.1.2** All LP-Gas cargo vehicles, whether used in interstate or intrastate service, shall comply with the applicable portion of the U.S. Department of Transportation Hazardous Materials Regulations (Title 49, *Code of Federal Regulations* Parts 171-179) and Parts 393, 396, and 397 of the DOT *Federal Motor Carrier Safety Regulations* and shall also comply with the added requirements of this code.

### **6-3.2 Containers Mounted on, or a Part of, Cargo Vehicles.**

**6-3.2.1** Containers mounted on, or comprising in whole, or in part, the stress member used in lieu of a frame for cargo vehicles shall comply with DOT cargo tank specifications for LP-Gas service. Such containers shall also comply with Section 2-2 and be equipped with appurtenances as provided in Section 2-3 for cargo service.

Liquid hose of 1 1/2-in. (nominal size) and larger size and vapor hose of 1 1/4-in. (nominal size) and larger size shall be protected with an emergency shutoff valve complying with 2-4.5.4.

*Exception No. 1: If an internal valve meets the functional provisions for an emergency shutoff valve in compliance with 2-4.5.4 and 3-2.10.11(b), an emergency shutoff valve shall not be required in the cargo container piping.*

*Exception No. 2: A backflow check valve shall be permitted to be used in the cargo container piping or container in lieu of an emergency shutoff valve if the flow is only into the cargo container.*

### **6-3.3 Piping (Including Hose), Fittings, and Valves.**

**6-3.3.1** Pipe, tubing, pipe and tubing fittings, valves, hose, and flexible connectors shall comply with Section 2-4, with the provisions of DOT cargo tank specifications for LP-Gas, and shall be suitable for the working pressure specified in 2-5.1.2. In addition, the following shall apply:

(a) Pipe shall be wrought iron, steel, brass, or copper in accordance with 2-4.2.

(b) Tubing shall be steel, brass, or copper in accordance with 2-4.3(a), (b), or (c).

(c) Pipe and tubing fittings shall be steel, brass, copper, malleable iron, or ductile (nodular) iron suitable for use with the pipe or tubing used as specified in 6-3.3.1(a) or (b).

(d) Pipe joints shall be threaded, flanged, welded, or brazed. Fittings, where used, shall comply with 6-3.3.1(c).

1. Where joints are threaded, or threaded and back welded, pipe and nipples shall be Schedule 80 or heavier. Copper or brass pipe and nipples shall be of equivalent strength.

2. Where joints are welded or brazed, the pipe and nipples shall be Schedule 40 or heavier. Fittings or flanges shall be suitable for the service. (See 6-3.3.2.)

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

(e) Tubing joints shall be brazed, using a brazing material having a melting point of at least 1000°F (538°C).

**6-3.3.2** Pipe, tubing, pipe and tubing fittings, valves, hose, and flexible connectors, and complete cargo vehicle piping systems including connections to equipment (see 6-3.4), after assembly, shall comply with 2-5.1.2.

**6-3.3.3** Valves, including shutoff valves, excess-flow valves, backflow check valves, and remotely controlled valves, used in piping shall comply with the applicable provisions of DOT

cargo tank specifications for LP-Gas service, and with 2-4.5, and shall comply with the minimum design pressure requirements of 2-5.1.2.

**6-3.3.4\*** Hose, hose connections, and flexible connectors shall comply with 2-4.6 and 6-3.3.1. Flexible connectors used in the piping system to compensate for stresses and vibration shall be limited to 3 ft (1 m) in overall length. Flexible connectors on existing LP-Gas cargo units replaced after December 1, 1967, shall comply with 2-4.6.

(a) Flexible connectors assembled from rubber hose and couplings shall be permanently marked to indicate the date of installation of the flexible connector, and the flexible portion of the connector shall be replaced with an unused connector within 10 years of the indicated date of installation of the connector and visually inspected annually.

(b) The rubber hose portion of flexible connectors shall be replaced whenever a cargo unit is remounted on a different chassis, or whenever the cargo unit is repiped, if such repiping encompasses that portion of piping in which the connector is located.

*Exception: This shall not be required if the remounting or repiping is performed within 1 year of the date of assembly of the connector.*

**6-3.3.5** All threaded primary valves and fittings used in liquid filling or vapor equalization directly on the cargo container of transportation equipment shall be of steel, malleable, or ductile iron construction. All existing equipment shall be so equipped not later than the scheduled requalification date of the container.

#### **6-3.4 Equipment.**

**6-3.4.1** LP-Gas equipment, such as pumps, compressors, meters, dispensers, regulators, and strainers, shall comply with Section 2-5 for design and construction and shall be installed in accordance with the applicable provisions of 3-2.15. Equipment on vehicles shall be securely mounted in place and connected to the piping system in accordance with the manufacturer's instructions, taking into account the greater (compared with stationary service) jarring and vibration problems incident to vehicular use.

**6-3.4.2** Container openings whose only function is for pump bypass return shall be provided with one of the following:

- (a) A positive shutoff valve capable of being secured in the open position located as close to the tank as practical in combination with a steel backflow check valve installed in the tank
- (b) An internal valve with excess flow protection
- (c) A valve specifically recommended and listed by the manufacturer for this type of service and that meets the requirements of 3-2.15.1(b)

**6-3.4.3** Pumps or compressors used for LP-Gas transfer shall be permitted to be mounted on tank trucks, trailers, semitrailers, or tractors. If an electric drive is used, obtaining energy from the electrical installation at the delivery point, the installation on the vehicle (and at the delivery point) shall comply with 3-7.2.

**6-3.4.4** The installation of compressors shall comply with the applicable provisions of 3-2.15.2 and 6-3.4.1.

**6-3.4.5** The installation of liquid meters shall be in accordance with 3-2.15.4(a). If venting of LP-Gas to the air is necessary, provision shall be made to vent it at a safe location.

**6-3.4.6** Where wet hose is carried while connected to the truck's liquid pump discharge piping, an automatic device, such as a differential regulator, shall be installed between the pump discharge and the hose connection to prevent liquid discharge while the pump is not operating. Where a meter or dispenser is used, this device shall be installed between the meter outlet and the hose connection. If an excess-flow valve is used, it shall not be the exclusive means of complying with this provision.

**6-3.5 Protection of Container Appurtenances, Piping System, and Equipment.** Container appurtenances, piping, and equipment comprising the complete LP-Gas system on the cargo vehicle shall be securely mounted in position (*see 6-3.2.1 for container mounting*), shall be protected against damage to the extent it is practical, and shall be in accordance with DOT regulations.

**6-3.6 Painting and Marking Liquid Cargo Vehicles.** Painting of cargo vehicles shall comply with *Code of Federal Regulations*, Title 49, Part 195. Placarding and marking shall comply with CFR 49.

**6-3.7 Fire Extinguishers.** Each tank truck or tractor shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 18 lb (8.2 kg) dry chemical with a B:C rating. (*Also see NFPA 10, Standard for Portable Fire Extinguishers.*)

**6-3.8 Chock Blocks for Liquid Cargo Vehicles.** Each tank truck and trailer shall carry chock blocks, which shall be used to prevent rolling of the vehicle whenever it is being loaded or unloaded or is parked.

**6-3.9 Exhaust Systems.** The truck engine exhaust system shall comply with *Federal Motor Carrier Safety Regulations*.

**6-3.10 Smoking Prohibition.** No person shall smoke or carry lighted smoking material on or within 25 ft (7.6 m) of a vehicle required to be placarded in accordance with DOT regulations containing LP-Gas liquid or vapor. This requirement shall also apply at points of liquid transfer and while delivering or connecting to containers.

#### **6-4 Trailers, Semitrailers, and Movable Fuel Storage Tenders, Including Farm Carts.**

**6-4.1 Application.** This section applies to all tank vehicles, other than trucks, that are parked at locations away from bulk plants.

**6-4.2 Trailers or Semitrailers Comprising Parts of Vehicles in Accordance with Section 6-3.** When parked, tank trailers or semitrailers covered by Section 6-3 shall be positioned so that the pressure relief valves shall communicate with the vapor space of the container.

#### **6-4.3 Fuel Storage Tenders Including Farm Carts.**

**6-4.3.1** Movable fuel storage tenders including farm carts (*see definition*) shall comply with this section. Where used over public ways, they shall comply with applicable state regulations.

**6-4.3.2** Such tenders shall be constructed in accordance with Section 2-2 and equipped with appurtenances as provided in Section 2-3.

**6-4.3.3** Threaded piping shall be not less than Schedule 80, and fittings shall be designed for not less than 250 psi (1.7 MPa).

**6-4.3.4** Piping, hoses, and equipment, including valves, fittings, pressure relief valves, and container accessories, shall be adequately protected against collision or upset.

**6-4.3.5** Tenders shall be so positioned that container safety relief valves communicate with the vapor space.

**6-4.3.6** Such tenders shall not be filled on a public way.

**6-4.3.7** Such tenders shall contain no more than 5 percent of their water capacity in liquid form during transportation to or from the bulk plant.

**6-4.3.8** The shortest practical route, consistent with safety, shall be used when transporting such tenders between points of utilization.

## **6-5 Transportation of Stationary Containers to and from Point of Installation.**

**6-5.1 Application.** This section applies to the transportation of containers designed for stationary service at the point of use and secured to the vehicle only for transportation. Such containers shall be transported in accordance with 6-5.2.1.

### **6-5.2 Transportation of Containers.**

**6-5.2.1** ASME containers of 125 gal (0.5 m<sup>3</sup>) or more water capacity shall contain no more than 5 percent of their water capacity in liquid form during transportation.

*Exception:* Containers shall be permitted to be transported with more LP-Gas than 5 percent of their water capacity in a liquid form, but less than the maximum permitted by Section 4-4, provided that all the following conditions apply:

- (a) Such transportation shall be permitted only to move containers from a stationary or temporary installation to a bulk plant.
- (b) The owner of the container or the owner's designated representative shall have authorized its transportation.
- (c) Valves and fittings shall be protected by a method approved by the authority having jurisdiction to minimize the possibility of damage.
- (d) Lifting lugs shall not bear more than the empty weight of the container plus 5 percent liquid volume. Additional means for lifting, securing, and supporting the container shall be provided.

**6-5.2.2** Containers shall be safely secured to minimize movement relative to each other or to the carrying vehicle while in transit, giving consideration to the sudden stops, starts, and changes of direction normal to vehicular operation.

**6-5.2.3** Valves, regulators, and other container appurtenances shall be adequately protected against physical damage during transportation.

**6-5.2.4** Pressure relief valves shall be in direct communication with the vapor space of the container.

## **6-6 Parking and Garaging Vehicles Used to Carry LP-Gas Cargo.**

**6-6.1 Application.** This section applies to the parking (except parking associated with a liquid transfer operation) and garaging of vehicles used for the transportation of LP-Gas. Such vehicles include those used to carry portable containers (see Section 6-2) and those used to carry LP-Gas in cargo tanks (see Section 6-3).

### **6-6.2 Parking.**

**6-6.2.1** Vehicles carrying or containing LP-Gas parked outdoors shall comply with the following:

(a) Vehicles shall not be left unattended on any street, highway, avenue, or alley, provided that drivers are not prevented from those necessary absences from the vehicle connected with their normal duties, nor shall this requirement prevent stops for meals or rest stops during the day or night.

*Exception No. 1:* This shall not apply in an emergency.

*Exception No. 2:* This shall not apply to vehicles parked in accordance with 6-6.2.1(b).

(b) Vehicles shall not be parked in congested areas. Such vehicles shall be permitted to be parked off the street in uncongested areas if at least 50 ft (15 m) from any building used for assembly, institutional, or multiple residential occupancy. This requirement shall not prohibit the parking of vehicles carrying portable containers or cargo vehicles of 3500 gal (13 m<sup>3</sup>) water capacity or less on streets adjacent to the driver's residence in uncongested residential areas, provided such parking locations are at least 50 ft (15 m) from a building used for assembly, institutional, or multiple residential occupancy.

**6-6.2.2** Vehicles parked indoors shall comply with the following:

- (a) Cargo vehicles parked in any public garage or building shall have LP-Gas liquid removed from the cargo container, piping, pump, meter, hoses, and related equipment, and the pressure in the delivery hose and related equipment shall be reduced to approximately atmospheric, and all valves shall be closed before the vehicle is moved indoors. Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved indoors.
- (b) Vehicles used to carry portable containers shall not be moved into any public garage or building for parking until all portable containers have been removed from the vehicle.
- (c) Vehicles carrying or containing LP-Gas shall be permitted to be parked in buildings complying with Chapter 7 and located on premises owned or under the control of the operator of such vehicles, provided the following occurs:
  1. The public is excluded from such buildings.
  2. There is floor level ventilation in all parts of the building where such vehicles are parked.
  3. Leaks in the vehicle LP-Gas systems are repaired before the vehicle is moved indoors.
  4. Primary shutoff valves on cargo tanks and other LP-Gas containers on the vehicle (except propulsion engine fuel containers) are closed and delivery hose outlets are plugged or capped to contain system pressure before the vehicle is moved indoors. Primary shutoff valves on LP-Gas propulsion engine fuel containers shall be closed while the vehicle is parked.
  5. No LP-Gas container is located near a source of heat or within the direct path of hot air being blown from a blower-type heater.
  6. LP-Gas containers are gauged or weighed to determine that they are not filled beyond the maximum filling limit according to Section 4-4.

**6-6.2.3** Vehicles shall be permitted to be serviced or repaired indoors as follows.

(a) When it is necessary to move a vehicle into any building located on premises owned or operated by the operator of such vehicle for service on engine or chassis, the provisions of 6-6.2.2(a) or (c) shall apply.

(b) When it is necessary to move a vehicle carrying or containing LP-Gas into any public garage or repair facility for service on the engine or chassis, the provisions of 6-6.2.2(a) or (b) shall apply, unless the driver or a qualified representative of an LP-Gas operator is in attendance at all times while the vehicle is indoors. In this case, the following provisions shall apply under the supervision of such qualified persons:

1. Leaks in the vehicle LP-Gas systems shall be repaired before the vehicle is moved indoors.
2. Primary shutoff valves on cargo tanks, portable containers, and other LP-Gas containers installed on the vehicle (except propulsion engine fuel containers) shall be closed. LP-Gas liquid shall be removed from the piping, pump, meter, delivery hose, and related equipment and the pressure therein reduced to approximately atmospheric before the vehicle is moved inside. Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved indoors.
3. No container shall be located near a source of heat or within the direct path of hot air blown from a blower or from a blower-type heater.
4. LP-Gas containers shall be gauged or weighed to determine that they are not filled beyond the maximum filling capacity according to Section 4-4.

(c) If repair work or servicing is to be performed on a cargo tank system, all LP-Gas shall be removed from the cargo tank and piping, and the system shall be thoroughly purged before the vehicle is moved indoors.

## Chapter 7 Buildings or Structures Housing LP-Gas Distribution Facilities

### 7-1 Scope.

#### 7-1.1 Application.

**7-1.1.1** This chapter covers the construction, ventilation, and heating of structures housing certain types of LP-Gas systems as referenced in this code. Such structures can be separate buildings used exclusively for this purpose (or for other purposes having similar hazards), or they can be rooms attached to, or located within, buildings used for other purposes.

**7-1.1.2** The provisions of this chapter apply only to buildings constructed or converted after December 31, 1972.

*Exception: Buildings previously constructed under the provisions of 5-3.3. (Also see 1-1.5.)*

### 7-2 Separate Structures or Buildings.

#### 7-2.1 Construction of Structures or Buildings.

**7-2.1.1** Separate buildings or structures shall be one story in height and shall have walls, floors, ceilings, and roofs constructed of noncombustible materials. Exterior walls, ceilings, and roofs shall be constructed as follows:

- (a) Of lightweight material designed for explosion venting, or
- (b) If of heavy construction, such as solid brick masonry, concrete block, or reinforced concrete construction, explosion venting windows or panels in walls or roofs shall be provided having an explosion venting area of at least 1 ft<sup>2</sup> (0.1 m<sup>2</sup>) for each 50 ft<sup>3</sup> (1.4 m<sup>3</sup>) of the enclosed volume.

**7-2.1.2** The floor of such structures shall not be below ground level. Any space beneath the floor shall be of solid fill or the perimeter of the space shall be left entirely unenclosed.

**7-2.2 Structure or Building Ventilation.** The structure shall be ventilated using air inlets and outlets, the bottom of which shall be not more than 6 in. (150 mm) above the floor, and shall be arranged to provide air movement across the floor as uniformly as practical and in accordance with the following:

(a) Where mechanical ventilation is used, air circulation shall be at least 1 ft<sup>3</sup>/min·ft<sup>2</sup> (0.3 m<sup>3</sup>/min·m<sup>2</sup>) of floor area. Outlets shall discharge at least 5 ft (1.5 m) from any opening into the structure or any other structure.

(b) Where natural ventilation is used, each exterior wall [up to 20 ft (6.1 m) in length] shall be provided with at least one opening, with an additional opening for each 20 ft (6.1 m) of length or fraction thereof. Each opening shall have a minimum size of 50 in.<sup>2</sup> (32 250 mm<sup>2</sup>), and the total of all openings shall be at least 1 in.<sup>2</sup>/ft<sup>2</sup> (720 mm<sup>2</sup>/m<sup>2</sup>) of floor area.

**7-2.3 Structure or Building Heating.** Heating shall be by steam or hot water radiation or other heating transfer medium with the heat source located outside of the building or structure (*see Section 3-7*), or by electrical appliances listed for Class I, Group D, Division 2 locations, in accordance with NFPA 70, *National Electrical Code* (*see Table 3-7.2.2*).

### 7-3 Attached Structures or Rooms within Structures.

**7-3.1 Construction of Attached Structures.** Attached structures shall comply with 7-2.1 [attachment shall be limited to 50 percent of the perimeter of the space enclosed; otherwise such space shall be considered as a room within a structure (*see 7-3.2*)], and shall comply with the following:

(a) Common walls at points at which structures are to be attached shall have the following:

1. As erected, a fire resistance rating of at least 1 hour

*NOTE:* For information on fire resistance of building materials, see NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*.

2. No openings. Common walls for attached structures used only for storage of LP-Gas shall be permitted to have doorways that shall be equipped with 1½-hour (B) fire doors.

*NOTE:* For information of fire doors, see NFPA 80, *Standard for Fire Doors and Fire Windows*.

3. Be designed to withstand a static pressure of at least 100 lb (0.7 MPa) per ft<sup>2</sup> (0.1 m<sup>2</sup>)

(b) The provisions of 7-3.1(a) shall be permitted to be waived if the building to which the structure is attached is occupied by operations or processes having a similar hazard.

(c) Ventilation and heating shall comply with 7-2.2 and 7-2.3.

**7-3.2 Construction of Rooms within Structures.** Rooms within structures shall be located in the first story and shall have at least one exterior wall with unobstructed free vents for freely relieving explosion pressures.

*NOTE:* For information on explosion venting, see NFPA 68, *Guide for Venting of Deflagrations*.

(a) Walls, floors, ceilings, or roofs of such rooms shall be constructed of noncombustible materials. Exterior walls and

ceilings either shall be of lightweight material designed for explosion venting or, if of heavy construction (such as solid brick masonry, concrete block, or reinforced concrete construction), shall be provided with explosion venting windows or panels in the walls or roofs having an explosion venting area of at least 1 ft<sup>2</sup> (0.1 m<sup>2</sup>) for each 50 ft<sup>3</sup> (1.4 m<sup>3</sup>) of the enclosed volume.

(b) Walls and ceilings common to the room and to the building within which it is located shall have the following:

1. As erected, a fire resistance rating of at least 1 hour

NOTE: For information on fire resistance rating of building materials, see NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*.

2. No openings. Common walls for rooms used only for storage of LP-Gas shall be permitted to have doorways that shall be equipped with 1 1/2-hour (B) fire doors.

NOTE: See NFPA 80, *Standard for Fire Doors and Fire Windows*.

3. Be designed to withstand a static pressure of at least 100 lb (0.7 MPa) per ft<sup>2</sup> (0.1 m<sup>2</sup>)

*Exception: The provisions of 7-3.2(b) shall be permitted to be waived if the building within which the room is located is occupied by operations or processes having a similar hazard.*

- (c) Ventilation and heating shall comply with 7-2.2 and 7-2.3.

