

NFPA 58

STANDARD FOR THE STORAGE AND HANDLING OF LIQUEFIED PETROLEUM GASES

1995 Edition



**National Fire Protection
Association**

ANSI/NFPA 58 An American National Standard February 7, 1995

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

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

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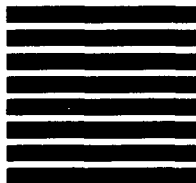
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Tentative Interim Amendment

NFPA 58

Standard for the Storage and Handling of Liquefied Petroleum Gases

1995 Edition

Reference: 4-2.2.2 (New)
TIA 95-1 (NFPA 33)

Pursuant to Section 4 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1995 edition. The TIA was processed by the Liquefied Petroleum Gases Committee, and was issued by the Standards Council on April 11, 1996, with an effective date of May 3, 1996.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a proposal of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process.

1. *Add a new 4-2.2.2 to read as follows:*

4-2.2.2 Injection of compressed air, oxygen, or any oxidizing gas into containers to transfer LP-Gas liquid shall not be permitted.

2. *Renumber accordingly.*

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NFPA 58
Standard for the
Storage and Handling of Liquefied Petroleum Gases
1995 Edition

This edition of NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, was prepared by the Technical Committee on Liquefied Petroleum Gases and acted on by the National Fire Protection Association, Inc., at its Fall Meeting held November 14-16, 1994, in Toronto, Ontario, Canada. It was issued by the Standards Council on January 13, 1995, with an effective date of February 7, 1995, and supersedes all previous editions.

The 1995 edition of this document has been approved by the American National Standards Institute.

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

Origin and Development of NFPA 58

This first NFPA standard on LP-Gas was adopted in 1932. In the next eight 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, and 1992.

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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, 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 and utility gas plants.

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NFPA 58

Standard for the Storage and Handling of Liquefied Petroleum Gases

1995 Edition

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

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

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

NOTE: All pressures used in this standard are gauge pressure unless otherwise indicated.

Foreword

General Properties of LP-Gas. LP-Gases, as defined in this standard (*see 1-2.1*), are gases at normal room temperatures 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 standard. Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission (ICC).

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 standard 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 of Standard. This standard shall apply to the operation of all LP-Gas systems including:

(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: Marine terminals associated with refineries, petrochemicals, and gas plants.

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

(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: Those systems designated by 1-1.3.

1-1.3 Nonapplication of Standard.

1-1.3.1 This standard shall not apply to:

(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 Standard 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, e.g., 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 first stage of pressure regulation.

(g) Transportation by air (including use in hot air balloons), rail, or water under the jurisdiction of the U.S. Department of Transportation.

(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 Section 1-7, Approved*). 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 standard 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 standard 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 standard 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 Section 1-7, Approved*) as specified in Table 1-2.

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.

1-3 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 of 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; and
- (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 2,000 gal (7.6 m³) individual water capacity, or with aggregate water capacity exceeding 4,000 gal (15.1 m³), 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 six months) installations of the sizes covered in 1-4.1 before the installation is started.

Table 1-2

Containers Used	Capacity in Water Gal (m ³)	Approval Applies to:
DOT Cylinders	Up to 120 (0.454) (1,000 lb, 454 kg)	1. Container Valves and Connectors 2. Manifold Valve Assemblies 3. Regulators and Pressure Relief Devices
ASME Tanks	2,000 (7.6 m ³) or less	1. Container System* including Regulator, or 2. Container Assembly* and Regulator separately
ASME Tanks	Over 2,000 (7.6 m ³)	1. Container Valves 2. Container Excess Flow Valves, Back Flow Check Valves, or alternate means of providing this protection such as remotely controlled Manual or Automatic Internal Valves 3. Container Gauging Devices 4. 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.

1-5 Qualification of Personnel. In the interest of safety, all persons employed in handling LP-Gases shall be trained in proper handling and operating procedures, which the employer shall document.

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 shutoff 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 aboveground 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.

NOTE: The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations that is in a position to determine compliance with appropriate standards for the current production of listed items.

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 1 of Section VIII of the ASME Code is applicable in this standard except UG-125 through UG-136 shall not apply. Division 2 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.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

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 [2,000 gal (7.6 m³) 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 portable container constructed to DOT (formerly ICC) cylinder specifications or, in some cases, constructed in accordance with the ASME Code of a similar size and for similar service. The maximum size permitted under DOT specifications is 1,000 lb (454 kg) water capacity.

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.

DOT Cylinder. See Cylinder.

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

Excess-Flow Valve (also called 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.

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 cu in. = 3.785 liters.

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 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 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 standard.

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 incident to plant operations, with LP-Gas storage of 2,000 gal (7.6 m³) 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 (i.e., forklift) trucks. Since only plant employees have access to these filling facilities, they are not considered to be distributing points.

Internal Valve. A primary shutoff valve for containers that has adequate means of actuation and that is constructed in such a manner that its seat is inside the container and that damage to parts exterior to the container or mating flange will not prevent effective seating of the valve.

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

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

Load, Loading. See Filling.

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 1,200 gal (4.5 m³) 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 high ways 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.

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 separately defined. Containers designed to be readily moved from one usage location to another, but substantially empty of product, are "portable storage containers" and are separately defined.

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 (also called Skid Tank). A container of more than 1,000 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 make up.

*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, PSIG, and PSIA. Pounds per square inch, pounds per square inch gauge, and pounds per square inch absolute, respectively.

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.

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 are 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 above-ground termination end of an anodeless riser (*see definition*). 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 which will permit propagation of flame away from them.

Special Protection. A means of limiting the temperature of an LP-Gas container for purposes of minimizing the possibility of failure of the container as the result of fire exposure.

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

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 DOT cylinder specification container, 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 using 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 wherein the electric element heats an interface solution in which the LP-Gas heat exchanger is immersed or heats an intermediate heat sink.

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

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

Vaporizing-Burner (also called Vaporizer-Burner and Self-Vaporizing Liquid Burner). A burner containing 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 to indicate the liquid level in a container throughout a range of levels. See Float, Rotary, and Slip Tube Gauge.

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 lb or gal, 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*.)

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* applicable at the date of manufacture; and as follows: (See *Appendices C and D*.)

(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 in use in accordance with 1-1.4.

2-2.1.4 Containers complying with 2-2.1.3 shall be permitted to be reused, reinstalled, or continued in use as follows:

(a) A container shall not be filled if it is not suitable for continued service.

(b) DOT cylinders shall not be refilled, continued in service, or transported unless they are properly qualified or requalified for LP-Gas service in accordance with DOT regulations.

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

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

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

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

3. All appurtenances shall be replaced.

2-2.1.5 ASME paragraph U-68 or U-69 containers shall be permitted to be continued in use, installed, reinstalled, or placed back into service. Installation of containers shall be in accordance with all provisions listed in this standard. (See *Section 2-2, Table 2-2.2.2, Table 2-3.2.3, and Appendix D*.)

2-2.1.6 Containers showing serious denting, bulging, gouging, or excessive corrosion shall be removed from service.

2-2.1.7 Repair or alteration of containers shall comply with the regulations, rules, or code under which the container was fabricated. Other welding is permitted only on saddle plates, lugs, or brackets attached to the container by the container manufacturer.

2-2.1.8 Containers for general use shall not have individual water capacities greater than 120,000 gal (454 m³). Containers in dispensing stations shall have an aggregate water capacity not greater than 30,000 gal (114 m³). This capacity restriction shall not apply to LP-Gas bulk plants, industrial plants, or industrial applications.

2-2.1.9 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 DOT specification containers 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.

Table 2-2.2.2 Vapor Pressures and Design Pressures

Maximum Vapor Press. in psi (mPa) at 100°F (37.8°C)	Design Press. in psi (mPa) Present ASME Code ¹	Design Press. in psi (mPa) Earlier Codes	
		API-ASME	ASME ²
80 (.6)	100 (.7)	100 (.7)	80 (.6)
100 (.7)	125 (.9)	125 (.9)	100 (.7)
125 (.9)	156 (1.1)	156 (1.1)	125 (.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)	312.5 (2.2)	—

¹ASME Code edition for 1949, Par. U-200 and U-201 and all later editions (See *D-2.1.5*).

²All ASME Codes up to the 1946 edition and paragraphs U-68 and U-69 of the 1949 edition (See *D-2.1.5*).

³See 8-2.2(a)(6) for certain service conditions that require a higher pressure relief valve start-to-leak setting.

⁴See Appendix D for information on earlier ASME or API-ASME Code.

2-2.2.3 In addition to the applicable provisions for horizontal ASME storage containers, vertical ASME storage containers over 125 gal (0.5 m³) 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 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 Containers of more than 30 gal (0.1 m³) and less than 2,000 gal (7.6 m³) 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 Containers of 125 gal (0.5 m³) through 2,000 gal (7.6 m³) 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 Containers of more than 2,000 gal (7.6 m³) 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 as to have direct communication with the vapor space, whether the container is in storage or in use.

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

(b) If located in a protecting enclosure, design shall be such as to permit this enclosure to be protected against corrosion and to permit inspection.

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

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

2-2.4 Portable Container Appurtenance Physical Damage Protection.

2-2.4.1 Portable containers of 1,000 lb (454 kg) [nominal 120 gal (0.5 m³)] water capacity or less shall incorporate protection against physical damage to container appurtenances and immediate connections to these while in transit, storage, while being moved into position for use, and when in use except in residential and commercial installations, by:

(a) Recessing connections into the container so that valves will not be struck if the container is dropped on a flat surface, or,

(b) A ventilated cap or collar designed to permit adequate 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. 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 1,000 lb (454 kg) [nominal 120 gal (0.5 m³)] water capacity, including skid tanks or for use as cargo containers, shall incorporate protection against physical damage to container appurtenances by recessing, 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 containers of more than 2,000 gal (7.6 m³) water capacity designed for permanent installation in stationary service shall be permitted to be provided with nonfireproofed structural steel saddles designed to allow mounting the containers on flat-topped concrete foundations. The total height of the outside bottom of the container shell above the top of the concrete foundation shall not exceed 6 in. (152 mm).

2-2.5.2 Horizontal containers of 2,000 gal (7.6 m³) water capacity or less, designed for permanent installation in stationary service, shall be permitted to be equipped with nonfireproofed 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 the outside bottom of the container shell. [See 3-2.4.2(a)(3) 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 m³) water capacity designed for permanent installation in stationary service shall be designed with steel supports 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 hr.

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 Containers to be used as portable storage containers (*see definition*) for temporary stationary service (normally less than 6 months at any given location) and to be 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, such supports shall be of steel and shall either 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 is 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, 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 shall also 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*) 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 and Recordkeeping.

2-2.6.1 Containers shall be marked as provided in the regulations, rules, or code under which they are fabricated and 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 containers shall be marked "Flammable" and either "LP-Gas," "LPG," "Propane," or "Butane." Compliance with marking requirements of Title 49 of the *Code of Federal Regulations* shall meet this provision.

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

2-2.6.2 Portable DOT containers designed to be filled by weight, including those optionally filled volumetrically but which may require check weighing, shall be marked with:

(a) The water capacity of the container in lb.

(b) The tare weight of the container in lb, fitted for service. The tare weight is the container weight plus the weight of all permanently attached valves and other fittings

but does not include the weight of protecting devices removed in order to load the container.

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 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; i.e., underground, aboveground, or both.

(c) Name and address of container supplier or trade name of container.

(d) Water capacity of container in lb or U.S. gal.

(e) Design pressure in psi.

(f) The wording "This container shall not contain a product having a vapor pressure in excess of _____ psi at 100°F." (*See Table 2-2.2.2.*)

(g) Tare weight of container fitted for service for containers to be filled by weight.

(h) Outside surface area in sq ft.

(i) Year of manufacture.

(j) Shell thickness _____ head thickness.

(k) OL _____ OD _____ HD _____.

(l) Manufacturer's serial number.

(m) ASME Code symbol.

2-2.6.4* Effective January 1, 1993, a warning label shall be applied to all portable refillable LP-Gas 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 containing 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.

2-2.6.6 The name and emergency service telephone number of the LP-Gas fuel suppliers shall be affixed and legibly maintained in a visible location on or near all stationary LP-Gas containers with an aggregate capacity of less than 4,000 gal (15.1 m³) water capacity installed at consumer premises.

(a) Effective January 1, 1996, the firm name and emergency telephone number on ASME containers shall be in text at least 1/2 in. (1.3 cm) in height.

(b) Effective January 1, 1996, the emergency telephone numbers shall be manned 24 hr a day to ensure that the LP-Gas supplier is available in the event of leakage or fire at the consumer premise. The use of an answering service or other means acceptable to the authority having jurisdiction during nonbusiness hours shall be permitted.

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 1-3.1 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 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 1,500°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 3,500 gal (13.2 m³) water capacity or less.

(b) Cast iron shall not be used.

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

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 1,500°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 3,500 gal (13.2 m³) water capacity or less shall be exempted from this provision.

