

NFPA 58

STANDARD FOR THE STORAGE AND HANDLING OF LIQUEFIED PETROLEUM GASES

1992 EDITION

NFPA/ANSI 58 • An American National Standard • February 10, 1992



**National Fire Protection
Association**

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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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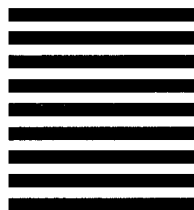
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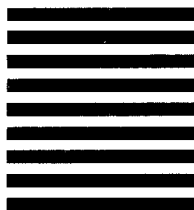
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Errata

NFPA 58

Standard for the Storage and Handling of Liquefied Petroleum Gases

1992 Edition

Reference 3-2.6.4

The Committee on Liquefied Petroleum Gases notes the following omission in the 1992 edition of NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*.

1. *The underlined text was inadvertently omitted from the 1992 edition.*

3-2.6.4 The discharge from the pressure relief device and from above the regulating equipment and relief device diaphragms installed inside buildings shall be vented 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.

Exception No. 1: This provision shall not apply to appliance regulators otherwise protected (see NFPA 54), or to regulators used in connection with containers in buildings as provided for in 3-2.2.1, Exceptions No. 1, 2, 4, 5, and 6.

Exception No. 2: When this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter this requirements shall not apply.

Issue Date: December 16, 1992

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NFPA 58

Standard for the Storage and Handling of

Liquefied Petroleum Gases

1992 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 18-20, 1991 in Montréal, Québec, Canada. It was issued by the Standards Council on January 17, 1992, with an effective date of February 10, 1992, and supersedes all previous editions.

The 1992 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

The 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, and 1988.

The 1989 edition included a new chapter on requirements for refrigerated storage facilities and extended application of the standard to marine and pipeline terminals and at the discretion of the owner or the authority having jurisdiction to the storage and transfer portions of refineries, petrochemical plants, and natural gas processing plants.

The 1992 edition is a complete revision which includes revision or addition of coverage of dispensing of LP-Gas, trackside transfer from tank cars, the container connection and appurtenance requirements table, mobile containers, plastic piping materials, and dispensing cylinder cabinet locations. In addition, editorial revisions were made to make the standard easier to use, understand, and enforce.

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NFPA 58

Standard for the Storage and Handling of Liquefied Petroleum Gases

1992 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.

Chapter 1 General Provisions

1-1 Introduction.

1-1.1 General Properties of LP-Gas.

1-1.1.1 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 this pressure. It is this property that permits transporting and storing them in concentrated liquid form, while normally using them 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: propane, 2.15 percent; butane, 1.55 percent. These figures represent volumetric percentages of gas in gas-air mixtures.

1-1.1.2 The boiling point of pure normal butane is 31°F (−0.6°C); of pure propane, −44°F (−42°C). Both products are liquids at atmospheric pressure at temperatures lower than their boiling points. Vaporization is rapid at temperatures above the boiling point; 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.

1-1.2 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).

1-2 Scope.

1-2.1* 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 may result from the dual use of transportation or storage equipment), the LP-Gas shall be tested. (*See appendix.*)

1-2.2 Application of Standard. This standard shall apply to the operation of all LP-Gas systems including:

(a) Highway transportation of LP-Gas and

(b) 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.

(c) 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 1-2.3.

1-2.3 Nonapplication of Standard.

1-2.3.1 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*.

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.

1-2.4 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 alternate is acceptable to the authority having jurisdiction (*see Section 1-7, Definitions*). The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claims made regarding the safety of such alternates.

1-2.5 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 existing 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 on hand 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.

1-3 Acceptance of Equipment and Systems.

1-3.1 Systems, or components assembled to make up systems, shall be approved (*see Section 1-7, Approved*) as specified in Table 1-3.

1-3.2 Acceptance applies to the complete system, or to the individual components of which it is comprised, as specified in Table 1-3.

1-4 LP-Gas Odorization.

1-4.1* All LP-Gases shall be odorized prior to delivery to a bulk plant by the addition of a warning agent of such character that they are detectable, by a distinct odor, down to a concentration in air of not over one-fifth the lower limit of flammability.

Exception: Odorization, however, is not 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.

1-4.2* If odorization is required, the presence of such odorant shall be determined by sniff testing or other means and the results documented:

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

1-5 Notification of Installations.

1-5.1 Fixed Installations. Plans for fixed (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).*]

Table 1-3

| 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 may be made by the use of approved components.

1-5.2 Temporary Installations. The authority having jurisdiction shall be notified of temporary (not to exceed six months) installations of the sizes covered in 1-5.1.1 before the installation is started.

1-6 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. Effective Jan 1, 1993, all employees shall carry written certification of their job qualification issued by the training agent or a written document issued by the authority having jurisdiction identifying the functions each person is authorized to perform.

1-7 Definitions, Glossary of Terms, and Abbreviations.

AGA. American Gas Association.

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 or 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 which 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. Only Division I of Section VIII of the ASME Code is applicable in this standard except UG-125 through UG-136 shall not apply.

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 "authority having jurisdiction" is 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, 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 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, and which 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 the 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 Filling.

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

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 noncargo containers that are mounted on vehicles or into portable containers. The public may 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 and providing 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 which indicates the liquid level at which the container is filled to its maximum permitted filling density.

Flexible Connector. A short [not exceeding 36 in. (1 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 them, or all metal may be 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 which 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, which mixes LP-Gas vapor with air to produce a mixed gas of a lower heating value than the LP-Gas. The mixture thus created is normally used in industrial or commercial facilities as a substitute for some other fuel gas. The mixture may replace another fuel gas completely, or may be mixed to produce similar characteristics and mixed with the basic fuel gas. Any gas-air mixer which 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 making 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 which receives gas in tank car, truck transport, or truck lots. Normally LP-Gas is used through piping systems in the plant but may also 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, which has adequate means of actuation and which 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 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 Service Station. See also Dispensing Station. A facility open to the public that consists of LP-Gas storage containers, piping, and pertinent equipment, including pumps and dispensing devices, and any buildings, and in which LP-Gas is stored and dispensed into engine fuel containers of highway vehicles.

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 which incorporates components intended to achieve control of quantity, flow, pressure, or state (either 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. They are basically non-highway vehicles but may occasionally be moved over public roads or highways for short distances to be used as a fuel supply for farm tractors, construction machinery, and similar equipment.

Multipurpose Passenger Vehicle. A motor vehicle with motive power, except a trailer, designed to carry 10 persons or fewer 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.

Permanent Installation. See Stationary Installation.

Piping, Piping Systems. Pipe, tubing, hose, and flexible rubber or metallic hose connectors made up with valves and fittings 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 readily moved, as distinguished from containers designed for stationary installations. Portable containers, designed for transportation, filled to their maximum filling density 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 readily moved 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 may be of the fold-down type, permitting 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 density. 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 in which the entire relief valve is outside the container connection except the threaded portion, which is screwed into the container connection, and all of the parts are 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.

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 is suitable for the range of liquid levels to be gauged. By 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.

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, and 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 the liquid level at the inner end 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 (also called "Fixed" or "Permanent" Installation). An installation of LP-Gas containers, piping, and equipment for use indefinitely at a particular location; an installation not normally expected to change in status, condition, or place.

UL. Underwriters Laboratories Inc.

Universal Cylinder. A DOT cylinder specification container, constructed and fitted with appurtenances in such a manner that it may 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.

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

2. *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 "Rules for the Construction of Unfired Pressure Vessels," Section VIII, Division 1, ASME *Boiler and Pressure Vessel Code*, 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 1-2.4.

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.

2-2.1.5 Containers showing serious denting, bulging, gouging, or excessive corrosion shall be removed from service.

2-2.1.6 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.

2-2.1.7 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

gate 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.

2-2.1.8 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

| For Gases with Vapor Pressure in psig (MPa gauge) at 100°F (37.8°C) Not to Exceed | Minimum Design Pressure in psig (MPa gauge) ASME Code, Section VIII, Division 1, 1991 Edition (Note 1) |
|---|---|
| 80 (0.6) | 100 (0.7) (Note 2) |
| 100 (0.7) | 125 (0.9) |
| 125 (0.9) | 156 (1.1) |
| 150 (1.0) | 187 (1.3) |
| 175 (1.2) | 219 (1.5) |
| 215 (1.5) | 250 (1.7) |
| 215 (1.5) | 312.5 (2.2) (Note 3) |

Note 1: See Appendix D for information on earlier ASME or API-ASME Code.

Note 2: New container for 100 psig (0.7 MPa gauge) design pressure (or equivalent under earlier codes) not authorized after December 31, 1947.

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

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 *Design Loads for Buildings and Other Structures*, ANSI A58.1. 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 in 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 part in one and part in the other.

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) or more water capacity manufactured after July 1, 1961, shall be provided with a connection, other than a plugged opening, for liquid evacuation, not smaller than 3/4-in. National Pipe Thread.

2-2.3.4 Containers of more than 2,000 gal 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, it 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 with-

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

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

Exception: Continuous steel skirts having only one opening 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 Markings.

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:

2-2.6.2 When 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.

2-2.6.3 When being transported, portable DOT containers shall be marked and labeled in accordance with Title 49 of the *Code of Federal Regulations*.

2-2.6.4 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.

2-2.6.5 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: When the container is buried, mounded, insulated, or otherwise covered so as to obscure the nameplate, 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 psig.

(f) The wording "This container shall not contain a product having a vapor pressure in excess of _____ psig 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.

2-2.6.6* Effective January 1, 1993, a warning label shall be applied to all portable refillable LP-Gas cylinders of 100 lb LP-Gas capacity or less not filled on site. The label shall include information on the potential hazards of LP-Gas.

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 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 A 395 or equivalent and malleable iron the requirements of ASTM A 47 or equivalent.

Exception: Approved or listed liquid level gauges used in containers of 3,500 gal (13.2 m³) water capacity or less shall be exempted from this provision.

(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 psig (1.7 MPa gauge).

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 and 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.

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, which, 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 aboveground) 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 psig 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 (0.1 MPa absolute); 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 psig (1.7 MPa gauge) 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: When 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), and 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 (including forklift truck cylinders) service 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 each 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 over-filling prevention devices that are used individually or in suitable combinations shall comply 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.

(b) For containers 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 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, not to exceed a No. 60 drill size opening, to allow equalization of pressure.

(c) Backflow check valves, which may be of spring-loaded or weight-loaded type with in-line or swing operation, shall close when 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 made up, 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.]

(c) Each container manufactured after December 31, 1972, 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. *For 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. *For 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 in the horizontal position.

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

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.

(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 show 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 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 will permit 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 internal excess-flow check 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 they 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 such valve. All connections, including couplings, nozzles, flanges, standpipes and manways, which are listed on the ASME Manufacturers' Data Report for the container, are considered part of the container.

(2) If required on DOT cylinders, they 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 in 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 with 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 which discharge into the manhole or housing.

(e) Container inlet and outlet connections 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 Section 3-8 and Chapter 8 for requirements for labeling smaller containers used for vehicular installations.

(f) Every storage container of more than 2,000 gal water capacity shall be provided with a pressure gauge.