## Chapter 8 Engine Fuel Systems

### 8-1 Application.

**8-1.1** This chapter applies to fuel systems using LP-Gas as a fuel for internal combustion engines. Included are provisions for containers, container appurtenances, carburetion equipment, piping, hose and fittings, and provisions for their installation. This chapter covers engine fuel systems for engines installed on vehicles for any purpose, as well as fuel systems for stationary and portable engines. It also includes provisions for garaging of vehicles upon which such systems are installed.

NOTE: See Section 3-8 for systems on vehicles for purposes other than for engine fuel.

**8-1.2** Containers supplying fuel to stationary engines, or to portable engines used in lieu of stationary engines, shall be installed in accordance with Section 3-2. (*See Section 3-4 for portable engines used in buildings or on roofs or exterior balconies under certain conditions.*)

**8-1.3** Containers supplying fuel to engines on vehicles, regardless of whether the engine is used to propel the vehicle or is mounted on it for other purposes, shall be constructed and installed in accordance with this section.

**8-1.4** In the interest of safety, each person engaged in installing, repairing, filling, or otherwise servicing an LP-Gas engine fuel system shall be properly trained in the necessary procedures.

### 8-2 General Purpose Vehicle Engines Fueled by LP-Gas.

**8-2.1** This section covers the installation of fuel systems supplying engines used to propel vehicles such as passenger cars, taxicabs, multipurpose passenger vehicles, buses, recreational

vehicles, vans, trucks (including tractors, tractor semi-trailer units, and truck trains), and farm tractors.

### 8-2.2 Containers.

**8-2.2.1\*** Containers designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT); or the "Rules for Construction of Unfired Pressure Vessels," Section VIII, Division I, ASME *Boiler and Pressure Vessel Code*, applicable at the date of manufacture shall be used as follows.

(a) Adherence to applicable ASME Code Case Interpretations and Addenda shall be considered as compliance with the ASME Code.

(b) Containers fabricated to earlier editions of regulations, rules, or codes shall be permitted to be continued in use in accordance with 1-1.5. (*See Appendixes C and D.*)

(c) Containers that have been involved in a fire and that show no distortion shall be requalified for continued service in accordance with the code under which they were constructed before being reused.

(d) Cylinders shall be designed and constructed for at least 240 psi (1.6 MPa) service pressure.

(e) Cylinders shall be requalified in accordance with DOT regulations. The owner of the cylinder shall be responsible for such requalification. (*See Appendix C.*)

(f) ASME containers covered in this section shall be constructed for a minimum 250-psi (1.7-MPa) design pressure.

*Exception: Containers installed in enclosed spaces on vehicles and all engine fuel containers for industrial trucks, buses (including school buses), and multipurpose passenger vehicles shall be constructed of design pressure of at least 312.5 psi (2.1 MPa).*

(g) Repair or alterations of containers shall comply with the regulations, rules, or code under which the container was fabricated. Field welding on containers shall be limited to attachments to nonpressure parts, such as saddle pads, wear plates, lugs, or brackets applied by the container manufacturer.

(h) Containers showing serious denting, bulging, gouging, or excessive corrosion shall be removed from service.

**8-2.2.2** Containers shall comply with 8-2.2.1 or shall be designed, fabricated, tested, and marked using criteria that incorporate an investigation to determine that they are safe and suitable for the proposed service, are recommended for that service by the manufacturer, and are acceptable to the authority having jurisdiction.

**8-2.2.3** ASME containers shall be marked in accordance with 8-2.2.3(a) through (l). The markings specified shall be on a stainless steel metal nameplate attached to the container, which shall be located to remain visible after the container is installed. The nameplate shall be attached in such a way to minimize corrosion of the nameplate or its fastening means and not contribute to corrosion of the container.

- (a) Service for which the container is designed that is above ground
- (b) Name and address of container manufacturer or trade name of container
- (c) Water capacity of container in pounds or U.S. gallons
- (d) Design pressure in pounds per square inch (psi)
- (e) The wording "This container shall not contain a product having a vapor pressure in excess of 215 psi (1.5 MPa) at 100°F (37.8°C)."

- (f) Tare weight of container fitted for service in order for containers to be filled by weight
- (g) Outside surface area in square feet
- (h) Year of manufacture
- (i) Shell thickness, head thickness
- (j) OL, OD, HD
- (k) Manufacturer's serial number
- (l) ASME Code symbol

**8-2.2.4** LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200 gal (0.8 m<sup>3</sup>) aggregate water capacity.

**8-2.2.5** Individual LP-Gas containers used on other than passenger-carrying vehicles normally operating on the highway shall not exceed 300 gal (1 m<sup>3</sup>) water capacity.

**8-2.2.6** Containers covered in this section shall be equipped for filling into the vapor space.

*Exception: Containers having a water capacity of 30 gal (0.1 m<sup>3</sup>) or less shall be permitted to be filled into the liquid space.*

- (a) The connections for pressure relief valves shall be located and installed in such a way as to have direct communication with the vapor space of the container and shall not reduce the relieving capacity of the relief device.
- (b) If the connection is located at any position other than the uppermost point of the container, it shall be internally piped to the uppermost point practical in the vapor space of the container.

**8-2.2.7** The container openings, except those for pressure relief valves and gauging devices, shall be labeled to designate whether they communicate with the vapor or liquid space. Labels shall be permitted to be on valves.

**8-2.2.8** Engine fuel containers constructed of steel shall be painted to retard corrosion. [See Appendix A-3-2.4.1(f).]

### 8-2.3 Container Appurtenances.

**8-2.3.1** Container appurtenances (such as valves and fittings) shall comply with Section 2-3 and the following. Container appurtenances subject to working pressures in excess of 125 psi (0.9 MPa) but not to exceed 250 psi (1.7 MPa) shall be suitable for a working pressure of at least 250 psi (1.7 MPa).

(a) Manual shutoff valves shall be designed to provide positive closure under service conditions and shall be equipped with an internal excess-flow check valve designed to close automatically at the rated flows of vapor or liquid specified by the manufacturers.

(b) Double backflow check valves shall be of the spring-loaded type and shall close when flow is either stopped or reversed. This valve shall be installed in the fill opening of the container for either remote or direct filling.

(c) Containers shall be fabricated so they can be equipped with a fixed maximum liquid level gauge capable of indicating the maximum permitted filling level in accordance with 4-4.2.2. Fixed maximum liquid level gauges in the container shall be designed so the bleeder valve maximum opening to the atmosphere is not larger than a No. 54 drill size. If the bleeder valve is installed at a location remote from the container, the container fixed maximum liquid level gauge opening and the remote bleeder valve opening shall not be larger than a No. 54 drill size.

(d) Systems complying with the provisions of 3-11.3 shall have a water- and weather-resistant label placed near the bleeder valve with the following text: "Do not use fixed maximum liquid level gauge at low emission transfer stations."

(e) ASME containers shall be equipped with full internal or flush-type full internal pressure relief valves conforming with applicable requirements of UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, or other equivalent pressure relief valve standards. The start-to-leak setting of such pressure relief valve, with relation to the design pressure of the container, shall be in accordance with Table 2-3.2.3. These relief valves shall be plainly and permanently marked with the following:

1. The pressure in psi (MPa) at which the valve is set to start to leak
2. The rated relieving capacity in cubic feet per minute of air at 60°F (15.6°C) and 14.7 psia (an absolute pressure of 0.1 MPa)
3. The manufacturer's name and catalog number. Fusible plugs shall not be used.

(f) Cylinders shall be equipped with full internal or flush-type full internal pressure relief valves in accordance with DOT regulations (see Appendix E). Fusible plugs shall not be used.

(g) A float gauge, if used, shall be designed and approved for use with LP-Gas.

(h) A solid steel plug shall be installed in unused openings.

(i) Containers fabricated after January 1, 1984, for use as engine fuel containers on vehicles shall be equipped or fitted with an automatic means to prevent filling in excess of the maximum permitted filling limit.

(j) An overfilling prevention device shall be permitted to be installed on the container or exterior of the compartment where remote filling is used, provided that a double backflow check valve is installed in the container fill valve opening.

(k) The venting of gas through a fixed maximum liquid level gauge during filling shall not be required when the engine fuel container being fueled is equipped with an overfilling prevention device.

### 8-2.4 Carburetion Equipment.

**8-2.4.1** Carburetion equipment shall comply with 8-2.4.2 through 8-2.4.5 of this section or shall be designed, fabricated, tested, and marked using criteria that incorporate an investigation to determine that they are safe and suitable for the proposed service, are recommended for that service by the manufacturer, and are acceptable to the authority having jurisdiction. Carburetion equipment subject to working pressures in excess of 125 psi (0.9 MPa) but not to exceed 250 psi (1.7 MPa) shall be suitable for a working pressure of at least 250 psi (1.7 MPa).

**8-2.4.2** Vaporizers shall comply with the following requirements:

(a) Vaporizers shall be fabricated of materials suitable for LP-Gas service and shall be resistant to the action of LP-Gas under service conditions. Such vaporizers shall be designed and approved for engine fuel service and the vaporizer proper, any of its parts, or any devices used with it that can be subjected to container pressure shall have a design pressure of at least 250 psi (1.7 MPa), where working pressures do not exceed 250 psi (1.7 MPa), and shall be plainly and perma-

nently at a readily visible point with the marked design pressure of the fuel containing portion in psi (MPa).

(b) The vaporizer shall not be equipped with a fusible plug.

(c) Each vaporizer shall have a valve or suitable plug located at or near the lowest portion of the section occupied by the water or other heating liquid to allow substantially complete drainage. The engine cooling system drain or water hoses shall be permitted to serve this purpose if effective.

(d) Engine exhaust gases shall be permitted to be used as a direct source of heat to vaporize the fuel if the materials of construction of those parts of the vaporizer in contact with the exhaust gases are resistant to corrosion from these gases and if the vaporizer system is designed to prevent pressure in excess of 200 psi (1.4 MPa).

(e) Devices that supply heat directly to the fuel container shall be equipped with an automatic device to cut off the supply of heat before the pressure in the container reaches 200 psi (1.4 MPa).

**8-2.4.3** The regulator shall be approved and shall be permitted to be either part of the vaporizer unit or a separate unit.

**8-2.4.4** An approved automatic shutoff valve shall be provided in the fuel system as close as practical to the inlet of the gas regulator. The valve shall prevent flow of fuel to the carburetor when the engine is not running even if the ignition switch is in the on position. Atmospheric-type regulators (zero governors) shall not be considered as automatic shutoff valves for this purpose.

**8-2.4.5** Fuel filters, if used, shall be approved and shall be permitted to be either a separate unit or part of a combination unit.

### 8-2.5 Piping, Hose, and Fittings.

**8-2.5.1** Pipe shall be wrought iron or steel (black or galvanized), brass, or copper and shall comply with the following:

- (a) Wrought-iron pipe — ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*
- (b) Steel pipe — ASTM A53, *Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
- (c) Steel pipe — ASTM A106, *Specification for Seamless Carbon Steel Pipe for High-Temperature Service*
- (d) Brass pipe — ASTM B43, *Specification for Seamless Red Brass Pipe, Standard Sizes*
- (e) Copper pipe — ASTM B42, *Specification for Seamless Copper Pipe, Standard Sizes*

For LP-Gas vapor in excess of 125 psi (0.9 MPa) or for LP-Gas liquid, the pipe shall be Schedule 80 or heavier. For LP-Gas vapor at pressures of 125 psi (0.9 MPa) or less, the pipe shall be Schedule 40 or heavier.

**8-2.5.2** Tubing shall be steel, brass, or copper and shall comply with the following:

- (a) Steel tubing — ASTM A539, *Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines*, with a minimum wall thickness of 0.049 in.
- (b) Copper tubing — Type K or L, ASTM B88, *Specification for Seamless Copper Water Tube*
- (c) Copper tubing — ASTM B280, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*
- (d) Brass tubing — ASTM B135, *Specification for Seamless Brass Tube*

**8-2.5.3** Cast-iron pipe fittings such as ells, tees, crosses, couplings, unions, flanges, or plugs shall not be used. Fittings shall be steel, brass, copper, malleable iron, or ductile iron and shall comply with the following:

(a) Pipe joints in wrought iron, steel, brass, or copper pipe shall be permitted to be screwed, welded, or brazed. Tubing joints in steel, brass, or copper tubing shall be flared, brazed, or made up with approved gas tubing fittings.

(b) Fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psi (0.9 MPa), where working pressures do not exceed 250 psi (1.7 MPa), shall be suitable for a working pressure of at least 250 psi (1.7 MPa).

(c) Fittings for use with vapor LP-Gas at pressures in excess of 5 psi (34.5 kPa) and not exceeding 125 psi (0.9 MPa) shall be suitable for a working pressure of 125 psi (0.9 MPa).

(d) Brazing filler material shall have a melting point exceeding 1000°F (538°C).

**8-2.5.4** Hose, hose connections, and flexible connectors shall comply with the following requirements.

(a) Hose, hose connections, and flexible connectors (*see definition*) used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psi (34.5 kPa) shall be fabricated of materials resistant to the action of LP-Gas both as liquid and vapor and shall be of wire braid reinforced construction. The wire braid shall be stainless steel. The hose shall comply with the following:

1. Hose shall be designed for a working pressure of 350 psi (2.4 MPa) with a safety factor of 5 to 1 and shall be continuously marked LP-GAS, PROPANE, 350 PSI WORKING PRESSURE, and the manufacturer's name or trademark. Each installed piece of hose shall contain at least one such marking.
2. Hose assemblies after the application of connections shall have a design capability to withstand a pressure of not less than 700 psi (4.8 MPa). If a test is performed, such assemblies shall not be leak-tested at pressures higher than the working pressure [350 psi (2.4 MPa) minimum] of the hose.
- (b) Hose used for vapor service at 5 psi (34.5 kPa) or less shall be constructed of material resistant to the action of LP-Gas.
- (c) Hose in excess of 5 psi (34.5 kPa) service pressure and quick connectors shall be approved for this application by the authority having jurisdiction as specified in Section 1-2.

### 8-2.6 Installation of Containers and Container Appurtenances.

**8-2.6.1** Containers shall be located in a place and in a manner to minimize the possibility of damage to the container and its fittings. Containers located in the rear of the vehicles, where protected by substantial bumpers, shall be considered in conformance with this requirement. If the fuel container is installed within 8 in. (20 cm) of the engine or exhaust systems, it shall be shielded against direct heating.

**8-2.6.2** Container markings shall be readable after a container is permanently installed on a vehicle. A portable lamp and mirror shall be permitted to be used when reading markings.

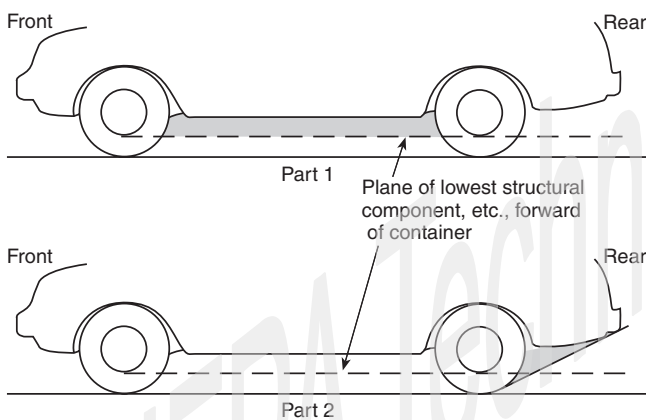
**8-2.6.3** Container valves, appurtenances, and connections shall be adequately protected to prevent damage due to accidental contacts with stationary objects or from stones, mud, or



ice thrown up from the ground and from damage due to an overturn or similar vehicular accident. Location on the container where parts of the vehicle furnish the necessary protection or the use of a fitting guard furnished by the manufacturer of the container shall be permitted to meet these requirements.

**8-2.6.4** Containers shall not be mounted directly on roofs or ahead of the front axle or beyond the rear bumper of the vehicles. In order to minimize the possibility of physical damage, no part of a container or its appurtenances shall protrude beyond the sides or top of the vehicle.

**8-2.6.5** Containers shall be installed with as much road clearance as practical. This clearance shall be measured to the bottom of the container or the lowest fitting, support, or attachment on the container or its housing, if any, whichever is lowest, as follows [see Figure 8-2.6.5].



**Figure 8-2.6.5** Container installation clearances.

(a) Containers installed between axles shall comply with 8-2.6.5(c) or shall be not lower than the lowest point forward of the container on the following points:

1. The lowest structural component of the body
2. The lowest structural component of the frame or sub-frame if any
3. The lowest point on the engine
4. The lowest point of the transmission (including the clutch housing or torque converter housing, as applicable). [See Part 1, Figure 8-2.6.5]

(b) Containers installed behind the rear axle and extending below the frame shall comply with 8-2.6.5(c) or shall be not lower than the lowest of the following points and surfaces:

1. They shall not be lower than the lowest point of a structural component of the body, engine, transmission (including clutch housing or torque converter housing, as applicable), forward of the container. Also they shall not be lower than lines extending rearward from each wheel at the point where the wheels contact the ground directly below the center of the axle to the lowest and most rearward structural interference (e.g., bumper, frame). [See Figure 8-2.6.5, Part 2.]
2. Where there are two or more rear axles, the projections shall be made from the rearmost axle.

(c) Where an LP-Gas container is substituted for the fuel container installed by the original manufacturer of the vehi-

cle (whether or not that fuel container was intended for LP-Gas), the LP-Gas container either shall fit within the space in which the original fuel container was installed or shall comply with 8-2.6.5(a) or (b).

**8-2.6.6** Fuel containers shall be securely mounted to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand without permanent visible deformation static loading in any direction equal to four times the weight of the container filled with fuel.

**8-2.6.7** Welding for the repair or alterations of containers shall comply with 8-2.2.1(g).

**8-2.6.8** Main shutoff valves on a container for liquid and vapor shall be readily accessible without the use of tools, or other means shall be provided to shut off the container valves.

**8-2.6.9** The pressure relief valve discharge system(s) shall be installed to meet the following requirements.

(a) The relief valve discharge from fuel containers on vehicles other than industrial (and forklift) trucks (see 8-3.3) shall be directed upward or downward within 45 degrees of vertical; shall not directly impinge on the vehicle fuel container(s), the exhaust system, or any other part of the vehicle; and shall not be directed into the interior of the vehicle.

(b) Where the relief valve discharge must be piped away, the pipeaway system shall consist of a breakaway adapter recommended by the relief valve manufacturer, a length of non-metallic hose, and a protective cover to minimize the possibility of the entrance of water or dirt into either the relief valve or its discharge system. No portion of the system shall have an internal diameter less than the internal diameter of the recommended breakaway adapter.

1. The breakaway adapter shall be threaded for direct connection to the relief valve and shall not interfere with the operation of the relief valve. It shall break away without impairing the function of the relief valve and shall have a melting point of not less than 1500°F (816°C).

*Exception:* The breakaway adapter shall be permitted to be an integral part of the pressure relief valve.

2. The nonmetallic hose shall be as short as practical and shall be able to withstand the downstream pressure from the relief valve in the full open position. The hose shall be fabricated of materials resistant to the action of LP-Gas.
3. Where hose is used to pipe away the relief valve discharge on containers installed on the outside of the vehicle, the breakaway adapter and any attached fitting shall deflect the relief valve discharge upward or downward within 45 degrees of vertical and shall meet the other requirements of 8-2.6.9(a) without the hose attached. If an additional fitting is necessary to meet this requirement, it shall have a melting point not less than 1500°F (816°C) and shall meet the requirements of 8-2.6.9(b).

(c) The pipeaway system connections shall be mechanically secured and shall not depend on adhesives or sealing compounds. The system shall not be routed between a bumper system and the vehicle body.

(d) Where a pipeaway system is not required, the pressure relief valve shall have a protective cover in accordance with 8-2.6.9(b).

## 8-2.7 Containers Mounted in the Interior of Vehicles.

**8-2.7.1** Containers mounted in the interior of vehicles shall be installed so that any LP-Gas released from container appurte-

nances due to operation, leakage, or connection of the appurtenances will not be in an area communicating directly with the driver or passenger compartment or with any space containing radio transmitters or other spark-producing equipment. This shall be permitted to be accomplished by the following means:

(a) \*Locating the container, including its appurtenances, in an enclosure that is securely mounted to the vehicle, is gastight with respect to driver or passenger compartments and to any space containing radio transmitters or other spark-producing equipment, and is vented outside the vehicle

(b) Enclosing the container appurtenances and their connections in a structure that is securely mounted on the container, is gastight with respect to the driver or passenger compartments or with any space carrying radio transmitters or other spark-producing equipment, and is vented outside the vehicle

**8-2.7.2** Fuel containers shall be installed and fitted so that no gas from fueling and gauging operations can be released inside of the passenger or luggage compartments, by permanently installing the remote filling connections [double backflow check valve — *see 8-2.3.1(b)*] and fixed maximum liquid level gauging device to the outside of the vehicle.