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) DOT cylinders complying 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 for additional information.)

(b) DOT 2P and 2Q inside nonrefillable metal containers complying 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 the *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, UL 132; or other equivalent pressure relief valve standards. The start-to-leak setting of such pressure relief valves, with relation to the design pressure of the container, shall be in accordance with Table 2-3.2.3.

Exception: On containers of 40,000 gal (151 m³) water capacity or more, a pilot-operated pressure relief valve in which the relief device is combined with and is controlled by a self-actuated, direct, spring-loaded pilot valve shall be permitted to be used provided it complies with Table 2-3.2.3, is approved (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) Pressure relief valves shall be of sufficient individual or aggregate capacity to provide the relieving capacity in accordance with Appendix E for the container on which they are installed, and to relieve at not less than the rate indicated before the pressure is in excess of 120 percent of the maximum (not including the 10 percent referred to in the footnote of Table 2-3.2.3) permitted start-to-leak pressure setting of the device. This provision is applicable to all containers (including containers installed partially above-ground) except containers installed wholly underground in accordance with E-2.3.1.

(b) Each pressure relief valve shall be plainly and permanently marked with:

1. the pressure in psi at which the valve is set to start-to-leak;
2. rated relieving capacity in cu ft per min of air at 60°F (16°C) and 14.7 psia (at an absolute pressure of 0.1 mPa); and
3. the manufacturer's name and catalog number.

Example: A pressure relief valve is marked 250-4050 AIR. This indicates that the valve is set to start-to-leak at 250 psi (1.7 mPa) and that its rated relieving capacity is 4050 cfm (1.9 m³/s) of air.

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

Exception: 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.

(d) 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.

(e) 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 sq in. (1.6 cm²), that communicate directly with the vapor space of the container shall be permitted to be used in addition to the spring-loaded pressure relief valves (as specified in Table 2-3.2.3) for aboveground containers of 1,200 gal (4.5 m³) water capacity or less.

2-3.2.5 All containers used in industrial truck service (including forklift truck cylinders) shall have the container pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the container 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 and 2-3.1.3 and with the following:

2-3.3.2 Container appurtenances shall be required as follows:

(a) For containers 2,000 gal (7.6 m³) 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 2,000 gal (7.6 m³) 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 m³) or more water capacity shall be provided with an actuated liquid withdrawal excess-flow valve with a connection not smaller than 3/4-in. National Pipe Thread. This valve shall not be connected for continuous service unless the valve is recommended by the manufacturer for such service.

(b) For containers of over 2,000 gal (7.6 m³) 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.

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 tank as practical, in combination with either a backflow check valve or excess-flow valve installed in the tank.

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

3. Other required appurtenances:

a. Internal spring-type, flush-type full internal, or external pressure relief valve (*see Appendix E*).

b. Fixed 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(b) shall comply with the following:

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

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

Exception: Excess-flow valves of less than 1/2 in. (1.3 cm) N.P.T. 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 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, designed to be filled on a volumetric basis shall be equipped with a fixed 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 apply:

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

(b) Containers constructed to DOT cylinder specifications shall have stamped on the container 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 container valve of which it is a part, is installed, to the end of the dip tube. [*See 2-3.4.2(c)(2) for DOT containers 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 (see Note 9)

Appurtenances	1. Portable DOT cylinders, 2-lb thru 100-lb (0.9- kg thru 45.4-kg) propane capacity for vapor service	2. Portable DOT cylinders, 2-lb thru 100-lb (0.9- kg thru 45.4-kg) propane capac- ity for liquid service	3. Portable DOT cylinders, 2-lb thru 100-lb (0.9-kg thru 45.4-kg) propane capacity for liq- uid and vapor service	4. DOT cylinders, 100-lb thru 420-lb (45.4-kg thru 190-kg) pro- pane capacity filled on site	5. Stationary ASME containers thru 2,000-gal (7.6-m ³) water capacity	6. DOT Engine Fuel or Mobile containers (see Note 2)	7. ASME Engine Fuel or Mobile containers (see Note 2)
A. Manual Shutoff Valve (CGA 510 outlet) with Integral External Pressure Relief Valve	R✓ (See Notes 4, 8, 10, 12)						
B. Manual Shutoff Valve (CGA 555 outlet) with Integral External Pressure Relief Valve and Internal Excess-Flow Valve		R✓ (See Notes 4, 8, 10)					
C. Manual Shutoff Valve (CGA 555 outlet) with Internal Excess-Flow Valve for Liquid Service; Manual Shutoff Valve (CGA 510 outlet) with Integral External Pressure Relief Valve for Vapor Service			R✓ (See Notes 4, 8, 10)				
D. Double Backflow Check Filler Valve		O✓		R✓	R✓	O	R
E. Manual Shutoff Valve for Vapor Service	(see Notes 11, 12)			R✓	R✓		
F. Fixed Liquid Level Gauge (See Note 3)	O✓	O✓	O✓	R✓	R✓	R	R
G. External Pressure Relief Valve (See Note 4)				R✓			
H. Internal Spring-type Pressure Relief Valve (See Note 4)					R (See Note 1)		
I. Float Gauge	O✓	O✓	O✓	O	R✓	O	O
J. Backflow Check and Excess-Flow Vapor Return Valve					O✓		
K. Liquid Withdrawal Excess-Flow Actuated Valve (See Note 5)					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 (See Note 6)
N. Overfilling Prevention Device						R (See Note 7)	R (See Note 7)

O. R = Required. O = Optional. R✓ = Required, but may be installed as part of a multipurpose valve. O✓ = Optional, but may be installed as part of a multipurpose valve.

Notes to Table 2-3.3.2(a):

- See 2-3.3.2(a)(1).
- Mobile containers are containers that are permanently mounted on a vehicle and are connected for uses other than engine fuel (see Section 1-6, Definitions).
- See 2-3.4.2.
- See Appendix E for references on DOT and ASME pressure relief valve standards. See 1-6 for definitions of pressure relief valves.
- A liquid withdrawal excess-flow check valve in combination with a manual shutoff valve, plugged, or internal valve with excess-flow protection, plugged, will also meet these requirements. Liquid withdrawal connections are not required on containers less than 125 gal (0.5 m³) water capacity. (See 2-2.3.3.) Actuated liquid withdrawal excess-flow valves shall not be used for continuous service unless recommended for continuous service by the valve manufacturer.
- Reference: 8-2.2(a)(6).
- Reference: 8-2.3(a)(8).

- NOTE: An overfilling prevention device is not required for portable engine fuel containers used on industrial (and forklift) trucks powered by LP-Gas or for portable engine fuel containers used on vehicles having LP-Gas powered engines mounted on them (including floor maintenance machines, etc.).
- Individual container valves meeting these requirements may be used instead of multipurpose valves.
 - Table 2-3.3.2(a) and paragraph 2-3.3.2(b) are not intended to restrict the utilization of additional container openings with appropriate appurtenances for use in other applications.
 - CGA outlets 510 and 555 are described in Compressed Gas Association Standards.
 - Excess-flow protection shall not be required when 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 $\frac{7}{16}$ in. (8 mm) in diameter.
 - Separate external excess-flow valve protection shall be provided for vapor service shutoff valves in DOT cylinders or ASME containers when used inside buildings, or on building roofs or exterior balconies.

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

1. Containers 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 container boss or coupling into which the gauge is installed to the maximum permitted filling level.

2. Universal-type containers (*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 container 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 container boss or coupling opening into which the gauge is installed to the inside top of the container when the container 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 $\frac{1}{10}$ 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 1,200 gal (4.5 m³) 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, unless they are equipped with excess-flow check valves.

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, 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 (*also see 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 DOT cylinders, 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 multicontainer systems shall be arranged so that replacement of containers can be made without shutting off the flow of gas in the system. This provision shall not be construed as requiring an automatic changeover device.

(d) Connections to 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 containers of more than 2,000 gal (7.6 m³) 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 on containers of 2,000 gal (7.6 m³) water capacity or more.

NOTE: See 3-8.2.5(e) and 8-2.2(g) for requirements for labeling smaller containers used for vehicular installations.

(f) Every storage container of more than 2,000 gal (7.6 m³) 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 Section 3-2.9, shall have a minimum design pressure of 350 psi (2.41 mPa) or a design pressure that is equivalent to the maximum dis-

charge pressure of any pump or other source feeding the piping system if it is greater than 350 psi (2.41 mPa).

2-4.2 Pipe. Pipe shall be wrought iron or steel (black or galvanized), brass, copper, or polyethylene (see 3-2.8.7) and shall comply with the following:

(a) Wrought-iron pipe: ANSI 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 3-2.8.7) 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 3-2.7(d), *Exception No. 3*]: ASTM B135, *Specification for Seamless Brass Tube*.

(c) Copper tubing [see 3-2.7(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.

2-4.4 Fittings for Pipe and Tubing. Fittings shall be steel, brass, copper, malleable iron, ductile (nodular) iron, or plastic and shall comply with paragraphs (a) through (c). 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(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 1,000°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(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 1,000°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 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 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 recommended for LP-Gas use by the manufacturer and shall be design certified to meet the requirements of Category 1 of ASTM D2513, and U.S. Department of Transportation, *Code of Federal Regulations*, Title 49, Part 192.281(e), and the requirements of 3-2.8.7. The manufacturer shall provide the user qualified installation instructions as prescribed by U.S. Department of Transportation, *Code of Federal Regulations*, Title 49, Part 192.283(b).

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 incorporate all of the following means of closing (see 3-2.8.10, 3-3.3.8, and 3-3.3.9):

(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 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 (240 mPa) with a safety factor of 5 to 1 and be continuously marked "LP-GAS," "PROPANE," "350 PSI WORKING PRESSURE," and 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: Hoses 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 3-2.8.9 and 3-2.8.11.

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 Equipment shall be suitable for the appropriate working pressure as follows:

(a) Equipment to be used at pressures higher than container pressure, such as on the discharge of a liquid pump, shall be suitable for a working pressure of at least 350 psi (2.4 mPa). If pressures above 350 psi (2.4 mPa) are necessary, the pump and all equipment under pressure from the pump shall be suitable for the pump discharge pressure.

(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 suitable 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 suitable for a working pressure of at least 125 psi (0.9 mPa).

(d) Equipment to be used with vapor LP-Gas at pressures not to exceed 20 psi (138 kPa) shall be suitable for a working pressure adequate for the service in which it is to be used.

2-5.1.3 Equipment shall be fabricated of materials suitable for LP-Gas service and resistant to the action of 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 and 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.

2-5.2.1 Pumps shall be designed for LP-Gas service.

2-5.2.2 The maximum discharge pressure of a liquid pump under normal operating conditions shall be limited to 350 psi (2.4 mPa).

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 3-2.13.2(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:

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

Exception: Indirect vaporizers having 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 250-psi (1.7-mPa) design pressure.

(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 quart (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 quart (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 with the following:

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

1. The markings required by the Code.
2. The maximum vaporizing capacity in gal per hr.
3. The rated heat input in Btu/h.
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 providing 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 2,000 Btuh (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 equip-

ment, 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:

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

Exception: Heat exchangers for waterbath vaporizers having 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 providing 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 Btuh (422 MJ/h) 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 cu ft 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 upon conservative heat transfer calculations (i.e., 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 E-2.2.2 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:

1. The rated input to the burner in Btuh.
2. The maximum vaporizing capacity in gal 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 1,000 gal (3.8 m³) water capacity, the heater control system shall include a valve to automatically shut off the flow of gas to both the main and pilot burners if the container becomes empty of liquid.

(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:

1. The maximum burner input in Btuh.
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 61B, *Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities*, 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 standard.

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

(c) In addition to the interlocks provided for in 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 shall be considered as acceptable shutdown devices.

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

(e) Gas-air mixers that utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere, and are so designed that maximum air entrained is less than 85 percent of the mixture, need not include the interlocks specified in 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 Dispensing Devices.

2-5.7.1 Components of dispensing devices, such as meters, vapor separators, valves, and fittings within the dispenser, shall comply with 2-5.1.2(a) and 2-5.1.3.

2-5.7.2 Pumps of dispensers used to transfer LP-Gas shall comply with 2-5.1.2(a), 2-5.1.3, and 2-5.2. Such pumps shall be equipped to permit control of the flow and to minimize the possibility of leakage or accidental discharge. Means shall be provided on the outside of the dispenser to readily shut off the power in the event of fire or accident. This means shall be permitted to be integral with the dispenser or shall be provided externally when the dispenser is installed.

2-5.7.3 Dispensing hose shall comply with 2-4.6.1 through 2-4.6.3.

2-5.8 Regulators.

2-5.8.1 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 3-2.6.4 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 the *Standard for LP-Gas Regulators*, UL 144.