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 pro- pane capacity for vapor service | 2. Portable DOT cylinders, 2 lb thru 100 lb pro- pane capacity for liquid service | 3. Portable DOT cylinders, 2 lb thru 100 lb pro- pane capacity for liquid and vapor service | 4. DOT cylinders, 100 lb thru 420 lb propane capac- ity filled on site | 5. Stationary ASME containers thru 2,000 gal water capacity | 6. DOT Engine Fuel or Mobile containers (see Note 2) | 7. ASME Engine Fuel or Mobile containers (see Note 2) |
|--|---|---|---|--|---|--|---|
| Manual Shutoff Valve (CGA 510 outlet) with Integral External Pressure Relief Valve | R✓ (See Notes 4, 8, 10) | | | | | | |
| Manual Shutoff Valve (CGA 555 outlet) with Integral External Pressure Relief Valve and Internal Excess-Flow Valve | | R✓ (See Notes 4, 8, 10) | | | | | |
| Manual Shutoff Valve (CGA 555 outlet) with Integral 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) | | | | |
| Double Backflow Check Filler Valve | | O✓ | | R✓ | R✓ | O | R |
| Manual Shutoff Valve | | | | R✓ | R✓ | | |
| Fixed Liquid Level Gauge (See Note 3) | O✓ | O✓ | O✓ | R✓ | R✓ | R | R |
| External Pressure Relief Valve (See Note 4) | | | | R✓ | | | |
| Internal Spring-type Pressure Relief Valve (See Note 4) | | | | | R (See Note 1) | | |
| Float Gauge | O✓ | O✓ | O✓ | O | R✓ | O | O |
| Backflow Check and Excess-Flow Vapor Return Valve | | | | | O✓ | | |
| Liquid Withdrawal Excess-Flow Check Valve Actuated by an Adapter or Other Means (See Note 5) | | | | | R | | |
| Manual Shutoff Liquid or Vapor Valve with Internal Excess-Flow Check Valve | | | | | | R | R |
| Full Internal or Flush-Type Full Internal Pressure Relief Valve | | | | | | R | R (See Note 6) |
| Overfilling Prevention Device | | | | | | R (See Note 7) | R (See Note 7) |

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 1-7, Definitions).
 - See 2-3.4.2.
 - See Appendix E for references on DOT and ASME pressure relief valve standards. See 1-7 for definitions of pressure relief valves.
 - A liquid withdrawal excess-flow check valve in combination with a manual shutoff valve, plugged, or internal valve, 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.)
 - 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.

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.

2-4.2 Pipe. Pipe shall be wrought iron or steel (black or galvanized), brass, copper, or polyethylene (see 3-2.8.6) and shall comply with the following:

(a) Wrought-iron pipe; ANSI B36.10M, *Welded and Seamless Wrought Steel Pipe*.

(b) Steel pipe; ASTM A 53, *Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*.

(c) Steel pipe; ASTM A 106, *Specification for Seamless Carbon Steel Pipe for High-Temperature Service*.

(d) Brass pipe; ASTM B 43, *Specification for Seamless Red Brass Pipe, Standard Sizes*.

(e) Copper pipe; ASTM B 42, *Specification for Seamless Copper Pipe, Standard Sizes*.

(f) Polyethylene pipe; ASTM D 2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and be recommended by the manufacturer for use with LP-Gas. Polyethylene pipe shall be marked in full compliance with the product marking requirements of ANSI/ASTM D 2513, and 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 D 2513.

2-4.3 Tubing. Tubing shall be steel, brass, copper, or polyethylene (see 3-2.8.6) and shall comply with the following:

(a) Steel tubing; ASTM A 539, *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 B 135, *Specification for Seamless Brass Tube*.

(c) Copper tubing [see 3-2.7(d), *Exception No. 3*]:

(1) Type K or L, ASTM B 88, *Specification for Seamless Copper Water Tube*.

(2) ASTM B 280, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*.

(d) Polyethylene tubing; ASTM D 2513, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and 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 D 2513, and 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 D 2513.

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 2-4.4 (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 D 2513, used to join polyethylene pipe shall comply with ASTM D 2513, 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 psig (2.4 MPa gauge).

(2) Fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psig (0.9 MPa gauge), shall be suitable for a working pressure of 250 psig (1.7 MPa gauge).

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 psig (0.9 MPa gauge) shall be suitable for a working pressure of 125 psig (0.9 MPa gauge).

(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 psig (2.4 MPa gauge).

(2) Fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psig (0.9 MPa gauge), shall be suitable for a working pressure of 250 psig (1.7 MPa gauge).

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 psig (0.9 MPa gauge) shall be suitable for a working pressure of 125 psig (0.9 MPa gauge).

(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 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 D 2683, *Specifications for Socket-type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe* or ASTM D 3261, *Specification for Butt Heat Fusion Polyethylene (PE) Plastic Pipe and Tubing*, or ASTM F 1055, *Specifications for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing* and be recommended by the manufacturer for use with LP-Gas.

(2) Mechanical fittings shall comply with Category 1 of ASTM D 2513 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. Fitting shall be installed according to the procedure provided by the manufacturer.

(3)* All persons installing polyethylene piping shall be trained under 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 ANSI/ASTM A 395 or equivalent and malleable iron shall meet the requirements of ANSI/ASTM A 47 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 psig (2.4 MPa gauge) [400 psig (2.8 MPa gauge) 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 psig (0.9 MPa gauge), but not to exceed 250 psig (1.7 MPa gauge), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

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 psig (0.9 MPa gauge) shall be suitable for a working pressure of at least 125 psig (0.9 MPa gauge).

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 3-2.8.9 and 3-3.3.8*):

(a) Automatic shutoff through thermal (fire) actuation. When 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 (*see definition of Approved, Section 1-7, Definitions*).

2-4.6.3 Hose, hose connections, and flexible connectors used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psig (34.5 kPa gauge), and as provided in Section 3-4 regardless of the pressure, shall comply with 2-4.6.3(a) and (b):

(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.

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

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 3-2.8.8 and 3-2.8.10.

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

in systems designed to operate above 350 psig (2.4 MPa gauge) 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 are not 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 psig (2.4 MPa gauge). If pressures above 350 psig (2.4 MPa gauge) 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 psig (0.9 MPa gauge) but not to exceed 250 psig (1.7 MPa gauge), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(c) Equipment to be used with vapor LP-Gas at pressures over 20 psig (138 kPa gauge), but not to exceed 125 psig (0.9 MPa gauge), shall be suitable for a working pressure of at least 125 psig (0.9 MPa gauge).

(d) Equipment to be used with vapor LP-Gas at pressures not to exceed 20 psig (138 kPa gauge) 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 A 395 or A 536 Grade 60-40-18 or 65-45-12), malleable iron (ASTM A 47), higher strength gray iron (ASTM A 48, 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 B 86.

(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 psig (2.4 MPa gauge).

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 3-2.11.2(b)]. Portable compressors used with temporary connections are excluded from this requirement.

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 psig (1.7 MPa gauge) 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 sum of the outside surface area and the inside heat exchange surface area in sq ft.
- (4) The name or symbol of the manufacturer.

Exception: Indirect vaporizers having an inside diameter of 6 in. (152 mm) or less shall not be marked. They shall be constructed for a minimum 250 psig (1.7 MPa gauge) design pressure.

(b) Indirect vaporizers shall be provided with a suitable automatic means to prevent liquid passing 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 one 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 one quart (0.9 L) capacity need not 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 outside surface area in sq ft.
- (3) The area of the heat exchange surface in sq ft.
- (4) The maximum vaporizing capacity in gal per hour.
- (5) The rated heat input in Btuh.
- (6) 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 liquid passing 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 shut off the flow of gas to the pilot also.

(f) Direct-fired vaporizers shall be equipped with a limit control to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, and to prevent raising the pressure within the storage container above the pressure shown in the first column of Table 2-2.2.2 corresponding with the design pressure of the container (or its ASME Code equivalent—see Note 1 of 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 psig (1.7 MPa gauge) 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. (152 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 liquid passing 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 programming to provide for prepurge prior to ignition, proof of pilot before main burner valve opens, and full shutdown of 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) The surface area of that part of the vaporizer shell directly in contact with LP-Gas shall be added to the heat exchange surface area directly in contact with LP-Gas to obtain the total surface area in sq ft.

(b) Refer to Table E-2.2.2 to obtain the rate of discharge in cu ft of air per minute (Flow Rate CFM Air) for the total surface area in sq ft for the vaporizer computed in accordance with 2-5.4.5(a).

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 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) When 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 corresponding with the design pressure of the container (or its ASME Code equivalent—see Note 1 of Table 2-2.2.2).

2-5.4.7 Vaporizing-burners shall be constructed with a minimum design pressure of 250 psig (1.7 MPa gauge) with a safety factor of 5 and shall comply with 2-5.4.7(a) through (h):

(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 hydrostatic relief valve, located where it will not be subject to temperatures in excess of 140°F (60°C), and with a pressure setting such as to protect the components involved but not lower than 250 psig (1.7 MPa gauge). 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. 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 as not to be subject to temperatures above 140°F (60°C), unless it is designed and recommended for use by the manufacturer for a higher temperature.

(h) Pressure-regulating and control equipment located downstream of the vaporizing section shall be designed to withstand the maximum discharge temperature of the 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 psig (7 kPa gauge).

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 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. An excess-flow check valve complying with 2-4.5.3 or an emergency shutoff valve complying with 2-3.3.3(b) and 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 these provisions.

2-5.8 Regulators. Final stage regulators (excluding appliance regulators) shall be equipped with one of the following [see 3-2.6.2(b) for required protection from the elements that shall be permitted to be integral with the regulator]:

(a) A pressure relief valve on the low pressure side having a start-to-leak pressure setting within limits specified in Table 2-5.8.

(b) A shutoff device that shuts the gas off at the regulator inlet when the downstream pressure reaches the over-pressure limits specified in Table 2-5.8. Such a device shall not open to permit flow of gas until it has been manually reset.

Table 2-5.8

| Regulatory Delivery Pressure in psig (kPa gauge) | Relief Valve Start-to-Leak Pressure Setting, % of Regulatory Delivery Pressure | |
|--|--|---------|
| | Minimum | Maximum |
| 1 (7) or less | 170 | 300 |
| Above 1 (7), not over 3 (21) | 140 | 250 |
| Above 3 (21) | 125 | 250 |

2-5.9 Sight Flow Glasses. Flow indicators, either of the simple observation type or 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 may 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.

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 may apply. These include:

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

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

(c) NFPA 501A, *Standard for Firesafety Criteria for Mobile Home Installations, Sites, and Communities*.

(d) NFPA 501C, *Standard on Recreational Vehicles*.

(e) NFPA 96, *Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment*.

(f) NFPA 86, *Standard for Ovens and Furnaces*.

(g) NFPA 82, *Standard on Incinerators, Waste, and Linen Handling Systems and Equipment*.

(h) NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*.

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

(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 or resale 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 may be built upon, in accordance with Table 3-2.2.2, Table 3-2.2.4, and Table 3-2.2.6(f).

NOTE: See 3-3.3.1, 3-3.3.2, 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 firesafety 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 accordance with Table 3-2.2.4.

3-2.2.5 In the case of buildings of other than wood-frame construction devoted exclusively to gas manufacturing and distribution operations, the distances in Table 3-2.2.2 shall be permitted to be reduced provided that in no case shall containers having a water capacity exceeding 500 gal (1.9 m³) be located closer than 10 ft (3 m) to such gas manufacturing and distributing buildings.

3-2.2.6 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 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 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 when 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.

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 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.

(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 which may be built upon.

Note (e): When 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.

Table 3-2.2.6(f)

| LP-Gas Containers Having An | Separation From Oxygen Containers Having An | | | Separation From Gaseous Hydrogen Containers Having An | | |
|--|--|--|--|--|---|---|
| | 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)* | Aggregate capacity of more than 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) | 25 ft (7.6 m) |
| Over 500 Gal (1.9 m ³) | | | | None | 25 ft (7.6 m) | 50 ft (15 m) |

*Cubic feet measured at 70°F and atmospheric pressure.