**8-2.7.3** Container pressure relief valve installation shall comply with 8-2.6.9.

**8-2.7.4** Enclosures, structures, seals, and conduits used to vent enclosures shall be fabricated of durable materials and shall be designed to resist damage, blockage, or dislodgement through movement of articles carried in the vehicle or by the closing of luggage compartment enclosures or vehicle doors and shall require the use of tools for removal.

### 8-2.8 Pipe and Hose Installation.

**8-2.8.1** The piping system shall be designed, installed, supported, and secured in such a manner to minimize the possibility of damage due to expansion, contraction, vibration, strains, or wear and to preclude any loosening while in transit.

**8-2.8.2** Piping (including hose) shall be installed in a protected location. If outside, piping shall be under the vehicle and below any insulation or false bottom. Fastening or other protection shall be installed to prevent damage due to vibration or abrasion. At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chafing.

**8-2.8.3** Fuel line piping that must pass through the floor of a vehicle shall be installed to enter the vehicle through the floor directly beneath, or adjacent to, the container. If a branch line is required, the tee connection shall be in the main fuel line under the floor and outside the vehicle.

**8-2.8.4** Where liquid service lines of two or more individual containers are connected together, a spring-loaded backflow check valve or equivalent shall be installed in each of the liquid lines prior to the point where the liquid lines tee together to prevent the transfer of LP-Gas from one container to another.

**8-2.8.5** Exposed parts of the piping system shall be of corrosion-resistant material or shall be adequately protected against exterior corrosion.

**8-2.8.6** Piping systems, including hose, shall be tested and proven free of leaks at not less than normal operating pressure.

**8-2.8.7** There shall be no fuel connection between a tractor and trailer or other vehicle units.

**8-2.8.8** A hydrostatic relief valve or device providing pressure-relieving protection shall be installed in each section of piping (including hose) in which liquid LP-Gas can be isolated between shutoff valves so as to relieve to a safe atmosphere the pressure that could develop from the trapped liquid. This hydrostatic relief valve shall have a pressure setting not less than 400 psi (2.8 MPa) or more than 500 psi (3.5 MPa).

### 8-2.9 Equipment Installation.

**8-2.9.1** Installation shall be made in accordance with the manufacturer's recommendations and, in the case of listed or approved equipment, it shall be installed in accordance with the listing or approval.

**8-2.9.2** Equipment installed on vehicles shall be considered a part of the LP-Gas system on the vehicle and shall be protected against vehicular damage in accordance with 8-2.6.1.

**8-2.9.3** The gas regulator and the approved automatic shutoff valve shall be installed as follows:

- (a) Approved automatic pressure reducing equipment, properly secured, shall be installed between the fuel supply container and the carburetor to regulate the pressure of the fuel delivered to the carburetor.
- (b) An approved automatic shutoff valve shall be provided in the fuel system in compliance with 8-2.4.4.

**8-2.9.4** Vaporizers shall be securely fastened in position.

**8-2.10 Marking.** Each over-the-road general purpose vehicle powered by LP-Gas shall be identified with a weather-resistant diamond-shaped label located on an exterior vertical or near vertical surface on the lower right rear of the vehicle (on the trunk lid of a vehicle so equipped, but not on the bumper of any vehicle) inboard from any other markings. The label shall be approximately 4 <sup>3</sup>/<sub>4</sub> in. (120 mm) long by 3 <sup>1</sup>/<sub>4</sub> in. (83 mm) high. The marking shall consist of a border and the word PROPANE [1 in. (25 mm) minimum height centered in the diamond] in silver or white reflective luminous material on a black background. (*See Figure 8-2.10.*)



Figure 8-2.10 Example of vehicle identification marking.

### 8-3 Industrial (and Forklift) Trucks Powered by LP-Gas.

**8-3.1** This subsection applies to LP-Gas installation on industrial trucks (including forklift trucks), both to propel them and to provide the energy for their materials-handling attachments. LP-Gas fueled industrial trucks shall comply with NFPA

505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*.

**8-3.2** Cylinders used as fuel containers shall comply with 8-2.2 and 8-2.3.1(a) through (h).

(a) Cylinders shall be permitted to be designed, constructed, and fitted for filling in either the vertical or horizontal position, or, if of the universal type [see 2-3.4.2(c)2], in either position. The cylinder shall be in the appropriate position while being filled or, if of the universal type, shall be permitted to be filled in either position, provided the following:

1. The fixed maximum level gauge indicates correctly the maximum permitted filling level in either position.
2. The pressure relief valves are located in, or connected to, the vapor space in either position.

**8-3.3** The cylinder relief valve shall be vented upward within 45 degrees of vertical and otherwise shall comply with 8-2.6.9.

**8-3.4** Gas regulating and vaporizing equipment shall comply with 8-2.4.2(a) through (e) and 8-2.4.3, 8-2.4.4, and 8-2.4.5.

**8-3.5** Piping and hose shall comply with 8-2.5.1 through 8-2.5.4.

*Exception: Hose 60 in. (1.5 m) in length or less shall not be required to be of stainless steel wire braid construction.*

**8-3.6** The operation of industrial trucks (including forklift trucks) powered by LP-Gas engine fuel systems shall comply with NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*, and with the following:

(a) Refueling of such trucks shall be accomplished as follows:

1. Trucks with permanently mounted containers shall be refueled outdoors.
2. Exchange of removable fuel cylinders shall be done outdoors or indoors. If done indoors, means shall be provided in the fuel piping system to minimize the release of fuel when cylinders are exchanged, using one of the following methods:
  - a. Using an approved quick-closing coupling (a type that closes in both directions when uncoupled) in the fuel line
  - b. Closing the shutoff valve at the fuel cylinder and allowing the engine to run until the fuel in the line is exhausted.

(b) LP-Gas fueled industrial trucks shall be permitted to be used in buildings or structures as follows:

1. The number of fuel cylinders on such a truck shall not exceed two.
2. With the approval of the authority having jurisdiction, industrial trucks shall be permitted to be used in buildings frequented by the public, including those times when such buildings are occupied by the public. The total water capacity of the fuel cylinders on an individual truck shall not exceed 105 lb (48 kg) [nominal 45 lb (20 kg) LP-Gas capacity].
3. Trucks shall not be parked and left unattended in areas occupied by or frequented by the public except with the approval of the authority having jurisdiction. If left unattended with approval, the fuel system shall be checked to make certain there are no leaks and that the cylinder shutoff valve is closed.

4. In no case shall industrial trucks be parked and left unattended in areas of excessive heat or near sources of ignition.

**8-3.7** All cylinders used in industrial truck service (including forklift truck cylinders) shall have the cylinder pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the cylinder and every 10 years thereafter.

#### **8-4 General Provisions for Vehicles Having Engines Mounted on Them (Including Floor Maintenance Machines).**

**8-4.1** This section includes provisions for the installation of equipment on vehicles that supplies LP-Gas as a fuel for engines mounted on these vehicles. The term *vehicles* includes floor maintenance and any other readily portable mobile unit, whether the engine is used to propel the vehicle or is mounted on it for other purposes.

**8-4.2** Gas vaporizing, regulating, and carburetion equipment to provide LP-Gas as a fuel for engines shall be installed in accordance with 8-2.8 and 8-2.9.

- (a) In the case of industrial trucks (including forklift trucks) and other engines on vehicles operating in buildings other than those used exclusively to house engines, an approved automatic shutoff valve shall be provided in the fuel system in compliance with 8-2.4.4.
- (b) The source of air for combustion shall be completely isolated from the driver and passenger compartment, ventilating system, or air conditioning system on the vehicle.

**8-4.3** Piping and hose shall comply with 8-3.5.

**8-4.4** Non-self-propelled floor maintenance machinery (floor polishers, scrubbers, buffers) and other similar portable equipment shall be listed and shall comply with the following:

- (a) The provisions of 8-3.2 through 8-3.5 and 8-3.6(a) and (b) shall apply.
- (b) The storage of cylinders mounted or used on such machinery or equipment shall comply with Chapter 5.

A label shall be affixed to the machinery or equipment, with the label facing the operator, denoting that the cylinder or portion of the machinery or equipment containing the cylinder shall be stored in accordance with Chapter 5.

**8-4.5** With approval of the authority having jurisdiction, floor maintenance machines shall be permitted to be used in buildings frequented by the public, including the times when such buildings are occupied by the public.

#### **8-5 Engine Installation Other than on Vehicle.**

**8-5.1** Stationary engines and gas turbines installed in buildings, including portable engines used in lieu of, or to supplement, stationary engines, shall comply with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, and the applicable provisions of Chapters 1 and 2 and Section 3-2 of this code.

**8-5.2** Portable engines, except as provided in 8-4.1, shall be permitted to be used in buildings only for emergencies, and the following shall apply:

- (a) The capacity of the cylinders used with such engines and the equipment used to provide fuel to them shall comply with the applicable provisions of Section 3-4.
- (b) An approved automatic shutoff valve shall be provided in the fuel system in compliance with 8-2.4.4. Atmospheric-type regulators (zero governors) used for portable engines of 12 horsepower or less with magneto

ignition and used exclusively outdoors shall be considered as in compliance with 8-2.4.4.

- (c) Provision shall be made to supply sufficient air for combustion and cooling. Exhaust gases shall be discharged to a point outside the building or to an area in which they will not constitute a hazard.

**8-5.3** Piping and hose shall comply with 8-2.5.1 through 8-2.5.4.

**8-5.4** Gas regulating, vaporizing, and carburetion equipment shall comply with 8-2.4.2, 8-2.4.3, and 8-2.4.5.

**8-5.5** Installation of piping, carburetion, vaporizing, and regulating equipment for the engine fuel system shall comply with 8-2.8 and 8-2.9.

**8-5.6** Engines installed or operated exclusively outdoors shall comply with 8-5.3, 8-5.4, and 8-5.5.

Atmospheric-type regulators (zero governor) shall be considered as automatic shutoff valves only in the case of completely outdoor operations, such as farm tractors, construction equipment, or similar outdoor engine applications.

**8-5.7** Engines used to drive portable pumps and compressors or pumps shall be equipped in accordance with 2-5.1.4.

**8-6 Garaging of Vehicles.** Vehicles with LP-Gas engine fuel systems mounted on them and general purpose vehicles propelled by LP-Gas engines shall be permitted to be stored or serviced inside garages, provided the following conditions apply:

- (a) The fuel system is leak-free, and the cylinder(s) is not filled beyond the limits specified in Chapter 4.
- (b) The cylinder shutoff valve is closed when vehicles or engines are under repair except when engine is operated.
- (c) The vehicle is not parked near sources of heat, open flames, or similar sources of ignition, or near inadequately ventilated pits.

## Chapter 9 Refrigerated Containers

### 9-1 Provisions for Construction, Design, and Testing of Refrigerated Containers.

**9-1.1** Refrigerated LP-Gas containers shall be designed, constructed, and tested in accordance with the following codes.

**9-1.1.1** Containers designed to operate at greater than 15 psi (103 kPa) shall be designed and constructed in accordance with the ASME *Boiler and Pressure Vessel Code*, Section VIII, except that construction using joint efficiencies in Table UW 12, Column C, Division 1, shall not be permitted. Materials shall be selected from those recognized by the American Society of Mechanical Engineers (ASME) that meet the requirements of ASME Section VIII, Appendix R, or Appendix Q of API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*.

**9-1.1.2** Containers that operate at below 15 psi (103 kPa) shall be in accordance with API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, including Appendix R.

**9-1.1.3** Where austenitic stainless steels or nonferrous materials are used, API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Appendix Q, shall be used in the selection of materials.

**9-1.2** The operator shall specify the maximum allowable working pressure, which includes a suitable margin above the operating pressure and the maximum allowable vacuum.

**9-1.2.1** For ASME vessels, the positive margin for design pressure shall be at least 5 percent of the absolute vapor pressure of the LP-Gas at the design storage temperature. The margin (both positive and vacuum) for low-pressure API 620 vessels shall include the control range of the boil-off handling system, the effects of flash or vapor collapse during filling operations, the flash that can result from withdrawal pump recirculation, and the normal range of barometric pressure changes.

**9-1.2.2** Allowance shall be made for the service temperature limits of the particular process and the products to be stored when determining material specifications and the design pressure. The design temperature for those parts of a refrigerated LP-Gas container that are in contact with the liquid or refrigerated vapor shall be equal to or lower than the boiling point of the product to be stored at atmospheric pressure.

**9-1.3** The design wind loading on refrigerated LP-Gas containers shall be in accordance with the projected area at various height zones above ground in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. Design wind speeds shall be based on a mean occurrence interval of 100 years.

**9-1.4** The design seismic loading on refrigerated LP-Gas containers shall be based on forces recommended in the ICBO *Uniform Building Code (UBC)*. For those areas identified as Zones 3 and 4 on the seismic risk map of the United States (Figures 1, 2, and 3 of Chapter 23 of the *UBC*), a seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction.

**9-1.5** All piping that is part of a refrigerated LP-Gas container and refrigerated LP-Gas systems, including transfer and process piping, shall be in accordance with ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*. The container piping shall include all piping internal to the container, all piping within the insulation spaces, and all external piping attached or connected to the container up to the first circumferential external joint of the piping. Inert gas purge systems wholly within the insulation spaces shall be exempt from this provision.

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

**9-1.6** Refrigerated aboveground containers shall be installed on foundations that have been engineered with consideration for soil conditions and loadings.

**9-1.6.1** Prior to the start of design and construction of the foundation, a subsurface investigation shall be conducted by a soils engineer. Foundations designed by an engineer who is experienced in foundations and soils shall be constructed in accordance with recognized structural engineering practices.

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

**9-1.6.2** For product storage at less than 30°F(-1.1°C), the foundation design and the container bottom insulation shall

be such that damage from frost heave shall not occur. The bottom of the container shall be constructed of materials that are suitable for the temperatures to which they will be exposed. If the bottom of the refrigerated LP-Gas container is in contact with the soil, a heating system shall be provided to prevent the 32°F (0°C) isotherm from extending into the soil. Ambient or supplied heat shall be permitted to be used. The heating system shall be designed to permit both functional and performance monitoring. As a minimum, the undertank temperature shall be observed and logged on a weekly basis. Where there is a discontinuity in the foundation, such as bottom piping, careful attention and separate treatment shall be given to the heating system in that zone. Heating systems shall be installed so that any heating elements or temperature sensors used for control can be replaced while the tank is in service. Provisions shall be incorporated to protect against the detrimental effects of moisture accumulation in the conduit, which could result in galvanic corrosion or other forms of deterioration within the conduit or heating element.

**9-1.6.3** The refrigerated LP-Gas container foundation shall be periodically monitored for settlement during the life of the facility. The monitoring shall include construction, hydrostatic testing, commissioning, and operation. Any settlement in excess of that anticipated in the design shall be investigated, and corrective action shall be taken if appropriate.

**9-1.6.4** The bottom of a refrigerated LP-Gas container, either the bottom of an outer tank or the bottom of the undertank insulation, shall be above the ground water table or otherwise protected from contact with ground water at all times and shall be protected from possible high flood waters. Secure anchorage or adequate pier height shall be provided to protect against container flotation wherever sufficiently high water might occur.

**9-1.6.5** Where two or more containers are sited in a common dike, the container foundations shall be capable of withstanding contact with LP-Gas or shall be protected against contact with an accumulation of LP-Gas that might endanger structural integrity.

**9-1.6.6** If the foundation of a refrigerated LP-Gas container is installed to provide adequate air circulation in lieu of a heating system, the bottom of the container shall be constructed of materials that are suitable for the temperatures to which they will be exposed. The material in contact with the bottom of the container shall be selected to minimize corrosion.

**9-1.7 Marking on Refrigerated LP-Gas Containers.** Each refrigerated LP-Gas container shall be identified by the attachment of a nameplate on the outer covering. The nameplate shall be in an accessible, visible place and marked with the following information:

- (a) Manufacturer's name and date built
- (b) Liquid volume of the container in U.S. gallons (U.S. standard) or barrels
- (c) Maximum allowable working pressure in pounds per square inch
- (d) Minimum temperature (in degrees Fahrenheit) for which the container was designed
- (e) Density of the product to be stored in pounds per cubic foot, or specific gravity for which the container was designed
- (f) Maximum level to which the container is permitted to be filled with the LP-Gas for which it was designed

## 9-2 Refrigerated LP-Gas Container Instruments and Controls.

**9-2.1** Each refrigerated LP-Gas container shall be equipped with at least two independent liquid level gauging devices. These devices shall be installed so that they can be replaced without taking the container out of service.

**9-2.2** The refrigerated LP-Gas container shall be provided with a high-liquid level alarm. The alarm shall be set so that the operator will have sufficient time to stop the flow without exceeding the maximum permissible filling height. The alarm shall be located so that it is audible to the personnel who control the filling. A high-liquid level flow cutoff device shall not be considered as a substitute for the alarm.

**9-2.3** The refrigerated LP-Gas container shall be equipped with a high-liquid level flow cutoff device that is independent from all gauges.

*Exception: Refrigerated LP-Gas containers of 70,000 gal (265 m<sup>3</sup>) or less, if attended during the filling operation, shall be permitted to be equipped with liquid trycocks in lieu of the high-liquid level alarm, and manual flow cutoff shall be permitted.*

**9-2.4** Each refrigerated LP-Gas container shall be provided with temperature-indicating devices that assist in controlling cool-down rates when placing the container in service.

**9-2.5** The internal pressure and vacuum of refrigerated LP-Gas containers shall be maintained within the limits established in the design specification. The design of pressure control means shall include the following failure modes.

- (a) For pressure, the failure modes include the following:
  1. Loss of refrigeration
  2. Operational upset, including failure of control devices
  3. Vapor displacement and flash vaporization during filling, as a result of filling, and controlled mixing or pump recirculation of different compositions and temperatures
  4. Drop in atmospheric pressure
  5. Fire exposure
  6. Flash vaporization resulting from pump recirculation
- (b) For vacuum, the failure modes include the following:
  1. Withdrawal of liquid or vapor at the maximum rate
  2. Rise in atmospheric pressure
  3. Reduction in vapor pressure as a result of introduction of subcooled LP-gas

**9-2.6** The minimum start-to-discharge of air from a pressure relief valve at 120 percent of the maximum permissible start-to-discharge pressure shall be computed using the following formula:

$$Q_a = \frac{633,000 FA^{0.82}}{LC} \sqrt{\frac{ZT}{M}}$$

where:

$Q_a$  = minimum required flow capacity of air, in cubic feet per minute, at 60°F and 14.7 psia

$F$  = a composite environmental factor, as tabulated in Table 9-2.6A. To receive credit for reduced heat input, the insula-

tion shall resist dislodgment by fire hose streams, shall be noncombustible, and shall not decompose at temperatures up to 1500°F (816°C). If insulation does not comply with these criteria, the environmental factor,  $F$ , for a bare container shall be used.

$A$  = total exposed wetted surface, in square feet. For a vertical container, the wetted area shall be equal to the total surface area of the shell up to a height of 30 ft (9.1 m) above grade

$L$  = latent heat of product at the flow rating pressure, Btu/lb. (The latent heat of pure propane at atmospheric pressure is 183.5 Btu/lb and of isobutane is 157.8 Btu/lb.)

$C$  = constant for gas or vapor related to specific heats at 60°F (16°C) and 14.696 psia (an absolute pressure of 101.325 kPa). [The ratio of specific heat ( $k$ ) is 1.13 and  $C = 330$  for pure propane, and  $k = 1.10$  and  $C = 316$  for butane.]