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

2-5.8.2 Second-stage regulators and integral two-stage regulators shall have a maximum outlet pressure setting of 14 in. W.C. (4.0 kPa) and shall be equipped with one of the following (see 3-2.6.4 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 the *Standard for LP-Gas Regulators*, UL 144. 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 *Standard for LP-Gas Regulators*, UL 144.

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

Exception: Regulators with a rated capacity of more than 500,000 Btu/hr (147 kw/hr) shall be permitted to have a separate overpressure protection device complying with paragraphs 2.9.2 through 2.9.8 of the National Fuel Gas Code, NFPA 54 (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.

2-5.8.3 Integral two-stage regulators except automatic changeover regulators shall be provided with a means to determine the outlet pressure of the high pressure regulator portion of the integral two-stage regulator.

2-5.8.4 Integral two-stage regulators shall not incorporate an integral pressure relief valve in the high pressure regulator portion of the unit.

2-5.8.5 First-stage regulators shall incorporate an integral pressure relief valve having a start-to-discharge setting within the limits specified in the *Standard for LP-Gas Regulators*, UL 144.

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.

2-5.8.6 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.

2-5.8.7 First-stage regulators shall have an outlet pressure setting up to 10.0 psi (69 kPa) in accordance with the *Standard for LP-Gas Regulators*, UL 144.

2-5.8.8 Regulators shall be designed so as to drain all condensate from the regulator spring case when the vent is directed vertically down.

2-5.9 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).

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 utilizing components, subassemblies, container assemblies, and container systems fabricated in accordance with Chapter 2.

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

NOTE: Section 3-2 includes general provisions applicable to most stationary systems. Sections 3-3 to 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 standard and other national standards or regulations that apply. These include:

(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 61B, *Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities*.

(d) NFPA 82, *Standard on Incinerators, 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 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: Portable containers as specifically provided for in Section 3-4.

Exception No. 2: Containers of less than 125 gal (0.5 m³) water capacity for the purposes of being filled in buildings or structures complying with Chapter 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 8-6.

Exception No. 7: Portable containers 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 Table 3-2.2.2, Table 3-2.2.4, and Table 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.

3-2.2.3 Where storage containers having an aggregate water capacity of more than 4,000 gal (15.1 m³) 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 m³) 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.

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 are 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 (3.0 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 m³) shall not be located closer than 10 ft (3.0 m) to such gas manufacturing and distributing buildings.

Table 3-2.2.2

Water Capacity Per Container Gallons (m ³)	Minimum Distances		
	Mounded or Underground Containers [Note (d)]	Aboveground Containers [Note (f)]	Between Containers [Note (e)]
Less than 125 (0.5) [Note (a)]	10 ft (3 m)	None [Note (b)]	None
125 to 250 (0.5 to 1.0)	10 ft (3 m)	10 ft (3 m)	None
251 to 500 (1.0 + to 1.9)	10 ft (3 m)	10 ft (3 m)	3 ft (1 m)
501 to 2,000 (1.9 + to 7.6)	10 ft (3 m)	25 ft (7.6 m) [Note (c)]	3 ft (1 m)
2,001 to 30,000 (7.6 + to 114)	50 ft (15 m)	50 ft (15 m)	5 ft (1.5 m)
30,001 to 70,000 (114 + to 265)	50 ft (15 m)	75 ft (23 m)	(1/4 of sum of diameters of adja- cent containers)
70,001 to 90,000 (265 + to 341)	50 ft (15 m)	100 ft (30 m)	
90,001 to 120,000 (341 + to 454)	50 ft (15 m)	125 ft (38 m)	
120,001 to 200,000 (454 to 757)		200 ft (61 m)	
200,001 to 1,000,000 (757 to 3 785)		300 ft (91 m)	
Over 1,000,000 (3 785)		400 ft (122 m)	

Notes to Table 3-2.2.2

Note (a): At a consumer site, if the aggregate water capacity of a multicontainer installation comprised of individual containers having a water capacity of less than 125 gal (0.5 m³) is 501 gal (1.9 + m³) or more, the minimum distance shall comply with the appropriate portion of this table, applying the aggregate capacity rather than the capacity per container. If more than one such installation is made, each installation shall be separated from any other installation by at least 25 ft (7.6 m). Do not apply the MINIMUM DISTANCES BETWEEN CONTAINERS to such installations.

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

1. DOT specification containers shall be located and installed so that the discharge from the container pressure relief device is at least 3 ft (1 m) horizontally away from any building opening that is below the level of such discharge, and shall not be beneath any building unless this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter. The discharge from container pressure relief devices shall be located not less than 5 ft (1.5 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.
2. ASME containers shall be located and installed so that the discharge from the container pressure relief device is at least 5 ft (1.5 m) horizontally away from any building opening that is below the level of such discharge, and not less than 10 ft (3 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.
3. The filling connection and the vent from liquid level gauges on either DOT or ASME containers filled at the point of installation shall be not

less than 10 ft (3 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

Note (c): This distance may be reduced to not less than 10 ft (3 m) for a single container of 1,200 gal (4.5 m³) 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 m³) water capacity.

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

Note (e): Where underground multicontainer installations are made of individual containers having a water capacity of 125 gal (0.5 m³) or more, such containers shall be installed so as to permit access at their ends or sides to facilitate working with cranes or hoists.

Note (f): In applying the distance between buildings and ASME containers of 125 gal (0.5 m³) or more water capacity, a minimum of 50 percent of this horizontal distance shall also apply to all portions of the building that project more than 5 ft (1.5 m) from the building wall and that are higher than the relief valve discharge outlet. This horizontal distance shall be measured from a point determined by projecting the outside edge of such overhanging structure vertically downward to grade or other level upon which the container is installed. Under no conditions shall distances to the building wall be less than those specified in Table 3-2.2.2.

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

Table 3-2.2.4

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

*In the design of fixed water spray and fixed monitor nozzle systems, the area of container surface to be protected may reflect portion of containers not likely to be subject to fire exposure as determined by good fire protection engineering practices.

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 321, *Standard on Basic Classification of Flammable and Combustible Liquids*.

- (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 m³) or less water capacity are installed adjacent to fuel oil supply tanks of 660 gal (2.5 m³) 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 hr 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*, on 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 and those containing butane and its isomers.

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.

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).

Table 3-2.2.7(f)

LP-Gas Containers Having an	Separation from Oxygen Containers Having an			Separation from Gaseous Hydrogen Containers Having an		
	Aggregate water capacity of	Aggregate capacity of 400 CF (11 m ³)* or less	Aggregate capacity of more than 400 CF (11 m ³)* to 20,000 CF (566 m ³)*, including unconnected reserves	Aggregate capacity of more than 20,000 CF (566 m ³)*, including unconnected reserves	Aggregate capacity of less than 400 CF (11 m ³)*	Aggregate capacity of 400 CF (11 m ³)* to 3000 CF (85 m ³)*
1200 gal (4.5 m ³) or less		None	20 ft (6 m)	25 ft (7.6 m)		
Over 1200 gal (4.5 m ³)		None	20 ft (6 m)	50 ft (15 m)		
500 gal (1.9 m ³) or less					None	10 ft (3 m)
Over 500 gal (1.9 m ³)					None	25 ft (7.6 m)
						50 ft (15 m)

*Cubic feet (m³) measured at 70°F (21°C) and atmospheric pressure.

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, e.g., 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.

3-2.2.10 ASME tanks filled on site, of 125 gal (0.5 m³) water capacity or more, shall be located so that the filling connection and fixed liquid level gauge are at least 10 ft (3.0 m) from any external source of ignition (i.e., open flame, window A/C, compressor, etc.)

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 prohibited.

(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).

3-2.4 Installation of Containers.

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

(a) DOT cylinder specification containers shall be installed only aboveground, and shall be set upon a firm foundation,

Table 3-2.3.3 Distance Between Point of Transfer and Exposures

Part	Exposure	Min. Horizontal Distance, Feet (Meters)
1.	Buildings, ¹ mobile homes, recreational vehicles, and modular homes with fire-resistive walls. ²	10 (3.1)
2.	Buildings ¹ with other than fire-resistive walls. ²	25 (7.6)
3.	Building wall openings or pits at or below the level of the point of transfer.	25 (7.6)
4.	Line of adjoining property that can be built upon.	25 (7.6)
5.	Outdoor places of public assembly, including school yards, athletic fields, and playgrounds.	50 (15)
6.	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)
7.	Driveways. ³	5 (1.5)
8.	Mainline railroad track centerlines.	25 (7.6)
9.	Containers ⁴ other than those being filled.	10 (3.1)
10.	Flammable and Class II combustible liquid ⁵ dispensers and aboveground and underground containers.	20 (6.1)

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

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

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

⁴ Not applicable to filling connections at the storage container or to dispensing vehicle fuel dispensers units 2,000 gal (7.6 m³) water capacity or less when used for filling containers not mounted upon vehicles.

⁵ NFPA 30 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).

or otherwise firmly secured. Flexibility shall be provided in the connecting piping. (See 3-2.8.6 and 3-2.8.9.)

(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 2-2.1.7.

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

3-2.4.2 Horizontal ASME containers designed for permanent installation in stationary service aboveground shall be placed on substantial masonry or noncombustible structural supports on concrete or firm masonry foundations, and shall be supported as follows:

(a) Horizontal 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)2.b.

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

1. Containers of more than 2,000 gal (7.6 m³) water capacity shall be provided with concrete or masonry foundations formed to fit the container contour, or if furnished with saddles in compliance with 2-2.5.1, shall be permitted to be placed on flat-topped foundations.

2. Containers of 2,000 gal (7.6 m³) 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.)

3. 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 m³) water capacity designed for permanent installation in sta-

tionary service aboveground 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 having a fire resistance rating of at least 2 hr. Continuous steel skirts having only one opening 18 in. (457 mm) or less in diameter shall be permitted to have such fire protection applied only to the outside of the skirts.

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 (normally not more than 12 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 (3.0 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, 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 (3.0 m) of the container.

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

3-2.4.6 Portable containers of 2,000 gal (7.6 m³) water capacity or less complying with 2-2.5.5 shall be permitted to be installed for stationary service as provided in 3-2.4.2(a)(2) for stationary containers.

3-2.4.7 Mounded containers shall be installed as follows:

(a) Mounding material shall be earth, sand, or other noncombustible, 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.

(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. (0.15 m) 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. (0.46 m) 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 (3.0 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 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 Container Appurtenances.

3-2.5.1 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.

3-2.5.2 Pressure relief devices on portable DOT cylinder specification containers, or their equivalent in accordance with ASME construction, of 1,000 lb (454 kg) [120 gal (0.5 m³)] water capacity or less shall be installed to minimize the possibility of relief device(s) discharge(s) impingement on the container.

3-2.5.3 Pressure relief devices on ASME containers of 125 gal (0.5 m³) 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 m³) 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 2,000 gal (7.6 m³) water capacity, the relief device discharge shall be installed vertically upward and 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 3-2.5.3(f).

2. In providing for drainage in accordance with 3-2.5.3(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 2,000 gal (7.6 m³) 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, of adequate area as specified in 2-3.7(d).

Exception: Pressure relief devices installed in dispensing stations covered in the exception to 3-2.5.3(d).

(d) On underground containers of more than 2,000 gal (7.6 m³) 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 3-2.5.3(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 3-2.5.3(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 used shall be adequate in size to allow sufficient relief device relieving capacity. 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(c), 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.

3-2.5.4 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 3-2.5.3.

3-2.5.5 Additional provisions (over and above the applicable provision in 3-2.5.2 and 3-2.5.3) 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.

3-2.6 Regulator Installation.

3-2.6.1 A two-stage regulator system or an integral two-stage regulator shall be required on all fixed piping systems that serve ½ 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 2-5.8. This requirement includes fixed piping systems for appliances on RV (recreational vehicles), mobile home installations, manufactured home installations, cater-

ing 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 are 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.

3-2.6.2 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 shall also 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.

3-2.6.3 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 m³) 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 portable containers awaiting use, resale, or exchange when stored in accordance with Chapter 5.

3-2.6.4 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.

3-2.6.5 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 build-

ing 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.

3-2.6.6 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, Exceptions Nos. 1, 2, 4, 5, and 6.

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

3-2.6.7 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.

3-2.7 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

1. Vapor service not exceeding 30 psi (208 kPa).
2. Installation outdoors and underground (see 3-2.8.7).

(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: Buildings, or separate areas of buildings, constructed in accordance with Chapter 7, and used exclusively to:

(a) House equipment for vaporization, pressure reduction, gas mixing, gas manufacturing, or distribution.

(b) House 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 3-2.7(d), Exception No. 1(b), is not always necessary depending upon 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 3-2.7(d), Exceptions 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 $\frac{3}{32}$ -in. (2.4-mm) internal diameter and with a wall thickness not less than $\frac{3}{64}$ in. (1.2 mm) is used.

3-2.8 Installation of Pipe, Tubing, Pipe and Tubing Fittings, Valves, and Hose.

3-2.8.1 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.