(f) The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with Table 3-2.2.6(f).

Exception: Lesser distances shall be permitted where protective structures having a minimum fire resistance rating of two hours interrupt the line of sight between uninsulated portions of the oxygen or hydrogen containers and the LP-Gas containers. The location and arrangement of such structures shall minimize the problems cited in the Note to 3-2.2.8.

NOTE: Also, see NFPA 50 and NFPA 51 for oxygen systems and NFPA 50A on gaseous hydrogen systems.

(g) The minimum separation between LP-Gas containers and liquefied hydrogen containers shall be in accordance with NFPA 50B.

(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) When 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 Standard 748.1, *Method of Marking Portable Compressed Gas Containers to Identify the Material Contained* (CGA C-4).

(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.

3-2.2.7 Impoundment in accordance with 9-2.5 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 released to the atmosphere, dikes normally serve no useful purpose for nonrefrigerated installations.

3-2.2.8 Structures such as fire walls, fences, earth or concrete barriers, and other similar structures shall be avoided around or over installed nonrefrigerated containers.

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

Exception No. 2: Structures used to prevent flammable or combustible liquid accumulation or flow shall be permitted in accordance with 3-2.2.6(c).

Exception No. 3: Structures between LP-Gas containers and gaseous hydrogen containers shall be permitted in accordance with 3-2.2.6(f).

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

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.

3-2.3 Location of Transfer Operations.

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

(a) The transfer of liquid into containers mounted on vehicles shall not be within a building but may be 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 is prohibited.

(d) Transfer hose shall not be routed in or through any building except those covered 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 may 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 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 do not apply to the structure containing the point of transfer.

(b) If LP-Gas is vented to the atmosphere under the conditions stipulated in 4-3.1, Exception No. 4, the distances in Table 3-2.3.3 shall be doubled.

(c) If the point of transfer is housed in a structure complying with Chapter 7, the distances in Table 3-2.3.3 shall be permitted to be reduced provided either the exposing wall(s) or the exposed wall(s) complies with 7-3.1(a).

Table 3-2.3.3 Distance Between Point of Transfer and Exposures

| Part | Exposure | Min. Horizontal Distance, Feet (Meters) |
|------|--|---|
| 1. | Buildings ¹ with fire-resistive walls. ² | 10 (3.1) |
| 2. | Buildings 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 2 combustible liquid ⁵ dispensers and aboveground and underground containers. | 20 (6.1) |

NOTES:

¹ Buildings, for the purpose of the table, include structures such as mobile homes, 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 per sq in. (absolute) (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 (69°C).

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, or otherwise firmly secured. Flexibility shall be provided in the connecting piping. (See 3-2.8.5 and 3-2.8.8.)

(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 2-2.1.6.

(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 supported as follows:

(a) Horizontal containers shall be mounted on saddles in such a manner as to permit expansion and contraction, and not to cause an excessive concentration of stresses. Structural steel supports shall be permitted to be used as follows, or if in compliance with 3-2.4.2(b).

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 at a given location, not to exceed 6 months, fire-resistive foundations or saddles shall not be required provided 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.

3-2.4.3 Vertical ASME containers over 125 gal (0.5 m³) water capacity designed for permanent installation in stationary 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 two hours. 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 the following shall apply:

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

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

(c) If such containers are to be set with the bottoms of the skids or runners above the ground, 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 as to the location of a container of that capacity for normal stationary service, and in accordance with the following:

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

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

3-2.4.6 Portable containers of 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 (300 mm).

(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. (153 mm) 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 this case, a noninterchangeable underground container shall be used and the container shell placed at least 18 in. (457 mm) below grade [*see 3-2.4.8(c)*] or equivalent protection shall be otherwise provided, such as the use of a concrete slab, to prevent imposing the weight of a vehicle directly on the container shell. Protection of the fitting housing, housing cover, tank connections, and piping shall be provided to protect against vehicular damage.

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

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

(h) When 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 this 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 left after the liquid removal procedure of 3-2.4.8(h)(1).

NOTE: If vapor is vented too rapidly the pressure drop due to the refrigeration of the liquid may lead to the erroneous conclusion that no liquid remains in the container.

(3) When only vapor LP-Gas at atmospheric pressure remains in the container, it shall be filled with water, sand, or foamed plastic, or 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 above-ground 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 of 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 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 shall be provided, such as rain caps, to minimize the possibility of the entrance of water or other extraneous matter (which might render the relief device inoper-

ative 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 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 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 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. Discharge piping used shall be adequate in size to permit 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 its 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 Regulators used to control distribution or utilization pressure shall be as close to the container or vaporizer outlets as is practical. First stage regulating equipment shall be 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 8-7.

Exception No. 7: Regulators on portable containers awaiting use or resale when stored in accordance with Chapter 5.

3-2.6.2 Regulators shall be securely attached to container valves, containers, supporting standards, or building walls.

(a) First stage regulators shall be either connected directly to the container shutoff valve or outlet of vaporizer where used.

Exception: Unless attached thereto with flexibility provided in the connecting piping or the interconnecting piping of manifolded containers or vaporizers.

(b) 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).

Exception: Regulators used for portable industrial applications. Note: This protection may be integral with the regulator.

3-2.6.3 The discharge from a pressure relief device on regulating equipment installed outside of buildings shall be located not less than 3 ft (1 m) horizontally away from any building opening below the level of such discharge, and not beneath any building.

Exception: When this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter this requirement shall not apply.

3-2.6.4 The discharge from the pressure relief device and from above the regulating equipment and relief device diaphragms installed inside buildings shall be vented 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.

Exception No. 1: This provision shall not apply to appliance regulators otherwise protected (see NFPA 54), or to regulators used in connection with containers in buildings as provided for in 3-2.2.1, Exceptions No. 1, 2, 4, 5, and 6.

Exception No. 2: When this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter this requirement shall not apply.

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 psig (208 kPa gauge).

(2) Installation outdoors and underground (see 3-2.8.6).

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

(d) LP-Gas vapor at pressures exceeding 20 psig (138 kPa gauge) 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 1(b), may not be necessary depending upon the prevailing conditions. Construction of buildings or separate areas of buildings housing certain internal combustion engines is covered in NFPA 37.

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 1 and 2, in which liquid feed systems are used, liquid piping shall be permitted to enter the building or structure to connect to a vaporizer provided heavy walled seamless brass or copper tubing not exceeding 3/52 in. (2.4 mm) internal diameter and with a wall thickness not less than 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* 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 psig (2.4 MPa gauge).

(b) Vapor LP-Gas piping with operating pressures in excess of 125 psig (0.9 MPa gauge), and liquid piping not covered by 3-2.8.1(a), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

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

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

3-2.8.2 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 psig (0.9 MPa gauge), or for LP-Gas liquid, the pipe and nipples shall be Schedule 80 or

(2) For LP-Gas vapor at pressures of 125 psig (0.9 MPa gauge) or less, the pipe and nipples shall be Schedule 40 or heavier.

(b) When 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 in 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: Aluminum O-rings and spiral wound metal gaskets shall be acceptable.

3-2.8.3 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.

3-2.8.4 Piping in systems shall be run as directly as is practical from one point to another, and with as few restrictions, such as ells and bends, as conditions will permit, giving consideration to provisions of 3-2.8.5.

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

3-2.8.5 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 3-2.8.8*). The use of nonmetallic pipe, tubing, or hose for permanently interconnecting such containers is prohibited.

3-2.8.6 Aboveground piping shall be well supported and protected against physical damage. That portion of aboveground piping in contact with supports or corrosion-causing substances shall be protected against corrosion. Where underground is beneath driveways, roads, or streets, possible damage by vehicles shall be taken into account. Nonmetallic piping, including mechanical fittings and nonmetallic portion of factory-assembled transition fittings, shall be installed outside underground with a minimum of 18 in. (460 mm) of cover. If a minimum of 12 in. (300 mm) of cover cannot be maintained, the piping shall be installed in conduit or bridged (shielded).

Exception: Polyethylene pipe and tubing shall be permitted to terminate above ground, outside of buildings, when the portion of the polyethylene pipe or tubing above 12 in. (300 mm) below grade is protected against deterioration and external damage by a factory-assembled riser designed for such purpose constructed of schedule 40 steel pipe or materials offering equivalent protection against external damage and protected to minimize corrosion in accordance with 3-2.8.7.

(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) Pipe that is not encased shall have a minimum wall thickness of 0.090 in. (23 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 D 2513, which have been shown to be resistant to the action of LP-Gas and comply with ASTM D 2513, or from metals protected to minimize corrosion in accordance with 3-2.8.7. 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.

3-2.8.7 Underground metallic piping shall be protected against corrosion as warranted by soil conditions. Corrosion protection shall comply with the following:

(a) Underground piping shall be protected as needed with a suitable coating to retard the effects of the corrosion conditions existing in the local soil. Coated pipe shall extend at least 6 in. (152 mm) aboveground on all risers.

(b) When dissimilar metals are joined underground, an insulating fitting shall be installed to electrically isolate them from each other.

(c) If cathodic protection is used, insulating fittings shall be installed to electrically isolate the cathodically protected underground system from all aboveground piping and systems.

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

3-2.8.8 Flexible components used in piping systems shall comply with 2-4.6 for the service in 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 (see 3-9.4.3 for explanation of term "wet hose") is recommended for liquid.

3-2.8.9 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) When 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. When either a liquid or vapor line has two or more hoses or swivel-type piping of the sizes designated, either 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, 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 3-2.8.9(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 may be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting.

3-2.8.10 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 for 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 for 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 is not permissible.

(d) A shutoff valve shall be provided in the piping immediately upstream of the inlet connection of the hose. When 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, *National Fuel Gas Code* [see 1-2.3.1(f)], shall be pressure tested in accordance with that code. Tests shall not be made with a flame.

3-2.11 Equipment Installation.

3-2.11.1 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 psig (2.4 MPa gauge) 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 psig (2.8 MPa gauge) 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.

3-2.11.2 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.

3-2.11.3 Strainers shall be installed so that the strainer element can be serviced.

3-2.11.4 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 housing 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 When 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 buildings as one housing a point of transfer.

3-3.4.4 The use of pits to house gas distribution facilities shall be permitted when automatic flammable vapor detecting systems are installed in the pit. Drains or blowoff 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 permit maintenance to be performed, and a clearance of at least 3 ft (1 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 1-6.)

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 m) of a gate and containers being filled are not located within the enclosure, a second gate need not be provided.

(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 are 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 are in addition to those specified in Section 3-2.

3-4.1.5 Liquid transfer systems are covered in Chapter 4.

3-4.1.6 Engine fuel systems used inside buildings are covered in Chapter 8.

3-4.1.7 LP-Gas transport or cargo vehicles stored, serviced, or repaired in buildings are covered in 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).

(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 psig (1.7 MPa gauge) 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 psig (1.7 MPa gauge) 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 psig (0.9 MPa gauge). [*See 3-2.8.1(b).*]

(b) Hose, hose connections, and flexible connectors used shall be designed for a working pressure of at least 350 psig (2.4 MPa gauge), shall comply with 2-4.6, and shall be installed in accordance with 3-2.8.10. Hose length shall be permitted to exceed that specified by 3-2.8.10(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.

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 When 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(b).

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

(a) Movement of containers having water capacities greater than 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] within a building shall be restricted to movement directly associated with the uses covered by Sections 3-4.3 through 3-4.9 and 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 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall be tightly plugged and the provisions of 2-2.4.1 shall be complied with.