$Z$  = compressibility factor at flowing conditions

$T$  = absolute temperature at flowing conditions

$M$  = molecular weight of gas

**Table 9-2.6A Environmental Factors**

Insulation	Factor $F$
Bare container	1.0
Insulated containers with the following typical conductance values, $k$ , in Btu per hour per ft <sup>2</sup> per degrees Fahrenheit, based on 1600°F temperature difference:	
$k = 4.0$	0.3
$k = 2.0$	0.15
$k = 1.0$	0.075

**Table 9-2.6B Chart for Gas Constant,  $C$**

$k$	$C$	$k$	$C$	$k$	$C$
1.00	315	1.26	343	1.52	366
1.02	318	1.28	345	1.54	368
1.04	320	1.30	347	1.56	369
1.06	322	1.32	349	1.58	371
1.08	324	1.34	351	1.60	372
1.10	327	1.36	352	1.62	374
1.12	329	1.38	354	1.64	376
1.14	331	1.40	356	1.66	377
1.16	333	1.42	358	1.68	379
1.18	335	1.44	359	1.70	380
1.20	337	1.46	361	2.00	400
1.22	339	1.48	363	2.20	412
1.24	341	1.50	364	—	—

### 9-3 Refrigerated LP-Gas Container Impoundment.

**9-3.1** Each refrigerated LP-Gas container shall be located within an impoundment that complies with this section, in order to minimize the possibility that the accidental release of liquid LP-Gas from the container would endanger adjoining property or lives, process equipment, or structures, or that an accidental release could reach waterways or enclosed drainage systems.

**9-3.2** Enclosed drainage channels for LP-Gas shall be prohibited.

*Exception:* Container downcomers used to conduct spilled LP-Gas away from materials subject to failure upon exposure to liquid LP-Gas shall be permitted to be enclosed.

**9-3.3** Impoundment for refrigerated LP-Gas and flammable refrigerant containers shall have a minimum volumetric holding capacity, including any useful holding capacity of the area, and with allowance made for the displacement of snow accumulation, other containers, or equipment, that is equal to the total liquid volume of the largest container served, assuming that container is full.

**9-3.4** More than one container shall be permitted to be installed in a single impoundment, under the following conditions:

- Where an outer shell is used to contain loose insulation, containers shall be elevated above grade so that liquid will not reach the outside container wall in the event of a liquid spill; or, if liquid can reach the outside container wall, the material that can be wetted by spilled liquid shall be suitable for use at -44°F (-42°C).
- Container foundations are constructed of concrete that is properly designed for fire exposure.

**9-3.5** An impoundment structure shall be of compacted earth, concrete, metal, or other suitable material. Such structures shall be permitted to be constructed independently of the container, mounted integrally to the container, or constructed against the container. These structures, and any penetrations thereof, shall be designed to withstand the full hydrostatic head of impounded LP-Gas or flammable refrigerant, the effect of rapid cooling to the temperature of the liquid to be confined, any anticipated fire exposure, and natural forces such as earthquake, wind, or rain.

**9-3.6** Where topography can provide suitable containment, dike walls, where required, shall be required to be only as high as the containment capacity requires.

**9-3.7** Provision shall be made to clear rain or other water from the impoundment area. Automatically controlled sump pumps shall be permitted if equipped with an automatic cutoff device that prevents their operation when exposed to LP-Gas temperatures. Piping, valves, and fittings whose failure could permit liquid to escape from the impounding area shall be suitable for continuous exposure to LP-Gas temperature. If gravity drainage is employed for water removal, provision shall be made to prevent the escape of LP-Gas by way of the drainage system. Gravity drainage utilizing piping penetrations through or below impoundment dikes shall not be permitted.

### 9-4 Inspection of Refrigerated LP-Gas Containers and Systems.

**9-4.1** During construction and prior to the initial operation or commissioning, each refrigerated LP-Gas container and system shall be inspected or tested in accordance with the provisions of this standard and other applicable referenced codes and standards. Such inspections or tests shall ensure that the design, material specifications, fabrication methods, and quality comply with the requirements of this standard and other applicable referenced codes and standards.

**9-4.2** The inspections or tests required shall be the responsibility of the operator. The operator shall be permitted to delegate any part of those inspections or tests to the operator's employees or a third party engineering, scientific, recognized insurance, or inspection organization. Each inspector shall be qualified in accordance with the code or standard that is applicable to the test or inspection being performed.

**9-4.3** After acceptance tests are completed, there shall be no field welding on the LP-Gas containers. Retesting by a method appropriate to the repair or modification shall be required

only where the repair or modification is of such a nature that a retest actually tests the element affected and is necessary to demonstrate the adequacy of the repair or modification.

*Exception: Welding shall be permitted on saddle plates or brackets that are provided for the purpose or as otherwise permitted by the code under which the container was fabricated.*

## 9-5 Locating Aboveground Refrigerated LP-Gas Containers.

**9-5.1** Spacing of refrigerated propane containers from important buildings, storage containers for flammable or combustible liquids, and lines of adjoining property that can be built upon shall be in accordance with Table 9-5.1.

**Table 9-5.1 Minimum Distances**

Water Capacity per Container in gal (m <sup>3</sup> )	Aboveground Containers in ft (m)
Up – 70,000 (265)	75 (23)
70,001 – 90,000 (265 – 341)	100 (30)
90,001 – 120,000 (341 – 454)	125 (38)
120,001 – 200,000 (454 – 757)	200 (61)
200,001 – 1,000,000 (757 – 3785)	300 (91)
Over 1,000,000 (3785)	400 (122)

**9-5.2** The edge of a dike, impoundment, or drainage system that is intended for a refrigerated LP-Gas container shall be 100 ft (31 m) or more from a property line that can be built upon, a public way, or a navigable waterway.

**9-5.3** Nonrefrigerated LP-Gas containers or flammable liquid tanks shall not be located within dikes or impoundments enclosing refrigerated LP-Gas containers.

**9-5.4** Refrigerated LP-Gas containers shall not be installed one above the other.

**9-5.5** The minimum distance between aboveground refrigerated LP-Gas containers shall be one-half the diameter of the larger container.

**9-5.6** The ground within 25 ft (7.6 m) of any aboveground refrigerated LP-Gas container and all ground within a dike, impoundment, or drainage area shall be kept clear of readily ignitable materials such as weeds and long, dry grass.

## Chapter 10 Marine Shipping and Receiving

### 10-1 Piers.

**10-1.1** Design, construction, and operation of piers, docks, and wharves shall comply with relevant regulations and the requirements of the authorities having jurisdiction.

NOTE: Federal regulations applicable to marine terminals are contained in Title 33 of the U.S. Code of Federal Regulations.

**10-1.2** General cargo, flammable liquids, or compressed gases, other than ships' general stores for the LP-Gas tank vessel, shall not be handled over a pier or dock within 100 ft (30.5 m) of the point of transfer connection while LP-Gas or other flammable liquids are being transferred. Ship bunkering operations shall not be permitted prior to or during cargo transfer operations.

**10-1.3** Trucks and other motorized vehicles shall be prohibited on the pier or dock within 100 ft (30.5 m) of the transfer connection while transfer operations are in progress. Authorized parking areas, if provided for in the waterfront area, shall be properly marked. Suitable warning signs or barricades shall be used to indicate when transfer operations are in progress.

**10-1.4** The shore facility shall ensure that security personnel and measures are available to prevent unauthorized individuals access to the waterfront area while the LP-Gas vessel is alongside the pier or dock. Security personnel shall maintain control of visitors, delivery trucks, and service personnel. The facility operator shall ensure that any person assigned security duty has been instructed on security procedures.

**10-1.5** The shore mooring equipment shall be designed and maintained to safely hold the vessel to the pier or dock under all anticipated weather, current, and tidal conditions.

**10-1.6** All electrical equipment and wiring installed on the pier or dock shall comply with 3-7.2.1 and 3-7.2.2 and shall be suitable for the electrical area classification.

**10-1.7** If the terminal conducts transfers between sunset and sunrise, the pier or dock area shall have a lighting system that allows operations personnel to safely conduct operations and illuminate the transfer connection area, control valves, storage containers, other equipment, and walkways.

- Lighting shall illuminate communications, fire fighting, and other emergency equipment.
- All lighting shall be located or shielded so that it is not confused with any aids to navigation and does not interfere with navigation on the adjacent waterway.
- All lighting fixtures and wiring shall comply with 3-7.2.1 and 3-7.2.2.

**10-1.8** Welding and cutting, if required, shall be conducted in accordance with NFPA 51B, *Fire Prevention in Use of Cutting and Welding Processes*. Smoking shall be permitted only in conspicuously marked, designated areas.

**10-1.9** The shore facility shall ensure that medical first aid equipment and fire extinguishers are installed and available in appropriate locations, types, and quantities for any reasonably anticipated abnormal condition, while the vessel is alongside the berth, and shall ensure:

- That extinguishers are installed and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*, and are ready for use.
- That emergency equipment is positioned and ready to operate prior to the start of the transfer operation.
- That locations of all fire extinguishers are conspicuously marked and ready accessibility and lighting is maintained.

**10-1.10** Prior to the start of the transfer, the shore facility shall ensure that warning signs be placed in the marine transfer area, readily visible from the shoreline and berth areas, that have the following text:

Warning  
 Dangerous Cargo  
 No Visitors  
 No Smoking  
 No Open Light

**10-1.11** The shore facility shall have a flammable gas detector, capable of detecting LP-Gas, readily available for use at the berth.

**10-1.12** The shore facility shall ensure that portable electrical equipment is not used within 100 ft (30.5 m) of the transfer connection while transfer operations are in progress. When the transfer operation is completed (secured) and the transfer piping is disconnected, the equipment used shall be in compliance with 3-7.2.1 and 3-7.2.2.

*Exception: Electrical equipment listed for use in Class I, Division I locations and intrinsically safe equipment.*

**10-1.13** The berth owner or shore facility operator shall ensure that the following life safety equipment is positioned on the berth and ready for immediate use, while personnel are working on the berth or a vessel is alongside:

- (a) Life rings with attendant rope of sufficient length
- (b) Approved fire blanket

## 10-2 Pipelines.

**10-2.1** Pipelines shall be located on the dock or pier so that they are not exposed to damage from vehicular traffic or other possible cause of physical damage. Underwater pipelines shall be located or protected so that they are not exposed to damage from marine traffic, and their locations shall be posted or identified in accordance with federal regulations.

NOTE: Refer to *Code of Federal Regulations*, Title 49, Part 195.

**10-2.2** Isolation valving and bleed connections shall be provided at the loading or unloading manifold for both liquid and vapor return lines so that hoses and arms can be blocked off, drained or pumped out, and depressurized before disconnecting. Liquid isolation valves, regardless of size, and vapor valves 8 in. (20 mm) and larger in size shall be equipped with powered operators in addition to means for manual operation. Power-operated valves shall be capable of being closed from a remote control station located at least 50 ft (15 m) from the manifold area, as well as locally. Unless the valve will automatically fail closed on loss of power, the valve actuator and its power supply within 50 ft (15 m) of the valve shall be protected against operational failure due to fire exposure of at least 10 minutes. Valves shall be located at the point of hose or arm connection to the manifold. Bleeds or vents shall discharge to a safe area.

**10-2.3** In addition to the isolation valves at the manifold, each vapor return and liquid transfer line shall be provided with a readily accessible isolation valve located on shore near the approach to the pier or dock. Where more than one line is involved, the valves shall be grouped in one location. Valves shall be identified as to their service. Valves 8 in. (20 mm) and larger in size shall be equipped with power operators. Means for manual operation shall be provided.

**10-2.4** Pipelines used for liquid unloading only shall be provided with a check valve located at the manifold adjacent to the manifold isolation valve.

## 10-3 Prior to Transfer.

**10-3.1** Prior to starting transfer operations, the officer in charge of the vessel transfer operation and the person in charge of the shore facility shall inspect their respective facilities. The inspection shall ensure that all cargo transfer equipment and hoses have been maintained, tested, and are in operating condition. Following this inspection, they shall meet to discuss the transfer procedures and, when ready, each will notify the other that each facility is ready in all respects to start transfer operations.

NOTE: For guidance refer to *Code of Federal Regulations*, Title 33.

**10-3.2** The supervisor in charge of the shore facility and the officer in charge of vessel operations shall ensure that their respective facilities are, in all respects, ready to start transfer operations.

NOTE: For guidance refer to 46 *Code of Federal Regulations*, Part 35, 35-30.

**10-3.3** The shore facility transfer system shall be equipped with a remotely operated emergency shutdown system.

**10-3.4** The supervisor in charge of the shore facility shall ensure that a facilities Emergency Procedures Manual is readily available and contains the following information:

- (a) LP-Gas release response and emergency shutdown procedures
- (b) Telephone number for all emergency response organizations, U.S. Coast Guard, emergency medical facilities, and hospital(s)
- (c) Description and location of the facility fire systems and emergency equipment

**10-3.5** The supervisor in charge of the shore facility shall ensure that a facilities Standard Operating Procedures Manual is readily available and contains the following information:

- (a) Procedures for startup, operation, and shutdown of the transfer system and equipment. In the case of refrigerated product transfer, procedures for cooling down the transfer hose and line.
- (b) Telephone numbers for all emergency response organizations, U.S. Coast Guard, emergency medical facilities, and hospital(s).
- (c) Description, location, and operational guidelines for the facility fire systems and emergency equipment.

Each transfer operation shall be conducted in accordance with the Operations Manual, using established safe practices.

**10-3.6** The supervisor in charge of the shore facility shall ensure that, at the completion of the transfer, and prior to disconnect of the transfer hose or arm, the transfer connection has been purged of all liquid and depressurized. The liquid and vapor pressure shall be returned either back to the vessel or to the shore facility; it shall not be vented to the atmosphere.



## Chapter 11 Pipe and Tubing Sizing Tables

Table 11-1 Pipe Sizing Between First Stage and Second Stage Regulators: Nominal Pipe Size, Schedule 80

Pipe Length, ft	1/2 in. 0.546	3/4 in. 0.742	1 in. 0.957	1 1/4 in. 1.278	1 1/2 in. 1.5	2 in. 1.939	3 in. 2.9	3 1/2 in. 3.364	4 in. 3.826
30	1309	2927	5706	12185	18548	36368	104539	154295	216246
40	1121	2505	4884	10429	15875	31127	89472	132057	185079
50	993	2221	4328	9243	14069	27587	79297	117039	164032
60	900	2012	3922	8375	12748	24996	71849	106046	148625
70	828	1851	3608	7705	11728	22996	66100	97561	136733
80	770	1722	3357	7168	10911	21393	61494	90762	127204
90	723	1616	3149	6725	10237	20073	57697	85159	119351
100	683	1526	2975	6353	9670	18960	54501	80440	112738
150	548	1226	2389	5105	7765	15236	43766	64596	90533
200	469	1049	2045	4366	6646	13031	37458	55286	77484
250	416	930	1812	3870	5890	11549	33198	48999	68673
300	377	842	1642	3506	5337	10465	30080	44397	62223
350	347	775	1511	3226	4910	9627	27673	40844	57244
400	322	721	1405	3001	4568	8956	25745	37998	53255
450	303	676	1318	2816	4286	8403	24155	35652	49967
500	286	639	1245	2660	4048	7938	22817	33677	47199
600	259	579	1128	2410	3668	7192	20674	30514	42765
700	238	533	1038	2217	3375	6617	19020	28072	39344
800	222	495	966	2062	3139	6156	17694	26116	36602
900	208	465	906	1935	2946	5776	16602	24504	34342
1000	196	439	856	1828	2782	5456	15682	23146	32439
1500	158	353	687	1468	2234	4381	12593	18587	26050
2000	135	302	588	1256	1912	3750	10778	15908	22295

## Notes:

1. Maximum undiluted propane capacities listed are based on a gauge pressure of 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.
2. To convert to capacities at a gauge pressure of 5 psi with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15 psi with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

**Table 11-2 Pipe Sizing Between Second Stage Regulator and Appliance: Nominal Pipe Size, Schedule 80**

Pipe Length, ft	1/2 in. 0.546	3/4 in. 0.742	1 in. 0.957	1 1/4 in. 1.278	1 1/2 in. 1.5	2 in. 1.939	3 in. 2.9	3 1/2 in. 3.364	4 in. 3.826
10	207	462	901	1924	2928	5741	16503	24357	34137
20	142	318	619	1322	2012	3946	11342	16740	23462
30	114	255	497	1062	1616	3169	9108	13443	18841
40	98	218	426	909	1383	2712	7795	11506	16125
50	87	193	377	805	1226	2404	6909	10197	14292
60	78	175	342	730	1111	2178	6260	9239	12949
80	67	150	292	625	951	1864	5358	7908	11083
100	59	133	259	553	842	1652	4748	7009	9823
125	53	118	230	491	747	1464	4208	6212	8706
150	48	107	208	444	677	1327	3813	5628	7888
200	41	91	178	380	579	1135	3264	4817	6751
250	36	81	158	337	513	1006	2892	4269	5983
300	33	73	143	305	465	912	2621	3868	5421
350	30	68	132	281	428	839	2411	3559	4987
400	28	63	122	261	398	780	2243	3311	4640

Note: Maximum undiluted propane capacities listed are based on a 11 in. w.c. setting and 0.5 in. w.c. pressure drop. Capacities in 1000 Btu/hr.

**Table 11-3 Pipe Sizing Between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator): Schedule 40 Pipe Size (1 psi drop)**

Pipe Length, ft	1/2 in. 0.622	3/4 in. 0.824	1 in. 1.049	1 1/4 in. 1.38	1 1/2 in. 1.61	2 in. 2.067	3 in. 3.068	3 1/2 in. 3.548	4 in. 4.026
30	1843	3854	7259	14904	22331	43008	121180	177425	247168
40	1577	3298	6213	12756	19113	36809	103714	151853	211544
50	1398	2923	5507	11306	16939	32623	91920	134585	187487
60	1267	2649	4989	10244	15348	29559	83286	121943	169877
70	1165	2437	4590	9424	14120	27194	76622	112186	156285
80	1084	2267	4270	8767	13136	25299	71282	104368	145393
90	1017	2127	4007	8226	12325	23737	66882	97925	136417
100	961	2009	3785	7770	11642	22422	63176	92499	128859
150	772	1613	3039	6240	9349	18005	50733	74280	103478
200	660	1381	2601	5340	8002	15410	43421	63574	88564
250	585	1224	2305	4733	7092	13658	38483	56345	78493
300	530	1109	2089	4289	6426	12375	34868	51052	71120
350	488	1020	1922	3945	5911	11385	32078	46967	65430
400	454	949	1788	3670	5499	10591	29843	43694	60870
450	426	890	1677	3444	5160	9938	28000	40997	57112
500	402	841	1584	3253	4874	9387	26449	38725	53948
600	364	762	1436	2948	4416	8505	23965	35088	48880
700	335	701	1321	2712	4063	7825	22047	32280	44969
800	312	652	1229	2523	3780	7279	20511	30031	41835
900	293	612	1153	2367	3546	6830	19245	28177	39253
1000	276	578	1089	2236	3350	6452	18178	26616	37078
1500	222	464	875	1795	2690	5181	14598	21373	29775
2000	190	397	748	1537	2302	4434	12494	18293	25483

Note: Maximum undiluted propane capacities listed are based on a 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

Table 11-4 Pipe Sizing Between First Stage and Second Stage Regulators

Tubing Length, ft	(a) Outside Diameter Copper Tubing, Type K					Tubing Length, ft	(b) Outside Diameter Refrigeration Tubing				
	$\frac{3}{4}$ in. 0.305	$\frac{1}{2}$ in. 0.402	$\frac{5}{8}$ in. 0.527	$\frac{3}{4}$ in. 0.652	$\frac{7}{8}$ in. 0.745		$\frac{3}{8}$ in. 0.311	$\frac{1}{2}$ in. 0.436	$\frac{5}{8}$ in. 0.555	$\frac{3}{4}$ in. 0.68	$\frac{7}{8}$ in. 0.785
30	284	587	1193	2085	2959	30	299	726	1367	2329	3394
40	243	502	1021	1785	2532	40	256	621	1170	1993	2904
50	216	445	905	1582	2244	50	227	551	1037	1766	2574
60	195	403	820	1433	2033	60	206	499	939	1600	2332
70	180	371	754	1319	1871	70	189	459	864	1472	2146
80	167	345	702	1227	1740	80	176	427	804	1370	1996
90	157	374	659	1151	1633	90	165	401	754	1285	1873
100	148	306	622	1087	1542	100	156	378	713	1214	1769
150	119	246	500	873	1239	150	125	304	572	975	1421
200	102	210	428	747	1060	200	107	260	490	834	1216
250	90	186	379	662	940	250	95	230	434	739	1078
300	82	169	343	600	851	300	86	209	393	670	976
350	75	155	316	552	783	350	79	192	362	616	898
400	70	144	294	514	729	400	74	179	337	573	836
450	66	136	276	482	654	450	69	168	316	538	784
500	62	128	260	455	646	500	65	158	298	508	741
600	56	116	236	412	585	600	59	144	270	460	671
700	52	107	217	379	538	700	54	132	249	424	617
800	48	99	202	353	501	800	51	123	231	394	574
900	45	93	189	331	470	900	48	115	217	370	539
1000	43	88	179	313	444	1000	45	109	205	349	509
1500	34	71	144	251	356	1500	36	87	165	281	409
2000	29	60	123	215	305	2000	31	75	141	240	350