3-2.8.2 Metallic piping shall comply with the following:

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

(b) Vapor LP-Gas piping with operating pressures in excess of 125 psi (0.9 mPa), and liquid piping not covered by 3-2.8.2(a), shall be suitable for a working pressure of at least 250 psi (1.7 mPa).

(c) 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).

3-2.8.3 Metallic pipe joints shall be permitted to be threaded, flanged, welded, or brazed using pipe and fittings complying with 2-4.2 and 2-4.4 as follows:

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

1. 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 or

2. 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:

1. The pipe shall be Schedule 40 or heavier.

2. The fittings or flanges shall be suitable for the service for which they are to be used.

3. Brazed joints shall be made with a brazing material having a melting point exceeding 1,000°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 1,500°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.

3-2.8.4 Metallic tubing joints shall be permitted to be flared or brazed using tubing and fittings and brazing material complying with 2-4.3 and 2-4.4.

3-2.8.5 Piping in systems shall be run as directly as is practical from one point to another, and with as few restrictions, such as ellis and bends, as conditions will permit, giving consideration to provisions of 3-2.8.6.

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.

3-2.8.6 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* 3-2.8.9). The use of nonmetallic pipe, tubing, or hose for permanently interconnecting such containers shall be prohibited.

3-2.8.7 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. 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 of 12 in. (300 mm) of cover cannot be maintained, the piping shall be installed in conduit or bridged (shielded). 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 3-2.12.

The polyethylene pipe or tubing shall be centered inside the aboveground portion of the riser casing to provide an annular air space around the pipe or tubing to prevent excessive temperature buildup in the pipe or tubing.

The factory-assembled riser shall be sealed and leak tested by the manufacturer and the field-assembled riser shall be sealed and leak tested by the installer.

The casing of the riser shall be constructed of ASTM A53 Schedule 40 steel pipe or ASTM A513 mechanical steel tubing with a minimum wall thickness of 0.073 in. (1.9 mm).

Exception: The belowgrade casing section of the riser shall be permitted to be 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.

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

(a) 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.

(b) 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

(c) 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.

(d) 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).

(e) Valve installation in plastic 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*, which 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 3-2.8.8. Valves shall be recommended for LP-Gas service by the manufacturer.

(f) 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.

3-2.8.8 Underground metallic piping shall be protected against corrosion as warranted by soil conditions (*see* 3-2.12).

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

3-2.8.9 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) Hoses shall be permitted to be installed if flexibility is required for liquid or vapor transfer. The use of wet hose is recommended for liquid.

3-2.8.10 On new installations, and by December 31, 1980, on existing installations,

(1) stationary single container systems of over 4,000-gal (15.1-m³) water capacity, or

(2) stationary multiple container systems with an aggregate water capacity of more than 4,000 gal (15.1 m³) utilizing a common or manifolded liquid transfer line, or

(3) 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 1½ in. (38 mm) or larger is used for liquid transfer or a 1¼-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 hoses 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.

1. 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.

2. Temperature-sensitive elements of emergency shutoff valve shall not be painted nor have any ornamental finishes applied after manufacture.

(b) The emergency shutoff valve(s) or backflow check valve(s) specified in 3-2.8.10(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 unloading.

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

3-2.8.11 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.

3-2.9 Hydrostatic Relief Valve Installation. A hydrostatic relief valve complying 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.

3-2.10 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 (ANSI Z223.1), *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.

3-2.11 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.

3-2.12 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.

3-2.13 Equipment Installation.

3-2.13.1 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 2-5.2.2.

1. The bypass valve or recirculating device to limit the normal operating discharge pressure to not more than 350 psi (2.4 mPa) shall discharge either into a storage container (preferably the supply container from which the product is being pumped) or into the pump suction.

2. If this primary device is equipped with a shutoff valve, an adequate secondary device designed to operate at not more than 400 psi (2.8 mPa) shall, if not integral with the pump, be incorporated in the pump piping. This secondary device shall be designed or installed so that it cannot be rendered inoperative and shall discharge either into the supply container or into the pump suction.

(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 motor fuel dispensers.

3-2.13.2 Compressors shall be installed as recommended by the manufacturer and 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 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.

3-2.13.3 Strainers shall be installed so that the strainer element can be serviced.

3-2.13.4 Liquid or vapor meters shall be installed as recommended by the manufacturer, and in compliance with the applicable provisions of the following:

(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. Substantial bumpers shall be provided at the ends of sidings and as necessary to protect storage containers and points of transfer.

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 Transfer systems using positive displacement pumps shall comply with 2-5.2.2.

3-3.3.7 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.

3-3.3.8 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 3-2.8.9 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:

1. A backflow check valve, or
2. An emergency shutoff valve complying with 2-4.5.4, or
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:

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

3-3.3.9 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.

3-3.3.10 Transfer hoses larger than 1/2-in. (12-mm) internal diameter shall not be used for making connections to individual containers being filled indoors.

3-3.3.11 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 portable containers 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 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 sq ft (9 m²) 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, adequate 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 portable containers 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. Containers in use shall mean connected for use.

(a) The portable use of containers 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 portable use of containers necessary and location outside is impractical.

(b) Installations using portable containers on roofs shall be as specified in 3-4.9.1. Such use shall be limited to those

conditions where operational requirements make portable use of containers necessary and location not on roofs of buildings or structures is impractical.

(c) Installations using portable containers 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 3-2.7(d).

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

3-4.1.3 Transportation of containers 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 Containers, Equipment, Piping, and Appliances.

3-4.2.1 Containers 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) Containers shall be marked as provided in 2-2.6.

(b) Containers 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 containers shall be protected in accordance with 2-2.4.1.

(d) Containers having water capacities greater than 2.7 lb (1.2 kg) filled with no more than 16.8 oz (0.522 kg) of LP-Gas, and connected for use shall stand on a firm and substantially level surface. If necessary, they shall be secured in an upright position.

(e) Containers 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 container and adjacent containers.

3-4.2.2 Regulators, if used, shall be suitable for use with LP-Gas. Manifolds and fittings connecting containers 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 3-2.8 for liquid piping or for vapor piping for pressures above 125 psi (0.9 mPa). [See 3-2.8.2(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 3-2.8.11. Hose length shall be permitted to exceed that specified by 3-2.8.11(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: Hoses at a pressure of 5 psi (34 kPa) or less used in agricultural buildings not normally occupied by the public.

3-4.2.4 Containers, 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 containers are located on a floor, roof, or balcony, provisions shall be made to minimize the possibility of containers falling over the edge.

(a) Filling containers on roofs or balconies shall be prohibited. See 3-2.3.1(c).

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

(a) Movement of containers having water capacities greater than 2.7 lb (1.2 kg) and filled with no more than 16.8 oz (0.522 kg) of LP-Gas 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 containers having water capacities greater than 2.7 lb (1.2 kg) and filled with no more than 16.8 oz (0.522 kg) of LP-Gas 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 container 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 container.

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 container mounting (see 3-4.3.4). Container 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 Btuh (53 mJ/h), and those manufactured prior to May 17, 1967, with inputs of more than 100,000 Btuh (105 mJ/h), shall be equipped with either:

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

(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 7,500 Btuh (8 mJ/h) input if used with containers 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 Containers 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, containers 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 Containers, 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 LP-Gas container.

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

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

3-4.3.6 If heaters are connected to containers manifolded together for use in an unpartitioned area on the same floor, the total water capacity of containers 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, containers shall be permitted to be manifolded together for connection to a heater or heaters on another floor, provided:

(a) The total water capacity of the containers connected to any one manifold is not greater than 2,450 lb (1111 kg) [nominal 1,000 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. Containers 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 containers shall be 50 lb (23 kg) [nominal 20 lb (9.1 kg) LP-Gas capacity], and the number of containers in the building shall not exceed the number of workers assigned to the use of the LP-Gas.

2. Containers having a water capacity greater than 2.7 lb (1.2 kg) and filled with no more than 16.8 oz (0.522 kg) LP-Gas shall not be left unattended.

(b) During the hours the building is not open to the public, containers 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 containers with a greater water capacity than 2.7 lb (1.2 kg) and filled with no more than 16.8 oz (0.522 kg) LP-Gas shall not be left unattended.

3-4.5 Buildings Housing Industrial Occupancies.

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

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

(b) If containers are manifolded together, the total water capacity of the connected containers 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 containers for research and experimental use in the building shall be limited to the smallest practical quantity.

3-4.5.2 Containers 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 containers and heaters comply with and are used in accordance with 3-4.3.

3-4.6 Buildings Housing Educational and Institutional Occupancies. Containers 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 containers used shall be:

1. 50 lb (23 kg) [nominal 20 lb (9.1 kg) LP-Gas capacity] if used in educational occupancies.

2. 12 lb (5.4 kg) [nominal 5 lb (2 kg) LP-Gas capacity] if used in institutional occupancies.

(b) If more than one such container is located in the same room, the containers shall be separated by at least 20 ft (6.1 m).

(c) Containers not connected for use shall be stored in accordance with Chapter 5.

Exception: Containers 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 Containers 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 containers 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 Containers 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 container is located in a room, the containers shall be separated by at least 20 ft (6.1 m).

3-4.8.2 Containers 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 containers 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 container.

(b) If more than one such container is located in the same room, the containers shall be separated by at least 20 ft (6.1 m).

(c) The training location shall be acceptable to the authority having jurisdiction.

(d) Containers shall be promptly removed from the building when the training class has terminated.

3-4.8.3* Containers complying with UL 147A, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*, and 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 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 (Disposal) 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 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 Portable Containers on Roofs or Exterior Balconies.

3-4.9.1 Containers 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 containers 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) 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.

(c) Containers shall not be located on roofs that are entirely enclosed by parapets more than 18 in. (457 mm) high unless:

1. the parapets are breached with low-level ventilation openings no more than 20 ft (6.1 m) apart, or

2. 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 containers.

(e) The fire department shall be advised of each such installation.

3-4.9.2 Containers 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 container.

3-4.10 Liquid Piped into Buildings or Structures.

3-4.10.1 Liquid LP-Gas piped into buildings in accordance with 3-2.7(d), Exception No. 1 shall comply with 3-2.8.

3-4.10.2 Liquid LP-Gas piped into buildings in accordance with 3-2.7(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. I.P.S. and shall comply with 3-2.7 and 3-2.8. If approved by the authority having jurisdiction, copper tubing complying with 2-4.3(c)(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:

1. Securely fastening it to walls or other surfaces to provide adequate 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, 3-2.8.9, and 3-2.8.11.

(e) Hydrostatic relief valves shall be installed in accordance with 3-2.9.

(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 Reference Standards. LP-Gas appliances shall be installed in accordance with this standard and other national standards that apply. These include:

(a) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*.

(b) NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*.

(c) NFPA 61B, *Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities*.

(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, or

(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 (ANSI Z223.1), *National Fuel Gas Code*, where:

1. The heat transfer fluid is steam or hot water and is not recirculated, and

2. A backflow 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
Container	10 ft (3.0 m)
Container shutoff valves	15 ft (4.6 m)
Point of transfer	15 ft (4.6 m)
Nearest important buildings or group of buildings or line of adjoining property that may be built upon (except buildings in which vaporizer is installed; see 3-6.3.2 and 3-6.3.3).	25 ft (7.6 m)
Ch. 7 building or room housing gas-air mixer	10 ft (3.0 m)
Cabinet housing gas-air mixer outdoors	0 ft (0 m)

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 above-ground 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.

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.

Table 3-6.4.2

Container Water Capacity	Minimum Distance Required
500 gal or less	10 ft (3.0 m)
501 to 2,000 gal	25 ft (7.6 m)
2,001 to 30,000 gal	50 ft (15 m)
30,001 to 70,000 gal	75 ft (23 m)
70,001 to 90,000 gal	100 ft (30.0 m)
90,001 to 120,000 gal	125 ft (38.1 m)

For SI Units: 1 gal = 3.785 L

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:

(a) 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.

Table 3-6.5

Container Water Capacity	Minimum Distance Required
500 gal or less	10 ft (3.0 m)
501 to 2,000 gal	25 ft (7.6 m)
Over 2,000 gal	50 ft (15 m)

For SI Units: 1 gal = 3.785 L

(b) Manually operated positive shutoff valves shall be located at the containers to shut off all flow to the vaporizing-burners.

3-6.6 Installation of Waterbath Vaporizers. Waterbath vaporizers shall comply with 2-5.4.4 and shall be installed as follows:

(a) If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class 1, Group D, locations, the unit shall be treated as indirect-fired and shall be installed in accordance with 3-6.2.

(b) 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 installed in accordance with 3-6.2.

3-6.8 Installation of Gas-Air Mixers.

3-6.8.1 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 vaporizer(s), a mixer(s) shall be permitted to be installed outdoors or in buildings complying with Chapter 7.