(c) Only emergency stairways not generally used by the public shall be used, and reasonable 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 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:

(a) 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:

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

(2) An approved electric ignition system.

(b) The provisions of 3-4.2.8 shall not be applicable to the following:

(1) Tar kettle burners, hand torches, or melting pots.

(2) 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) 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 when 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 3-4.3.1 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- and radiant-type units shall not be directed toward any LP-Gas container within 20 ft (6 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 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 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 of the day the public normally is in the building the following shall apply:

(1) The maximum water capacity of individual containers shall be 50 lb (23 kg) [nominal 20 lb (9 kg) LP-Gas capacity], and the number of containers in the building shall not exceed the number of workers assigned to using 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 of the day when the building is not open to the public, containers shall be permitted to be used and transported in the building for repair or minor renovation in accordance with 3-4.2 and 3-4.3, provided, however, 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 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 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 m).

(c) Containers not connected for use shall be stored in accordance with Chapter 5, except that they shall not be stored in a laboratory room.

3-4.7 Temporary Heating in Buildings in Emergencies.

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.

3-4.8 Use in Buildings for Demonstrations or Training, or 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 the same room, the containers shall be separated by at least 20 ft (6 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:

(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 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 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 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.

Containers of any capacity used to supply appliances for residential food service shall not be used in buildings.

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 nonrefillable butane gas

containers having a maximum water capacity of 1.08 lb 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 5-3.1.1.

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 which 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 m) from building openings (such as windows and doors), and at least 20 ft (6 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 either (1) the parapets are breached with low-level ventilation openings no more than 20 ft (6 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, provided, however, that hose shall not be used for connecting 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 attached to a multiple family dwelling of three or more living units located one above the other.

Exception: Not applicable when such balconies are served by outside stairways and when 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 $\frac{3}{4}$ 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 $\frac{3}{4}$ 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) and 2-4.5.3 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 the building, or 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, 3-2.8.8, and 3-2.8.10.

(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 is covered in 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 need not be equipped with an automatic device designed to shut off the flow of gas to main burners and 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 may 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 the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment*.

(g) NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*.

(h) NFPA 501A, *Standard for Firesafety Criteria for Mobile 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 When 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 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) 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) If the heat transfer fluid is steam or hot water and the condensed water is not returned to the heat source for recirculation and a back flow preventer is not installed between the vaporizer and the heat source, the heat source shall be permitted to be installed within any Industrial Occupancy (*see definition*) complying with Chapter 28 of NFPA 101,[®] *Life Safety Code*[®] and Section 6-3 of NFPA 54, *National Fuel Gas Code*. The source of heat shall be permitted to be shared with other heating equipment.

(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 and shall be equipped with an emergency shutoff valve in accordance with 2-4.5.4 located at the LP-Gas inlet.

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 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 The inlet of a direct-fired vaporizer shall be connected only to the liquid space of a container or to a pumped liquid source. Such liquid connections shall be equipped with an emergency shutoff valve in accordance with 2-4.5.4.

3-6.3.5 Direct-fired vaporizers of any capacity shall be located in accordance with Table 3-6.3.5.

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 may be built upon.

Table 3-6.3.5

| Exposure | Minimum Distance Required |
|--|---------------------------|
| Container | 10 ft (3 m) |
| Container shutoff valves | 15 ft (5 m) |
| Point of transfer | 15 ft (5 m) |
| Nearest important buildings or group of buildings or line of adjoining property which may be built upon (except buildings in which vaporizer is installed; <i>see 3-6.3.2 and 3-6.3.3</i>). | 25 ft (7.6 m) |
| Ch. 7 building or room housing gas-air mixer | 10 ft (3 m) |
| Cabinet housing gas-air mixer outdoors | 0 ft (0 m) |

Table 3-6.4.2

| Container Water Capacity | Minimum Distance Required |
|--------------------------|---------------------------|
| 500 gal or less | 10 ft (3 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 m) |
| 90,001 to 120,000 gal | 125 ft (38 m) |

For SI Units: 1 gal = 3.785 L

3-6.4.3 If the tank heater is gas fired, an automatic shut-off shall be provided on the fuel supply (including the pilot) that will operate if either the container pressure exceeds 75 percent of the maximum design pressure shown in Table 2-2.2.2 or if the liquid level in the container falls below the top of the tank heater.

3-6.4.4 If the tank heater is of the electric immersion type, the heater shall be automatically de-energized when the pressure or level conditions specified in 3-6.4.3 are reached.

3-6.4.5 If the tank heater is similar in operation to an indirect vaporizer, the flow of the heat transfer fluid shall be automatically interrupted under the pressure or temperature conditions specified under 3-6.4.3 and the heat source shall comply with 3-6.2.6 through 3-6.2.7.

3-6.4.6 If a point of transfer is located within 15 ft (5 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, stating the following:

"A gas-fired device which 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.

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

Table 3-6.5

| Container Water Capacity | Minimum Distance Required |
|--------------------------|---------------------------|
| 500 gal or less | 10 ft (3 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

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 I, Group D locations, the unit shall be treated as indirect-fired and installed in accordance with 3-6.2.

(b) All others shall be treated as direct-fired vaporizers and 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) When used without vaporizer(s), mixer(s) shall be permitted to be installed outdoors or in buildings complying with Chapter 7.

(b) When used with indirect-heated vaporizer(s), mixer(s) shall be permitted to be installed outdoors, or in the same compartment or room with the vaporizer(s), in building(s) complying with Chapter 7, or shall be permitted to be installed remotely from the vaporizer(s) and shall be located in accordance with 3-6.2.

(c) When used with direct-fired vaporizer(s), mixer(s) shall be installed as follows:

(1) Listed or approved in a common cabinet with the vaporizer(s) outdoors in accordance with 3-6.3.5.

(2) 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) In a building complying with Chapter 7 with no direct-fired vaporizer in the same room.

3-6.8.2 Gas-air mixers shall be equipped with safety interlocks on both the LP-Gas and air supply lines to shut down the system if flammable limits are approached. Gas mixing control valves that fail in the closed position and provide tight shutoff of both the LP-Gas and air supply lines shall be considered to meet this requirement.

Exception: Gas-air mixers that utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere at atmospheric pressure.

3-6.8.3 A means shall be provided to prevent air from entering the mixed gas lines without LP-Gas being present.

Exception: Gas-air mixers that utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere at atmospheric pressure.

3-6.8.4 A means shall be provided to prevent backflow of LP-Gas into the air supply system. Check valves shall not be acceptable.

3-6.8.5 If it is possible for LP-Gas to condense between the vaporizer and mixer, an interlock shall be provided to prevent liquid LP-Gas from entering the gas-air mixer.

3-6.8.6 Gas-air mixers shall be installed outdoors or in buildings or structures used only for gas-air mixing or for indirect vaporizing. Direct vaporizers shall be installed in buildings or structures complying with Section 7-2.

3-7 Ignition Source Control.

3-7.1 Application.

3-7.1.1 This section includes provisions to minimize 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 78, *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 except that 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.

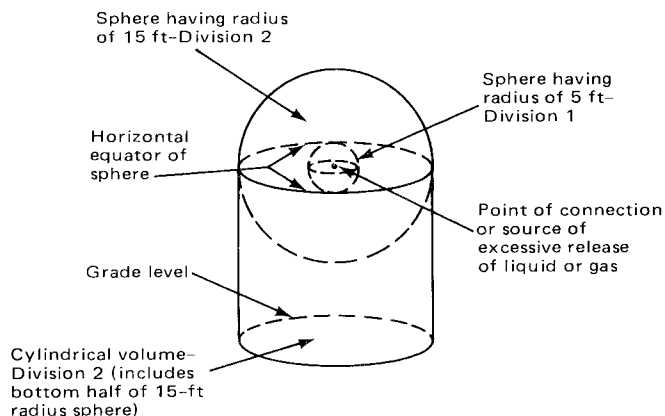


Figure 3-7.2.2 (See Table 3-7.2.2.)

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 for 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 observed under carefully controlled conditions.

3-7.4 Control of Ignition Sources during Transfer.

3-7.4.1 Sources of ignitions shall be controlled during transfer operations while connections or disconnections are made or while LP-Gas is being vented to the atmosphere (see 4-2.3).

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:

- (a) Systems installed on mobile homes.
- (b) Systems installed on recreational vehicles [see 3-1.3(d)].
- (c) Tank trucks, truck transports (trailers and semitrailers), and similar units used to transport LP-Gas as cargo, which are covered by Chapter 6.
- (d) LP-Gas engine fuel systems on the vehicles covered by Section 3-8 and those cited in 3-8.1.2, which are covered by Chapter 8.

3-8.2 Construction, Location, Mounting, and Protection of Containers and Systems.

3-8.2.1 Containers shall comply with Section 2-2, and appurtenances used to equip them for service shall comply with Section 2-3. In addition, the following shall apply:

- (a) ASME containers shall be constructed for a minimum 250 psig (1.7 MPa gauge) 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 psig (1.6 MPa gauge) service pressure.
 - (2) ASME containers shall be constructed for at least a 312.5 psig (2.2 MPa gauge) design pressure.
 - (c) Portable (removable) containers shall comply with 2-2.4.
 - (d) Containers to be permanently mounted shall be constructed so that, after mounting the protection of all container appurtenances and the connections to these appurtenances, they 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 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 (3.0 m³) water capacity.*
- (g) Containers designed for stationary service only, and not in compliance with 2-2.4, shall not be used.

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 feet in all directions from connections, except connections otherwise covered in Table 3-7.2.2. | Division 2 |
| B | Refrigerated Storage Containers. | Within 15 feet 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 feet in all directions from connections regularly made or disconnected for product transfer. | Division 1 |
| | | Beyond 5 feet but within 15 feet 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 feet in all directions from point of discharge. | Division 1 |
| | | Beyond 5 feet but within 15 feet 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. | Within direct path of discharge. | Division 1 <i>Note: Fixed electrical equipment should preferably not be installed.</i> |
| | | Within 5 feet in all directions from point of discharge. | Division 1 |
| | | Beyond 5 feet but within 15 feet in all directions from point of discharge except within the direct path of discharge. | Division 2 |
| F | Pumps, Vapor Compressors, Gas-Air Mixers and Vaporizers (other than direct-fired or indirect-fired with an attached or adjacent gas-fired heat source). Indoors without ventilation. | Entire room and any adjacent room not separated by a gastight partition. | Division 1 |
| | | Within 15 feet of the exterior side of any exterior wall or roof that is not vaportight or within 15 feet 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 feet 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 inches horizontally from enclosure exterior up to an elevation 4 feet above dispenser base. Entire pit or open space beneath dispenser. | Division 1 |
| | | Up to 18 inches aboveground within 20 feet horizontally from any edge of enclosure. <i>Note: For pits within this area, see Part H of this table.</i> | Division 2 |

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 feet 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 feet 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 feet in all directions from point of discharge. | Division 1 |
| | | Beyond 5 feet from point of discharge, same as Part F of this table. | |
| K | Container Filling. Indoors with adequate ventilation. ⁴ | Within 5 feet in all directions from a point of transfer. | Division 1 |
| | | Beyond 5 feet and entire room. | Division 2 |
| | Outdoors in open air. | Within 5 feet in all directions from a point of transfer. | Division 1 |
| | | Beyond 5 feet but within 15 feet 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 |

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.