## Notes:

1. Maximum undiluted propane capacities listed are based on a gauge pressure of 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.
2. To convert to capacities at a gauge pressure of 5 psi setting with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15 psi setting with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

**Table 11-5 Copper Tube Sizing Between Second Stage Regulator and Appliance**

Tubing Length, ft	(a) Outside Diameter Copper Tubing, Type K					Tubing Length, ft	(b) Outside Diameter, Refrigeration Tubing				
	<sup>3</sup> / <sub>8</sub> in. 0.305	<sup>1</sup> / <sub>2</sub> in. 0.402	<sup>5</sup> / <sub>8</sub> in. 0.527	<sup>3</sup> / <sub>4</sub> in. 0.652	<sup>7</sup> / <sub>8</sub> in. 0.745		<sup>3</sup> / <sub>4</sub> in. 0.311	<sup>1</sup> / <sub>2</sub> in. 0.436	<sup>5</sup> / <sub>8</sub> in. 0.555	<sup>3</sup> / <sub>4</sub> in. 0.68	<sup>7</sup> / <sub>8</sub> in. 0.785
10	45	93	188	329	467	10	47	115	216	368	536
20	31	64	129	226	321	20	32	79	148	253	368
30	25	51	104	182	258	30	26	63	119	203	296
40	21	44	89	156	221	40	22	54	102	174	253
50	19	39	79	138	196	50	20	48	90	154	224
60	17	35	71	125	177	60	18	43	82	139	203
80	15	30	61	107	152	80	15	37	70	119	174
100	13	27	54	95	134	100	14	33	62	106	154
125	11	24	48	84	119	125	12	29	55	94	137
150	10	21	44	76	108	150	11	26	50	85	124
200	9	18	37	65	92	200	9	23	43	73	106
250	8	16	33	58	82	250	8	20	38	64	94
300	7	15	30	52	74	300	8	18	34	58	85
350	7	14	28	48	68	350	7	17	32	54	78
400	6	13	26	45	63	400	6	16	29	50	73

**Table 11-6 Copper Tube Sizing Between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)**

Tubing Length, ft	Outside Diameter Copper Tubing, Type L					Tubing Length, ft	Outside Diameter Copper Tubing, Type L				
	<sup>3</sup> / <sub>8</sub> in. 0.315	<sup>1</sup> / <sub>2</sub> in. 0.430	<sup>5</sup> / <sub>8</sub> in. 0.545	<sup>3</sup> / <sub>4</sub> in. 0.666	<sup>7</sup> / <sub>8</sub> in. 0.785		<sup>3</sup> / <sub>8</sub> in. 0.315	<sup>1</sup> / <sub>2</sub> in. 0.430	<sup>5</sup> / <sub>8</sub> in. 0.545	<sup>3</sup> / <sub>4</sub> in. 0.666	<sup>7</sup> / <sub>8</sub> in. 0.785
30	309	700	1303	2205	3394	350	82	185	345	584	898
40	265	599	1115	1887	2904	400	76	172	321	543	836
50	235	531	988	1672	2574	450	71	162	301	509	784
60	213	481	896	1515	2332	500	68	153	284	481	741
70	196	443	824	1394	2146	600	61	138	258	436	671
80	182	412	767	1297	1996	700	56	127	237	401	617
90	171	386	719	1217	1873	800	52	118	221	373	574
100	161	365	679	1149	1769	900	49	111	207	350	539
150	130	293	546	923	1421	1000	46	105	195	331	509
200	111	251	467	790	1216	1500	37	84	157	266	409
250	90	222	414	700	1078	2000	32	72	134	227	350
300	89	201	375	634	976						

Note: Maximum undiluted propane capacities listed are based on 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

Table 11-7 Polyethylene Plastic Pipe Sizing Between First Stage and Second Stage Regulator

Plastic Pipe Length, ft	Plastic Pipe Nominal Outside Diameter (IPS) (dimensions in parenthesis are inside diameter)					
	$\frac{1}{2}$ in. SDR 9.33 (0.660)	$\frac{3}{4}$ in. SDR 11.0 (0.860)	1 in. SDR 11.00 (1.077)	$1\frac{1}{4}$ in. SDR 10.00 (1.328)	$1\frac{1}{2}$ in. SDR 11.00 (1.554)	2 in. SDR 11.00 (1.943)
30	2143	4292	7744	13416	20260	36402
40	1835	3673	6628	11482	17340	31155
50	1626	3256	5874	10176	15368	27612
60	1473	2950	5322	9220	13924	25019
70	1355	2714	4896	8483	12810	23017
80	1261	2525	4555	7891	11918	21413
90	1183	2369	4274	7404	11182	20091
100	1117	2238	4037	6994	10562	18978
125	990	1983	3578	6199	9361	16820
150	897	1797	3242	5616	8482	15240
175	826	1653	2983	5167	7803	14020
200	778	1539	2775	4807	7259	13043
225	721	1443	2603	4510	6811	12238
250	681	1363	2459	4260	6434	11560
275	646	1294	2336	4046	6111	10979
300	617	1235	2228	3860	5830	10474
350	567	1136	2050	3551	5363	9636
400	528	1057	1907	3304	4989	8965
450	495	992	1789	3100	4681	8411
500	468	937	1690	2928	4422	7945
600	424	849	1531	2653	4007	7199
700	390	781	1409	2441	3686	6623
800	363	726	1311	2271	3429	6161
900	340	682	1230	2131	3217	5781
1000	322	644	1162	2012	3039	5461
1500	258	517	933	1616	2441	4385
2000	221	443	798	1383	2089	3753

Note: Maximum undiluted propane capacities listed are based on 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

**Table 11-8 Polyethylene Plastic Tube Sizing, Sizing Between First Stage and Second Stage Regulator**

Plastic Tubing Length, ft	Plastic Tubing Size (CTS) (dimensions in parenthesis are inside diameter)	
	1/2 in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
30	762	5225
40	653	4472
50	578	3964
60	524	3591
70	482	3304
80	448	3074
90	421	2884
100	397	2724
125	352	2414
150	319	2188
175	294	2013
200	273	1872
225	256	1757
250	242	1659
275	230	1576
300	219	1503
350	202	1383
400	188	1287
450	176	1207
500	166	1140
600	151	1033
700	139	951
800	129	884
900	121	830
1000	114	784
1500	92	629
2000	79	539

Note: Maximum undiluted propane capacities listed are based on 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

**Table 11-9 Polyethylene Plastic Tube Sizing, Sizing Between Single or Second Stage Regulator and Building**

Plastic Tubing Length, ft	Plastic Tubing Size (CTS) (dimensions in parenthesis are inside diameter)	
	1/2 in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
10	121	829
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113

Note: Maximum undiluted propane capacities listed are based on 11 inch water column setting and a 0.5 inch water column pressure drop. Capacities in 1000 Btu/hr.

NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites*, 1994 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 1997 edition.

NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, 1994 edition.

NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*, 1996 edition.

NFPA 59, *Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants*, 1998 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*, 1995 edition.

NFPA 70, *National Electrical Code®*, 1996 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*, 1994 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 1995 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 1994 edition.

NFPA 101®, *Life Safety Code®*, 1997 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, 1994 edition.

NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*, 1997 edition.

NFPA 501C, *Standard on Recreational Vehicles*, 1996 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*, 1996 edition.

## Chapter 12 Referenced Publications

**12-1** The following documents or portions thereof are referenced within this code as mandatory requirements and shall be considered part of the requirements of this code. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this code. Some of these mandatory documents might also be referenced in this code for specific informational purposes and, therefore, are also listed in Appendix J.

**12-1.1 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1998 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 1996 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1996 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 1998 edition.

**12-1.2 API Publications.** American Petroleum Institute, 2101 L St., NW, Washington, DC 20037.

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

API Standard 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 1996.

**12-1.3 ASCE Publication.** American Society of Civil Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

ASCE 7, *Design Loads for Buildings and Other Structures*, 1993.

**12-1.4 ASME Publications.** American Society for Mechanical Engineers, 345 East 47th St., New York, NY 10017.

"Rules for the Construction of Unfired Pressure Vessels," Section VIII, *ASME Boiler and Pressure Vessel Code*, 1992.

ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*, 1993.

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*, 1985.

**12-1.5 ASTM Publications.** American Society for Testing and Materials, 100 Bar Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A47, *Standard Specification for Ferritic Malleable Iron Castings*, 1990.

ASTM A48, *Standard Specification for Gray Iron Castings*, 1994.

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*, 1993.

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*, 1994.

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

ASTM A513, *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing*, 1992.

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

ASTM A539, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines*, 1990.

ASTM B42, *Standard Specification for Seamless Copper Pipe, Standard Sizes*, 1993.

ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*, 1991.

ASTM B86, *Standard Specification for Zinc-Alloy Die Casting*, 1988.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, 1993.

ASTM B135, *Standard Specification for Seamless Brass Tube*, 1991.

ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, 1993.

ASTM D2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, 1994.

ASTM D2683, *Standard Specification for Socket-Type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe*, 1993.

ASTM D3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*, 1997.

ASTM F1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing*, 1993.

**12-1.6 AWS Publication.** American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

ANSI Z49.1-1988, *Safety in Welding and Cutting*.

**12-1.7 CGA Publications.** Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

ANSI/CGA C-4-1990, *Method of Marking Portable Compressed Gas Containers to Identify the Material Contained*.

CGA S-1.1, *Pressure Relief Device Standards, Part 1, Cylinders for Compressed Gases*, 1994.

**12-1.8 Federal Regulations.** U.S. Government Printing Office, Washington, DC 20401.

*Code of Federal Regulations*, Title 49. (Also available from the Association of American Railroads, American Railroads Bldg., 1920 L Street NW, Washington, DC 20036 and American Trucking Assns., Inc., 2201 Mill Road, Alexandria, VA 22314.)

**12-1.9 IAS Publication.** International Approval Services, U.S., Inc., 8501 East Pleasant Valley Road, Cleveland, OH 44131.

AGA LC-1, *Interior Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*, 1991.

**12-1.10 ICBO Publications.** International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, CA 90601.

*Uniform Building Code*, 1991.

ICC, *Rules for Construction of Unfired Pressure Vessels*.

**12-1.11 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, 1993.

UL 144, *Standard for LP-Gas Regulators*, 1994.

UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*, 1992.

UL 147B, *Standard for Nonrefillable (Disposal) Type Metal Container Assemblies for Butane*, 1992.

UL 567, *Standard Pipe Connectors for Flammable and Combustible Liquids and LP-Gas*, 1992.

## Appendix A Explanatory Material

*Appendix A is not a part of the requirements of this NFPA document but is included for informational purposes only. This appendix contains explanatory material, numbered to correspond with the applicable text paragraphs.*

**A-1-1.1** To test for the presence of ammonia, allow a moderate vapor stream of the product to be tested to escape from the container. A rotary, slip tube, or fixed level gauge is a convenient vapor source. Wet a piece of red litmus paper by pouring distilled water over it while holding it with clean tweezers. Hold the wetted litmus paper in the vapor stream from the container for 30 seconds. The appearance of any blue color on the litmus paper indicates that ammonia is present in the product.

NOTE 1: Since the red litmus paper will turn blue when exposed to any basic (alkaline) solution, care is required in making the test and interpreting the results. Tap water, saliva, perspiration, or hands that have been in contact with water having a pH greater than 7, or with any alkaline solution, will give erroneous results.

NOTE 2: For additional information on the nature of this problem and conducting the test, see NPGA Safety Bulletin

122, *Recommendations for Prevention of Ammonia Contamination of LP-Gas*, published by the National Propane Gas Association.

**A-1-3.1** It is recognized that no odorant will be completely effective as a warning agent in every circumstance.

It is recommended that odorants be qualified as to compliance with 1-3.1 by tests or experience. Where qualifying is by tests, such tests should be certified by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb (0.45 kg) per 10,000 gal (37.9 m<sup>3</sup>) of liquid LP-Gas has been recognized as an effective odorant. Other odorants and quantities meeting the provisions of 1-3.1 may be used. Research on odorants has shown that thiophane (tetrahydrothiophene) in a ratio of at least 6.4 lb (2.9 kg) per 10,000 gal (37.9 m<sup>3</sup>) of liquid LP-Gas may satisfy the requirements of 1-3.1.

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

**A-1-3.2** Another method of determining the presence of odorant is the stain tube test. This method uses a small handheld pump to draw a sample across a filled glass tube and reading the length of color change. For additional information see GPA Standard 2188-89, *Tentative Method for the Determination of Ethyl Mercaptan in LP-Gas Using Length of Stain Tubes* and CAN/CGSB-3.0 No. 18.5-M89, *Test for Ethyl Mercaptan Odorant in Propane, Field Method*. At the time of the preparation of this code additional analytical methods were under development.

**A-1-6 Approved.** The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

**A-1-6 Authority Having Jurisdiction.** The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having juris-

dition; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

**A-1-6 External Pressure Relief Valve.** Describes the type of relief valves used on older domestic tanks, relief valve manifolds, and piping protection.

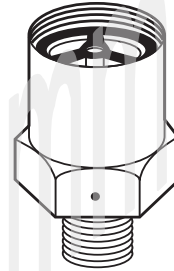


Figure A-1-6(a) External pressure relief valve.

**A-1-6 Flush-Type Full Internal Pressure Relief Valve.** Describes the type of relief valve being required on cargo vehicles in most states.

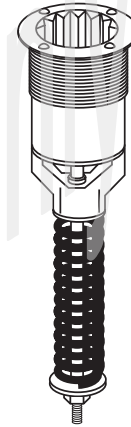


Figure A-1-6(b) Flush-type full internal pressure relief valve.

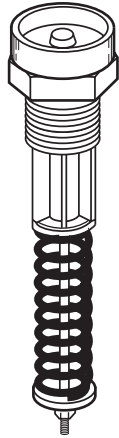
**A-1-6 Full Internal Pressure Relief Valve.** Describes the type of relief valve being converted to for engine fuel use.



Figure A-1-6(c) Full internal pressure relief valve.



**A-1-6 Internal Spring-Type Pressure Relief Valve.** Describes the type of relief valve used on modern domestic tanks; looks similar to full internal relief valve but has seat and poppet above the tank connection.



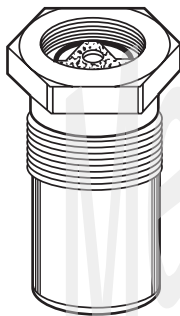
**Figure A-1-6(d) Internal spring-type pressure relief valve.**

**A-1-6 Listed.** The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**A-1-6 Sump-Type Full Internal Pressure Relief Valve.** Describes the type of relief valve used on older engine fuel tanks.

**A-2-2.1.3** Prior to April 1, 1967, regulations of the U.S. Department of Transportation were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply. Available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

Construction of containers to the API-ASME Code, has not been authorized after July 1, 1961.



**Figure A-1-6(e) Sump-type full internal pressure relief valve.**

**A-2-3.1.5(a)** See Table F-5.3.4.

**A-2-4.4.1(c)3** The *Code of Federal Regulations*, Title 49, Part 192.281 (e), states:

Mechanical joints. Each compression-type mechanical joint on plastic pipe must comply with the following:

(1) The gasket material in the coupling must be compatible with the plastic.

(2) A rigid internal tubing stiffener, other than a split tubular stiffener, must be used in conjunction with the coupling.

Part 192.283 (b) states:

(b) Mechanical joints. Before any written procedure established under 192.273 (b) is used for plastic making mechanical plastic pipe joints that are designed to withstand tensile forces, the procedure must be qualified by subjecting 5 specimen joints made according to the procedure to the following tensile test:

- (1) Use an apparatus for the test as specified in ASTM D638.77a (except for conditioning).
- (2) The specimen must be of such length that the distance between the grips of the apparatus and the end of the stiffener does not affect the joint strength.
- (3) The speed of testing is 5.0 mm (0.2 in.) per min, plus or minus 25 percent.
- (4) Pipe specimens less than 102 mm (4 in.) in diameter are qualified if the pipe yields to an elongation less than 25 percent or failure initiates outside the joint area.
- (5) Pipe specimens 102 mm (4 in.) and larger in diameter shall be pulled until the pipe is subjected to a tensile stress equal to or greater than the maximum thermal stress that would be produced by a temperature change of 55°C (100°F) or until the pipe is pulled from the fitting. If the pipe pulls from the fitting, the lowest value of the five test results or the manufacturer's rating, whichever is lower, must be used in the design calculations for stress.
- (6) Each specimen that fails at the grips must be retested using new pipe.
- (7) Results obtained pertain only to the outside diameter and material of the pipe tested, except that testing of a heavier wall pipe may be used to qualify pipe of the same material but with a lesser wall thickness.

**A-2-4.4.1(c)4** Persons joining PE pipe should be trained under the applicable joining procedure established by the manufacturer including the following:

- (a) Appropriate training in the use of joining procedures.
- (b) Making a specimen joint from pipe sections joined according to the procedures.
- (c) Visually examining these joints during and after assembly.

**A-3.2.4.1(f)** Generally, a light reflecting color paint is preferred unless the system is installed in an extremely cold climate.

**A-3-2.4.7(d)** For information on corrosion protection of containers and piping systems, see the following:

- (a) API Publication 1632, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems*, 1983.
- (b) Underwriters Laboratories of Canada, ULC S603.1-M, 1982, *Standard for Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids*.
- (c) National Association of Corrosion Engineers Standard RP-01-69 (1983 Rev.), Recommended Practice, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*.
- (d) National Association of Corrosion Engineers Standard RP-02-85, Recommended Practice, *Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems*.

(e) Underwriters Laboratories Inc., UL 1746, *External Corrosion Protection Systems for Steel Underground Storage Tanks*, 1993.

**A-3-2.4.8(f)** See A-3-2.4.7(d).

**A-3-2.4.8(h)2** If vapor is vented too rapidly, the pressure drop due to the refrigeration of the liquid can lead to the erroneous conclusion that no liquid remains in the container.

**A-3-2.10.10(a)** This is not to be construed to mean that flexible connectors must be used if provisions were incorporated in the design to compensate for these effects.

**A-3-4.8.3** The weight will be affected by the specific gravity of the liquefied petroleum (LP) gas. Weights varying from 16.0 oz (454 g) to 16.8 oz (476 g) are recognized as being within the range of what is nominal.

**A-3-7.2.2** When classifying the extent of hazardous area, consideration should be given to possible variations in the spotting of tank cars and tank vehicles at the unloading points and the effect these variations of actual spotting point may have on the point of connection.

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

**A-3-10.2.2** The National Fire Protection Association, American Petroleum Institute, and National Propane Gas Association publish material, including visual aids, useful in such planning.

**A-3-10.2.3** In recent years the concept of total product control systems has been developed. Facilities that have redundant automatic product controls systems provide a high level of confidence that propane will not be released during an emergency. Therefore, not only will the storage be protected from a fire that could lead to container rupture, but major fires at the facility would be prevented. The public would be protected, fire fighting operations would be safer, and applications of large quantities of water would not be needed to prevent tank failure.

A fire safety analysis should include the following:

- (a) An analysis of local conditions of hazard within the container site
- (b) Exposure to or from other properties, population density, and congestion within the site
- (c) The probable effectiveness of plant fire brigades or local fire departments based on adequate water supply, response time, and training
- (d) Consideration for the adequate application of water by hose stream or other method for effective control of leakage, fire, or other exposures

**A-3-10.3.1** For LP-Gas fixed storage facilities of 60,000-gal (227-m<sup>3</sup>) water capacity or less, a competent fire safety analysis (see 3-10.2.3) could indicate that applied insulating coatings are quite often the most practical solution for special protection.

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

**A-4.4.2.1** The maximum permitted filling limit in percent by weight should be as shown in Table 4-4.2.1.

**A-5-4.1** The filling process in (e) refers to the time period beginning when a cylinder or cylinders are brought to a dispensing station to be filled and ending when the last cylinder is filled and all the cylinders are removed from the filling area. This is meant to define a continuous process with the cylinders being unattended for only brief periods, such as operator breaks or lunch.