(b) Where used with 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 direct-fired vaporizer(s), a mixer(s) shall be:

1. Listed or approved and installed in a common cabinet with the vaporizer(s) outdoors in accordance with 3-6.3.5.
2. Installed outdoors on a common skid with the vaporizer(s) in accordance with 3-6.3.
3. Installed adjacent to the vaporizer(s) to which it is connected in accordance with 3-6.3.
4. 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 standard.

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, *Lightning Protection Code*.

3-7.1.3 Grounding and bonding shall not be required on LP-Gas systems.

NOTE: Since 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.

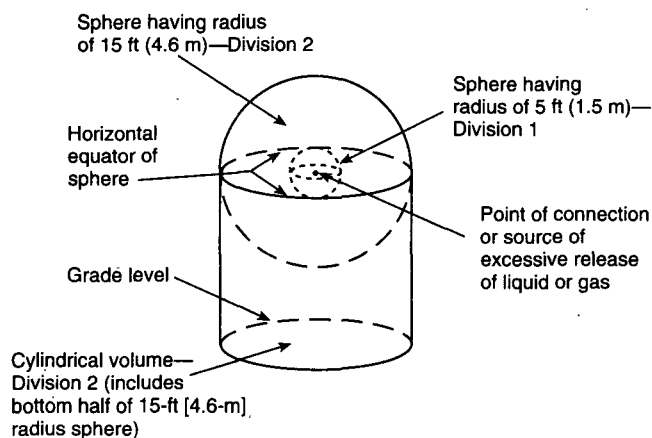


Figure 3-7.2.2 (See Table 3-7.2.2.)

3-7.2.3 Electrical equipment installed on LP-Gas cargo vehicles shall comply with 6-1.1.4.

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, container 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 container 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 non-engine 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) container systems and by permanently mounted containers.

3-8.1.2 This section shall not apply to:

- Systems installed on mobile homes.
- Systems installed on recreational vehicles [see 3-1.3(d)].
- Tank trucks, truck transports (trailers and semitrailers), and similar units used to transport LP-Gas as cargo, which are covered by Chapter 6.
- 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. DOT cylinder specification containers 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) Portable (removable) containers 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 m³) aggregate water capacity.

(f) Individual LP-Gas containers used on other than passenger-carrying vehicles normally operating on the highway shall not exceed 300 gal (1.1 m³) 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: Containers on road surface heating equipment shall not exceed 1,000 gal (3.8 m³) 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 Containers 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 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(e).

(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).

Table 3-7.2.2

Part	Location	Extent of Classified Area ¹	Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D ²
A	Unrefrigerated Containers Other than DOT Cylinders and ASME Vertical Containers of Less than 1,000 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. ³	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. (See Figure 3-7.2.2.)	Division 2
D	Gauge Vent Openings Other than Those on DOT Cylinders and ASME Vertical Containers of Less than 1,000 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 DOT Cylinders and ASME Vertical Containers of Less than 1,000 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. ⁴	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 adequate ventilation. ⁴	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. (See Figure 3-7.2.2.)	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. aboveground within 20 ft horizontally from any edge of enclosure. Note: For pits within this area, see Part H of this table.	Division 2

(continued)

Table 3-7.2.2 (cont.)

Part	Location	Extent of Classified Area ¹	Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D 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 adequate 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 Portable Containers.	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.	
K	Container Filling. Indoors with adequate ventilation. ⁴	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

SI Conversions for Table 3-7.2.2

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

¹The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.²See Article 500 "Hazardous (Classified) Locations" in NFPA 70 (ANSI) for definitions of Classes, Groups, and Divisions.³When classifying extent of hazardous area, consideration shall 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.⁴Where specified for the prevention of fire or explosion during normal operation, ventilation is considered adequate where provided in accordance with the provisions of this standard.⁵Fired vaporizers, calorimeters with open flames, and other areas where open flames are present either intermittently or constantly shall not be considered electrically classified areas.

(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 containers, this provision shall be met by the location on the vehicle, with parts of the vehicle furnishing the protection. On portable (removable) containers, the protection for container valves and connections shall be attached permanently to the container. (See 2-2.4.1 and 2-2.4.2.) Such weather protection necessary to ensure safe operation shall be provided for containers 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(i).

3-8.2.4 Containers 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 container(s) on the vehicle to prevent the temperature of the fuel in the container from becoming abnormally high. In addition, the following shall apply:

(a) Container location, mounting, and protection shall comply with 3-8.2.3(a), (b), and (c) except that the protection for DOT container valves shall not be required to be attached to the container 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) Container pressure relief devices shall be located and installed as follows:

1. On containers mounted in the interior of vehicles complying with 8-2.7, the pressure relief valve installation shall comply with 8-2.6(i).

2. Pressure relief valve installations on containers installed on the outside of vehicles shall comply with 8-2.6(i) 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 container for liquid and vapor shall be readily accessible.

(d) Containers to be filled volumetrically shall be equipped with liquid level gauging devices as provided in 2-3.4. Portable containers shall be permitted to be designed, constructed, and fitted for filling in either the vertical or horizontal position or, if of the portable universal type [see 2-3.4.2(c)(2)], in either position. The container shall be in the appropriate position when filled or, if of the portable universal type, shall be permitted to be loaded in either position, provided:

1. The fixed 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 2-5.8 and shall be installed in accordance with 3-2.6. 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 3-2.6.1 and protected from the elements in accordance with 3-2.6.4. 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-sq in. (6.5-cm²) 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 3-2.8. 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 removable containers, flexibility shall be provided in the piping between the container and the gas piping system or regulator.

(c) Flexible connectors shall comply with 2-4.6 and shall be installed in accordance with 3-2.8.9(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 3-2.9.

(i) Piping systems, including hose, shall be tested and proven free of leaks in accordance with 3-2.10.

(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 3-2.13 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 2-4.5.3 and 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 to ensure an adequate supply of outside air for 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 2-2.1.4.

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 m³) 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 3-2.9.

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)3 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 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 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) 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 standard.

3-10.2 General.

3-10.2.1 The wide range in size, arrangement, and location of LP-Gas installations covered by this standard 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 4,000 gal (15.1 m³) subject to exposure from a single fire. The mode of such protection shall be determined through a competent fire safety analysis (see 3-2.2.9).

The first consideration in any such analysis shall be an evaluation of the total product control system including emergency internal and shutoff valves having remote and thermal shutoff capability and pullaway protection.

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

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.)

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 min 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 constitute adequate protection.

3-10.3.3 If burial is utilized, the provisions of 3-2.4.8 shall constitute adequate protection.

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 also have a capability for manual actuation.

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 assure 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 1-6 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 Valve outlets on portable containers 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 container is not connected for use.

Exception: Nonrefillable (disposable) and new unused containers shall not be required to comply.

4-2.2.3 Containers shall be filled only after determination that they comply with the design, fabrication, inspection, marking, and requalification provisions of this standard. (See 2-2.1.3 and 2-2.1.4.)

4-2.2.4 DOT specification cylinders authorized as "single trip," "nonrefillable," or "disposable" containers shall not be refilled with LP-Gas.

4-2.2.5 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 DOT specification cylinders, the service pressure marked on the container 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 assure 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 containers 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 non-stationary 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 3-2.8.10.

(b) Compressors, if used, shall comply with 2-5.3 and 3-2.13.2.

(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 4-2.2.3.

(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, containers shall be permitted to be vented only in structures designed and constructed for container 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 container 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 standard.

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.)

Table 4-4.2.1
Maximum Permitted Filling Limit
(Percent of marked water capacity in lb)

Specific Gravity at 60°F (15.6°C)	Aboveground Containers		Underground Containers All Capacities
	0 to 1,200 U.S. gal (0 to 4.5 m ³) Total Water Cap.	Over 1,200 U.S. gal (0 to 4.5 m ³) Total Water Cap.	
.496-.503	41%	44%	45%
.504-.510	42	45	46
.511-.519	43	46	47
.520-.527	44	47	48
.528-.536	45	48	49
.537-.544	46	49	50
.545-.552	47	50	51
.553-.560	48	51	52
.561-.568	49	52	53
.569-.576	50	53	54
.577-.584	51	54	55
.585-.592	52	55	56
.593-.600	53	56	57

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 aboveground 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 density of " L ," shall be computed by use of the formula (see Appendix F-4.1.2 for example):

$$V_t = \frac{L}{G} \div F, \text{ or } V_t = \frac{L}{G \times F} \text{ where:}$$

V_t = percent of container capacity that may 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).

4-4.3 Compliance with Maximum Permitted Filling Limit Provisions.

4-4.3.1 The maximum permitted filling limit for any container, where practical, shall be determined by weight.

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) DOT specification cylinders of less than 200 lb (91 kg) water capacity that are not subject to DOT jurisdiction (such as, but not limited to, motor fuel containers on vehicles not in interstate commerce or cylinders filled at the installation).

(b) DOT specification 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.

4-4.3.3 Where used, the volumetric method shall be in accordance with the following:

(a) If a maximum fixed 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 (4.4°C) for aboveground containers or at 50°F (10°C) for underground containers.

(b) When a variable liquid level gauge is used and the liquid volume is corrected for temperature, the maximum permitted liquid level shall be in accordance with Tables 4-4.2.2(a), (b), and (c).

(c) Containers with a water capacity of 2,000 gal (7.6 m) or less filled at consumer sites shall be gauged in accordance with 4-4.3.3(a), utilizing the fixed 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 (see F-3.1.2).

Table 4-4.2.2(a)
Maximum Permitted Liquid Volume
(Percent of Total Water Capacity)

Aboveground Containers 0 to 1,200 Gal (0 to 4.5 m³)													
Liquid Temperature °F (°C)	Specific Gravity												
	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .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 1,200 Gal (0 to 4.5 m ³)													
Liquid Temperature °F (°C)	Specific Gravity												
	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .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)

Table 4-4.2.2(c)
Maximum Permitted Liquid Volume
(Percent of Total Water Capacity)

All Underground Containers													
Liquid Temperature °F (°C)	Specific Gravity												
	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .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).

Chapter 5 Storage of Portable Containers 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 portable containers of 1,000 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 containers stored at bulk plants.

5-2 General Provisions.

5-2.1 General Location of Containers.

5-2.1.1 Containers in storage shall be located to minimize exposure to excessive temperature rise, physical damage, or tampering.

5-2.1.2 Containers in storage having individual water capacity greater than 2½ lb (1 kg) [nominal 1 lb (0.45 kg)] LP-Gas capacity, and filled with not more than 16.8 oz (0.522 kg) LP-Gas, shall be positioned such that the pressure relief valve is in direct communication with the vapor space of the container.

5-2.1.3 Containers 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 Empty containers that have been in LP-Gas service shall preferably be stored outdoors. If stored indoors, they shall be considered as full containers 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 Containers that are not connected for use shall not be stored on roofs.

5-2.2 Protection of Valves on Containers in Storage.

5-2.2.1 Container valves shall be protected as required by 2-2.4.1. Screw-on type caps or collars shall be securely in place on all containers stored, regardless of whether they are full, partially full, or empty, and container outlet valves shall be closed and plugged or capped. The provisions of 4-2.2.2 for valve outlet plugs and caps shall apply.

5-3 Storage within Buildings.

5-3.1 Storage within Buildings Frequented by the Public. DOT specification cylinders with a maximum water capacity of 2½ lb (1 kg) [nominal 1 lb (0.45 kg)] LP-Gas capacity, and filled with no more than 16.8 oz (0.522 kg) LP-Gas, 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-gr) butane nonrefillable containers shall be limited to no more than 24 containers.

Exception No. 2: An additional twenty-four 10-oz (283-gr) 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-hr 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 Containers 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 LP-Gas containers with a total aggregate capacity per vehicle not exceeding 100 lb (45.4 kg) of LP-Gas. Container 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 that may be 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 containers 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 containers 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 2 containers 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 containers per each living space unit. Each container shall meet DOT specifications.

5-4 Storage Outside of Buildings.

5-4.1* Location of Storage Outside of Buildings. Storage outside of buildings for containers awaiting use, exchange, or resale shall be located at least 5 ft (1.5 m) from any doorway in a building frequented by the public in accordance with Table 5-4.1 with respect to:

(a) The nearest important building or group of buildings.

(b) The line of adjoining property that can be built upon.

Table 5-4.1

Quantity of LP-Gas Stored	Horizontal Distance to:		
	(a) and (b)	(c) and (d)	(e)
720 lb (227 kg) or less	0	0	5 ft (1.5 m)
721 (227 + kg) to 2,500 lb (1134 kg)	0	10 ft (3 m)	10 ft (3 m)
2,501 (1134 + kg) to 6,000 lb (2721 kg)	10 ft (3 m)	10 ft (3 m)	10 ft (3 m)
6,001 (2721 + kg) to 10,000 lb (4540 kg)	20 ft (6 m)	20 ft (6 m)	20 ft (6 m)
Over 10,000 lb (4540 kg)	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)

(c) Busy thoroughfares or sidewalks.

(d) The line of adjoining property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering.

(e) A dispensing station.