SI Conversions for Table 3-7.2.2

18 in. = 256 mm

4 ft = 1.2 m

5 ft = 1.5 m

15 ft = 5 m

20 ft = 6 m

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 securely mounted 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 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. When containers are mounted within a vehicle housing, the securing of the housing to the vehicle shall comply with this provision. Any hoods, domes, or removable portions of the housing or cabinet shall be provided with means to keep them firmly in place in transit. Field welding shall comply with 3-2.4.1(e).

(c) All container valves, appurtenances, and connections shall be adequately protected to prevent damage due to 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 permanently attached 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, or on the vehicle frame, or on road surface heating equipment, shall be protected against 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 so as 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 need not be permanently attached to the container; 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 4-3.2.4(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 on 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 and 2-5.8 and shall be installed in accordance with 3-2.6. If in an enclosed space, the regulator relief device and the space above the regulator and relief device diaphragms shall be vented to the outside air. Such venting shall not be required if the regulator is located in a recess or cabinet as provided for in 3-8.2.2.

(a) If a regulator(s) is (are) installed in conjunction with the vapor withdrawal portion of an LP-Gas system installed

upon a vehicle, (an) approved two-stage regulator(s) shall be used. Such regulator(s) shall have a capacity not less than the total input of all LP-Gas appliances installed in the vehicle. The regulator(s) shall be mounted with the vent position downward within 45 degrees of vertical with the diaphragm area being drained. 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.

NOTE: Durable means that the cover will not become brittle at temperatures as low as -40°F (-40°C).

(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 permit 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, as 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 be installed in accordance with 3-2.8.8(a). Flexible connectors of more than 36 in. (914.4 mm) overall length, or fuel lines of essentially all 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 working loose 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 in the main gas line under the floor and outside the vehicle.

(g) Exposed parts of the piping system shall either be 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 as to design and construction and shall be installed in accordance with 3-2.11, and with 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) Whenever 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 located to 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 either to the appliance, or to the vehicle outside of any enclosure and adjacent to the container(s), including 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 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 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 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 The dispensing hose shall comply with 2-4.6. An excess-flow check valve, or an emergency shutoff valve [see 2-3.3.3(d) and 2-4.5.4] shall be installed at the terminus of the liquid piping at the point of attachment of the dispensing hose. 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.

3-9.4 Installation of Vehicle Fuel Dispensers.

3-9.4.1 A manual shutoff valve and an excess-flow check valve of suitable capacity shall be located in the liquid line between the pump and the dispenser inlet.

3-9.4.2 Vehicle fuel dispensers shall be installed on a concrete foundation and securely bolted in place. Protection shall be provided against physical damage.

3-9.4.3 A listed quick-acting shutoff valve shall be installed at the discharge end of the transfer hose. This hose (called "wet hose") shall be protected against excessive hydrostatic pressure as specified in 3-2.9.

3-9.4.4 Hose length shall not exceed 18 ft (5.5 m) unless approved by the authority having jurisdiction. All hose shall be listed. When not in use, hose shall be secured to protect it from damage.

3-9.4.5 A listed emergency breakaway device designed to retain liquid on both sides of breakaway point or other devices affording equivalent protection approved by the authority having jurisdiction shall be installed.

3-9.4.6 A clearly identified and accessible switch(es) or circuit breaker(s) shall be provided at a location remote from the vehicle fuel dispenser to shut off power in the event of an emergency.

3-9.4.7 Vehicle fuel dispensers shall not be located on the same island as a gasoline dispenser.

3-9.5 Installation of Dispensing Stations.

3-9.5.1 Dispensing stations shall either be installed on a concrete foundation or be part of a complete storage and dispensing unit mounted on a common base [to be mounted as provided in 3-2.4.1(b) and (d)]. In either case, protection shall be provided against physical damage.

3-9.5.2 Means shall be provided outside at some point away from the dispensing station, such as a remote switch [see 3-2.11.1(c)] to shut off the power in the event of fire or accident.

3-9.5.3 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 only when the dispensing device is installed at a remote location and not part of a complete storage and dispensing unit mounted on a common base.

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 m³) subject to exposure from a single fire. The mode of such protection shall be arrived at through competent firesafety analysis of local conditions of hazard within the container site, exposure to or from other properties, water supply, the probable effectiveness of plant fire brigades, and the time of response and probable effectiveness of fire departments. (See 3-2.2.8.)

The first consideration in such an analysis shall consist of the use of water applied by hose streams by the fire brigade or fire department for the effective control of hazardous leakage or fire exposing storage tanks, cargo vehicles, or railroad tank cars that may be present.

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 minutes after the start of the fire when 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 need 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 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 minutes as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate. The insulation system shall be inherently resistant to weathering and the action of hose streams. (See Appendix H.)

3-10.3.2 If mounding is utilized, the provisions of 3-2.4.7 shall 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 whenever the 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 1-6. 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 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 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 or an approved quick closing coupling. This seal shall be in place whenever the container is not connected for use. Single trip nonrefillable, disposable, and new unused containers are excluded from this requirement.

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 2-2.1.2, 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 as 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 psig (2.0 MPa gauge) at 130°F (54.4°C), the service pressure must be at least 80 percent of 300, or 240 psig (1.6 MPa gauge).

(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 carefully controlled during transfer operations while connections or disconnections are made, or while LP-Gas is being vented to the atmosphere. In addition to the other provisions of Section 3-7, the following shall apply:

(a) Internal combustion engines within 15 ft (5 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.

(3) Engines on vehicles entering or departing LP-Gas filling stations.

(b) Smoking, open flames, metal cutting or welding, portable electrical tools, and extension lights capable of igniting LP-Gas shall not be permitted within 15 ft (5 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 the transfer is started.

(c) Sources of ignition, such as pilot lights, their igniters, burners, electrical appliances, and engines, located on the vehicle being refueled shall be turned off during the filling of any LP-Gas containers on the vehicle or whenever these sources of ignition are within 15 ft (5 m) of a point of transfer while filling operations are in process.

4-2.3.3 Cargo vehicles (see Section 6-3) unloading into storage containers shall be at least 10 ft (3 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, 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 When 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 providing the following are complied with. Such operation shall be considered a bulk plant (see definition).

(a) Transfer protection shall be provided in accordance with 3-2.8.9.

(b) Compressors, if used, shall comply with 2-5.3 and 3-2.11.2.

(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 the LP-Gas between shutoff valves before disconnecting the liquid transfer line from the container. When necessary, suitable bleeder valves shall be used.

Exception No. 3: LP-Gas may 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 opening. (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) When outdoors, container venting shall be done 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 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*).

Table 4-4.2.1
Maximum Permitted Filling Density

| Specific Gravity at 60°F (15.6°C) | Aboveground Containers | | Underground Containers All Capacities |
|-----------------------------------|--|--|---------------------------------------|
| | 0 to 1,200 U.S. gal (1,000 Imp. gal, 4.5 m ³) Total Water Cap. | Over 1,200 U.S. gal (1,000 Imp. gal, 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 |

4-4.2.1* The maximum LP-Gas content of any container shall be that quantity which equals the maximum permitted filling density given in Table 4-4.2.1. (*See Appendix F.*)

4-4.2.2 Determination that the LP-Gas content of a container complies with Table 4-4.2.1 shall be 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 density shall be calculated by 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 density 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 which may be filled with liquid.

L = filling density.

G = specific gravity of particular LP-Gas.

F = correction factor to correct volume at temperature " t " to 60°F (15.6°C).

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

| Aboveground Containers 0 to 1,200 Gallons (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) | 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 Gallons (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).

4-4.3 Compliance with Maximum Permitted Filling Density Provisions.

4-4.3.1 The maximum permitted filling density 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 When the volumetric method is used, it 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 must be computed on the basis of the maximum permitted filling density 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 m³) or less, filled at consumer sites, shall be gauged in accordance with the following:

(1) The variable gauge shall have been checked for accuracy by comparison with the liquid level indicated by the fixed maximum liquid level gauge.

(2) If the container is to be filled beyond the level indicated by the fixed maximum liquid level gauge, the reading of the variable gauge, adjusted for the error indicated by the check with the fixed maximum liquid level gauge, shall be corrected for the LP-Gas liquid temperature.

Exception: Containers fabricated on or before December 31, 1965, shall be exempt from this provision.

4-4.3.4 When 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*).

Chapter 5 Storage of Portable Containers Awaiting Use or Resale

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, but not connected for use.

(b) In storage for resale by dealer or reseller.

5-1.1.2 The provisions of this chapter shall not apply to containers stored at distributing 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 2.7 lb (1.2 kg) 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 people.

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 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 2.7 lb (1.2 kg) 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 butane nonrefillable containers shall be limited to no more than twenty-four containers.

Exception No. 2: An additional twenty-four 10-oz butane nonrefillable containers shall be permitted to be stored in another location within the building provided that the storage area is constructed with at least a 2-hour fire wall protection.

5-3.2 Storage within Buildings Not Frequented by the Public (Such as Industrial Buildings).

5-3.2.1 The maximum quantity allowed in one storage location shall not exceed 735 lb (334 kg) water capacity [nominal 300 lb (136 kg) LP-Gas]. If additional storage locations are required on the same floor within the same building, they shall be separated by a minimum of 300 ft (91 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 in the total storage capacity in 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 (4 540 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, located at least 5 ft (1.5 m) away 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 or resale, shall be located in accordance with Table 5-4.1 and at least 5 ft (1.5 m) from any doorway in a building frequented by the public.

- (a) Nearest important building or group of buildings.
- (b) Line of adjoining property that may be built upon.
- (c) Busy thoroughfares or sidewalks.
- (d) Line of adjoining property occupied by schools, churches, hospitals, athletic fields, or other points of public gathering.
- (e) Dispensing station.

Exception: 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. When 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 dry chemical with a B:C rating. (Also see NFPA 10, Standard for Portable Fire Extinguishers.)

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) (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) |

Chapter 6 Vehicular Transportation of LP-Gas

6-1 Scope.

6-1.1 Application.

6-1.1.1 This chapter includes provisions applying 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 are not applicable 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 8-5, 8-6, 8-7, and 3-8.

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. 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 vapor-tight partition which 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 over, 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 may 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 (2 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 1000 lb (454 kg) [nominal 420 lb (191 kg) LP-Gas capacity] when filled with LP-Gas shall be transported in compliance with the requirements of this section.

6-2.3.2 Containers shall be constructed in accordance with Section 2-2 and equipped in accordance with Section 2-3 for portable use or shall comply with DOT portable tank container specifications for LP-Gas service.

6-2.3.3 The quantity of LP-Gas put into containers shall be in accordance with Chapter 4.

6-2.3.4 Valves and other container appurtenances shall be protected in accordance with 2-2.4.2.

6-2.3.5 Containers and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Containers shall be transported in a suitable rack or frame or on a flat surface. Containers shall be fastened securely in a position to minimize the possibility of movement, tipping, or physical damage, relative to each other or to the supporting structure, while in transit.

6-2.3.6 Containers shall be transported with relief devices in communication with the vapor space.

6-2.3.7 Vehicles carrying more than 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 When portable containers complying with the requirements of this section are permanently or semipermanently mounted 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 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 distributing 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 Regula-*

tions 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 3-2.8.9(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 6-3.3.2. 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 when used shall comply with 6-3.3.1(c).

(1) When 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) When 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, provided, however, that their minimum design pressure shall comply with 6-3.3.2.

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 six 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, unless the remounting or repiping is performed within one 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 3-2.11. Equipment on vehicles shall be securely mounted in place and connected into the piping system in accordance with the manufacturer's instructions, taking into account the greater (than for 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 3-2.11.1 and 8-4.1.

6-3.4.4 The installation of liquid meters shall be in accordance with 3-2.11.4(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 When wet hose is carried connected to the truck 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 when the pump is not operating. When 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 per DOT regulations containing LP-Gas liquid or vapor. This 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 distributing points.

6-4.2 Trailers or Semitrailers Comprising Parts of Section 6-3, Vehicles. 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. When 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. Container mounting 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 psig (1.7 MPa gauge).

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 distributing 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 not be transported in excess of that specified in 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 containing more LP-Gas than 5 percent of their water capacity shall be permitted to be transported subject to such limitations as may be specified by the authority having jurisdiction.

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.

6-5.2.5 Lifting lugs on containers filled to no more than 5 percent of their water capacity shall be permitted to be used for lifting and lowering. Additional means for securing and supporting the container shall be provided for transporting or when lifting or lowering with more than 5 percent of its water capacity [see *Exception to 6-5.2.1*].

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 (*cargo vehicles*, 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 this shall not prevent drivers from the necessary absences from the vehicle in connection with their normal duties, nor shall it prevent stops for meals or rest stops during the day or at night.

Exception No. 1: In an emergency this shall not apply.

Exception No. 2: When 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 shall not prohibit the parking of vehicles carrying portable containers or cargo vehicles of 3500 gal (13 m³) water capacity or less on streets adjacent to the driver's residence in uncongested residential areas, provided such points of parking 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 reduced to approximately atmospheric, and all valves closed before being moved inside. Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved inside.

(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 are 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 these vehicles are parked.

(3) Leaks in the vehicle LP-Gas systems are repaired before the vehicle is moved inside.

(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 inside. Primary shutoff valves on LP-Gas propulsion engine fuel containers shall be closed when 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 density 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 take 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 be followed.

(b) When it is necessary to take 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 be followed, unless the driver or qualified representative of an LP-Gas operator is in attendance at all times when the vehicle is inside. In that case, the following provisions shall be followed under the supervision of such qualified persons:

(1) Leaks in the vehicle LP-Gas systems shall be repaired before the vehicle is moved inside.

(2) Primary shutoff valves on cargo tanks, portable containers, and other LP-Gas containers installed on the vehicle (except propulsion engine fuel containers) are 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 inside.

(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 thoroughly purged before the vehicle is moved inside.

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 may be separate buildings used exclusively for the purpose (or for other purposes having similar hazards), or they may 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: Those 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) When mechanical ventilation is used, air circulation shall be at least one cu ft per minute per sq ft (0.3 m³/min/m²) of floor area. Outlets shall discharge at least five ft (1.5 m) away from any opening into the structure or any other structure.

(b) When 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. (12 900 mm²) and the total of all openings shall be at least 1 sq in. (645 mm²) per sq ft (0.1 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 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 one hour.

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 are permitted to have doorways that shall be equipped with 1½-hour (B) fire doors.

NOTE: For information of fire doors, see NFPA 80, *Standard for Fire Doors and 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 one hour.

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 are permitted to have doorways that shall be equipped with 1½-hour (B) fire doors.

NOTE: See NFPA 80, *Standard for Fire Doors and 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.

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, 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 1, *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 1-2.5. (*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 psig (1.6 MPa gauge) 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 psig (1.7 MPa gauge) design pressure except that 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 for at least a 312.5 psig (2.1 MPa gauge) design pressure.

(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 psig.

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

(6) Tare weight of container fitted for service 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 communication with the vapor space of the container and shall not reduce the relieving capacity of the relief device.

(2) If the connection is located in 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 8-2.3(a). Container appurtenances subject to working pressures in excess of 125 psig (0.9 MPa gauge) but not to exceed 250 psig (1.7 MPa gauge) shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(1) Manual shutoff valves shall be designed to provide positive closure under service conditions and 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 remote location away from the container, the container fixed liquid level gauge opening and the remote bleeder valve shall be orificed to 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 (1) the pressure in psig (MPa gauge) at which the valve is set to start to leak; (2) the rated relieving capacity in cu ft per minute of air at 60°F (15.6°C) and 14.7 psia (0.1 MPa absolute); and (3) 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 for additional information). 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 density.

a. An overfilling prevention device shall be permitted to be installed on the container or exterior of the compartment when remote filling is used, provided that a double back check valve is installed in the container fill valve opening.

8-2.4 Carburetion Equipment.

(a) *General.* Carburetion equipment shall comply with 8-2.4(b) through 8-2.4(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 psig (0.9 MPa gauge) but not to exceed 250 psig (1.7 MPa gauge) shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(b) *Vaporizer.*

(1) Vaporizers shall be fabricated of materials suitable for LP-Gas service and 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 part of it, or any devices used with it that may be subjected to container pressure shall have a design pressure of at least 250 psig (1.7 MPa gauge), where working pressures do not exceed 250 psig (1.7 MPa gauge), and shall be plainly and permanently marked at a readily visible point with a design pressure of the fuel containing portion in psig (MPa gauge).

(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 permit 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 psig (1.4 MPa gauge).

(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 psig (1.4 MPa gauge).

(c) *Regulator.* The regulator shall be approved and can either be 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 can 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; ANSI B36.10M, *Welded and Seamless Wrought Steel Pipe*.

b. Steel pipe; ASTM A 53, *Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*.

c. Steel pipe; ASTM A 106, *Specification for Seamless Carbon Steel Pipe for High-Temperature Service*.

d. Brass pipe; ASTM B 43, *Specification for Seamless Red Brass Pipe, Standard Sizes*.

e. Copper pipe; ASTM B 42, *Specification for Seamless Copper Pipe, Standard Sizes*.

(2) For LP-Gas vapor in excess of 125 psig (0.9 MPa gauge) or for LP-Gas liquid, the pipe shall be Schedule 80 or heavier. For LP-Gas vapor at pressures of 125 psig (0.9 MPa gauge) 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 A 539, *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, ANSI H23.1, *Specification for Seamless Copper Water Tube* (ASTM B 88).

c. Copper tubing; ANSI H23.5, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service* (ASTM B 280).

d. Brass tubing; ANSI H36.1, *Specification for Seamless Brass Tube* (ASTM B 135).

(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 psig (0.9 MPa gauge), where working pressures do not exceed 250 psig (1.7 MPa gauge), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(ii) Fittings for use with vapor LP-Gas at pressures in excess of 5 psig (34.5 kPa gauge) and not exceeding 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of 125 psig (0.9 MPa gauge).

(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 psig (34.5 kPa gauge) shall be fabricated of materials resistant to the action of LP-Gas both as liquid and vapor and 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 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 of withstanding a pressure of not less than 700 psig (4.8 MPa gauge). If a test is made, such assemblies shall not be leak tested at pressures higher than the working pressure [350 psig (2.4 MPa gauge) minimum] of the hose.

(2) Hose used for vapor service at 5 psig (34.5 kPa gauge) or less shall be constructed of material resistant to the action of LP-Gas.

(3) Hose in excess of 5 psig (34.5 kPa gauge) service pressure and quick connectors shall have the approval for this application of any of the authorities listed 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, when protected by substantial bumpers, shall be considered in conformance with this requirement. In case the fuel container must be installed near the engine or exhaust system, 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 may 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 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)*]:

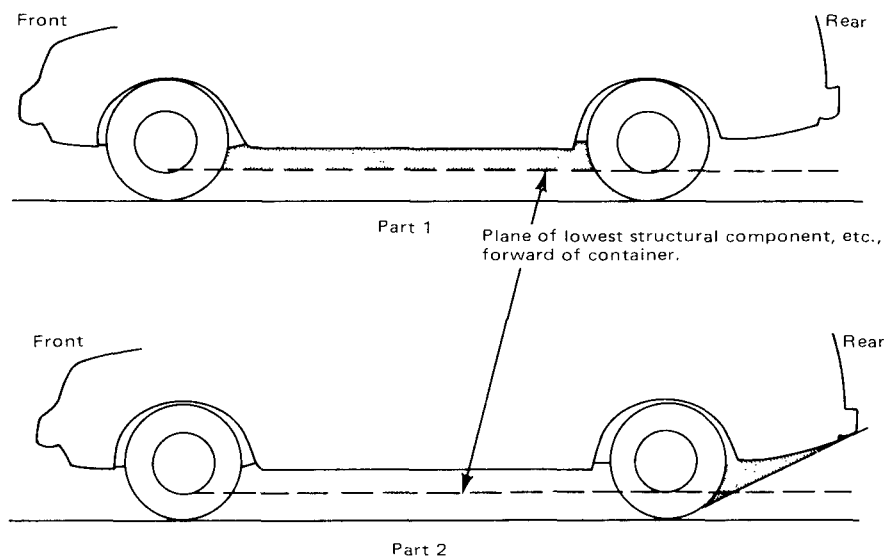


Figure 8-2.6(e) Container installation clearances.

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

- a. The lowest structural component of the body;
- b. The lowest structural component of the frame or subframe if any;
- c. The lowest point on the engine;
- d. 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 be not lower than the lowest of the following points and surfaces.

a. Not 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 not 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 (i.e. bumper, frame, etc.). [See Part 2, Figure 8-2.6(e).]

b. Where there are two or more rear axles the projections shall be made from the rearmost one of them.

(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 for LP-Gas), the LP-Gas container shall either fit within the space in which the original fuel container was installed or 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 paragraph 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, or be directed into the interior of the vehicle.

(2) When 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 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 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. When 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 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 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) When a pipeaway system is not required, the pressure relief valve shall have a protective cover as stated in 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 as follows:

(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 that is vented outside the vehicle.

NOTE: The luggage compartment (trunk) of a vehicle may constitute such an enclosure provided it meets all these requirements.

(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 that is vented to 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 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 as to minimize the possibility of damage due to expansion, contraction, vibration, strains or wear, and to preclude any working loose 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) When liquid service lines of two or more individual containers are connected together, a spring-loaded back-flow 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 either be of corrosion-resistant material or 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 psig (2.8 MPa gauge) or more than 500 psig (3.5 MPa gauge).

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 shutoff 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 letters "PROPANE" [1 in. (25 mm) minimum height centered in the diamond] of 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, *Firesafety Standard for Powered Industrial Trucks*.

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 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 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 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) except that hose 60 in. (1.5 m) in length or less need not be of stainless steel wire braid construction.

8-3.6 Industrial trucks (including forklift trucks) powered by LP-Gas engine fuel systems shall comply as to operation with NFPA 505, *Firesafety Standard for Powered Industrial Trucks*, 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 closing 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 the 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 so left, the fuel system shall be checked to be sure 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 each 10 years thereafter.

8-4 General Provisions for Vehicles Having Engines Mounted on Them (Including Floor Maintenance Machines).

8-4.1 This subsection includes provisions for the installation of equipment on vehicles to supply 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 it 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 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.

(1) 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.

8-5 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.

(a) 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 psig (103 kPa gauge) or more, use the ASME Code, Section VIII, 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, which meet the requirements of Appendix R of ANSI/API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*.

9-1.1.2 For pressures below 15 psig (103 kPa gauge) use ANSI/API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, including Appendix R.

9-1.1.3 When austenitic steels or nonferrous materials are used, ANSI/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 may 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 ANSI A58.1, *Design Loads for Buildings and Other Structures*. Wind speeds shall be based on a Mean Occurrence Interval of 100 years.

9-1.4 The design seismic loading on refrigerated LP-Gas containers shall be based on forces recommended in the ICBO *Uniform Building Code*. 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.

9-1.5 All piping that is part of a refrigerated LP-Gas container shall be in accordance with ANSI/ASME B31.3. 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.

9-1.6 Refrigerated LP-Gas containers shall be installed on foundations designed by an engineer experienced in foundations and soils and 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.

9-1.6.1 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.

9-1.6.2 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.

9-1.6.3 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.

9-1.6.4 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.

9-1.7 Refrigerated LP-Gas Container Instruments and Controls.

9-1.7.1 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.

9-1.7.2 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.

9-1.7.3 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, are permitted to be equipped with liquid trycocks in lieu of the high-liquid-level alarm, and manual flow cutoff is permitted.

9-1.7.4 Each refrigerated LP-Gas container shall be provided with temperature indicating devices to assist in controlling cooldown rates when placing the container in service.

9-1.8 Inspection of Refrigerated LP-Gas Containers.

9-1.8.1 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.

9-1.8.2 The inspections or tests required by 9-1.8.1 are the responsibility of the operator who is permitted to delegate any part of those inspections to his or her own

employees, 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.

9-1.9 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 in 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 are 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 construct such structures independent of the container, mounted integral to, or constructed against, the container. They, 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 assure that any accidentally discharged liquid stays within an area enclosed by a dike or impounding wall and yet to provide 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

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 (31 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 may 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: NFPA 30, *Flammable and Combustible Liquids Code*, may be used for guidance as appropriate.

10-1.2 General cargo, other than ships' stores for the LPG tank vessel, shall not be handled over a pier or dock within 100 ft (30 m) of the point of transfer connection while LPG or flammable fluids are being transferred through piping systems. Ship bunkering shall be permitted to be done provided that bunkering is from a pipeline, rather than a barge.

10-1.3 Vehicle traffic shall be prohibited on the pier or dock within 100 ft (30 m) of the loading and unloading manifold while transfer operations are in progress. Suitable warning signs or barricades shall be used to indicate when transfer operations are in progress.

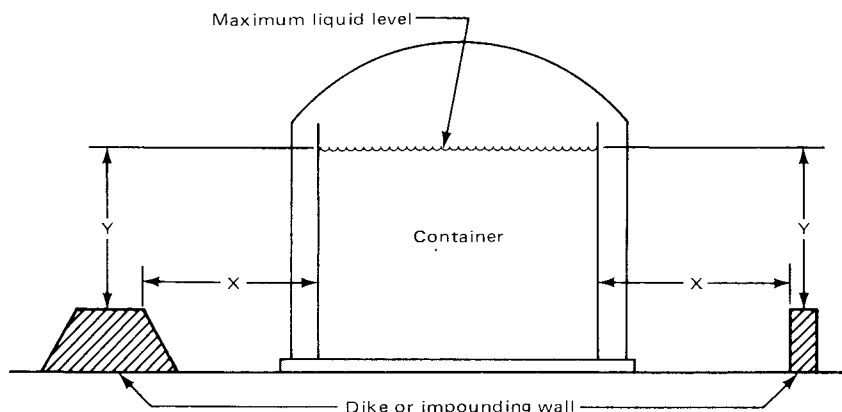


Figure 9-2.5 Dike or impounding wall proximity to containers.

Notes to Figure 9-2.5

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

10-2 Pipelines.

10-2.1 Pipelines shall be located on the dock or pier so that they are not exposed to damage from vehicular traffic or other possible cause of physical damage. Underwater pipelines shall be located or protected so that they are not exposed to damage from marine traffic and their locations shall be posted or identified in accordance with federal regulations.

NOTE: Refer to *Code of Federal Regulations*, Title 49, Part 195.

10-2.2 Isolation valving and bleed connections shall be provided at the loading or unloading manifold for both liquid and vapor return lines so that hoses and arms can be blocked off, drained or pumped out, and depressurized before disconnecting. Liquid isolation valves, regardless of size, and vapor valves 8 in. (20 mm) and larger in size shall be equipped with powered operators in addition to means for manual operation. Power operated valves shall be capable of being closed from a remote control station located at least 50 ft (15 m) from the manifold area, as well as locally. Unless the valve will automatically fail closed on loss of power, the valve actuator and its power supply within 50 ft (15 m) of the valve shall be protected against operational failure due to fire exposure of at least 10 minutes duration. 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.

10-2.5 Marine terminals used for loading ships or barges shall be equipped with a vapor return line designed to connect to the vessel's vapor return connections.

10-3 Prior to Transfer. Prior to transfer, the officer in charge of vessel cargo transfer and the person in charge of the shore terminal shall inspect their respective facilities to ensure that transfer equipment is in proper operating condition. Following this inspection, they shall meet and determine the transfer procedure, verify that ship-to-shore communications exist, and review emergency procedures.

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*, 1990 edition

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

NFPA 30, *Flammable and Combustible Liquids Code*, 1990 edition

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 1990 edition

NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites*, 1989 edition

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 1992 edition

NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*, 1988 edition

NFPA 59, *Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants*, 1992 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*, 1990 edition

NFPA 82, *Standard on Incinerators, Waste, and Linen Handling Systems and Equipment*, 1990 edition

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

NFPA 96, *Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment*, 1991 edition

NFPA 101, *Life Safety Code*, 1991 edition

NFPA 220, *Standard on Types of Building Construction*, 1992 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*, 1989 edition

NFPA 321, *Standard on Basic Classification of Flammable and Combustible Liquids*, 1991 edition

NFPA 501A, *Standard for Firesafety Criteria for Manufactured Home Installations, Sites, and Communities*, 1987 edition

NFPA 501C, *Standard on Recreational Vehicles*, 1990 edition

NFPA 505, *Firesafety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance, and Operation*, 1987 edition.

11-1.2 ANSI Publications. American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI A58.1-1982, *Design Loads for Buildings and Other Structures*

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

11-1.3 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

ANSI/API 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, 1990.

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, Division 1, *ASME Boiler and Pressure Vessel Code*, 1989, and all addenda and errata through 1991.

ANSI/ASME B31.3-1991, Chemical Plant and Refinery Piping.

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

ASTM A 47-1990, Standard Specification for Ferritic Malleable Iron Castings

ASTM A 48-1990, Standard Specification for Gray Iron Castings

ASTM A 53-1990, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 106-1990, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 395-1988, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

ASTM A 536-1984, Standard Specification for Ductile Iron Castings

ASTM A 539-1990, Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines

ASTM B 42-1989, Standard Specification for Seamless Copper Pipe, Standard Sizes

ASTM B 43-1991, Standard Specification for Seamless Red Brass Pipe, Standard Sizes

ASTM B 86-1988, Standard Specification for Zinc-Alloy Die Casting

ASTM B 88-1989, Standard Specification for Seamless Copper Water Tube

ASTM B 135-1991, Standard Specification for Seamless Brass Tube

ASTM B 280-1988, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASTM D 2513-1990, Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings

ASTM D 2683-1990, Standard Specification for Socket-Type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe

ASTM D 3261-1990, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM F 1055-1987, 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.

ANSI/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-4-1978, 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, 1988.

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

UL 132-1984, Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas

UL 243-1991, Outline of Investigation for Commercial Butane-Fueled Portable Cook Stoves.

Appendix A

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

A-1-2.1 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 litmus paper in the vapor stream from the container for 30 seconds. The appearance of any blue color on the litmus paper indicates that ammonia is present in the product.

NOTE 1: Since the red litmus paper will turn blue when exposed to any basic (alkaline) solution, care is required in making the test and interpreting the results. Tap water, saliva, perspiration, or hands that have been in contact with water having a pH greater than 7, or with any alkaline solution, will give erroneous results.

NOTE 2: For additional information on the nature of this problem and conducting the test, see *Recommendations for Prevention of Ammonia Contamination of LP-Gas*, published by the National Propane Gas Association.

A-1-4.1 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 1-4.1 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 1-4.1 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 1-4.1.

NOTE: Odorant research includes *A New Look at Odorization Levels for Propane Gas*, BERC/R1-77/1, United States Energy Research & Development Administration, Technical Information Center, September, 1977.

A-1-4.2 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-1-7 External Pressure Relief Valve. Describes the type of relief valves used on older domestic tanks, relief valve manifolds, and piping protection.

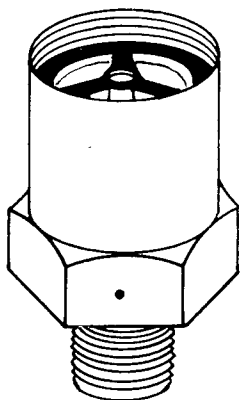


Figure A-1-7(a) External relief valve.

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

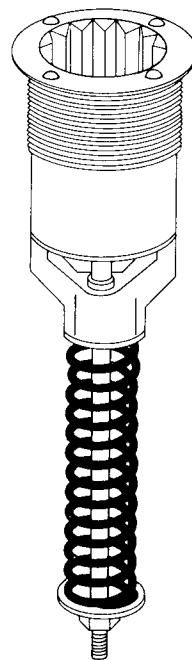


Figure A-1-7(b) Flush-type full internal relief valve.

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

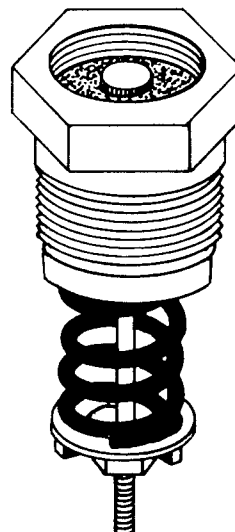


Figure A-1-7(c) Full internal relief valve.

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.

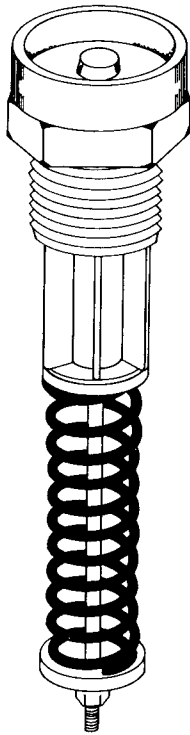


Figure A-1-7(d) Internal spring-type relief valve.

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

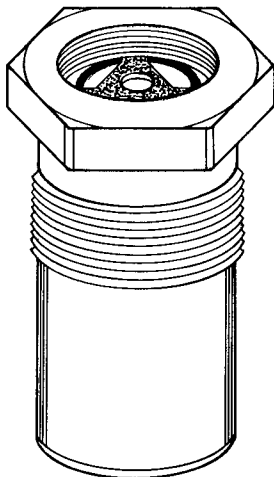


Figure A-1-7(e) Sump-type full internal relief valve.

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-2-2-6.6 A sample warning label, which is intended for use with gas grill cylinders, is shown in Figure A-2-2.6.6.

A-2-4.4(c)(3) Persons joining PE pipe should be trained under the applicable joining procedure established by the manufacturer including the following:

- (1) Appropriate training in the use of joining procedures.
- (2) Making a specimen joint from pipe sections joined according to the procedures.
- (3) Visually examining these joints during and after assembly.

A-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*.
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*.

A-3-2.4.8(j) See A-3-2.4.7(d).

A-3-2.8.1 LP-Gas normally is transferred into containers as a liquid but may also be conveyed as a liquid or vapor under container or lower regulated pressure.

A-3-2.8.8(a) This is not to be construed to mean that flexible connectors shall 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-3-10.3.1 For LP-Gas fixed storage facilities of 60,000 gal (227 m³) water capacity or less, a competent firesafety 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.

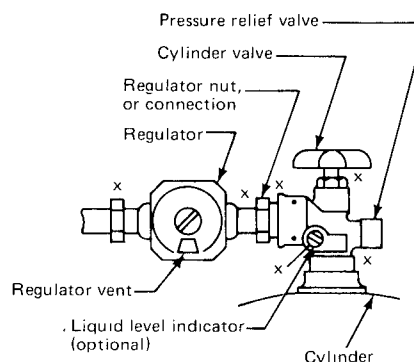
DANGER—FLAMMABLE GAS UNDER PRESSURE
LEAKING LP-GAS MAY CAUSE A FIRE OR EXPLOSION IF IGNITED
CONTACT LP-GAS SUPPLIER FOR REPAIRS, OR DISPOSAL OF THIS
CYLINDER OR UNUSED LP-GAS
FOR OUTDOOR USE ONLY*
DO NOT USE OR STORE CYLINDER IN A BUILDING, GARAGE, OR ENCLOSED AREA

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

WHEN CONNECTING FOR USE:

- Use only in compliance with applicable codes.
- Read and follow manufacturers' 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.



* EXCEPT AS AUTHORIZED BY ANSI/NFPA 58

Figure A-2-2.6.6 A sample cylinder warning label.

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 density 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.

Appendix B Properties of LP-Gases

This Appendix is not a part of the requirements of this NFPA document, but is included for information 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 may 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 may 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, *Liquefied Petroleum Gas Specifications for Test Methods Standard 2140*, or *Specification for Liquefied Petroleum (LP) Gases*, ASTM D 1835.

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 information 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 may not 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.

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

| | Commercial Propane | Commercial Butane |
|---|-----------------------|----------------------|
| Vapor Pressure in psig 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 |

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 psig 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 may 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 may 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:

(a) The pressure in the container at 70°F must be less than the service pressure for which the container is marked, and

(b) The pressure in the container at 130°F must not exceed $\frac{3}{4}$ times the pressure for which the container is marked.

EXAMPLE: Commercial propane has a vapor pressure at 70°F of 132 psig. However, its vapor pressure at 130°F is 300 psig, so service pressure ($\frac{3}{4}$ times which must not exceed 300 psig) is 300 divided by $\frac{3}{4}$, or 240 psig. Thus commercial propane requires at least 240 psig service pressure cylinder.

C-2.3 DOT Cylinder Specifications Used for LP-Gas.

C-2.3.1 A number of different specifications were approved by DOT (and its predecessor ICC) for use with LP-Gases. Some of these are no longer published or used for new construction. However, containers built under these old specifications, if properly maintained and requalified, are still acceptable for LP-Gas transportation.

C-2.3.2 DOT specifications cover primarily safety in transportation. However, in order for the product to be used, it is necessary for it to come to rest at the point of use and serve as LP-Gas storage during the period of use. Containers adequate for transportation are also deemed to be adequate for use as provided in NFPA 58. As small size ASME containers were not available at the time tank truck delivery was started, ICC (now DOT) cylinders have been equipped for tank truck deliveries and permanently installed.

C-2.3.3 The DOT cylinder specifications most widely used for the LP-Gases are shown in Table C-2.3.3. The differing materials of construction, method of fabrication, and the date of the specification reflect the progress made in knowledge of the products to be contained and improvement in metallurgy and methods of fabrication.

Table C-2.3.3

| Specification No. & Marking | Material of Construction | Method of Fabrication |
|-----------------------------|--------------------------|-------------------------|
| 26-150* | Steel | Welded and Brazed |
| 3B-300 | Steel | Seamless |
| 4-300 | Steel | Welded |
| 4B-300 | Steel | 2 piece Welded & Brazed |
| 4B-240 | Steel | 2 piece Welded & Brazed |
| 4BA-240 | Alloy Steel | 2 piece Welded & Brazed |
| 4E-240 | Aluminum | Welded and Brazed |
| 4BW-240 | Steel | 3 piece Welded |

* The term "service pressure" had a different connotation at the time the specification was adopted.

C-3 Requalification, Retesting, and Repair of DOT Cylinder Specification Containers.

C-3.1 Application.

C-3.1.1 This section outlines the requalification, retesting and repair requirements for DOT cylinder specification, containers but should be used only as a guide. For official information, the applicable DOT regulations should be consulted.

C-3.2 Requalification (Including Retesting) of DOT Cylinders.

C-3.2.1 DOT rules prohibit DOT cylinders from being refilled, continued in service, or transported unless they are properly qualified or requalified for LP-Gas service in accordance with DOT regulations.

C-3.2.2 DOT rules require a careful examination of every container each time it is to be filled, and it must be rejected if there is evidence of exposure to fire, bad gouges or dents, seriously corroded areas, leaks, or other conditions indicating possible weaknesses that might render it unfit for service. The following disposition is to be made of rejected cylinders:

(a) Containers subjected to fire are required to be requalified, reconditioned, or repaired in accordance with C-3.3.1, or permanently removed from service except that DOT 4E (aluminum) cylinders must be permanently removed from service.

(b) Containers showing serious physical damage, leaks, or with a reduction in the marked tare weight of 5 percent or more are required to be retested in accordance with C-3.2.4(a) or (b) and, if necessary, repaired in accordance with C-3.3.1.

C-3.2.3 All containers, including those apparently undamaged, are required to be periodically requalified for continued service. The first requalification for a new cylinder is required within 12 years after the date of manufacture. Subsequent requalifications are required within the periods specified under the requalification method used.

C-3.2.4 DOT regulations permit three alternative methods of requalification for most commonly used LP-Gas specification containers (*see DOT regulations for permissible requalification methods for specific cylinder specifications*). Two use hydrostatic testing, and the third uses a carefully made and duly recorded visual examination by a competent person. In the case of the two hydrostatic test methods, only test results are recorded, but a careful visual examination of each container is also required. DOT regulations cite in detail the data to be recorded for the hydrostatic test methods, the observations to be made during the recorded visual examination method, and the marking of containers to indicate the requalification date and the method used. The three methods are outlined as follows:

(a) The water jacket type hydrostatic test is permitted to be used to requalify containers for 12 years before the next requalification is due. A pressure of twice the marked service pressure is applied, using a water jacket (or the equivalent) so that the total expansion of the container during the application of the test pressure can be observed and recorded for comparison with the permanent expansion of the container after depressurization. The following disposition is made of containers tested in this manner:

(1) Containers that pass the retest, and the visual examination required with it (*see C-3.2.4*), are marked with the date and year of the test (Example: "6-70," indicating requalification by the water jacket test method in June 1970) and may be placed back in service.

(2) Containers that leak, or for which the permanent expansion exceeds 10 percent of the total expansion (12 percent for Specification 4E aluminum cylinders), must be rejected. If rejected for leakage, containers may be repaired in accordance with C-3.3.1.

(b) The simple hydrostatic test is permitted to be used to requalify containers for seven years before the next requalification is due. A pressure of twice the marked service pressure is applied, but no provision is made for measuring total and permanent expansion during the test outlined in C-3.2.4(a) above. The container is carefully observed while under the test pressure for leaks, undue swelling, or bulging indicating weaknesses. The following disposition is made of containers tested in this matter:

(1) Containers that pass the test, and the visual examination required with it (*see C-3.2.4*), are marked with the date and year of the retest followed by an "S" (Example: "8-71S," indicating requalification by the simple hydrostatic test method in August 1971) and may be placed back in service.

(2) Containers developing leaks or showing undue swelling or bulging must be rejected. If rejected for leaks, containers may be repaired in accordance with C-3.3.1.

(c) The recorded visual examination is permitted to be used to requalify containers for five years before the next qualification is due provided the container has been used exclusively for LP-Gas commercially free of corroding components. Inspection is to be made by a competent person, using as a guide the Compressed Gas Association *Standard for Visual Inspection of Steel Compressed Gas Cylinders* (CGA Pamphlet C-6), and recording the inspection results as required by DOT regulations. [Note: Reference to NLPGA Safety Bulletin, *Recommended Procedures for Visual Inspection and Requalification of DOT (ICC) Cylinders in LP-Gas Service*, is also recommended.] The following disposition is to be made of containers inspected in this manner:

(1) Containers that pass the visual examination are marked with the date and year of the examination followed by an "E" (Example: "7-70E," indicating requalification by the recorded visual examination method in July 1970) and may be placed back in service.

(2) Containers that leak, show serious denting or gouging, or excessive corrosion must either be scrapped or repaired in accordance with C-3.3.1.

C-3.3 Repair of DOT Cylinder Specification Containers.

C-3.3.1 Repair of DOT cylinders is required to be performed by a manufacturer of the type of cylinder to be repaired or by a repair facility authorized by DOT.

Repairs normally made are for fire damage, leaks, denting, gouges, and for broken or detached valve protecting collars or foot rings.

Appendix D Design of ASME and API-ASME Containers

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

D-1 General.

D-1.1 Application.

D-1.1.1 This appendix provides general information on containers designed and constructed in accordance with ASME or API-ASME codes, usually referred to as ASME containers. For complete information on either ASME or API-ASME containers the applicable code should be consulted. Construction of containers to the API-ASME Code has not been authorized since July 1, 1961.

D-1.1.2 DOT (ICC) specification portable tank containers and cargo tanks are either ASME or API-ASME containers. In writing these specifications, which should be consulted for complete information, additions were made to these pressure vessel codes to cover the following:

(a) Protection of container valves and appurtenances against physical damage in transportation.

(b) Holddown devices for securing cargo containers to conventional vehicles.

(c) Attachments to relatively large [6,000 gal (22.7 m³) or more water capacity] cargo containers in which the container serves as a stress member in lieu of a frame.

D-1.2 Development of ASME and API-ASME Codes.

D-1.2.1 ASME-type containers of approximately 12,000 gal (45.4 m³) water capacity or more were initially used for bulk storage in processing, distribution, and industrial plants. As the industry expanded and residential and commercial usage increased, the need for small ASME containers with capacities greater than the upper limit for DOT cylinders grew. This ultimately resulted in the development of cargo containers for tank trucks and the wide use of ASME containers ranging in size from less than 25 gal (0.1 m³) to 120,000 gal (454 m³) water capacity.

D-1.2.2 The American Society of Mechanical Engineers (ASME) in 1911 set up the Boiler and Pressure Vessel Committee to formulate "standard rules for the construction of steam boilers and other pressure vessels." The *ASME Boiler and Pressure Vessel Code*, first published in 1925, has been revised and republished in 22 separate editions including the 1980 edition. During this period there have been changes in the code as materials of construction improved and more was known about them, and as fabrication methods changed and inspection procedures were refined.

D-1.2.3 One major change involved the so-called "factor of safety" (the ratio of the ultimate strength of the metal to the design stress used). Prior to 1946, a 5:1 safety factor was used. Fabrication changed from the riveting widely used when the code was first written (some forge welding was used) to fusion welding. This latter method was incorporated into the code as welding techniques were perfected and now predominates.

D-1.2.4 The safety factor change in the ASME Code was based on the technical progress made since 1925 and on experience with the use of the API-ASME Code. This offshoot of the ASME Code, initiated in 1931, was formulated and published by the American Petroleum Institute (API) in cooperation with the ASME. It justified the 4:1 safety factor on the basis of certain quality and inspection controls not at that time incorporated in the ASME Code editions.

D-1.2.5 *ASME Code Case Interpretations and Addenda* are published between Code editions and normally become part of the Code in the new edition. Adherence to these is considered compliance with the Code. [See 2-2.1.3(a).]

D-2 Design of Containers for LP-Gas.

D-2.1 ASME Container Design.

D-2.1.1 When ASME containers were first used to store LP-Gas, the properties of the CP grades of the principal constituents were available, but the average properties for the commercial grades of propane and butane were not. Also, there was no experience as to what temperatures and pressures to expect for product stored in areas with high