**A-6-3.3.4** For more information, see NPGA Safety Bulletin 114, *Guide to Hose Inspection*.

**A-8-2.2.1** Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply, which are available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

**A-8-2.7.1(a)** The luggage compartment (trunk) of a vehicle can constitute such an enclosure provided it meets all these requirements.

## Appendix B Properties of LP-Gases

*This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.*

### B-1 Approximate Properties of LP-Gases.

#### B-1.1 Source of Property Values.

**B-1.1.1** The property values for the LP-Gases are based on average industry values and include values for LP-Gases coming from natural gas liquids plants as well as those coming from petroleum refineries. Thus, any particular commercial propane or butane might have properties varying slightly from the values shown. Similarly, any propane-butane mixture might have properties varying from those obtained by computation from these average values (see B-1.2 for computation method used). Since these are average values, the interrelationships between them (e.g., lb per gal, specific gravity) will not cross-check perfectly in all cases.

**B-1.1.2** Such variations are not sufficient to prevent the use of these average values for most engineering and design purposes. They stem from minor variations in composition. The commercial grades are not pure (CP—Chemically Pure) propane or butane, or mixtures of the two, but might also contain small and varying percentages of ethane, ethylene, propylene, isobutane, or butylene, which can cause slight variations in property values. There are limits to the accuracy of even the most advanced testing methods used to determine the percentages of these minor components in any LP-Gas.

**B-1.2 Approximate Properties of Commercial LP-Gases.** The principal properties of commercial propane and commercial butane are shown in Table B-1.2. Reasonably accurate property values for propane-butane mixtures can be obtained by computation, applying the percentages by weight of each in the mixture to the values for the property it is desired to obtain. Slightly more accurate results for vapor pressure are obtained by using the percentages by volume. Very accurate results can be obtained using data and methods explained in petroleum and chemical engineering data books.

Table B-1.2 (English) Approximate Properties of LP-Gases

	Commercial Propane	Commercial Butane
Vapor pressure in psi at		
70°F	127	17
100°F	196	37
105°F	210	41
130°F	287	69
Specific gravity of liquid at 60°F	0.504	0.582
Initial boiling point at 14.7 psia, °F	-44	15
Weight per gallon of liquid at 60°F, lb	4.20	4.81
Specific heat of liquid, Btu/lb at 60°F	0.630	0.549
Cubic feet of vapor per gallon at 60°F	36.38	31.26
Cubic feet of vapor per pound at 60°F	8.66	6.51
Specific gravity of vapor (air = 1) at 60°F	1.50	2.01
Ignition temperature in air, °F	920-1120	900-1000
Maximum flame temperature in air, °F	3595	3615
Limits of flammability in air, percent of vapor in air/gas mixture:		
Lower	2.15	1.55
Upper	9.60	8.60
Latent heat of vaporization at boiling point		
Btu per pound	184	167
Btu per gallon	773	808
Total heating values after vaporization		
Btu per cubic foot	2488	3280
Btu per pound	21,548	21,221
Btu per gallon	91,502	102,032

Table B-1.2 (Metric) Approximate Properties of LP-Gases

	Commercial Propane	Commercial Butane
Vapor pressure in kPa at		
20°C	895	103
40°C	1482	285
45°C	1672	345
55°C	1980	462
Specific gravity	0.504	0.582
Initial boiling point at 1.00 atm. pressure, °C	-42	-9
Weight per cubic meter of liquid at 15.56°C, kg	504	582
Specific heat of liquid, kilojoule per kilogram, at 15.56°C	1.464	1.276
Cubic meter of vapor per liter of liquid at 15.56°C	0.271	0.235
Cubic meter of vapor per kilogram of liquid at 15.56°C	0.539	0.410
Specific gravity of vapor (air = 1) at 15.56°C	1.50	2.01
Ignition temperature in air, °C	493-549	482-538
Maximum flame temperature in air, °C	1980	2008
Limits of flammability in air, % of vapor in air/gas mixture		
Lower	2.15	1.55
Upper	9.60	8.60
Latent heat of vaporization at boiling point		
Kilojoule per kilogram	428	388
Kilojoule per liter	216	226
Total heating value after vaporization		
Kilojoule per cubic meter	92 430	121 280
Kilojoule per kilogram	49 920	49 140
Kilojoule per liter	25 140	28 100

**B-1.3 Specifications of LP-Gases.** Specifications of LP-Gases covered by this code are listed in Gas Processors Association, Standard 2140, *Liquefied Petroleum Gas Specifications for Test Methods*, or ASTM D1835, *Specification for Liquefied Petroleum (LP) Gases*.

## Appendix C Design, Construction, and Requalification of DOT (ICC) Cylinders

*This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.*

### C-1 Scope.

#### C-1.1 Application.

**C-1.1.1** This appendix provides general information on cylinders referred to in this code. For complete information, consult the applicable specification (*see C-2.1*). The water capacity of such cylinders is not permitted to be more than 1000 lb (454 kg).

**C-1.1.2** This appendix is not applicable to Department of Transportation (DOT) tank car portable tank container or cargo tank specifications. Portable and cargo tanks are basically ASME containers and are covered in Appendix D.

**C-1.1.3** Prior to April 1, 1967, these specifications were promulgated by the Interstate Commerce Commission (ICC). On this date, certain functions of the ICC, including the promulgation of specifications and regulations dealing with LP-Gas cylinders, were transferred to the Department of Transportation. Throughout this appendix both ICC and DOT are used, ICC applying to dates prior to April 1, 1967, and DOT to subsequent dates.

### C-2 LP-Gas Cylinder Specifications.

**C-2.1 Publishing of DOT Cylinder Specifications.** DOT cylinder specifications are published under Title 49, *Code of Federal Regulations*, Parts 171–190, available from U.S. Government Printing Office, Washington, D.C. The information in this publication is also issued as a Tariff at approximately three-year intervals by the Bureau of Explosives, American Railroads Building, 1920 L Street NW, Washington, DC 20036.

#### C-2.2 DOT Specification Nomenclature.

**C-2.2.1** The specification designation consists of a one-digit number, sometimes followed by one or more capital letters, then by a dash and a three-digit number. The one-digit number alone, or in combination with one or more capital letters, designates the specification number. The three-digit number following the dash shows the service pressure for which the cylinder is designed. Thus, "4B-240" indicates a cylinder built to Specification 4B for a 240-psi (1650-kPa) service pressure. (*See C-2.2.3.*)

**C-2.2.2** The specification gives the details of cylinder construction, such as material used, method of fabrication, tests required, and inspection method, and prescribes the service pressure or range of service pressures for which that specification can be used.

**C-2.2.3** The term *service pressure* is analogous to, and serves the same purpose as, the ASME *design pressure*. However, it is not identical, representing instead the highest pressure to which the cylinder will normally be subjected in transit or in use but not necessarily the maximum pressure to which it might be subjected under emergency conditions in transportation. The service pressure stipulated for the LP-Gases is based on the vapor pressures exerted by the product in the cylinder at two different temperatures, the higher pressure of the two becoming the service pressure, as follows:

- (a) The pressure in the cylinder at 70°F (21°C) must be less than the service pressure for which the cylinder is marked.
- (b) The pressure in the container at 130°F (54.4°C) must not exceed  $\frac{5}{4}$  times the pressure for which the cylinder is marked.

**Example:** Commercial propane has a vapor pressure at 70°F (21°C) of 132 psi (910 kPa). However, its vapor pressure at 130°F (54.4°C) is 300 psi (2070 kPa), so service pressure [ $\frac{5}{4}$  times, which must not exceed 300 psi (2070 kPa)] is 300 divided by  $\frac{5}{4}$ , or 240 psi (1650 kPa). Thus, commercial propane requires at least a 240-psi (1650-kPa) service pressure cylinder.

#### C-2.3 DOT Cylinder Specifications Used for LP-Gas.

**C-2.3.1** A number of different specifications were approved by DOT (and its predecessor ICC) for use with LP-Gases. Some of these are no longer published or used for new construction. However, cylinders built under these old specifications, if properly maintained and requalified, are still acceptable for LP-Gas transportation.

**C-2.3.2** DOT specifications cover primarily safety in transportation. However, in order for the product to be used, it is necessary for it to come to rest at the point of use and serve as LP-Gas storage during the period of use. Cylinders adequate for transportation are also deemed to be adequate for use as provided in NFPA 58. As small-size ASME containers were not available at the time tank truck delivery was started, ICC (now DOT) cylinders have been equipped for tank truck deliveries and permanently installed.

**C-2.3.3** The DOT cylinder specifications most widely used for the LP-Gases are shown in Table C-2.3.3. The differing materials of construction, the method of fabrication, and the date of the specification reflect the progress made in knowledge of the products to be contained and the improvement in metallurgy and methods of fabrication.

### C-3 Requalification, Retesting, and Repair of DOT Cylinders.

**C-3.1 Application.** This section outlines the requalification, retesting, and repair requirements for cylinders but should be used only as a guide. For official information, the applicable DOT regulations should be consulted.

#### C-3.2 Requalification (Including Retesting) of DOT Cylinders.

**C-3.2.1** DOT rules prohibit cylinders from being refilled, continued in service, or transported unless they are properly qualified or requalified for LP-Gas service in accordance with DOT regulations.

**C-3.2.2** DOT rules require a careful examination of every cylinder each time it is to be filled, and it must be rejected if there is evidence of exposure to fire, bad gouges or dents, seriously corroded areas, leaks, or other conditions indicating possible weaknesses that might render it unfit for service. The following disposition is to be made of rejected cylinders:

- (a) Cylinders subjected to fire are required to be requalified, reconditioned, or repaired in accordance with C-3.3 or permanently removed from service except that DOT 4E (aluminum) cylinders must be permanently removed from service.
- (b) Cylinders showing serious physical damage or leaks or showing a reduction in the marked tare weight of 5 percent or more are required to be retested in accordance with C-3.2.4(a) or (b) and, if necessary, repaired in accordance with C-3.3.

Table C-2.3.3

Specification No. and Marking	Material of Construction	Method of Fabrication
26-150*	Steel	Welded and brazed
3B-300	Steel	Seamless
4-300	Steel	Welded
4B-300	Steel	2 piece welded and brazed
4B-240	Steel	2 piece welded and brazed
4BA-240	Alloy steel	2 piece welded and brazed
4E-240	Aluminum	Welded and brazed
4BW-240	Steel	3 piece welded

\*The term *service pressure* had a different connotation at the time the specification was adopted.

**C-3.2.3** All cylinders, including those apparently undamaged, are required to be periodically requalified for continued service. The first requalification for a new cylinder is required within 12 years after the date of manufacture. Subsequent requalifications are required within the periods specified under the requalification method used.

**C-3.2.4** DOT regulations permit three alternative methods of requalification for most commonly used LP-Gas cylinders (see *DOT regulations for permissible requalification methods for specific cylinder specifications*). Two use hydrostatic testing, and the third uses a carefully made and duly recorded visual examination by a competent person. In the case of the two hydrostatic test methods, only test results are recorded, but a careful visual examination of each cylinder is also required. DOT regulations cite in detail the data to be recorded for the hydrostatic test methods, the observations to be made during the recorded visual examination method, and the marking of cylinders to indicate the requalification date and the method used. The three methods are outlined as follows:

(a) The water jacket-type hydrostatic test is permitted to be used to requalify cylinders for 12 years before the next requalification is due. A pressure of twice the marked service pressure is applied, using a water jacket (or the equivalent) so that the total expansion of the cylinder during the applica-

tion of the test pressure can be observed and recorded for comparison with the permanent expansion of the cylinder after depressurization. The following disposition is made of cylinders tested in this manner:

1. Cylinders that pass the retest and the visual examination required with it (see C-3.2.4) are marked with the date and year of the test (Example: " 6-90," indicating requalification by the water jacket test method in June 1990) and are permitted to be placed back in service.
2. Cylinders that leak, or for which the permanent expansion exceeds 10 percent of the total expansion (12 percent for Specification 4E aluminum cylinders), must be rejected. If rejected for leakage, cylinders are permitted to be repaired in accordance with C-3.3.

(b) Cylinders for seven years before the next requalification is due. A pressure of twice the marked service pressure is applied, but no provision is made for measuring total and permanent expansion during the test outlined in C-3.2.4(a). The cylinder is carefully observed while under the test pressure for leaks, undue swelling, or bulging indicating weaknesses. The following disposition is made of cylinders tested in this matter:

1. Cylinders that pass the test and the visual examination required with it (see C-3.2.4) are marked with the date and year of the retest followed by an *S* (Example: 8-91S, indicating requalification by the simple hydrostatic test method in August 1991) and are permitted to be placed back in service.
2. Cylinders developing leaks or showing undue swelling or bulging must be rejected. If rejected for leaks, Cylinders are permitted to be repaired in accordance with C-3.3.

(c) The recorded visual examination is permitted to be used to requalify cylinders for five years before the next qualification is due provided the cylinder has been used exclusively for LP-Gas commercially free of corroding components. Inspection is to be made by a competent person, using as a guide the Compressed Gas Association *Standard for Visual Inspection of Steel Compressed Gas Cylinders* (CGA Pamphlet C-6), and recording the inspection results as required by DOT regulations. [Note: Reference to NPGA Safety Bulletin 118, *Recommended Procedures for Visual Inspection and Requalification of DOT (ICC) Cylinders in LP-Gas Service*, is also recommended.] The following disposition is to be made of cylinders inspected in this manner:

1. Cylinders that pass the visual examination are marked with the date and year of the examination followed by an *E* (Example: 7-90E, indicating requalification by the recorded visual examination method in July 1990) and are permitted to be placed back in service.
2. Cylinders that leak, show serious denting or gouging, or excessive corrosion must either be scrapped or repaired in accordance with C-3.3.

**C-3.3 Repair of DOT Cylinders.** Repair of DOT cylinders is required to be performed by a manufacturer of the type of cylinder to be repaired or by a repair facility authorized by DOT.

Repairs normally made are for fire damage, leaks, denting, and gouges and for broken or detached valve-protecting collars or foot rings.

## Appendix D Design of ASME and API-ASME Containers

*This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.*

### D-1 General.

#### D-1.1 Application.

**D-1.1.1** This appendix provides general information on containers designed and constructed in accordance with ASME or API-ASME codes, usually referred to as ASME containers. For complete information on either ASME or API-ASME containers, the applicable code should be consulted. Construction of containers to the API-ASME code has not been authorized since July 1, 1961.

**D-1.1.2** DOT (ICC) specification portable tank containers and cargo tanks are either ASME or API-ASME containers. In writing these specifications, which should be consulted for complete information, additions were made to these pressure vessel codes to cover the following:

- Protection of container valves and appurtenances against physical damage in transportation
- Hold-down devices for securing cargo containers to conventional vehicles
- Attachments to relatively large [6000 gal (22.7 m<sup>3</sup>) or more water capacity] cargo containers in which the container serves as a stress member in lieu of a frame

#### D-1.2 Development of ASME and API-ASME Codes.

**D-1.2.1** ASME-type containers of approximately 12,000-gal (45.4-m<sup>3</sup>) water capacity or more were initially used for bulk storage in processing, distribution, and industrial plants. As the industry expanded and residential and commercial usage increased, the need for small ASME containers with capacities greater than the upper limit for cylinders grew. This ultimately resulted in the development of cargo containers for tank trucks and the wide use of ASME containers ranging in size from less than 25 gal (0.1 m<sup>3</sup>) to 120,000 gal (454 m<sup>3</sup>) water capacity.

**D-1.2.2** The American Society of Mechanical Engineers (ASME) in 1911 set up the Boiler and Pressure Vessel Committee to formulate "standard rules for the construction of steam boilers and other pressure vessels." The ASME *Boiler and Pressure Vessel Code*, first published in 1925, has been revised regularly since that time. During this period there have been changes in the code as materials of construction improved and more was known about them and as fabrication methods changed and inspection procedures were refined.

**D-1.2.3** One major change involved the so-called "factor of safety" (the ratio of the ultimate strength of the metal to the design stress used). Prior to 1946, a 5:1 safety factor was used. Fabrication changed from the riveting widely used when the code was first written (some forge welding was used) to fusion welding. This latter method was incorporated into the code as welding techniques were perfected and now predominates.

**D-1.2.4** The safety factor change in the ASME code was based on the technical progress made since 1925 and on experience with the use of the API-ASME code. This offshoot of the ASME code, initiated in 1931, was formulated and published by the American Petroleum Institute (API) in cooperation with the ASME. It justified the 4:1 safety factor on the basis of certain

quality and inspection controls not at that time incorporated in the ASME code editions.

**D-1.2.5** *ASME Code Case Interpretations and Addenda* are published between code editions and normally become part of the code in the new edition. Adherence to these is considered compliance with the code. [See 2-2.1.3(a).]

### D-2 Design of Containers for LP-Gas.

#### D-2.1 ASME Container Design.

**D-2.1.1** When ASME containers were first used to store LP-Gas, the properties of the CP grades of the principal constituents were available, but the average properties for the commercial grades of propane and butane were not. Also, there was no experience as to what temperatures and pressures to expect for product stored in areas with high atmospheric temperatures. A 200-psi (1.40-MPa) design pressure was deemed appropriate for propane [the CP grade of which has a vapor pressure of 176 psi (1.2 MPa) at 100°F (37.8°C)] and 80 psi (0.55 MPa) for butane [CP grade has vapor pressure of 37 psi (0.26 MPa) at 100°F (37.8°C)]. These containers were built with a 5:1 safety factor (*see D-1.2.3*).

**D-2.1.2** Pressure vessel codes, following boiler pressure relief valve practice, require that the pressure relief valve start-to-leak setting be the design pressure of the container. In specifying pressure relief valve capacity, however, they stipulate that this relieving capacity be adequate to prevent the internal pressure from rising above 120 percent of the design pressure under fire exposure conditions.

**D-2.1.3** Containers built in accordance with D-2.1.1 were entirely adequate for the commercial grades of the LP-Gases [the vapor pressure of propane at 100°F (37.8°C) is 205 psi (1.41 MPa); the vapor pressure of butane at 100°F (37.8°C) is 37 psi (0.26 MPa)]. However, as they were equipped with pressure relief valves set to start-to-leak at the design pressure of the container, these relief valves occasionally opened on an unusually warm day. Since any unnecessary release of a flammable gas is potentially dangerous, and considering recommendations of fire prevention and insurance groups as well as to the favorable experience with API-ASME containers (*see D-2.2.1*), relief valve settings above the design pressure [up to 250 psi (1.7 MPa) for propane and 100 psi (0.69 MPa) for butane] were widely used.

**D-2.1.4** In determining safe filling limits for compressed liquefied gases, DOT (ICC) uses the criterion that the container not become liquid full at the highest temperature the liquid may be expected to reach due to the normal atmospheric conditions to which the container may be exposed. For containers of more than 1200-gal (4.5-m<sup>3</sup>) water capacity, the liquid temperature selected is 115°F (46°C). The vapor pressure of the gas to be contained at 115°F (46°C) is specified by DOT as the minimum design pressure for the container. The vapor pressure of CP propane at 115°F (46.1°C) is 211 psi (1450 kPa), and of commercial propane, 243 psi (1670 kPa). The vapor pressure of both normal butane and commercial butane at 115°F (46.1°C) is 51 psi (350 kPa).

**D-2.1.5** The ASME *Boiler and Pressure Vessel Code* editions generally applicable to LP-Gas containers, and the design pressures, safety factors, and exceptions to these editions for LP-Gas use, are shown in Table D-2.1.5. They reflect the use of the information in D-2.1.1 through D-2.1.4.

## D-2.2 API-ASME Container Design.

**D-2.2.1** The API-ASME code was first published in 1931. Based on petroleum industry experience using certain material quality and inspection controls not at that time incorporated in the ASME code, the 4:1 safety factor was first used. Many LP-Gas containers were built under this code with design pressures of 125 psi (0.86 MPa) [100 psi (0.69 MPa) until December 31, 1947] for butane and 250 psi (1.7 MPa) for propane. Containers constructed in accordance with the API-ASME code were not required to comply with Section 1 or to the appendix to Section 1. Paragraphs W-601 through W-606 of the 1943 and earlier editions were not applicable to LP-Gas containers.

Table D-2.1.5

Year ASME Code Edition Published	Design Pressure, psi (MPa)		Safety Factor
	Butane	Propane	
1931 through 1946 <sup>a</sup>	100 <sup>a</sup> (0.7)	200 (1.4)	5:1
1949 Par. U-68 & U-69 <sup>b</sup>	100 (0.7)	200 (1.4)	5:1
1949 Par. U-200 & U-201 <sup>c</sup>	125 (0.9)	250 (1.7)	4:1
1952 through 80	125 (0.9)	250 <sup>3</sup> (1.7)	4:1

<sup>a</sup>Until December 31, 1947, containers designed for 80 psi (0.6 MPa) under prior (5:1 safety factor) codes were authorized for butane. Since that time, either 100 psi (0.7 MPa) (under prior codes) or 125 psi (0.9 MPa) (under present codes) is required.

<sup>b</sup>Containers constructed in accordance with the 1949 edition and prior editions of the ASME code were not required to be in compliance with paragraphs U-2 to U-10 inclusive or with paragraph U-19. Construction in accordance with paragraph U-70 of these editions was not authorized.

<sup>c</sup>Higher design pressure [312.5 psi (2.2 MPa)] is required for small ASME containers used for vehicular installations (such as forklift trucks used in buildings or those installed in enclosed spaces) because they may be exposed to higher temperatures and consequently develop higher internal pressure.

**D-2.2.2** The ASME code, by changing from the 5:1 to the 4:1 safety factor through consideration of the factors described in D-2.1.1 through D-2.1.4, became nearly identical in effect to the API-ASME code by the 1950s. Thus, the API-ASME code was phased out, and construction was not authorized after July 1, 1961.

**D-2.3 Design Criteria for LP-Gas Containers.** To prevent confusion in earlier editions of this code, the nomenclature *container type* was used to designate the design pressure of the container to be used for various types of LP-Gases. With the adoption of the 4:1 safety factor in the ASME code and the phasing out of the API-ASME code, the need for *container type* ceased to exist.

## D-2.4 DOT (ICC) Specifications Utilizing ASME or API-ASME Containers.

**D-2.4.1** DOT (ICC) specifications for portable tank containers and cargo tanks require ASME or API-ASME construction for the container proper (*see D-1.1.2*). Several such specifications were written by the ICC prior to 1967, and DOT has continued this practice.

**D-2.4.2** ICC specifications written prior to 1946, and to some extent through 1952, used ASME containers with a 200-psi (1380-kPa) design pressure for propane and 80 psi (550 kPa) for butane [100 psi (690 kPa) after 1947] with a 5:1 safety fac-

tor. During this period and until 1961, ICC specifications also permitted API-ASME containers with a 250-psi (1720-kPa) design pressure for propane and 100 psi (690 kPa) for butane [125 psi (862 kPa) after 1947].

**D-2.4.3** To prevent any unnecessary release of flammable vapor during transportation (*see D-2.1.3*), the use of safety relief valve settings 25 percent above the design pressure was common for ASME 5:1 safety factor containers. To eliminate confusion, and in line with the good experience with API-ASME containers, the ICC permitted the rerating of these particular ASME containers used under its specifications to 125 percent of the originally marked design pressure.

**D-2.4.4** DOT (ICC) specifications applicable to portable tank containers and cargo tanks currently in use are listed in Table D-2.4.4. New construction is not permitted under the older specifications. However, use of these older containers is permitted to continue provided they have been maintained in accordance with DOT (ICC) regulations.

## D-3 Underground ASME or API-ASME Containers.

### D-3.1 Use of Containers Underground.

**D-3.1.1** ASME or API-ASME containers are used for underground or partially underground installation in accordance with 3-2.4.8 or 3-2.4.9. The temperature of the soil is normally low so that the average liquid temperature and vapor pressure of product stored in underground containers will be lower than in aboveground containers.

**D-3.1.2** Containers listed to be used interchangeably for installation either aboveground or underground must comply as to pressure relief valve rated relieving capacity and filling limit with aboveground provisions when installed aboveground (*see 2-3.2.4*). When installed underground, the pressure relief valve rated relieving capacity and filling limit can be in accordance with underground provisions [*see 2-3.2.4(c)*], provided all other underground installation provisions are met. Partially underground containers are considered as aboveground insofar as filling limit and pressure relief valve rated relieving capacity are concerned.

## Appendix E Pressure Relief Devices

*This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.*

### E-1 Pressure Relief Devices for DOT Cylinders.

**E-1.1 Source of Provisions for Relief Devices.** The requirements for relief devices on DOT cylinders are established by the DOT. Complete technical information regarding these requirements will be found in the Compressed Gas Association (CGA) Publication S-1.1, *Pressure-Relief Device Standards, Part 1 — Cylinders for Compressed Gases*.

### E-2 Pressure Relief Devices for ASME Containers.

**E-2.1 Source of Provisions for Pressure Relief Devices.** Capacity requirements for pressure relief devices are in accordance with the applicable provisions of Compressed Gas Association (CGA) Publication S-1.2, *Pressure-Relief Device Standards, Part 2 — Cargo and Portable Tanks for Compressed Gases*; or with CGA Publication S-1.3, *Safety Relief-Device Standards, Part 3 — Compressed Gas Storage Containers*.

Table D-2.4.4

Specification Number	ASME Construction			API-ASME Construction		
	Design Pressure, psi		Safety Factor	Design Pressure, psi		Safety Factor
	Propane	Butane		Propane	Butane	
ICC-50 <sup>a</sup>	200 <sup>c</sup>	100 <sup>c</sup>	5:1	250	125	4:1
ICC-51 <sup>a</sup>	250	125	4:1	250	125	4:1
MC-320 <sup>b,d</sup>	200 <sup>c</sup>	100 <sup>c</sup>	5:1	250	125	4:1
MC-330 <sup>b</sup>	250	125	4:1	250	125	4:1
MC-331 <sup>b</sup>	250	125	4:1	250	125	4:1

Note: For SI units, 100 psi = 0.69 MPa; 125 psi = 0.86 MPa; 200 psi = 1.40 MPa; 250 psi = 1.72 MPa

<sup>a</sup>Portable tank container.

<sup>b</sup>Cargo tank.

<sup>c</sup>Permitted to be related to 125 percent of original ASME design pressure.

<sup>d</sup>Require DOT exemption.

**E-2.2 Spring-Loaded Pressure Relief Valves for Aboveground and Cargo Containers.** The minimum rate of discharge for spring-loaded pressure relief valves is based on the outside surface of the containers on which the valves are installed. Paragraph 2-2.6.3(g) provides that new containers be marked with the surface area in square feet. The surface area of containers not so marked (or not legibly marked) can be computed by use of the applicable formula.

(a) Cylindrical container with hemispherical heads:

$$\text{Surface area} = \text{overall length} \times \text{outside diameter} \times 3.1416$$

(b) Cylindrical container with other than hemispherical heads:

$$\text{Surface area} = (\text{overall length} + 0.3 \text{ outside diameter}) \times \text{outside diameter} \times 3.1416$$

NOTE: This formula is not precise, but will give results with limits of practical accuracy in sizing relief valves.

(c) Spherical containers:

$$\text{Surface area} = \text{outside diameter squared} \times 3.1416$$

$$\text{Flow rate CFM Air} = 53.632 \times A^{0.82}$$

where:

$$A = \text{total outside surface area of container in square feet}$$

### E-2.3 Pressure Relief Valve Testing.

**E-2.3.1** Frequent testing of pressure relief valves on LP-Gas containers is not considered necessary for the following reasons:

- The LP-Gases are so-called "sweet gases" having no corrosive or other deleterious effect on the metal of the containers or relief valves.
- The relief valves are constructed of corrosion-resistant materials and are installed so as to be protected against the weather. The variations of temperature and pressure due to atmospheric conditions are not sufficient to cause any permanent set in the valve springs.
- The required odorization of the LP-Gases makes escape almost instantly evident.
- Experience over the years with the storage of LP-Gases has shown a good safety record on the functioning of pressure relief valves.

**E-2.3.2** Since no mechanical device can be expected to remain in operative condition indefinitely, it is suggested that the pressure relief valves on containers of more than 2000 gal (7.6 m<sup>3</sup>) water capacity be tested at approximately 10-year intervals.

## Appendix F Liquid Volume Tables, Computations, and Graphs

*This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.*

### F-1 Scope.

**F-1.1 Application.** This appendix explains the basis for Table 4-4.2.1, includes the LP-Gas liquid volume temperature correction table, Table F-4, and describes its use. It also explains the methods of making liquid volume computations to determine the maximum permissible LP-Gas content of containers in accordance with Tables 4-4.2.2(a), (b), and (c).

**F-2 Basis for Determination of LP-Gas Container Capacity.** The basis for determination of the maximum permitted filling limits shown in Table 4-4.2.1 is the maximum safe quantity that will assure that the container will not become liquid full when the liquid is at the highest anticipated temperature.

- For portable containers built to DOT specifications and other aboveground containers with water capacities of 1200 (4.5 m<sup>3</sup>) gal or less, this temperature is assumed to be 130°F (54°C).
- For other aboveground uninsulated containers with water capacities in excess of 1200 gal (4.5 m<sup>3</sup>), including those built to DOT portable or cargo tank specifications, this temperature is assumed to be 115°F (46°C).
- For all containers installed underground, this temperature is assumed to be 105°F (41°C).

**F-3 Liquid Volume Correction Table.** Correction of observed volume to standard temperature condition (60°F and equilibrium pressure).

**F-3.1** The volume of a given quantity of LP-Gas liquid in a container is directly related to its temperature, expanding as tem-



perature increases and contracting as temperature decreases. Standard conditions, often used for weights and measures purposes and, in some cases, to comply with safety regulations, specify correction of the observed volume to what it would be at 60°F (16°C).

**F-3.2** To correct the observed volume to 60°F (16°C), the specific gravity of LP-Gas at 60°F (16°C) in relation to water at 60°F (16°C) (usually referred to as "60°/60°F") and its average temperature must be known. The specific gravity normally appears on the shipping papers. The average liquid temperature can be obtained as follows:

(a) Insert a thermometer in a thermometer well in the container into which the liquid has been transferred, and read the temperature after the completion of the transfer [see F-3.2(c) for proper use of a thermometer].

(b) If the container is not equipped with a well, but is essentially empty of liquid prior to loading, the temperature of the liquid in the container from which liquid is being withdrawn can be used. Otherwise, a thermometer can be inserted in a thermometer well or other temperature-sensing device installed in the loading line at a point close to the container being loaded. Read temperatures at intervals during transfer and averaging. [See F-3.2(c).]

(c) A suitable liquid should be used in thermometer wells to obtain an efficient heat transfer from the LP-Gas liquid in the container to the thermometer bulb. The liquid used should be noncorrosive and should not freeze at the temperatures to which it will be subjected. Water should not be used.

**F-3.3** The volume observed or measured is corrected to 60°F (16°C) by use of Table F-4. The column headings, across the top of the tabulation, list the range of specific gravities for the LP-Gases. Specific gravities are shown from 0.500 to 0.590 by 0.010 increments, except that special columns are inserted for chemically pure propane, isobutane, and normal butane. To obtain a correction factor, follow down the column for the specific gravity of the particular LP-Gas to the factor corresponding with the liquid temperature. Interpolation between the specific gravities and temperatures shown can be used if necessary.

#### F-4 Use of Liquid Volume Correction Factors, Table F-4.

**F-4.1** To correct the observed volume in gallons for any LP-Gas (the specific gravity and temperature of which is known) to gallons at 60°F (16°C), Table F-4 is used as follows:

- Obtain the correction factor for the specific gravity and temperature as described in F-3.3.
- Multiply the gallons observed by this correction factor to obtain the gallons at 60°F (16°C).

Example: A container has in it 4055 gal of LP-Gas with a specific gravity of 0.560 at a liquid temperature of 75°F. The correction factors in the 0.560 column are 0.980 at 76°F and 0.983 at 74°F, or, interpolating, 0.9815 for 75°F. The volume of liquid at 60°F is  $4055 \times 0.9815$ , or 3980 gal.

**F-4.2** To determine the volume in gallons of a particular LP-Gas at temperature  $t$  to correspond with a given number of gallons at 60°F (16°C), Table F-4 is used as follows:

- Obtain the correction factor for the LP-Gas, using the column for its specific gravity and reading the factor for temperature  $t$ .
- Divide the number of gallons at 60°F (16°C) by this correction factor to obtain the volume at temperature  $t$ .

Example: It is desired to pump 800 gal (3.03 m<sup>3</sup>) at 60°F (15.5°C) into a container. The LP-Gas has a specific gravity of 0.510 and the liquid temperature is 44°F. The correction factor in the 0.510 column for 44°F is 1.025. Volume to be pumped at 44°F is  $800 / 1.025 = 780$  gal (2.95 m<sup>3</sup>).

#### F-5 Maximum Liquid Volume Computations.

##### F-5.1 Maximum Liquid LP-Gas Content of a Container at Any Given Temperature.

**F-5.1.1** The maximum liquid LP-Gas content of any container depends on the size of the container, whether it is installed above ground or under ground, the maximum permitted filling limit, and the temperature of the liquid [see Tables 4-4.2.2(a), (b), and (c).]

**F-5.1.2** The maximum volume  $V_t$  (in percent of container capacity) of an LP-Gas at temperature  $t$ , having a specific gravity  $G$  and a filling limit of  $L$ , is computed by use of the following formula:

$$V_t = \frac{L}{G} \div F$$

or

$$V_t = \frac{L}{G \times F}$$

where:

$V_t$  = percent of container capacity that can be filled with liquid

$L$  = filling limit

$G$  = specific gravity of particular LP-Gas

$F$  = correction factor to correct volume at temperature  $t$  to 60°F (16°C)

Example: The maximum liquid content, in percent of container capacity, for an aboveground 30,000-gal (114-m<sup>3</sup>) water capacity container of LP-Gas having a specific gravity of 0.508 and at a liquid temperature of 80°F (27°C) is computed as follows:

From Table 4-4.2.1,  $L = 0.45$ , and from Table F-4,  $F = 0.967$ . Thus,

$$\begin{aligned} V_{80} &= \frac{0.45}{0.508 \times 0.967} \\ &= 0.915 \text{ 91\% or } 27,300 \text{ gal (103m}^3\text{)} \end{aligned}$$

##### F-5.2 Alternate Method of Filling Containers.

**F-5.2.1** Containers equipped with fixed maximum level gauges or with variable liquid level gauges when temperature determinations are not practical can be filled with either gauge provided that the fixed maximum liquid level is installed or the variable gauge is set to indicate the volume equal to the maximum permitted filling limit as provided in 4-4.3.3(a). The level is computed on the basis of the liquid temperature being 40°F (4.4°C) for aboveground containers or 50°F (10°C) for underground containers.



Table F-4 Liquid Volume Correction Factors (Continued)

Observed Temperature, Degrees Fahrenheit	Specific Gravities at 60°F/60°F												
	0.500	Propane 0.5079	0.510	0.520	0.530	0.540	0.550	0.560	iso-Butane 0.5631	0.570	0.580	n-Butane 0.5844	0.590
	Volume Correction Factors												
90	0.946	0.949	0.949	0.952	0.955	0.958	0.960	0.962	0.963	0.964	0.967	0.967	0.968
92	0.942	0.945	0.946	0.949	0.952	0.955	0.957	0.959	0.960	0.962	0.964	0.965	0.966
94	0.938	0.941	0.942	0.946	0.949	0.952	0.954	0.957	0.958	0.959	0.962	0.962	0.964
96	0.935	0.938	0.939	0.942	0.946	0.949	0.952	0.954	0.955	0.957	0.959	0.960	0.961
98	0.931	0.934	0.935	0.939	0.943	0.946	0.949	0.952	0.953	0.954	0.957	0.957	0.959
100	0.927	0.930	0.932	0.936	0.940	0.943	0.946	0.949	0.950	0.952	0.954	0.955	0.957
105	0.917	0.920	0.923	0.927	0.931	0.935	0.939	0.943	0.943	0.946	0.949	0.949	0.951
110	0.907	0.911	0.913	0.918	0.923	0.927	0.932	0.936	0.937	0.939	0.943	0.944	0.946
115	0.897	0.902	0.904	0.909	0.915	0.920	0.925	0.930	0.930	0.933	0.937	0.938	0.940
120	0.887	0.892	0.894	0.900	0.907	0.912	0.918	0.923	0.924	0.927	0.931	0.932	0.934
125	0.876	0.881	0.884	0.890	0.898	0.903	0.909	0.916	0.916	0.920	0.925	0.927	0.928
130	0.865	0.871	0.873	0.880	0.888	0.895	0.901	0.908	0.909	0.913	0.918	0.921	0.923
135	0.854	0.861	0.863	0.871	0.879	0.887	0.894	0.901	0.902	0.907	0.912	0.914	0.916
140	0.842	0.850	0.852	0.861	0.870	0.879	0.886	0.893	0.895	0.900	0.905	0.907	0.910

**F-5.2.2** The percentage of container capacity that can be filled with liquid is computed by use of the formula shown in F-5.1.2, substituting the appropriate values as follows:

$$V_t = \frac{L}{G \times F}$$

where:

$t$  = the liquid temperature (assumed to be 40°F (4.4°C) for aboveground containers or 50°F (10°C) for underground containers)

$L$  = the loading limit obtained from Table 4-4.2.1 for:

- (a) The specific gravity of the LP-Gas to be contained
- (b) The method of installation, aboveground or underground, and if aboveground, then:
  - 1) for containers of 1200 gal (4.5 m<sup>3</sup>) water capacity or less
  - 2) for containers of more than 1200-gal (4.5-m<sup>3</sup>) water capacity

$G$  = the specific gravity of the LP-Gas to be contained

$F$  = the correction factor (obtained from Table F-4, using  $G$  and 40°F (4°C) for aboveground containers or 50°F (10°C) for underground containers)

Example: The maximum volume of LP-Gas with a specific gravity of 0.550 that can be in a 1000-gal (3.8-m<sup>3</sup>) water capacity aboveground container that is filled by use of a fixed maximum liquid level gauge is computed as follows:

$t$  is 40°F (4.4°C) for an aboveground container.

$L$  for 0.550 specific gravity, and an aboveground container of less than 1200-gal (4.5-m<sup>3</sup>) water capacity, from Table 4-4.2.1, is 47 percent.

$G$  is 0.550.

$F$  for 0.550 specific gravity at 40°F (4.4°C) from Table F-4 is 1.025. Thus,

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$$V_{40} = \frac{0.47}{0.550 \times 1.025} = 0.834 \text{ (83\%)} \text{ or } 830 \text{ gal (3.1 m}^3\text{)}$$

**F-5.2.3** Percentage values, such as in the example in F-5.2.2, are rounded off to the next lower full percentage point, or to 83 percent in this example.

### F-5.3 Location of Fixed Maximum Liquid Level Gauges in Containers.

**F-5.3.1** Due to the diversity of fixed maximum liquid level gauges, and the many sizes [from cylinders to 120,000 gal (454 m<sup>3</sup>) ASME vessels] and types (vertical, horizontal, cylindrical, and spherical) of containers in which gauges are installed, it is not possible to tabulate the liquid levels such gauges should indicate for the maximum permitted filling limits [see Tables 4-4.2.1 and 4-4.2.2(a)].

**F-5.3.2** The percentage of container capacity that these gauges should indicate is computed by use of the formula in F-5.1.2. The liquid level this gauge should indicate is obtained by applying this percentage to the water capacity of the container in gallons [water at 60°F (16°C)] and then using the strapping table for the container (obtained from its manufacturer) to determine the liquid level for this gallonage. If such a table is not available, this liquid level is computed from the internal dimensions of the container, using data from engineering handbooks.

**F-5.3.3** The formula of F-5.1.2 is used to determine the maximum LP-Gas liquid content of a container to comply with Tables 4-4.2.1 and 4-4.2.2(a) as follows:

$$\text{Volumetric Percentage or } V_t = \frac{L}{G \times F}$$

and

$$\text{Vol. in gal} = V_t \times \text{container gal water capacity,}$$

or

$$\text{vol. in gal at } t = \left[ \frac{L \text{ (Table 4-4.2.1)}}{G \text{ (spec.grav.)}} \right] \times \left[ \frac{\text{Container gallons water capacity}}{F \text{ (for } G \text{ and temperature } t)} \right]$$

Example 1: Assume a 100-gal (379-L) water capacity container for underground storage of propane with a specific gravity of 0.510. From Table 4-4.2.1,  $L = 46$  percent; from 4-4.2.2(a),  $t = 50^\circ\text{F}$ ; and from Table F-4,  $^\circ\text{F}$  for 0.510 specific gravity and a temperature of  $50^\circ\text{F}$  ( $10^\circ\text{C}$ ) is 1.016; or

$$\begin{aligned} \text{Vol. in gal at } 50^\circ\text{F} &= \frac{0.46 \times 100}{0.510 \times 1.016} \\ &= 88.7 \text{ gal (335 L)} \end{aligned}$$

Example 2: Assume an 18,000-gal ( $68.1\text{-m}^3$ ) water capacity container for aboveground storage of a mixture with a specific gravity of 0.550. From Table 4-4.2.1,  $L = 50$  percent; from 4-4.2.2(a),  $t = 40^\circ\text{F}$ ; and from Table F-4,  $^\circ\text{F}$  for 0.550 specific gravity and  $40^\circ\text{F}$  ( $4.4^\circ\text{C}$ ) temperature is 1.025; or

$$\begin{aligned} \text{Vol. in gal at } 40^\circ\text{F} &= \frac{0.50 \times 18,000}{0.550 \times 1.025} \\ &= 15,950 \text{ gal (60.3 m}^3\text{)} \end{aligned}$$

**F-5.3.4** Table F-5.3.4 can be used to determine minimum dip tube length when installing an overfilling prevention device on cylinders for vapor service.

Table F-5.3.4

Cylinder Size	Material	Cylinder I.D. (in.)	Cylinder Water Capacity (lb)	Recommended Dip Tube Length (in.)
4.25#	Steel	8.9	10.2	2.2
5#	Steel	7.8	11.9	3.0
6#	Steel	7.5	15.5	3.2
10#	Steel	8.9	26.1	3.6
11#	Steel	8.9	26.2	3.6
11#	Steel	12.0	26.2	3.0
11.5#	Steel	12.0	27.3	3.2
20#	Steel	12.0	47.6	4.0
25#	Steel	12.0	59.7	4.8
30#	Steel	12.0	71.5	4.8
40#	Steel	12.0	95.3	6.5
6#	Aluminum	6.0	15.0	4.8
10#	Aluminum	10.0	23.6	4.0
20#	Aluminum	12.0	47.6	4.8
30#	Aluminum	12.0	71.5	6.0
40#	Aluminum	12.0	95.2	7.0

Notes:

1. This table indicates the approximate fixed maximum liquid level gauge dip tube lengths to be used for retrofitting cylinders with valves incorporating an overfilling prevention device. This table does not cover every cylinder design or configuration.

2. Important: If the dip tube length that is marked on the cylinder does not appear in the above table, use the next longer dip tube shown in the table. Example: When the dip tube length marked on the cylinder is 3.8 in., use a 4.0-in. dip tube for the retrofit.

If the dip tube length is not marked on the cylinder, contact the manufacturer for the recommended dip tube length.

## Appendix G Wall Thickness of Copper Tubing

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

Table G-1 Wall Thickness of Copper Tubing (Specification for Copper Water Tube, ASTM B 88)

Standard Size (in.)	Nominal OD (in.)	Nominal Wall Thickness Inches	
		Type K	Type L
1/4	0.375	0.035	0.030
3/8	0.500	0.049	0.035
1/2	0.625	0.049	0.040
5/8	0.750	0.049	0.042
3/4	0.875	0.065	0.045

Table G-2 Wall Thickness of Copper Tubing (Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service, ASTM B 280)

Standard Size (in.)	Outside Diameter (in.)	Wall Thickness (in.)
1/4	0.250	0.030
5/16	0.312	0.032
3/8	0.375	0.032
1/2	0.500	0.032
5/8	0.625	0.035
3/4	0.750	0.042
7/8	0.875	0.045

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

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

**H-1 Performance Standard.** Thermal protection insulating systems, proposed for use on LP-Gas containers as a means of "Special Protection" under 3-10.3.1, are required to undergo thermal performance testing as a precondition for acceptance. The intent of this testing procedure is to identify insulation systems that retard or prevent the release of a container's contents in a fire environment of 50 minutes duration and that will resist a concurrent hose stream of 10 minutes duration.

**H-2 Reference Test Standards.** The testing procedure described herein was taken with some modification from segments of the following two test standards:

- (a) *Code of Federal Regulations* – Title 49, Part 179.105-4, "Thermal Protection."
- (b) NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, Chapter 4, Section 4-3, "Hose Stream Test."

### H-3 Thermal Insulation Test.

**H-3.1** A torch fire environment shall be created in the following manner:

- (a) The source of the simulated torch shall be a hydrocarbon fuel. The flame temperature from the simulated torch

shall be 2200°F ± 100°F (1200°C ± 56°C) throughout the test duration. Torch velocities shall be 40 mph (64 km/h) ± 10 mph (16 km/h) throughout the duration of the test.

(b) An uninsulated square steel plate with thermal properties equivalent to ASME pressure vessel steel shall be used. The plate dimensions shall be not less than 4 ft × 4 ft (1.2 m × 1.2 m) by nominal  $\frac{5}{8}$  in. (16 mm) thick. The plate shall be instrumented with not less than 9 thermocouples to record the thermal response of the plate. The thermocouples shall be attached to the surface not exposed to the simulated torch and shall be divided into 9 equal squares with a thermocouple placed in the center of each square.

(c) The steelplate holder shall be constructed in such a manner that the only heat transfer to the back side of the plate is by heat conduction through the plate and not by other heat paths. The apex of the flame shall be directed at the center of the plate.

(d) Before exposure to the torch fire, none of the temperature recording devices shall indicate a plate temperature in excess of 100°F (38°C) or less than 32°F (0°C).

(e) A minimum of 2 thermocouples shall indicate 800°F (427°C) in a time of 4.0 ± 0.5 minutes of torch fire exposure.

**H-3.2** A thermal insulation system shall be tested in the torch fire environment described in H-3.1 of this section in the following manner:

- (a) The thermal insulation system shall cover one side of a steel plate identical to that used under paragraph H-3.1(b) of this section.
- (b) The back of the steel plate shall be instrumented with not less than 9 thermocouples placed as described in paragraph H-3.1(b) of this section to record the thermal response of the steel.
- (c) Before exposure to the torch fire, none of the thermocouples on the thermal insulation system steel plate configuration shall indicate a plate temperature in excess of 100°F (37.8°C) or less than 32°F (0°C).
- (d) The entire outside surface of the thermal insulation system shall be exposed to the torch fire environment.

- (e) A torch fire test shall be run for a minimum of 50 minutes. The thermal insulation system shall retard the heat flow to the steel plates so that none of the thermocouples on the uninsulated side of the steel plate indicates a plate temperature in excess of 800°F (427°C).

**H-4 Hose Stream Resistance Test.** After 20 minutes exposure to the torch test, the test sample shall be hit with a hose stream concurrently with the torch for a period of 10 minutes. The hose stream test shall be conducted in the following manner:

(a) The stream shall be directed first at the middle and then at all parts of the exposed surface, making changes in direction slowly.

(b) The hose stream shall be delivered through a 2½-in. (64-mm) hose discharging through a National Standard play-pipe of corresponding size equipped with 1⅛-in. (29-mm) discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure at the base of the nozzle and for the duration of the test shall be 30 psi (207 kPa). [Estimated delivery rate is 205 gpm (776 L/min).]

(c) The tip of the nozzle shall be located 20 ft (6 m) from and on a line normal to the center of the test specimen. If impossible to be so located, the nozzle may be on a line deviating not to exceed 30 degrees from the line normal to the center of the test specimen. When so located, the distance from the center shall be less than 20 ft (6 m) by an amount equal to 1 ft (0.3 m) for each 10 degrees of deviation from the normal.

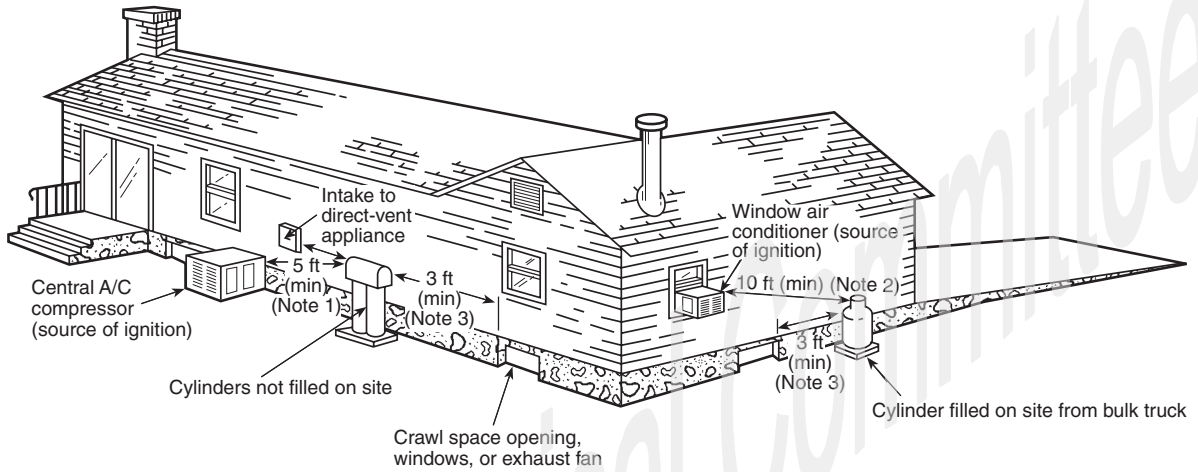
(d) Subsequent to the application of the hose stream, the torching shall continue until any thermocouple on the uninsulated side of the steel plate indicates a plate temperature in excess of 800°F (427°C).

(e) The thermal insulation system shall be judged to be resistant to the action of the hose stream if the time from initiation of torching for any thermocouple on the uninsulated side of the steel plate to reach in excess of 800°F (427°C) is 50 minutes or greater.

(f) One (1) successful combination torch fire and hose stream test shall be required for certification.

Appendix I Container Spacing

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.



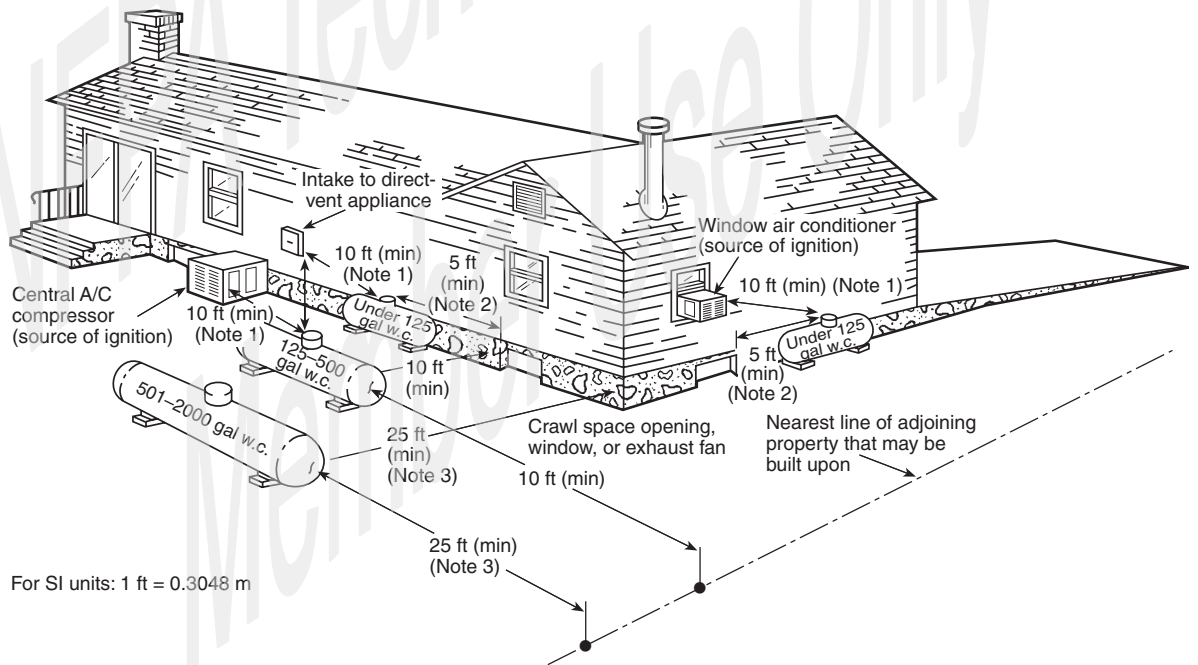
For SI units: 1 ft = 0.3048 m

Note 1: 5-ft minimum from relief valve in any direction away from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to 3-2.2.2(b).

Note 2: If the cylinder is filled on site from a bulk truck, the filling connection and vent valve must be at least 10 ft from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. Refer to 3-2.2.2(d).

Note 3: Refer to 3-2.2.2(b).

Figure I-1 Cylinders. (This figure for illustrative purposes only; text shall govern.)



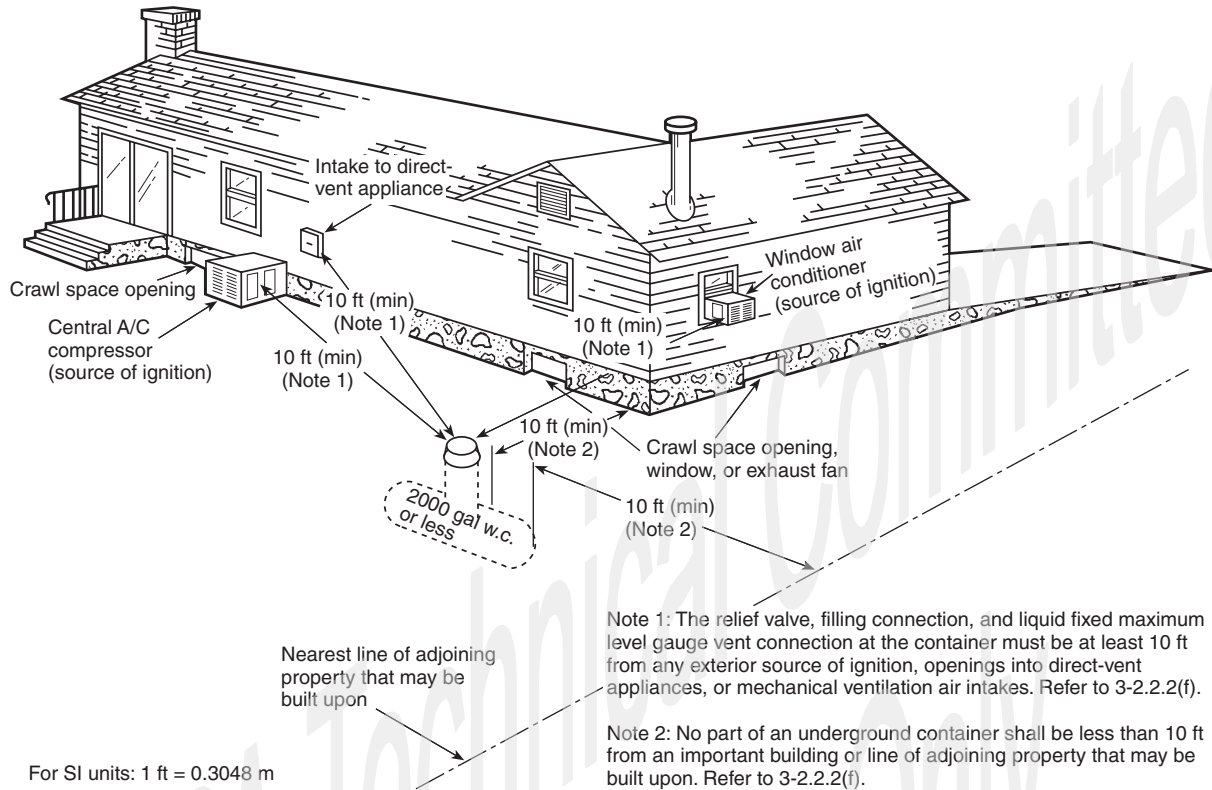
For SI units: 1 ft = 0.3048 m

Note 1: Regardless of its size, any ASME container filled on site must be located so that the filling connection and fixed maximum liquid level gauge are at least 10 ft from any external source of ignition (e.g., open flame, window A/C, compressor), intake to direct-vented gas appliance, or intake to a mechanical ventilation system. Refer to 3-2.2.2(d).

Note 2: Refer to 3-2.2.2(c)

Note 3: This distance may be reduced to no less than 10 ft for a single container of 1200 gal (4.5 m<sup>3</sup>) water capacity or less, provided such container is at least 25 ft from any other LP-Gas container of more than 125 gal (0.5 m<sup>3</sup>) water capacity. Refer to 3-2.2.2(e).

Figure I-2 Aboveground ASME containers. (This figure for illustrative purposes only; text shall govern.)



**Figure I-3 Underground ASME containers.**  
(This figure for illustrative purposes only; text shall govern.)

## Appendix J Referenced Publications

**J-1** The following documents or portions thereof are referenced within this code for informational purposes only and are thus not considered part of the requirements of this code unless also listed in Chapter 12. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this code.

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 1998 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1996 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 1998 edition.

NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites*, 1996 edition.

NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, 1994 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 1997 edition.

NFPA 54, *National Fuel Gas Code*, 1996 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities*, 1995 edition.

NFPA 68, *Guide for Venting of Deflagrations*, 1994 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 1993 edition.

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1995 edition.

NFPA 220, *Standard on Types of Building Construction*, 1995 edition.

NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*, 1995 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, 1995 edition.

NFPA 321, *Standard on Basic Classification of Flammable and Combustible Liquids*, 1991 edition.

NFPA 501C, *Standard on Recreational Vehicles*, 1996 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 1997 edition.

**J-1.2 API Publications.** American Petroleum Institute, 2101 L St., NW, Washington, DC 20037.

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

API 1632, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems*, 1983.

API 2510, *Design and Construction of LP-Gas Installations*, 1989.

API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases.

**J-1.3 ASCE Publication.** American Society of Civil Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

ASCE 56, *Sub-Surface Investigation for Design and Construction of Foundation for Buildings*.

**J-1.4 ASME Publication.** American Society for Mechanical Engineers, 345 East 47th St., New York, NY 10017.

ASME *Boiler and Pressure Vessel Code*, 1992.

ASME *Code Case Interpretations and Addenda*.

**J-1.5 ASTM Publication.** American Society for Testing and Materials, 100 Barr Harbor Drive, Conshohocken, PA 19428-2959.

ASTM D1835, *Specification for Liquefied Petroleum (LP) Gases*, 1991.

**J-1.6 CAN/CSGB Publication.** Canadian General Standards Board, 222 Queen St., Suite 1402, Ottawa, Ontario K1A 1G6.

CAN/CSGB-3.0 No. 18.5-M89, *Test for Ethyl Mercaptan Odorant in Propane, Field Method*, November 1989.

**J-1.7 CGA Publications.** Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

CGA Pamphlet C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, 1984.

Pressure-Relief Device Standards:

S-1.1, *Cylinders for Compressed Gases* (Errata, 1982), 1994.

S-1.2, *Cargo and Portable Tanks for Compressed Gases*, 1982.

S-1.3, *Compressed Gas Storage Containers*, 1980.

**J-1.8 Federal Publications.** National Technical Information Service, U.S. Dept. of Commerce, Springfield, VA 22161.

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

*Code of Federal Regulations*, Title 46, Part 33.

*Code of Federal Regulations*, Title 49.

*Code of Federal Regulations*, Title 49, Parts 171-190.

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

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

**J-1.9 GPA Publications.** Gas Processors Association, 1812 First National Bank Bldg., Tulsa, OK 74103.

Standard 2140, *Liquefied Petroleum Gas Specifications for Test Methods*, 1992.

Standard 2188, *Tentative Method for the Determination of Ethyl Mercaptan in LP-Gas Using Length of Stain Tubes*, 1989.

**J-1.10 NACE Publications.** National Association of Corrosion Engineers, 1440 South Creek Drive, Houston, TX 77084.

RP-01-69, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*, 1992 (Rev. 1983).

RP-02-85, *Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems*, 1985.

**J-1.11 NPGA Publications.** National Propane Gas Association, 1600 Eisenhower Lane, Lisle, IL 60532.

NPGA Safety Bulletin 114, *Guide to Hose Inspection*.

NPGA Safety Bulletin 122, *Recommendations for Prevention of Ammonia Contamination of LP-Gas*, 1992.

**J-1.12 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

UL 1746, *External Corrosion Protection Systems for Steel Underground Storage Tanks*, 1993.

**J-1.13 ULC Publication.** Underwriters Laboratories of Canada, 7 Crouse Road, Scarborough, Ontario M1R 3A9.

ULC-S603.1-M, *Standard for Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids*, 1982.



## Index

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