Exception: Location of cylinders in the filling process shall not be considered to be in storage.

5-4.2 Protection of Containers.

5-4.2.1 Containers 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 containers 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 portable containers.

Exception: The provisions of this chapter shall not apply to LP-Gas containers 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, 8-6, and 8-7.

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 motor 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. Wiring used shall have adequate mechanical strength and current-carrying capacity with suitable overcurrent protection (fuses or automatic circuit breakers) and shall be properly insulated and protected against 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 DOT Specification Cylinders or Portable ASME Containers.

6-2.2.1 Portable containers having an individual water capacity not exceeding 1,000 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 Containers shall be constructed as provided in Section 2-2 and equipped in accordance with Section 2-3 for transportation as portable containers.

6-2.2.3 The quantity of LP-Gas in containers shall be in accordance with Chapter 4.

6-2.2.4 Valves of containers 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 4-2.2.2 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 container (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 Containers and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Containers shall be loaded into vehicles with substantially flat floors or equipped with suitable racks for holding containers. Containers shall be securely fastened in position to minimize the possibility of movement, tipping, or physical damage.

6-2.2.7 Containers having an individual water capacity not exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas] capacity transported in open vehicles and containers 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. Containers having an individual water capacity exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas] capacity transported in open vehicles and containers 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 1,000 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 Transportation of Portable Containers of More than 1,000 lb (454 kg) Water Capacity.

6-2.3.1 Portable containers having an individual water capacity exceeding 1,000 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 1,000 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 standard.

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 1½ in. (nominal size) and larger size and vapor hose of 1¼ 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 3-2.8.10(a)(1), 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 1,000°F (538°C).

(e) Tubing joints shall be brazed, using a brazing material having a melting point of at least 1,000°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 installed after December 31, 1974, shall be permanently marked to indicate the date of assembly of the flexible connector, and the flexible portion of the connector shall be replaced within 6 years of the indicated date of assembly of the connector.

(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 3-2.13. 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 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.

6-3.4.3 The installation of compressors shall comply with the applicable provisions of 3-2.13.2 and 6-3.4.1.

6-3.4.4 The installation of liquid meters shall be in accordance with 3-2.13.4(a). If venting of LP-Gas to the air is necessary, provision shall be made to vent it at a safe location.

6-3.4.5 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 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 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. Mounting of containers shall be adequate for the service involved.

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 m³) 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:

(a) Such transportation shall be permitted only to move containers from a stationary or temporary installation to a bulk plant; and

(b) The owner of the container or the owner's designated representative authorizes its transportation; and

(c) Valves and fittings shall be protected to minimize the possibility of damage by a method approved by the authority having jurisdiction; and

(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: Where 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 3,500 gal (13 m³) 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:

1. The public is excluded from such buildings.

2. There is adequate 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 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 standard. Such structures can be separate buildings used exclusively for the 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 1-2.5.)

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 sq ft (0.1 m²) for each 50 cu ft (1.4 m³) 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 preferably be of solid fill. If not so filled, the perimeter of the space shall be left entirely unenclosed.

7-2.2 Structure or Building Ventilation.

7-2.2.1 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 cu ft per min per sq ft (0.3 m³/min/m²) 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 sq in. (3225 mm²) and the total of all openings shall be at least 1 sq in. per sq ft (720 mm²/m²) 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, *Ignition Source Control*), 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:

1. Have, as erected, a fire resistance rating of at least 1 hr.

NOTE: For information on fire resistance of building materials, see NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

2. Have 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-hr (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 sq ft (0.1 m²).

(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 7-2.2.1 and 7-2.3.

7-3.2 Construction of Rooms within Structures.

7-3.2.1 Rooms within structures shall be located in the first story and shall have at least one exterior wall with unobstructed free vents for freely relieving explosion pressures.

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 shall either 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 sq ft (0.1 m²) for each 50 cu ft (1.4 m³) of the enclosed volume.

(b) Walls and ceilings common to the room and to the building within which it is located shall:

1. Have, as erected, a fire resistance rating of at least 1 hr.

NOTE: For information on fire resistance rating of building materials, see NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

2. Not have openings. Common walls for rooms used only for storage of LP-Gas shall be permitted to have doorways that shall be equipped with 1½-hr (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 sq ft (0.1 m²).

Exception: The provisions of 7-3.2.1(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 7-2.2.1 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.

(a)* 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:

1. Adherence to applicable ASME Code Case Interpretations and Addenda shall be considered as compliance with the ASME Code.

2. 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 Appendices C and D.*)

3. 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.

4. DOT containers shall be designed and constructed for at least 240 psi (1.6 mPa) service pressure.

5. DOT specification containers shall be requalified in accordance with DOT regulations. The owner of the container shall be responsible for such requalification. (*See Appendix C.*)

6. 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).

7. 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.

8. Containers showing serious denting, bulging, gouging, or excessive corrosion shall be removed from service.

(b) Containers shall comply with 8-2.2(a) 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.

(c) ASME containers shall be marked in accordance with 8-2.2(c)1. through 12. 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.

1. Service for which the container is designed; i.e., aboveground.

2. Name and address of container manufacturer or trade name of container.

3. Water capacity of container in lb or U.S. gallons.

4. Design pressure in psi.

5. The wording "This container shall not contain a product having a vapor pressure in excess of 215 psi (1.5 mPa) at 100°F (37.8°C)."

6. Tare weight of container fitted for service in order for containers to be filled by weight.

7. Outside surface area in sq ft.

8. Year of manufacture.

9. Shell thickness _____ head thickness _____

10. OL _____ OD _____ HD _____

11. Manufacturer's serial number.

12. ASME Code symbol.

(d) LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200 gal (0.8 m³) aggregate water capacity.

(e) Individual LP-Gas containers used on other than passenger carrying vehicles normally operating on the highway shall not exceed 300 gal (1 m³) water capacity.

(f) 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 m³) or less shall be permitted to be filled into the liquid space.

1. The connections for pressure relief valves shall be located and installed in such a way as to have direct com-

munication with the vapor space of the container and shall not reduce the relieving capacity of the relief device.

2. 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.

(g) 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.

(h) 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.

(a) 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).

1. 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.

2. 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.

3. Containers shall be fabricated so they can be equipped with a fixed liquid level gauge capable of indicating the maximum permitted filling level in accordance with 4-4.2.2. Fixed 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 liquid level gauge opening and the remote bleeder valve opening shall not be larger than a No. 54 drill size.

4. ASME containers shall be equipped with full internal or flush-type full internal pressure relief valves conforming with applicable requirements of UL 132, *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:

a. the pressure in psi (mPa) at which the valve is set to start to leak;

b. the rated relieving capacity in cu ft per minute of air at 60°F (15.6°C) and 14.7 psia (an absolute pressure of 0.1 mPa); and

c. the manufacturer's name and catalog number. Fusible plugs shall not be used.

5. DOT containers 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.

6. A float gauge if used shall be designed and approved for use with LP-Gas.

7. A solid steel plug shall be installed in unused openings.

8. 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.

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.

8-2.4 Carburetion Equipment.

(a) *General.* Carburetion equipment shall comply with (b) through (e) 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).

(b) *Vaporizer.*

1. 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 shall comply with the following:

a. 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 permanently at a readily visible point with the marked design pressure of the fuel containing portion in psi (mPa).

2. The vaporizer shall not be equipped with a fusible plug.

3. 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.

4. 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).

5. 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).

(c) *Regulator.* The regulator shall be approved and shall be permitted to be either part of the vaporizer unit or a separate unit.

(d) *Automatic Shutoff Valve.* 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.

(e) *Fuel Filter.* 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.

(a) *Pipe.*

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*.

2. 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.

(b) *Tubing.*

1. 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*.

(c) *Pipe and Tube Fittings.*

1. 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.

(i) 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).

(ii) 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).

(iii) Brazing filler material shall have a melting point exceeding 1,000°F (538°C).

(d) *Hose, Hose Connections, and Flexible Connectors.*

1. 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:

a. Hose shall be designed for a working pressure of 350 psi (240 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.

b. 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.

2. 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.

3. 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 1-3.

8-2.6 Installation of Containers and Container Appurtenances.

(a) 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.

(b) 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.

(c) 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 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.

(d) 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.

(e) 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(e)*]:

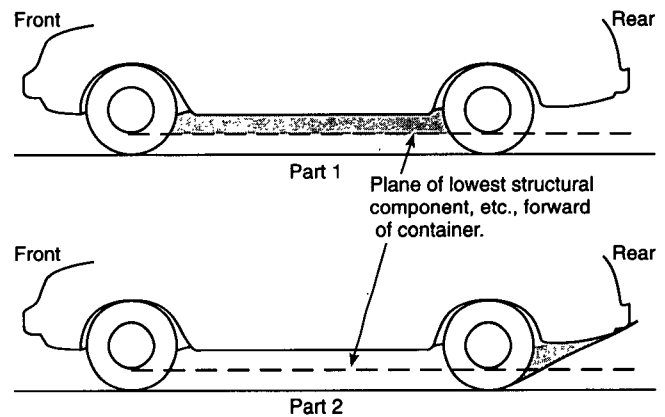


Figure 8-2.6(e) Container installation clearances.

1. Containers installed between axles shall comply with 8-2.6(e)3 or shall be not lower than the lowest point forward of the container on:

- The lowest structural component of the body;
- The lowest structural component of the frame or subframe if any;
- The lowest point on the engine;
- The lowest point of the transmission (including the clutch housing or torque converter housing as applicable) [*see Part 1, Figure 8-2.6(e)*].

2. Containers installed behind the rear axle and extending below the frame shall comply with 8-2.6(e)3 or shall be not lower than the lowest of the following points and surfaces.

a. 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, etc.). [*See Figure 8-2.6(e), Part 2.*]

b. Where there are two or more rear axles, the projections shall be made from the rearmost axle.

3. Where an LP-Gas container is substituted for the fuel container installed by the original manufacturer of the vehicle (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(e)1 or 2.

(f) 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.

(g) Welding for the repair or alterations of containers shall comply with 8-2.2(a)7.

(h) 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.

(i) The pressure relief valve discharge system(s) shall be installed so that:

1. 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.

2. 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 nonmetallic 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.

a. 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 1,500°F (816°C.).

Exception: The breakaway adapter shall be permitted to be an integral part of the pressure relief valve.

b. 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.

c. 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(i)1 without the hose attached. If an additional fitting is necessary to meet this requirement, it shall have a melting point not less than 1,500°F (816°C) and shall meet the requirements of 8-2.6(i)2.

3. 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.

4. Where a pipeaway system is not required, the pressure relief valve shall have a protective cover in accordance with 8-2.6(i)2.

8-2.7 Containers Mounted in the Interior of Vehicles.

(a) Containers mounted in the interior of vehicles shall be installed so that any LP-Gas released from container appurtenances due to operation, leakage, or connection of the appurtenances will not be in an area communicating directly with the driver or passenger compartment or with any space containing radio transmitters or other spark-producing equipment. This shall be permitted to be accomplished by the following means:

1.* 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.

2. 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.

(b) 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(a)(2)], and fixed liquid level gauging device to the outside of the vehicle.

(c) Container pressure relief valve installation shall comply with 8-2.6(i).

(d) 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.

(a) 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.

(b) 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.

(c) 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.

(d) 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.

(e) Exposed parts of the piping system shall be of corrosion-resistant material or shall be adequately protected against exterior corrosion.

(f) Piping systems, including hose, shall be tested and proven free of leaks at not less than normal operating pressure.

(g) There shall be no fuel connection between a tractor and trailer or other vehicle units.

(h) 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.

(a) 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.

(b) 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(a).

(c) The gas regulator and the approved automatic shut-off valve shall be installed as follows:

1. 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.

2. An approved automatic shutoff valve shall be provided in the fuel system in compliance with 8-2.4(d).

(d) 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 4¾ in. (120 mm) long by 3¼ 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, Maintenance and Operation*.

8-3.2 ASME and DOT fuel containers shall comply with 8-2.2 and 8-2.3(a)1 through 7.

(a) Portable containers shall be permitted to be designed, constructed, and fitted for filling in either the

vertical or horizontal position, or, if of the portable universal type [see 2-3.4.2(c)2], in either position. The container shall be in the appropriate position while being filled or, if of the portable universal type, shall be permitted to be filled in either position, provided:

1. The fixed 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 container relief valve shall be vented upward within 45 degrees of vertical and otherwise shall comply with 8-2.6(i).

8-3.4 Gas regulating and vaporizing equipment shall comply with 8-2.4(b)1 through 5 and 8-2.4(c), (d), and (e).

8-3.5 Piping and hose shall comply with 8-2.5(a) through (d).

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, 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 containers preferably should be done outdoors, but shall be permitted to be done indoors. If done indoors, means shall be provided in the fuel piping system to minimize the release of fuel when containers are exchanged, using one of the following methods:

- a. Use of an approved quick-closing coupling (a type that closes in both directions when uncoupled) in the fuel line; or

- b. Closing the shutoff valve at the fuel container 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 containers 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 containers 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 container 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 containers used in industrial truck service (including forklift truck cylinders) shall have the container pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the container 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(d).

(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 LP-Gas containers 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 container or portion of the machinery or equipment containing the LP-Gas container must 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 standard.

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 LP-Gas containers 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(d). 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(d).

(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(a) through (d).

8-5.4 Gas regulating, vaporizing, and carburetion equipment shall comply with 8-2.4(b)1 through 5, 8-2.4(c), and 8-2.4(e).

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:

(a) The fuel system is leak-free, and the container(s) is not filled beyond the limits specified in Chapter 4.

(b) The container 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 Storage

9-1 Refrigerated Containers.

9-1.1 Refrigerated LP-Gas containers shall be designed and constructed in accordance with the applicable provisions of the following codes as appropriate for the design loadings including design pressure and temperature.

9-1.1.1 For pressures of 15 psi (103 kPa) or more, the ASME Code, Section VIII shall apply, except that construction using joint efficiencies in Table UW 12, Column C, Division 1, shall not be permitted. Material shall be selected from those recognized by ASME that meet the requirements of API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, including Appendix R.

9-1.1.2 For pressures below 15 psi (103 kPa), API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, including Appendix R, shall apply.

9-1.1.3 Where austenitic steels or nonferrous materials are used, API 620, 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 shall be at least 5 percent of the absolute vapor pressure of the LP-Gas at the design storage temperature. The margin (both positive and vacuum) for low-pressure API vessels shall include the control range of the boil-off handling system, the effects of flash or vapor collapse during filling operations, the flash that can result from withdrawal pump recirculation, and the normal range of barometric pressure changes.

9-1.2.2 The minimum design temperature for those parts of a refrigerated LP-Gas container that are in contact with the refrigerated liquid or vapor shall be the boiling point at atmospheric pressure of the product to be stored.

9-1.3 The design wind loading on refrigerated LP-Gas containers shall be based on the projected area at various height zones aboveground 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.

9-1.4 Field-erected containers for refrigerated storage shall be designed as an integral part of the storage system including tank insulation, compressors, condensers, controls, and piping. 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. Welded construction shall be used.

9-1.5 The design seismic loading on refrigerated LP-Gas containers shall be based on forces recommended in the ICBO *Uniform Building Code*. In those areas identified as zones 3 and 4 on the Seismic Risk Map of the United States, Figures 1, 2, and 3 of Chapter 23 of the *UBC*, a seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction.

9-1.6 All piping that is part of a refrigerated LP-Gas container shall be in accordance with ASME B31.3, *Chemical Plant and Refinery Piping*. This container piping shall include all piping internal to the container, within the insulation spaces, and external piping attached or connected to the container up to the first circumferential external joint of the piping. Inert gas purge systems wholly within the insulation spaces are exempt from this provision.

9-1.7 Refrigerated LP-Gas containers shall be installed on foundations designed by an engineer experienced in foundations and soils and shall be constructed in accordance with recognized structural engineering practices. Prior to the start of design and construction of the foundation, a subsurface investigation shall be conducted by a soils engineer to determine the stratigraphy and physical properties of the soils underlying the site.

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

9-1.7.1 The refrigerated LP-Gas container foundation shall be periodically monitored for settlement during the life of the facility including construction, hydrostatic testing, commissioning, and operation. Any settlement in excess of that anticipated in the design shall be investigated and corrective action taken if appropriate.

9-1.7.2 The bottom of a refrigerated LP-Gas container, either the bottom of an outer tank or the bottom of the undertank insulation, shall be above the ground water table or otherwise protected from contact with ground water at all times, and the material in contact with the bottom of the container shall be selected to minimize corrosion.

9-1.7.3 If the bottom of the refrigerated LP-Gas container is in contact with the soil, a heating system shall be provided to prevent the 32°F (0°C) isotherm from extending into the soil. The heating system shall be designed to permit both functional and performance monitoring. As a minimum, the undertank temperature shall be observed and logged on a weekly basis. Where there is a discontinuity in the foundation, such as bottom piping, careful attention and separate treatment shall be given to the heating system in that zone. Heating systems shall be installed so that any heating elements or temperature sensors used for control can be replaced while the tank is in service. Provisions shall be incorporated to protect against the detrimental effects of moisture accumulation in the conduit, which could result in galvanic corrosion or other forms of deterioration within the conduit or heating element.

9-1.7.4 If the foundation of a refrigerated LP-Gas container is installed to provide adequate air circulation in lieu of a heating system, the bottom of the container shall be of materials that are suitable for the temperatures to which they will be exposed.

9-1.8 Refrigerated LP-Gas Container Instruments and Controls.

9-1.8.1 Each refrigerated LP-Gas container shall be equipped with at least two independent liquid level gauging devices. These devices shall be replaceable without taking the container out of service.

9-1.8.2 The refrigerated LP-Gas container shall be provided with a high-liquid-level alarm. The alarm shall be set so that the operator will have sufficient time to stop the flow without exceeding the maximum permissible filling height and shall be located so that it is audible to personnel controlling the filling. A high-liquid-level flow cutoff device shall not be considered as a substitute for the alarm.

9-1.8.3 The refrigerated LP-Gas container shall be equipped with a high-liquid-level flow cutoff device, which shall be independent from all gauges.

Exception: Refrigerated LP-Gas containers of 70,000 gal (265 m³) or less, if attended during the filling operation, shall be permitted to be equipped with liquid trycocks in lieu of the high-liquid-level alarm, and manual flow cutoff shall be permitted.

9-1.8.4 Each refrigerated LP-Gas container shall be provided with temperature indicating devices to assist in controlling cooldown rates when placing the container in service.

9-1.9 Inspection of Refrigerated LP-Gas Containers.

9-1.9.1 During construction and prior to the initial operation or commissioning, each refrigerated LP-Gas container shall be inspected or tested in accordance with the provisions of this standard and other applicable referenced codes and standards. Such inspections or tests shall be adequate to assure compliance with the design, material specifications, fabrication methods, and quality required by this and the referenced standards.

9-1.9.2 The inspections or tests required by 9-1.9.1 shall be the responsibility of the operator who shall be permitted to delegate any part of those inspections to his or her own employees, to a third party engineering or scientific organization, or to a recognized insurance or inspection company. Each inspector shall be qualified in accordance with the code or standard that is applicable to the test or inspection being performed.

9-1.10 Marking on Refrigerated LP-Gas Containers. Each refrigerated LP-Gas container shall be identified by the attachment of a nameplate on the outer covering in an accessible and visible place marked as specified with the following:

- (a) Manufacturer's name and date built.
- (b) Liquid volume of the container in gal (U.S. standard) or barrels.
- (c) Maximum allowable working pressure in lb per sq in.
- (d) Minimum temperature in degrees Fahrenheit for which the container was designed.
- (e) Maximum allowable water level to which the container shall be permitted to be filled for test purposes.
- (f) Density of the product to be stored in lb per cu ft, or specific gravity, for which the container was designed.
- (g) Maximum level to which the container shall be permitted to be filled with the LP-Gas for which it was designed.

9-2 Refrigerated LP-Gas Container Impoundment.

9-2.1 Each refrigerated LP-Gas container shall be located within an impoundment area that complies with this section, in order to minimize the possibility that the accidental discharge of liquid LP-Gas from the container would endanger adjoining property or lives, process equipment or structures, or reach waterways.

9-2.2 Enclosed drainage channels for LP-Gas shall be prohibited.

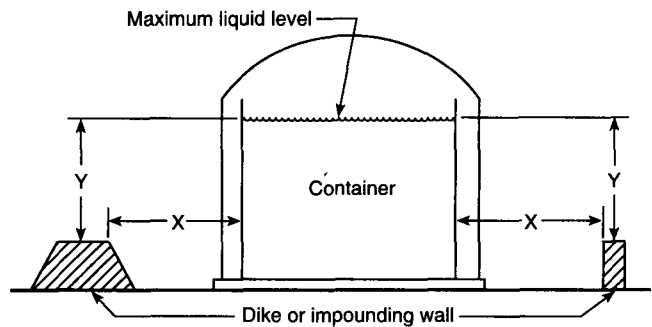
Exception: Container downcomers used to rapidly conduct spilled LP-Gas away from critical areas shall be permitted to be enclosed provided that an adequate drainage rate is achieved.

9-2.3 Dikes, impounding walls, and drainage for refrigerated LP-Gas and flammable refrigerant containment shall have a minimum volumetric holding capacity, including any useful holding capacity of the drainage area and with allowance made for the displacement of snow accumulation, other containers, or equipment, equal to the total liquid volume of the largest container served assuming that container is full.

9-2.4 Dikes, impounding walls, and drainage for refrigerated LP-Gas and flammable refrigerant containment shall be of compacted earth, concrete, metal, or other suitable materials. It shall be permitted to locate such structures independent of the container, mounted integral to, 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.

9-2.5 To ensure that any accidentally discharged liquid is contained within an area enclosed by a dike or an

impounding wall while providing a reasonably wide margin for area configuration design, the dike or impounding wall height and distance shall be determined in accordance with Figure 9-2.5.



Notes:

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

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

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

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

Figure 9-2.5 Dike or impounding wall proximity to containers.

9-2.6 Provision shall be made to clear rain or other water from the impounding area. Automatically controlled sump pumps shall be permitted if equipped with an automatic cutoff device that will prevent their operation when exposed to LP-Gas temperatures. Piping, valves, and fittings whose failure could permit liquid to escape from the impounding area shall be suitable for continuous exposure to LP-Gas temperatures. If gravity drainage is employed for water removal, provision shall be made to prevent the escape of LP-Gas by way of the drainage system.

9-2.7 Insulation systems used for impounding surfaces shall be, in the installed condition, noncombustible and suitable for the intended service considering the anticipated thermal and mechanical stresses and loadings. If flotation is a problem, mitigation measures shall be provided. Such insulation systems shall be inspected as appropriate for their intended service.

9-3 Locating Aboveground Refrigerated LP-Gas Containers.

9-3.1 Containers shall be located outside of buildings.

9-3.2 A refrigerated LP-Gas container having a capacity of 70,000 gal (265 m³) or less shall be installed in accordance with Table 3-2.2.2. Refrigerated LP-Gas containers of 70,001 gal (265 m³) or more shall be located 100 ft (30.5 m) or more from any occupied building, storage containers for flammable or combustible liquids, and from a property line that may be built upon.

9-3.3 The edge of a dike, impoundment, or drainage system intended for a refrigerated LP-Gas container shall be 100 ft (31 m) or more from a property line that can be built upon, a public way, or a navigable waterway.

9-3.4 Refrigerated LP-Gas containers shall not be located within dikes enclosing flammable liquid tanks or within dikes or impoundments enclosing nonrefrigerated pressurized LP-Gas containers.

9-3.5 Refrigerated LP-Gas containers shall not be installed one above the other.

9-3.6 The minimum distance between aboveground refrigerated LP-Gas containers of 70,001 gal (265 m³) or larger shall be one-half the diameter of the larger container.

9-3.7 The ground within 25 ft (7.6 m) of any aboveground refrigerated LP-Gas containers and all ground within a diked, impoundment, or drainage area shall be kept clear of readily 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 LPG tank vessel, shall not be handled over a pier or dock within 100 ft (30.5 m) of the point of transfer connection while LPG 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 adequate security personnel and measures are available to prevent unauthorized individuals access to the waterfront area while the LPG 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.

(a) Lighting shall illuminate communications, fire fighting, and other emergency equipment.

(b) 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.

(c) 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:

(a) That extinguishers are installed and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*, and are ready for use.

(b) That emergency equipment is positioned and ready to operate prior to the start of the transfer operation.

(c) 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:

1. Life rings with attendant rope of sufficient length.
2. 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 min. 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 Title 33 of the *U.S. Code of Federal Regulations*.

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 CFR 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) LPG 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 Referenced Publications

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

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

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

NFPA 30, *Flammable and Combustible Liquids Code*, 1993 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 1994 edition.

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*, 1992 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*, 1992 edition.

NFPA 59, *Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants*, 1995 edition.

NFPA 61B, *Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities*, 1989 edition.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*, 1994 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 1990 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 1994 edition.

NFPA 101, *Life Safety Code*, 1994 edition.

NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*, 1990 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*, 1992 edition.

NFPA 501C, *Standard on Recreational Vehicles*, 1993 edition.

NFPA 505, *Firesafety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance, and Operation*, 1992 edition.

11-1.2 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 620, *Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 1990.

11-1.3 ASCE Publication. American Society of Civil Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

ASCE 7-1993, *Design Loads for Buildings and Other Structures*.

11-1.4 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 B31.3-1993, *Chemical Plant and Petroleum Refinery Piping*.

ASME B36.10M-1985, *Welded and Seamless Wrought Steel Pipe*.

11-1.5 ASTM Publications. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM A47-1990, *Standard Specification for Ferritic Malleable Iron Castings*.

ASTM A48-1994, *Standard Specification for Gray Iron Castings*.

ASTM A53-1993, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*.

ASTM A106-1994, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*.

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

ASTM A513-1992, *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing*.

ASTM A536-1984, *Standard Specification for Ductile Iron Castings*.

ASTM A539-1990, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines*.

ASTM B42-1993, *Standard Specification for Seamless Copper Pipe, Standard Sizes*.

ASTM B43-1991, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*.

ASTM B86-1988, *Standard Specification for Zinc-Alloy Die Casting*.

ASTM B88-1993, *Standard Specification for Seamless Copper Water Tube*.

ASTM B135-1991, *Standard Specification for Seamless Brass Tube*.

ASTM B280-1993, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*.

ASTM D2513-1994, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*.

ASTM D2683-1993, *Standard Specification for Socket-Type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe*.

ASTM D3261-1993, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*.

ASTM F1055-1993, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing*.

11-1.6 AWS Publication. American Welding Society, 2501 NW 7th St., Miami, FL 33125.

AWS Z49.1-1988, *Safety in Welding and Cutting*.

11-1.7 CGA Publication. 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*.

11-1.8 Federal Regulations. U.S. Government Printing Office, Washington, DC 20401.

Code of Federal Regulations, Title 49, Parts 171-192 and Parts 393 and 397. (Also available from the Association of American Railroads, American Railroads Bldg., 1920 L St. NW, Washington, DC 20036 and American Trucking Assns., Inc., 2201 Mill Rd., Alexandria, VA 22314.)

11-1.9 ICBO Publication. International Conference of Building Officials, 5360 S. Workman Mill Rd., Whittier, CA 90601.

Uniform Building Code, 1991.

11-1.10 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

UL 132-93, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*.

UL 144-94, *Standard for LP-Gas Regulators*.

UL 147A-92, *Standard for Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies*.

UL 147B-92, *Standard for Nonrefillable (Disposal) Type Metal Container Assemblies for Butane*.

UL 567-92, *Standard Pipe Connectors for Flammable and Combustible Liquids and LP-Gas*.

Appendix A Explanatory Material

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

A-1-1.1 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 lit-

mus paper in the vapor stream from the container for 30 sec. 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 *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 m³) 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 m³) 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*, BERG/R1-77/1, United States Energy Research & 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 hand-held 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 and CAN/CGSB-3.0 No. 18.5-M89. At the time of the preparation of this standard additional analytical methods are under development.

A-1-6 External Pressure Relief Valve. Describes the type of relief valves used on older domestic tanks, relief valve manifolds, and piping protection.

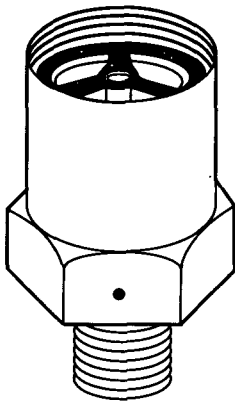


Figure A-1-6(a) External relief valve.

Flush-type Full Internal Pressure Relief Valve. Describes the type of relief valve being required on cargo vehicles in most states.

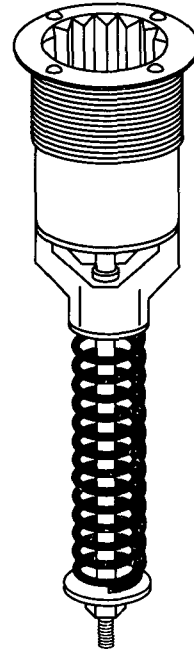


Figure A-1-6(b) Flush-type full internal relief valve.

Full Internal Pressure Relief Valve. Describes the type of relief valve being converted to for engine fuel use.

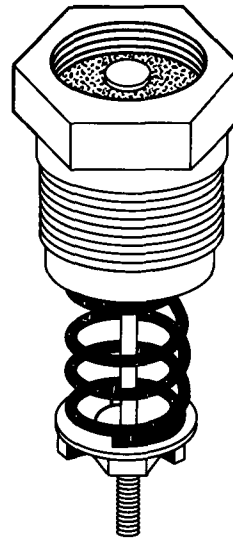


Figure A-1-6(c) Full internal relief valve.

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.

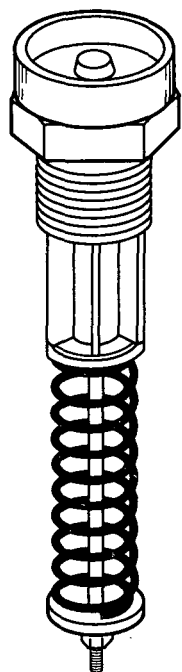


Figure A-1-6(d) Internal spring-type relief valve.

Sump-type Full Internal Pressure Relief Valve. Describes the type of relief valve used on older engine fuel tanks.

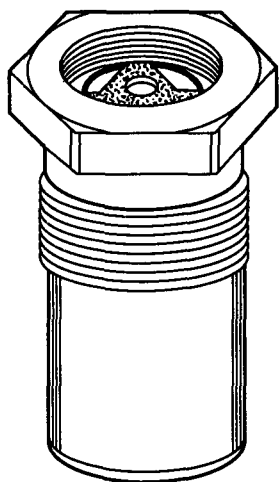


Figure A-1-6(e) Sump-type full internal relief valve.

A-2-2.1.3 Prior to April 1, 1967, regulations of the U.S. Department of Transportation were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply. 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.

A-2-2.6.4 A sample warning label, which is intended for use with gas grill cylinders, is shown in Figure A-2-2.6.4.

A-2-4.4(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(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) Aboveground Storage Tank Paint Color. 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:

1. API Publication 1632-1983, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems*.

2. Underwriters Laboratories of Canada, ULC S603.1-M, 1982, *Standard for Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids*.

DANGER—FLAMMABLE GAS UNDER PRESSURE
LEAKING LP-GAS MAY CAUSE A FIRE OR EXPLOSION IF IGNITED
CONTACT LP-GAS SUPPLIER FOR REPAIRS, OR DISPOSAL OF THIS CYLINDER OR UNUSED LP-GAS
FOR OUTDOOR USE ONLY*
DO NOT USE OR STORE CYLINDER IN A BUILDING, GARAGE, OR ENCLOSED AREA

CUSTOMER WARNING:

- Know the odor of LP-Gas. If you hear, see, or smell leaking LP-Gas, immediately get everyone away from the cylinder and call the Fire Department. Do not attempt repairs.
- Caution your LP-Gas supplier to:
 - Be certain cylinder is purged of trapped air prior to first filling.
 - Be certain not to overfill the cylinder.
 - Be certain cylinder requalification date is checked.**
- LP-Gas is heavier than air and may settle in low places while dissipating.
- Contact with the liquid contents of cylinder will cause freeze burns to the skin.
- Do not allow children to tamper or play with cylinder.
- When not connected for use, keep cylinder valve turned off and, for 45 lb propane capacity or less, plug or cap valve outlet. Self-contained outdoor cooking appliances shall be limited to a cylinder of 20 lb capacity or less.
- Do not use, store, or transport cylinder where it would be exposed to high temperatures. Relief valve may open, allowing a large amount of flammable gas to escape.
- When transporting, keep cylinder secured in an upright position with cylinder valve turned off and tightly plugged or capped.

*EXCEPT AS AUTHORIZED BY ANSI/NFPA 58

WHEN CONNECTING FOR USE:

- Use only in compliance with applicable codes.
- Read and follow manufactures' instructions.
- If regulator has a coupling nut, the nut has left-handed threads and must be **wrench** tightened. If the regulator has a plug-in connection, pull the pull ring back, insert fully, and release ring. Be sure regulator vent is pointing down.
- Turn off all valves on the appliance.
- **Do not check for gas leaks with a match or open flame. Apply soapy water at areas marked "X." Open cylinder valve. If bubble appears, close valve and have LP-Gas service person make needed repairs. Also, check appliance valves and connections to make sure they do not leak before lighting appliance.**
- Light appliance(s) following manufacturers' instructions
- When appliance is not in use, keep the cylinder valve closed.

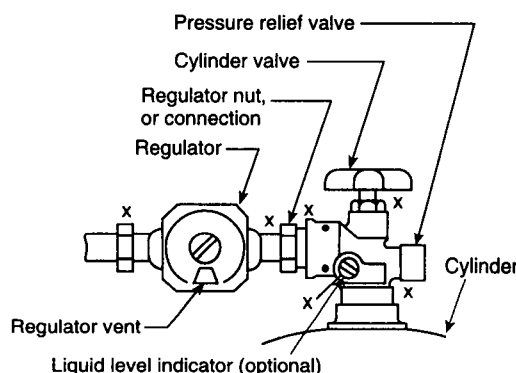


Figure A-2-2.6.4 A sample cylinder warning label.

3. National Association of Corrosion Engineers Standard RP-01-69 (1983 Rev.), Recommended Practice, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*.

4. 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*.

5. Underwriters Laboratories Inc., UL 1746, *External Corrosion Protection Systems for Steel Underground Storage Tanks*, 1989.

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-3-2.8.9(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 (454 g) to 16.8 oz (476 g) are recognized as being within the range of what is nominal.

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 A fire safety analysis should include the following:

- An analysis of local conditions of hazard within the container site.
- Exposure to or from other properties, population density, and congestion within the site.
- The probable effectiveness of plant fire brigades or local fire departments based on adequate water supply, response time, and training.
- 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 m³) water capacity or less, a competent fire safety analysis (see 3-10.2.3 and 3-10.2.5) 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-8-2.2(a) 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(a)1 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-1.2.1 for computation method used). Since these are average values, the interrelationships between them

(i.e., lb per gal, specific gravity, etc.) 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.

B-1.2.1 The principal properties of commercial propane and commercial butane are shown in Table B-1.2.1. 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.

B-1.3 Specifications of LP-Gases. Specifications of LP-Gases covered by this standard are listed in Gas Processors Association, Standard 2140, *Liquefied Petroleum Gas Specifications for Test Methods*, or ASTM D1835, *Specification for Liquefied Petroleum (LP) Gases*.

Table B-1.2.1 (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
Cu ft of Vapor per Gallon at 60°F	36.38	31.26
Cu ft of Vapor per Pound at 60°F	8.66	6.51
Specific Gravity of Vapor (Air = 1) at 60°F	1.50	2.01
Ignition Temperature in Air, °F	920-1,120	900-1,000
Maximum Flame Temperature in Air, °F	3,595	3,615
Limits of Flammability in Air, Percent of Vapor in Air-Gas Mixture:		
(a) Lower	2.15	1.55
(b) Upper	9.60	8.60
Latent Heat of Vaporization at Boiling Point:		
(a) Btu per Pound	184	167
(b) Btu per Gallon	773	808
Total Heating Values After Vaporization:		
(a) Btu per Cubic Foot	2,488	3,280
(b) Btu per Pound	21,548	21,221
(c) Btu per Gallon	91,502	102,032

Table B-1.2.1 (Metric) Approximate Properties of LP-Gases

	Commercial Propane	Commercial Butane
Vapor Pressure in kPa at:		
20°C	895	103
40°C	1 482	285
45°C	1 672	345
55°C	1 980	462
Specific Gravity	0.504	0.582
Initial Boiling Point at 1.00 Atm. Pressure, °C	-42	-9
Weight per Cubic Metre 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 Metre of Vapor per Litre of Liquid at 15.56°C	0.271	0.235
Cubic Metre of Vapor per Kilogram of Liquid at 15.56°C	0.539	0.410
Specific Gravity of Vapor (Air = 1) at 15.56°C	1.50	2.01
Ignition Temperature in Air, °C	493-549	482-538
Maximum Flame Temperature in Air, °C	1 980	2 008
Limits of Flammability in Air, % of Vapor in Air-Gas Mixture:		
(a) Lower	2.15	1.55
(b) Upper	9.60	8.60
Latent Heat of Vaporization at Boiling Point:		
(a) Kilojoule per kilogram	428	388
(b) Kilojoule per litre	216	226
Total Heating Value After Vaporization:		
(a) Kilojoule per Cubic Metre	92 430	121 280
(b) Kilojoule per Kilogram	49 920	49 140
(c) Kilojoule per Litre	25 140	28 100

Appendix C Design, Construction, and Requalification of DOT (ICC) Cylinder Specification Containers

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 DOT cylinder specification containers referred to in this standard. For complete information consult the applicable specification (*see C-2.1.1*). The water capacity of such cylinders are not permitted to be more than 1,000 lb (454 kg).

C-1.1.2 This appendix is not applicable to 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 (DOT). 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.

C-2.1.1 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 container is designed. Thus, "4B-240" indicates a cylinder built to Specification 4B for a 240 psi (1,650 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 container 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 container at two different temperatures, the higher pressure of the two becoming the service pressure, as follows: