Standard for the Storage and Handling of Liquefied Petroleum Gases

NFPA 58-1983

1983 Edition of NFPA 58

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. on November 17, 1982, at its Fall Meeting in Philadelphia, Pennsylvania. It was issued by the Standards Council on December 7, 1982 with an effective date of December 27, 1982, and supersedes all previous editions.

The 1983 edition of this standard has been approved by the American National Standards Institute.

Changes, other than editorial, are indicated by vertical line in the margin of the pages in 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 and 1982.

A major change in the 1983 edition is the combining of coverage of vehicle propulsion systems, formerly in Chapters 1 and 2 and Sections 35 and 38, into Section 3-6.

The 1983 edition has been entirely renumbered and arranged to comply with the NFPA *Manual of Style*. This includes relocation of some mandatory material formerly in Appendices B, C, D and E into the text. This includes 2-2.1.4(b), 2-5.4.5 and 3-2.3.8(e).

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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

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Standard for the Storage and Handling of Liquefied Petroleum Gases

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

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 which 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 (minus 0.56°C); of pure propane minus 44°F (minus 42.2°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 A.

1-1.2 Federal Regulations.

1-1.2.1 Regulations of the US 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.

1-2.1.1 As used in this standard, the terms "liquefied petroleum gas(es)', "LP-Gas" and "LPG" are synonymous and shall mean and include 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 iso-butane) and Butylene (including isomers).

1-2.1.2 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 as follows:

(a) 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.

(b) Wet a piece of red litmus paper by pouring distilled water over it while holding it with clean tweezers.

(c) Hold the wetted litmus paper in the vapor stream from the container for 30 seconds.

(d) 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 in making the test and interpreting the results is required. 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 LP-Gas Association.

1-2.2 Application of Standard.

1-2.2.1 This standard applies to the highway transportation of LP-Gas and to the design, construction, installation and operation of all LP-Gas systems except those designated by 1-2.3.

1-2.3 Nonapplication of Standard.

1-2.3.1 This standard does not apply to:

(a) LP-Gas refrigerated storage systems.

(b) Marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants or tank farms ("tank farm" storage at industrial locations is covered by NFPA 58).*

(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 Cutting and Welding*, 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 US Department of Transportation.

(h) Marine fire protection. NFPA 302, *Standard for Pleasure and Commercial Motor Craft*, shall apply.

1-2.4 Retroactivity.

1-2.4.1 Unless otherwise stated, the provisions of this standard shall not be applied retroactively.

(a) Existing plants, appliances, equipment, buildings, structures and installations for the storage, handling or use of LP-Gas in compliance with the provisions of this standard in effect at the time of manufacture or installation may be continued in use provided that such continued use does not constitute a distinct hazard to life or adjoining property.

*For LP-Gas installations (including refrigerated storage) at such facilities, it is recommended that API Standard 2510-1978, "The Design and Construction of Liquefied Petroleum Gas Installations at Marine and Pipeline Terminals, Natural Gas Processing Plants, Refineries, Petrochemical Plants and Tank Farms," be applied. Available from the American Petroleum Institute, 2101 L St., N.W., Washington, DC 20037.

(b) The stocks of equipment and appliances on hand in such locations as manufacturer's storage, distribution warehouses, and dealer's storage and showrooms in compliance with the provisions of this standard in effect at the time of manufacture may be placed in use (provided such use does not constitute a distinct hazard to life or adjoining property), but all new equipment and appliances manufactured after the effective date of this standard shall comply with its provisions.

1-3 Acceptance of Equipment and Systems.

1-3.1 Method of Acceptance.

1-3.1.1 Systems, or components assembled to make up systems, shall be approved (*see Section 1-7, APPROVED*) as specified in Table 1-3.

1-3.1.2 Acceptance applies to the complete system, or to the individual components of which it is comprised, as specified in Table 1-3.

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 Gaging 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.

1-4 LP-Gas Odorization.

1-4.1 LP-Gas to be Odorized.

1-4.1.1 All LP-Gases shall be odorized 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.[1],[2] Odorization, however, is not required if harmful in the use or further processing of the LP-Gas, or if odorization will serve no useful purpose as a warning agent in such further use or processing. (*See 1-1.1.1 and Appendix A for flammable limits of the LP-Gases.*)

1-5 Notification of Installations.

1-5.1 Fixed Installations.

1-5.1.1 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 m$3), shall be submitted to the authority having jurisdiction before the installation is started. [*See also 3-4.9.1(g).*]

1-5.2 Temporary Installations.

1-5.2.1 The authority having jurisdiction shall be notified of temporary (not to exceed 6 months) installations of the sizes covered in 1-5.1.1 before the installation is started.

1-6 Personnel.

1-6.1 Qualification of Personnel.

1-6.1.1 In the interests of safety, all persons employed in handling LP-Gases shall be trained in proper handling and operating procedures.

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[1]It is recognized that no odorant will be completely effective as a warning agent in every circumstance.

[2]It is recommended that odorants be qualified as to compliance with 1-4.1.1 by tests or experience. Where qualifying is by tests, such tests should be certified to 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 1-4.1.1 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 1-4.1.1.

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*"A New Look at Odorization Levels for Propane Gas," BERC/RI-77/1, United States Energy Research & Development Administration, Technical Information Center, September, 1977.

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 C*).

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 for 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 C.*)

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."

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 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 the 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 which applies hot gas from the heater combustion chamber directly to a portion of the container surface in contact with LP-Gas liquid.

Dispensing Device (or Dispenser). A device normally used to transfer and measure LP-Gas for engine fuel into a fuel container, serving the same purpose for an LP-Gas service station as that served by a gasoline dispenser in a gasoline service station.

Distributing Plant. A facility, the primary purpose of which is the distribution of gas, and which receives LP-Gas in tank car, truck transport or truck lots, 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 m^3) water capacity or more] and usually have container filling and truck loading facilities on the premises. So-called "bulk plants" are considered as being in this category. Normally no persons other than the plant management or plant employees have access to these facilities.

Distributing Point. A facility, other than a distributing plant or industrial plant, which normally receives gas by tank truck, and which fills small containers or the engine fuel tanks of motor vehicles on the premises. Any such facility having LP-Gas storage of 100 gal (0.4 m^3) or more water capacity, and to which persons other than the owner of the facility or his employees have access, is considered to be a distributing point. An LP-Gas service station is one type of distributing point.

DOT. US 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. US Standard. 1 US 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.

ICC. US Interstate Commerce Commission.

ICC Cylinder. See Cylinder.

Ignition Source. See Sources of Ignition.

Industrial Plant. An industrial facility which utilizes gas incident to plant operations, with LP-Gas storage of 2,000 gal (7.6 m^3) 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 iso-butane) 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. Liquefied Petroleum Gas.

LP-Gas Service Station. See Distributing Point. A facility open to the public which 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 intermittent-

ly) and which incorporates components intended to achieve control of quantity, flow, pressure, or state (either liquid or vapor).

Magnetic Gauge. See Float Gauge.

Movable Fuel Storage Tenders or Farm Carts. Containers not in excess of 1,200 gal (4.5 m^3) 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.

NFPA. National Fire Protection Association.

NLPGA. National LP-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, which 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."

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

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. (*See ANSI B95.1, Terminology for Pressure Relief Devices.*)

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 which, 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.

When 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 for converting liquid LP-Gas to vapor by means other than atmospheric heat transfer through the surface of the container.

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

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.

Vaporizer, Indirect (also called Indirect-Fired). A vaporizer in which heat furnished by steam, hot water 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 heat transfer medium, which is heated by an immersion heater not in contact with the LP-Gas heat exchange surface.

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 Application.

2-1.1.1 This chapter includes the basic provisions for individual components, or for such components shop-fabricated into subassemblies, container assemblies or complete container systems.

2-1-1.2 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 Containers shall comply with 2-2.1.3 or shall be designed, fabricated, tested and marked using criteria which incorporate an investigation to determine that it is safe and suitable for the proposed service, is recommended for that service by the manufacturer, and is acceptable to the authority having jurisdiction.

2-2.1.3 Containers shall be designed, fabricated, tested and marked (or stamped) in accordance with the Regulations of the US Department of Transportation (DOT)[1], 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*[2] applicable at the date of manufacture; and as follows:

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

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[1]Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply.

[2]Construction of containers to the API-ASME Code has not been authorized after July 1, 1961.

(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, may continue in use in accordance with 1-2.4.1. (*See Appendices B and C.*)

2-2.1.4 Containers complying with 2-2.1.3 may be reused, or reinstalled, as follows:

(a) The owner of a container shall be responsible for its suitability for continued service. 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.

(b) Containers which have been involved in a fire shall have been requalified for continued service before being reused 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 authorized by the Bureau of Explosives and 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 for general use shall not have individual water capacities greater than 120,000 gal (454 m^3). Containers in service stations shall not have individual water capacities greater than 30,000 gal (114 m^3).

2-2.1.6 Welding for the repair or alterations 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 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 DOT 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, 1980 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 C for information on earlier ASME or API-ASME Code.

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

Note 3. See 3-6.2.2 for certain service conditions which 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 2,000 gal (7.6 m^3) water capacity shall comply with 2-2.2.3(a) through (e).

(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 aboveground in accordance with "Building Code Requirements for Minimum Design Loads in 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 *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 which meets the approval of the authority having jurisdiction.

(e) 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 may 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 m^3) and less than 2,000 gal (7.6 m^3) water capacity, designed to be filled volumetrically, and manufactured after December 1, 1963, shall be equipped for filling into the vapor space.

2-2.3.3 ASME containers of 2,000 gal (7.6 m^3) or less water capacity shall have not more than two plugged openings.

2-2.3.4 Containers of 125 gal (0.5 m^3) or more water capacity manufactured after July 1, 1961, shall be provided with a connection for liquid evacuation, not smaller than ¾ in. National Pipe Thread. A plugged opening will not comply with this provision.

2-2.3.5 Containers of more than 2,000 gal (7.6 m^3) water capacity and all containers installed in LP-Gas service stations shall be provided with an opening for a pressure gauge (*see 2-3.5.2*).

2-2.3.6 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. 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. If located in a protecting enclosure, design shall be such as to permit this enclosure to be protected against corrosion and to permit inspection.

2-2.3.7 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 4-5.2.3.

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 m^3)] water capacity or less shall incorporate protection against physical damage to container appurtenances and immediate connections to these while in transit, storage, while being moved into position for use, and when in use except in residential and commercial installations, by:

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

(b) A ventilated cap or collar designed to permit adequate pressure relief valve discharge and capable of withstanding a blow from any direction equivalent to that of a 30 lb (14 kg) weight dropped 4 ft (1.2 m). Construction shall be such that the force of the blow will not be transmitted to the valve. Collars shall be designed so that they do not interfere with the free operation of the cylinder valve.

2-2.4.2 Portable containers of more than 1,000 lb (454 kg) [nominal 120 gal (0.5 m^3)] 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 m^3) water capacity designed for permanent installation in stationary service may be provided with 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 m^3) water capacity or less, designed for permanent installation in stationary service, may be equipped with nonfireproofed structural steel supports and designed to permit mounting on firm foundations in accordance with 2-2.5.2 (a) or (b).

(a) For installation on paved surfaces or concrete pads within 4 in. (102 mm) of ground level, 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. (305 mm) below the outside bottom of the container shell.

(b) For installation on concrete pads at the ground level, or not to exceed 2 in. (51 mm) above the ground level, the structural steel supports may 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 3-2.3.2(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 2,000 gal (7.6 m^3) 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.

(a) The steel supports shall be protected against fire exposure with a metal having a fire resistance rating of at least two hours. Continuous steel skirts having only one opening 18 in. (256 m) or less in diameter need such fire protection applied only to the outside of the skirt.

2-2.5.4 Containers to be used as portable storage containers (*see definition*) for temporary stationay service (normally less than 12 months at any given location) and to be moved only when substantially empty of liquid shall comply with 2-2.5.4(a) and (b).

(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 which 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 factor of safety 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 semitrailer 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. (305 mm) below the outside bottom of the container shell.

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 2-2.6.2 through 2-2.6.5 as applicable.

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 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 2-2.6.5(a) through (l). The markings specified shall be on a metal nameplate attached to the container, so located as to remain visible after the container is installed. The nameplate shall be attached in such a way that corrosion of either the nameplate or the container will be minimized.

(a) Service for which the container is designed; i.e. underground, aboveground, or both.

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

(c) Water capacity of container in lb or US Gallons.

(d) Design pressure in psig.

(e) 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.*)

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

(g) Outside surface area in sq ft.

(h) Year of manufacture.

(i) Shell thickness _____ head thickness.

(j) OL _____ OD _____ HD _____.

(k) Manufacturer's Serial Number.

(l) ASME Code Symbol.

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, back-flow 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 1-3.1.1 is a responsibility of the fabricator under the listing. Field installation of such appurtenances is covered in Chapter 3.

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. Cast iron shall not be used. Cast malleable or ductile iron is not considered as cast iron in this standard. The following also shall apply:

(a) Pressure containing metal parts of appurtenances, such as those listed in 2-3.1.1, except fusible elements, shall have a minimum melting point of 1500°F (816°C) such as steel, ductile (nodular) iron, malleable iron or brass. Ductile iron shall meet the requirements of ASTM A395 or equivalent and malleable iron the requirements of ASTM A47 or equivalent. Approved or listed liquid level gauges used in containers of 3500 gal (13.2 m^3) w.c. or less are exempted from this provision.

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 1500°F (816°C) or shall be protected against fire exposure, except that aluminum O-rings and spiral wound metal gaskets are acceptable and gaskets for use with approved or listed liquid level gauges for installation on a container of 3500 gal (13.2 m^3) w.c. or less are exempted from this provision. When a flange is opened, the gasket shall be replaced.

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 DOT containers shall be equipped with pressure relief valves or fusible plug devices as required by DOT Regulations. (*See Appendix D for additional information.*)

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; Standards for Safety Relief Valves of the Factory Mutual Research Corporation; 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 may 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 2-3.2.4(a) through (e).

(a) Pressure relief valves shall be of sufficient individual or aggregate capacity as to provide the relieving capacity in accordance with Appendix D 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 Note of Table 2-3.2.3) permitted start-to-leak pressure setting of the device. This provision is applicable to all con-

tainers (including containers installed partially aboveground) except containers installed wholly underground in accordance with D-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 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. 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 m^3/s) of air.

(c) Shutoff valves shall not be located between a pressure relief device and the container, unless 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 which remain operative.

(d) Pressure relief valves shall be so designed that the possibility of tampering will be minimized. 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 cm^2), and which communicate directly with the vapor space of the container, may 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 m^3) water capacity or less.

2-3.2.5 All containers used in industrial truck (including fork lift 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 Connections for Flow Control (Filling, Withdrawal Equalizing).

2-3.3.1 Shutoff valves, excess-flow check valves, back-flow check valves and quick closing internal valves, used individually or in suitable combinations, at container filling, withdrawal and equalizing connections, shall comply with 2-3.1.2 and 2-3.1.3.

2-3.3.2 Filling, withdrawal and equalizing connections shall be equipped with the appurtenances for the appropriate type and capacity of container and the service in which they are to be used in accordance with Table 2-3.3.2. Cylinder valve outlet connections on all DOT cylinders except those used for engine fuel, from which vapor can be withdrawn, shall not be interchangeable with those used for liquid withdrawal.

(a) If the loading or transfer point is not on the container, it shall be equipped as specified for filling connections on the container.

Table 2-3.3.2 Filling Withdrawal and Equalizing Connections

Type of Use	General Uses												Used as Fuel on Vehicles			Portable Tanks			Cargo Tanks		
Type of Container	DOT Cylinder Specifications									ASME			DOT or ASME			ASME			ASME		
Water Capacity of Containers — Pounds (kg)	1 (0.5) to 1,000 (454)			50 (23) to 1,000 (454)			2.5 (1) to 245 (110)			—			Any			Any			Any		
Water Capacity of Containers — Gallons (m^3)	—			—			—			Up to 120,000 (454 m^3)			Any			Any			Any		
Conditions under which Container is Used	Replacement or Exchange Outdoors			Filled at Point of Use Outdoors			When Used Inside Buildings			Filled at Point of Use Outdoors			Replacement or Fixed			Transportation of LP-Gas			Transportation of LP-Gas		
Connection Use (Note 1): "F" — Filling, "W" — Withdrawal, "E" — Equalizing	F	W	E	F	W	E	F	W	E	F	W	E	F	W	E	F	W	E	F	W	E
Appurtenances to be provided (Note 2):																					
1. Positive (Manual) Shutoff Valve	✓ 3*	✓ 3*	✓	5*	5*						✓ 6*										
2. Positive (Manual) Shutoff & Internal Excess Flow Check Valve			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ 8*	✓	✓	✓	✓	✓	✓		✓
3. Positive (Manual) Shutoff & External Excess Flow Check Valve (Note 4)				✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓
4. Single Back Flow Check Valve				✓																	
5. Positive (Manual) Shutoff & Internal Back Flow Check Valve										✓			✓			✓			✓		
6. Excess Flow Check Valve & Back Flow Check Valve			✓	✓		✓				✓		✓			✓	✓		✓	✓		✓
7. Double Back Flow Check Valve				✓						✓			✓			✓			✓		
8. Quick Closing Internal Valve										✓	✓	✓				✓	✓	✓	✓	✓ 7*	✓
Column Number	1			2			3			4			5			6			7		

* Note Number.

Notes to Table 2-3.3.2

Note 1: Containers are not required to be equipped with all three connections, but if used, appurtenances shall be those shown. Suitably fitted multipurpose valves may be used.

Note 2: If more than one appurtenance, or combination of appurtenances, is shown for any connection use, any one of the appurtenances or combinations shown will comply. (*See also DOT regulations for cargo and portable containers.*)

Note 3: Single manual shutoff valve normally used for both filling and withdrawal.

Note 4: External excess-flow check valves shall be installed in such a way that any undue strain beyond them will not cause breakage between the container and the excess-flow check valves.

Note 5: Containers of less than 50 lb (23 kg) water capacity need only be equipped with a positive shutoff valve for filling at the point of use.

Note 6: An excess flow check valve is not required in the withdrawal connection provided the following are all complied with:

(a) Container water capacity does not exceed 2,000 gal (7.6 m^3).

(b) Withdrawal outlet is equipped with a manually operable (having a handwheel or the equivalent) shutoff valve, which is:

(1) threaded directly into the container outlet, or

(2) an integral part of a substantial fitting which is threaded directly into or on the container outlet, or

(3) threaded directly into a substantial fitting which is threaded directly into or on the container outlet.

(c) The controlling orifice between the container contents and the shutoff valve outlet does not exceed 5/16 in. (8 mm) in diameter for vapor withdrawal or 1/8 in. (3 mm) for liquid withdrawal.

(d) An approved pressure-reducing regulator is directly attached to the outlet of the shutoff valve and is rigidly supported, or is adequately supported and properly protected on or at the container, and is connected to the shutoff valve by means of a suitable flexible connection.

Note 7: See 6-3.2.1(a) for special requirements for containers constructed to DOT cargo tank specifications.

Note 8: Authorized for exchangeable (removable) containers only.

2-3.3.3 The appurtenances specified in Table 2-3.3.2 shall comply with 2-3.3.3(a) through 2-3.3.3(d).

(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) Back-flow 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 back-flow 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(a) for special requirements for such valves used on cargo units.*]

2-3.3.4 The appurtenances specified in Table 2-3.3.2 may be installed as individual components or as combinations completely assembled by the appurtenance manufacturer.

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) may 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 4-5.3.3*). This may 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 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) Portable universal type containers that may be filled in either vertical or horizontal position 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 $\frac{5}{10}$ percent) of the container content which that particular gauge indicates.

2-3.4.3 The intent of 2-3.4.2 may be achieved by other methods acceptable to the authority having jurisdiction.

2-3.4.4 Variable liquid level gauges shall comply with 2-3.4.4(a) through (e).

(a) Variable liquid level gauges shall be so marked that the maximum liquid level, in in. 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 Fahrenheit degrees.

(b) The markings indicating the various liquid levels from empty to full shall either be 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 m^3) water capacity shall be so marked.

(e) Variable liquid level gauges shall comply with the accuracy provisions of 4-5.3.3(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 which 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.

2-3.6.1 Container openings, other than those equipped as provided in 2-2.2, 2-2.3, 2-2.4, and 2-2.5, shall be equipped with one of the following:

(a) A positive shutoff valve in combination with an excess-flow valve.

(b) A combination of an internal excess-flow valve and a plug.

(c) A plug.

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 Chapter 3.

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 2-4.2.1 and 2-4.3.1 or shall be of material which 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 be acceptable to the authority having jurisdiction.

2-4.2 Pipe.

2-4.2.1 Pipe shall be wrought iron or steel (black or galvanized), brass, copper, or polyethylene (*see 3-2.7.6*) and shall comply with 2-4.2.1(a) through (g).

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

(b) Steel Pipe; *Welded and Seamless Steel Pipe* (ANSI/ASTM A53).

(c) Steel pipe; *Seamless Carbon Steel Pipe for High Temperature Service* (ANSI/ASTM A106a).

(d) Steel pipe; *Black and Hot Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses* (ANSI/ASTM A120).

(e) Brass Pipe; *Seamless Red Brass Pipe* (ANSI/ASTM B43).

(f) Copper Pipe; *Seamless Copper Pipe* (ANSI/ASTM B42).

(g) Polyethylene Pipe; *Thermoplastic Gas Pressure Pipe, Tubing and Fittings* (ANSI/ASTM D-2513) and be listed or approved.

2-4.3 Tubing.

2-4.3.1 Tubing shall be steel, brass, copper, or polyethylene (*see 3-2.7.6*) and shall comply with 2-4.3.1(a) through (d):

(a) Steel tubing; *Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines* (ANSI/ASTM A539).

(b) Brass tubing [*see 3-2.6.1(d)(3)*]; *Seamless Brass Tube* (ANSI/ASTM B135).

(c) Copper tubing [see 3-2.6.1(d)(3)]:

(1) Type K or L, *Seamless Copper Water Tube*, (ANSI/ASTM B88).

(2) *Seamless Copper Tube for Air Conditioning and Refrigeration Field Service* (ANSI/ASTM B280).

(d) Polyethylene tubing; *Thermoplastic Gas Pressure Pipe, Tubing and Fittings* (ASTM D-2513) and be listed or approved.

2-4.4 Pipe and Tubing Fittings.

2-4.4.1 Fittings shall be steel, brass, copper, malleable iron, ductile (nodular) iron or polyethylene, and shall comply with 2-4.4.1(a) through (c). Cast iron pipe fittings (ells, tees, crosses, couplings, unions, flanges or plugs) shall not be used.

(a) Pipe joints in wrought iron, steel, brass or copper pipe may 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) Except as provided in 2-4.4.1(a)(1), 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).

(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) Soldering or 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, soldered or 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) Except as provided in 2-4.4.1(b)(1), 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).

(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) Soldering or brazing filler material shall have a melting point exceeding 1,000°F (538°C).

(c) Joints in polyethylene pipe and tubing shall be made by heat fusion in accordance with the manufacturers' instructions.

(1) Polyethylene fittings shall conform to ANSI/ASTM D-2683, *Socket Type Polyethylene Fittings for Outside Diameter — Controlled Polyethylene Pipe*, or ASTM D-3261, *Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*, and be listed or approved.

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 A395 or equivalent and malleable iron the requirements of ANSI/ASTM A47 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) Except as provided in 2-4.5.2(a), 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).

(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 3-2.7.9 and 3-3.3.4*):

(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 Section 1-7, Approved*).

2-4.6.3 Hose, hose connections and flexible connectors used for conveying LP-Gas liquid or vapor at pressures in excess of 5 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 minimum bursting pressure of 1,750 psig (12 MPa gauge) [350 psig (2.4 MPa gauge) working pressure], and shall be marked with "LP-Gas" or "LPG" and with the working pressure in psig at not greater than 10-ft (3-m) intervals.

(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 a 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 3-2.7.8 and 3-2.7.10.

2-4.7 Hydrostatic Relief Valves.

2-4.7.1 Hydrostatic relief valves designed to relieve the hydrostatic pressure which 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), 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) 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. Pressure containing metal parts shall be of steel, ductile (nodular) iron (ANSI/ASTM A395 or A536 Grade 60-40-18 or 65-45-12), malleable iron (ANSI/ASTM A47), higher strength gray iron (ANSI/ASTM A48, Class 40B), brass or the equivalent. Cast iron shall not be used for strainers or flow indicators which shall comply with provisions for materials for construction of valves. (*See 2-4.5.1.*) Aluminum may be used for approved meters. Aluminum or zinc may be used for approved regulators.

2-5.2 Pumps.

2-5.2.1 Pumps shall be designed for LP-Gas service and may be of rotary, centrifugal, turbine or reciprocating type.

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 and may be of the rotary or reciprocating type and shall be equipped with suitable glands or seals to minimize any release of LP-Gas.

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 3-2.10.2(b)*].

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

2-5.4.1 Vaporizers may 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 2-5.4.2(a) through (e):

(a) Indirect vaporizers with an inside diameter of more than 6 in. (152 mm) 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 (m^2).

(4) The name or symbol of the manufacturer.

(b) Indirect vaporizers having an inside diameter of 6 in. (152 mm) or less are exempt from the ASME Code and need not be marked. They shall be constructed for a minimum 250 psig (1.7 MPa gauge) design pressure.

(c) Indirect vaporizers shall be provided with a suitable automatic means to prevent liquid passing through the vaporizer to the vapor discharge piping. This means may be integral with the vaporizer, or otherwise provided in the external piping (*see 3-7.2.6*).

(d) 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.

(e) 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 3-7.2.9.

2-5.4.3 Direct-fired vaporizers shall comply with 2-5.4.3(a) through (f).

(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 it 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 2-5.4.4(a) through (j).

(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 sum of the outside surface and the inside heat exchange surface area in sq ft (m^2).

(4) The name or symbol of the manufacturer.

(b) Heat exchangers for waterbath vaporizers having an inside diameter of 6 in. (152 mm) or less are exempt from the ASME Code and need not be marked. They shall be constructed for a 250 psig (1.7 MPa gauge) minimum design pressure.

(c) 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.

(d) 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.

(e) Waterbath sections of waterbath vaporizers shall be designed to eliminate a pressure build-up above the design pressure.

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

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

(h) 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.

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

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

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

(a) The surface area of that part of the vaporizer shell directly in contact with LP-Gas to obtain the total surface area in sq ft.

(b) Refer to Table D-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 provisions of 2-5.4.6(a) through (f) 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 m^3) 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 factor of safety of five, 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 subjected 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, *Prevention of Fire and Dust Explosions in Grain Elevators and Bulk Grain Handling Facilities*, for ignition and combustion controls applicable to vaporizing-burners associated with grain dryers.

(g) Pressure regulating and control equipment shall be so located or so protected 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 pressure.

(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 2-5.4.8(a) through (e).

(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 which 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 which 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 which 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.

2-5.5.1 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 may 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(b) and 2-5.1.3.

2-5.7.2 Pumps of dispensers used to transfer LP-Gas shall comply with 2-5.1.2(b), 2-5.1.3 and with 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 may be integral with the dispenser or provided externally when the dispenser is installed. (*See 3-2.10.6.*)

2-5.7.3 Dispensing hose shall comply with 2-4.6.1 through 2-4.6.3. An excess-flow check valve or an automatic shutoff valve complying with 2-3.3.3(a), (b) and (c) and 2-4.5.3, or 2-3.3.3(d) 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.

2-5.8.1 Final stage regulators (excluding appliance regulators) shall be equipped with one or both of the following: [*See 3-2.5.2(b) for required protection from the elements which may 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 2-5.8.1

(b) A shutoff device that shuts the gas off at the regulator inlet when the downstream pressure reaches the overpressure limits specified in Table 2-5.8.1. Such a device shall not open to permit flow of gas until it has been manually reset.

Table 2-5.8.1

Regulator Delivery Pressure in psig (kPa gauge)	Relief Valve Start-to-Leak Pressure Setting, % of Regulator 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.

2-5.9.1 Flow indicators, either of the simple observation type or combined with a back-flow check valve, may be used in applications in which the observation of liquid flow through the piping is desirable or necessary.

2-6 Appliances.

2-6.1 General.

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

2-6.2 Approved Appliances.

2-6.2.1 New residential, commercial and industrial LP-Gas consuming appliances, except for those covered in 2-6.2.2 and 2-6.3.1, shall be approved.

2-6.2.2 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.

2-6.3 Provisions for Appliances.

2-6.3.1 Any appliance, originally manufactured for operation with a gaseous fuel other than LP-Gas, and in good condition, may be used with LP-Gas provided it is properly converted, adapted and tested for performance with LP-Gas before being placed into use.

2-6.3.2 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. (*See 3-5.1.3 for exception to this provision when such heaters are used in buildings without enclosing walls.*)

2-6.3.3 Appliances using vaporizing-burners shall comply with 2-5.4.7.

2-6.3.4 Appliances used in mobile homes and recreational vehicles shall be approved for such service.

2-6.3.5 LP-Gas appliances used on commercial vehicles (*see Section 4-9*) shall be approved for the service (*see 2-6.2*) and shall comply with 2-6.3.5(a) through (c).

(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 3-9.4.2*).

Chapter 3 Installation of LP-Gas Systems

3-1 Scope.

3-1.1 Application.

3-1.1.1 This chapter applies to the field installation of LP-Gas systems utilizing components, subassemblies, container assemblies and container systems fabricated in accordance with Chapter 2.

3-1.1.2 Section 3-2 includes general provisions applicable to most stationary systems. Sections 3-3 to 3-9 extend and modify Section 3-2 for systems installed for specific purposes.

3-1.1.3 Installation of systems used in the highway transportation of LP-Gas is covered in Chapter 6.

3-1.1.4 LP-Gas systems shall be installed in accordance with this standard and other national standards or regulations which may apply. These include:

(a) NFPA 54, *National Fuel Gas Code* (ANSI 223.1).

(b) NFPA 37, *Stationary Combustion Engines and Gas Turbines.*

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

(d) NFPA 501C, *Firesafety Criteria for Recreational Vehicles.*

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

(f) NFPA 86A, *Ovens and Furnaces.*

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

(h) NFPA 302, *Motor Craft (Pleasure and Commercial).*

(i) NFPA 61B, *Grain Elevators and Bulk Handling Facilities (Grain Dryers).*

(j) US DOT Regulations, 49 CFR 191 and 192, for LP-Gas pipeline systems subject to DOT.

3-2 General Provisions.

3-2.1 Application.

3-2.1.1 This section includes location and installation criteria for containers; the installation of container appurtenances and regulators; piping service limitations; the installation of piping (in-

cluding flexible connectors and hose); hydrostatic relief valves and equipment (other than vaporizers, see Section 3-7); and the testing of piping systems.

3-2.1.2 The provisions of this section are subject to modification for systems used for certain specific purposes (*see 3-1.1.2*).

3-2.1.3 For container appurtenances and gaskets installed on containers in excess of 3500 gal (13 m³) w.c., see 2-3.1.2(a) and 2-3.1.4.

3-2.2 Location of Containers.

3-2.2.1 LP-Gas containers shall be located outside of buildings, except as follows:

(a) Portable containers as specifically provided for in Section 3-4.

(b) 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.

(c) Containers on LP-Gas vehicles complying with, and parked or garaged in accordance with, Chapter 6.

(d) Containers used with LP-Gas stationary or portable engine fuel systems complying with Section 3-6.

(e) Containers used with LP-Gas fueled industrial trucks complying with 3-6.3.6.

(f) Containers on LP-Gas fueled vehicles garaged in accordance with 3-6.6.

(g) 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 which may be built upon, in accordance with Table 3-2.2.2 or with 3-2.2.3.

3-2.2.3 Where storage containers having an aggregate water capacity of more than 4,000 gal (15 m³) are located in heavily populated or congested areas, the siting provisions of 3-2.2.2 and Table 3-2.2.2 may be modified as indicated by the fire safety analysis described in 3-10.2.3.

Table 3-2.2.2

Water Capacity Per Container Gallons (m^3)	Minimum Distances		
	Mounded or Underground Containers [Note (d)]	Aboveground Containers	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)	(¼ of sum of diameters of adjacent 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)	

Notes to Table 3-2.2.2

Note (a) At a consumer site, if the aggregate water capacity of a multi-container installation comprised of individual containers having a water capacity of less than 125 gal (0.5 m^3) is 501 gal (1.9+ m^3) 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 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 of less than 125 gal (0.5 m^3) water capacity shall be located and installed so that the discharge from pressure relief devices shall not terminate in or beneath any building and shall be located at least 5 ft (1.5 m) horizontally away from any building opening 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 m^3) water capacity or less provided such container is at least 25 ft (7.6 m) from any other LP-Gas container of more than 125 gal (0.5 m^3) 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 multi-container 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.

3-2.2.4 In the case of buildings of other than wood-frame construction devoted exclusively to gas manufacturing and distribution operations, including LP-Gas service stations, the above distances may 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.

3-2.2.5 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) Suitable 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. Determination of flash points shall be in accordance with NFPA 321, *Standard on Basic Classification of Flammable and Combustible Liquids*.

(d) When tanks containing flammable or combustible liquids (*see NFPA 321 for definitions of these liquids*) are within a diked area, LP-Gas containers shall be outside the diked area and at least 10 ft (3 m) away from the centerline of the wall of the diked area.

(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). 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. No horizontal separation is 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*. See 3-2.2.5(c) for flash point determinations.

(f) The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with Table 3-2.2.5(f) except that lesser distances are 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 3-2.2.7. Also, see NFPA 50 and 51 for oxygen systems and NFPA 50A on gaseous hydrogen systems. The minimum separation between LP-Gas containers and liquefied hydrogen containers shall be in accordance with NFPA 50B.

Table 3-2.2.5(f)

LP-Gas Containers Having An	Separation From Oxygen Containers Having An			Separation From Gaseous Hydrogen Containers Having An		
Aggregate Water Capacity of	Aggregate capacity of 400 CF (11 m³)* or less	Aggregate capacity of more than 400 CF (11 m³)* to 20,000 CF (566 m³),* including unconnected reserves.	Aggregate capacity of more than 20,000 CF (566 m³),* including unconnected reserves.	Aggregate capacity of less than 400 CF (11 m³)*	Aggregate capacity of 400 CF (11 m³)* to 3000 CF (85 m³)*	Aggregate capacity of more than 3000 CF (85 m³)*
1200 Gal (4.5 m³) or less	None	20 ft (6 m)	25 ft (7.6 m)			
Over 1200 Gal (4.5 m³)	None	20 ft (6 m)	50 ft (15 m)			
500 Gal (1.9 m³) or less				None	10 ft (3 m)	25 ft (7.6 m)
Over 500 Gal (1.9 m³)				None	25 ft (7.6 m)	50 ft (15 m)

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

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

(h) 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 Z48.1, *Method of Marking Portable Compressed Gas Containers to Identify the Material Contained.*

3-2.2.6 Because of the pronounced volatility of LP-Gas in installations covered by this standard, dikes normally serve no useful purpose. [*See 3-2.2.5(c).*]

3-2.2.7 Except as permitted by 3-2.2.2, 3-2.2.5(c), 3-2.2.5(f) and 3-3.6.1, structures such as fire walls, fences, earth or concrete barriers and other similar structures shall be avoided around or over installed containers.

Exception: Such structures paritally enclosing containers are permissible if designed in accordance with a sound fire protection analysis.

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 Installation of Containers.

3-2.3.1 Containers shall be installed in accordance with 3-2.3.1(a) through (f):

(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 3-2.7.5 and 3-2.7.8.*)

(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 against such damage shall be taken.

(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.

3-2.3.2 Horizontal ASME containers designed for permanent installation in stationary service aboveground, except as provided in 3-2.3.2(a)(2)b and 3-2.3.2(b), 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 may be used as follows, or if in compliance with 3-2.3.2(b).

(1) Containers of more than 2,000 gal (7.6 m^3) 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, may be placed on flat-topped foundations.

(2) Containers of 2,000 gal (7.6 m^3) water capacity or less may 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), may 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. (305 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 are not 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) may be placed on paved surfaces or on concrete pads at ground level within 4 in. (102 mm) of ground level.

(b) With the approval of the authority having jurisdiction, single containers complying with 2-2.5.1 or 2-2.5.2 may 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.

(c) Suitable 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.

3-2.3.3 Vertical ASME containers over 2,000 gal (7.6 m^3) water capacity designed for permanent installation in stationary service aboveground shall be installed on reinforced concrete or steel structural supports on reinforced concrete foundations which 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 need such fire protection applied only to the outside of the skirts.

3-2.3.4 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 may 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.

3-2.3.5 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.

3-2.3.6 Portable containers of 2,000 gal (7.6 m^3) water capacity or less complying with 2-2.5.5 may be installed for stationary service as provided in 3-2.3.2(a)(2) for stationary containers.

3-2.3.7 Mounded containers shall be installed as follows:

(a) Mounding material shall be earth or sand and shall provide minimum thickness of cover for the container of at least 1 ft (305 mm).

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

3-2.3.8 ASME container assemblies or container systems listed for underground installation, or container assemblies listed for interchangeable aboveground-underground service, may be installed underground as follows:

(a) The top of the container shall be at least 6 in. (152 mm) below grade, unless the container might be subject to abrasive action or physical damage from vehicular traffic or from other causes such as in LP-Gas service stations. In this case, it shall be placed not less than 2 ft (610 mm) below grade or equivalent protection shall be otherwise provided (such as by the use of a concrete slab) to prevent imposing the weight of a loaded vehicle directly on the container shell.

(b) The portion of the container to which the manhole or other connections are attached need not be covered. However, where necessary, protection of the manhole and other connections against vehicular traffic damage shall be provided. When there is the possibility of a manhole or housing becoming flooded, the discharge from the regulator vent lines shall be above the highest probable water level.

(c) 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.

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

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

(1) Remove as much liquid LP-Gas as possible through the container liquid withdrawal connection.

(2) Remove as much of the remaining LP-Gas vapor as possible by venting it through a vapor connection; either 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 3-2.3.8(e)(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 may be burned or vented to the open air at a safe location.

3-2.3.9 Partially underground, unmounded 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 3-2.3.8(c).*]

(b) Containers shall be set substantially level on a firm foundation, with backfilling to be as required for underground containers. (*See 3-2.3.8.*)

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

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

3-2.4 Installation of Container Appurtenances.

3-2.4.1 Pressure relief devices shall be installed on containers in accordance with 3-2.4.2 through 3-2.4.5 and positioned so that the relief device is in direct communication with the vapor space of the container.

3-2.4.2 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 m^3)] water capacity or less, shall be installed to minimize the possibility of relief device(s) discharge(s) impingement on the container.

3-2.4.3 Pressure relief devices on ASME containers of 125 gal (0.5 m^3) water capacity or more permanently installed in stationary service, portable storage containers (see definition), portable containers (tanks) of nominal 120 gal (0.5 m^3) 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 inoperative or restrict its capacity) into the relief device or any discharge piping. If necessary, provision shall be made for drainage. The rain cap or other protector shall be designed to remain in place except when the relief device operates and shall permit the relief device to operate at sufficient relieving capacity.

(b) On each aboveground container of more than 2,000 gal (7.6 m^3) water capacity, the relief device discharge shall be virtually upward and unobstructed to the open air at a point at least 7 ft (2 mm) above the top of the container. The following also shall apply:

(1) Relief device discharge piping shall comply with 3-2.4.3(f).

(2) In providing for drainage in accordance with 3-2.4.3(a), the design of relief device discharge(s) and attached piping shall:

a. Be such as to protect the container against flame impingement which might result from ignited product escaping from the drain opening.

b. Be directed so that a container(s), piping or equipment which might be installed adjacent to container on which the relief device is installed is not subjected to flame impingement.

(c) On underground containers of 2,000 gal (7.6 m^3) or less water capacity, except those installed in LP-Gas service stations covered in 3-2.4.3(e), the relief device may 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 3-2.4.6(d).

(d) On underground containers of more than 2,000 gal (7.6 m^3) water capacity, except those installed in LP-Gas service stations, 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 3-2.4.3(f).

(e) On underground containers in LP-Gas service 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 3-2.4.3(f) and shall be adequately supported and protected against physical damage.

(f) The discharge terminals from relief devices shall be located so as to provide protection against physical damage. Discharge piping used shall be adequate in size to permit sufficient relief device relieving capacity. Such piping shall comply with 3-2.7.2 or 3-2.7.3. Return bends and restrictive pipe or tubing fittings shall not be used.

(g) Shutoff valves shall not be installed between relief devices and the container, or between the relief devices and the discharge piping, except for 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 which will allow the rated relieving capacity required for the container from the relief device or devices which remain in communication with the container.

3-2.4.4 Pressure relief devices on portable storage containers (constructed and installed in accordance with 2-2.5.4 and 3-2.3.4 respectively) used temporarily in stationary type service shall be installed in accordance with the applicable provisions of 3-2.4.3.

3-2.4.5 Additional provisions (over and above the applicable provision in 3-2.4.2 and 3-2.4.3) 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 Sections 3-6 and 3-9.

(b) For cargo containers (tanks) installed on cargo vehicles in accordance with Section 6-3, see 6-3.2.1(a).

3-2.4.6 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, 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) Except for DOT cylinders, excess-flow or backflow check valves shall be located between the LP-Gas in the container and the shutoff valves, either inside the container, or at a point immediately outside where the line enters or leaves the container. If outside, installation shall be made so that any undue strain beyond the excess-flow or backflow check valve will not cause breakage between the container and 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. On DOT cylinders, the excess-flow valve where required may be located at the outlet of the cylinder shutoff valve.

(2) Shutoff valves shall be located as close to the container as practicable. 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.

(3) 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, except pressure relief devices, liquid level gauging devices and pressure gauges, on containers of 2,000 gal (7.6 m^3) water capacity or more, or on containers of any capacity used in LP-Gas service stations, shall be labeled to designate whether they communicate with the vapor or liquid space. Labels may be on valves. (*See Sections 3-6 and 3-9 for requirements for labeling smaller containers used for vehicular installations.*)

(f) Every storage container of more than 2,000 gal (7.6 m^3) water capacity, or of any capacity used in LP-Gas service stations, shall be provided with a suitable pressure gauge. (*See 3-3.5.*)

3-2.5 Regulator Installation.

3-2.5.1 Regulators used to control distribution or utilization pressure shall be as close to the container or vaporizer outlets as is practicable. First stage regulating equipment shall be outside of buildings except as used with containers and liquid piping systems covered by 3-2.2.1(a), (b), (d), (e) and (f), and 3-2.6.1(d).

3-2.5.2 Regulators shall be securely attached to container valves, containers, supporting standards or building walls.

(a) First stage regulators shall be either directly connected to the container shutoff valve or outlet of vaporizer where used, 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, except regulators used for portable industrial applications, shall be designed, installed, or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud, or debris) . This protection may be integral with the regulator.

3-2.5.3 On regulating equipment installed outside of buildings, the discharge from a pressure relief device shall be located not less than 3 ft (1 m) horizontally away from any building opening below the level

of such discharge, and not beneath any building unless this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter.

3-2.5.4 On regulators installed inside buildings, the discharge from the pressure relief device and from above the regulator and relief device diaphragms 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. 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(a), (b), (d), (e) and (f).

3-2.6 Piping System Service Limitations.

3-2.6.1 This subsection describes the physical state (vapor or liquid) and pressure at which LP-Gas may be transmitted through piping systems under various circumstances:

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

(b) Polyethylene piping systems shall be limited to vapor service not exceeding 30 psig (208 kPa gauge).

(c) LP-Gas vapor at pressures not exceeding 20 psig (138 kPa gauge) may 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 except those meeting the following descriptions:

(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.

Exception: Complete compliance with Chapter 7 for buildings, or separate areas of buildings, housing industrial processes and other occupancies cited in 3-2.6.1(d)(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.

(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.

(3) In buildings or structures other than those covered by 3-2.6.1(d)(1) and (2) in which liquid feed systems are used, liquid piping may enter the building or structure to connect to a vaporizer provided heavy walled seamless brass or copper tubing not exceeding $\frac{3}{32}$ in. (2.4 mm) internal diameter and with a wall thickness not less than $\frac{3}{64}$ in. (1.2 mm) is used.

3-2.7 Installation of Pipe, Tubing, Pipe and Tubing Fittings, Valves and Hose.

3-2.7.1 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. 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 3-2.7.1(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).

3-2.7.2 Metallic pipe joints may 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 ex-

posure, except that aluminum O-rings and spiral wound metal gaskets are acceptable. When a flange is opened, the gasket shall be replaced.

3-2.7.3 Metallic tubing joints may be flared, soldered or brazed using tubing and fittings, and solder or brazing material complying with 2-4.3 and 2-4.4.

3-2.7.4 Piping in systems shall be run as directly as is practicable from one point to another, and with as few restrictions, such as ells and bends, as conditions will permit, giving consideration to provisions of 3-2.7.5.

(a) 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.

3-2.7.5 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 may be used. (*See 3-2.7.8.*) The use of nonmetallic pipe, tubing or hose for permanently interconnecting such containers is prohibited.

3-2.7.6 Metallic piping outside buildings may be underground or aboveground or both. Aboveground piping shall be well supported and protected against physical damage. Where underground piping is beneath driveways, roads or streets, possible damage by vehicles shall be taken into account. Nonmetallic piping, including the nonmetallic portions of transition fittings, shall be installed outside, a minimum of 12 in. (305 mm) underground and in accordance with the piping manufacturers' instructions.

3-2.7.7 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 protectd underground system from all aboveground piping and systems.

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

3-2.7.8 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*) may be used for liquid or vapor piping, on portable or stationary tanks, to compensate for expansion, contraction, jarring, vibration and settling. 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.

(b) Hoses may be installed if flexibility is required for liquid or vapor transfer. The use of wet hose (*see 4-2.3.4 for explanation of term "wet hose"*) is recommended for liquid.

3-2.7.9 On new installations, and by December 31, 1980 on existing installations, (1) stationary single container systems of over 4,000 gal (15.1 m^3) water capacity, or (2) stationary multiple container systems with an aggregate water capacity of more than 4,000 gal (15.1 m^3) utilizing a common or manifolded liquid transfer line, shall comply with 3-2.7.9(a) and (b).

(a) When a hose or swivel type piping 1½ in. or larger is used for liquid transfer or a 1¼ in. or larger vapor hose or swivel type piping is used in this service (excluding flexible connectors in such liquid and vapor piping), 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. The preceding sizes are nominal. Where the flow is only in one direction, a backflow check valve may 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. 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.

(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.

(b) The emergency shutoff valve(s) or backflow check valve(s) specified in 3-2.7.9(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. This may be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting. Such anchorage is not required for tank car unloading.

3-2.7.10 Hose may 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 though 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 may exceed 6 ft (1.8 m), but shall be kept as short as practicable.

(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.

3-2.8 Hydrostatic Relief Valve Installation.

3-2.8.1 A hydrostatic relief valve complying with 2-4.7.1 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 which could develop from the trapped liquid to a safe atmosphere or product-retaining section.

3-2.9 Testing Piping Systems.

3-2.9.1 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.

3-2.10 Equipment Installation.

3-2.10.1 Pumps shall be installed as recommended by the manufacturer and in accordance with 3-2.10.1(a) through (c).

(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.

3-2.10.2 Compressors shall be installed as recommended by the manufacturer and in accordance with 3-2.10.2 (a) and (b).

(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 may 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 practicable.

3-2.10.3 The installation of vaporizers of the types covered by 2-5.4 is covered in Section 3-7 and of engine fuel vaporizers in Section 3-6. Integral vaporizing-burners, such as are used for weed burners or tar kettles, are considered to be part of these units (or "appliances"). For appliance installation standards, see Section 3-5.

3-2.10.4 Strainers shall be installed so that the strainer element can be serviced.

3-2.10.5 Liquid or vapor meters shall be installed as recommended by the manufacturer, and in compliance with the applicable provisions of 3-2.10.5(a) and (b).

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

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

3-2.10.6 LP-Gas engine fuel dispensing devices installed in service stations shall be installed as recommended by the manufacturer and in accordance with 3-2.10.6(a) through (h).

(a) Installation shall not be within a building, but may be under weather shelter or canopy, provided this area is adequately ventilated and is not enclosed for more than 50 percent of its perimeter.

(b) Dispensing devices shall be located as follows:

(1) Not less than 10 ft (3 m) from aboveground storage containers of more than 2,000 gal (7.6 m^3) water capacity.

(2) Not less than 20 ft (6 m) from any building [not including canopies covered in 3-2.10.6(a)], basement, cellar, pit or line of adjoining property which may be built upon.

(3) Not less than 10 ft (3 m) from sidewalks, streets or thoroughfares.

(c) Dispensing devices 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 3-2.3.1(b) and (d)]. In either case, they shall be adequately protected against physical damage.

(d) Control for the pump used to transfer LP-Gas through the dispensing device into motor vehicle tanks shall be provided at the device in order to minimize the possibility of leakage or accidental discharge. The following also shall apply:

(1) Means shall be provided at some point outside the dispensing device, such as a remote switch [*see 3-2.10.1(c)*], to shut off the power in the event of fire or accident.

(2) 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.

(e) Provision shall be made for venting the LP-Gas contained in the dispenser to a safe location.

(f) The dispensing hose shall comply with 2-4.6. An excess-flow check valve, or an automatic 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.

(g) Piping leading to, and within the dispenser, and the dispensing hose shall be provided with hydrostatic relief valves as specified in 3-2.8.1 (*see also 2-4.7.1*).

(h) No drains or blowoffs from the dispensing device shall be directed toward, or be in close proximity to sewer systems.

3-3 Distributing and Industrial LP-Gas Systems.

3-3.1 Application.

3-3.1.1 This section includes provisions for LP-Gas systems installed at distributing plants, industrial plants, and distributing points (*see definitions*). These provisions extend and modify the provisions of Section 3-2 for these applications.

3-3.2 General.

3-3.2.1 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 4-3.2 and 4-3.3.

3-3.3.2 Separate buildings, and attachments to or rooms within other buildings, housing points of transfer or transfer pumps and compressors, constructed or converted to such use after December 31, 1972, shall comply with Chapter 7.

3-3.3.3 The back 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 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 3-2.7.9 shall apply. For all other LP-Gas systems, the following shall apply:

(a) The connection, or connecting piping, larger than ½-inch internal diameter into which the liquid or vapor is being transferred shall be equipped with:

(1) A back-flow 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 3-2.4.6(a)(3).

(b) The connection, or connecting piping, larger than ½ in. 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 3-2.4.6(a)(3).

3-3.3.5 See 4-2.3.6 for railroad tank car transfer operations.

3-3.3.6 If gas is to be discharged from containers inside a building, the installation provisions of 4-4.2.1 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 Except as provided in 3-3.4.3 and 3-3.4.4, 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.

3-3.4.3 Facilities for vaporizing LP-Gas and gas-air mixing shall be designed, located and installed in accordance with Section 3-7.

3-3.4.4 Facilities for storing LP-Gas in portable containers at industrial plants and distributing points shall comply with Chapter 5.

3-3.4.5 Buildings housing vapor compressors shall be located in accordance with 4-3.3.2 considering the building as one housing a point of transfer.

3-3.4.6 The use of pits to house gas distribution facilities shall be avoided unless 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.

3-3.4.7 If gas is to be discharged from containers inside a building, the installation provisions of 4-4.2.1 shall apply.

3-3.5 Installation of Electrical Equipment.

3-3.5.1 Installation of electrical equipment shall comply with Section 3-8.

3-3.6 Protection Against Tampering for Section 3-3 Systems.

3-3.6.1 To minimize the possibilities for trespassing and tampering, the area which 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 1-6.1.1.*)

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 which 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.

3-3.7.1 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.

3-3.8.1 Ignition source control shall comply with Section 3-8.

3-4 LP-Gas Systems in Buildings or on the Roofs of Buildings.

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 of, buildings or structures. Systems covered include those utilizing portable containers inside or on the roofs 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 3-4.1.1(a) through (c) and in accordance with 3-4.2.1 through 3-4.2.7. 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) Permanent installations using portable containers on roofs shall be as specified in 3-4.9. 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) Liquid LP-Gas shall be piped into buildings or structures only for the purposes specified in 3-2.6.1(d).

3-4.1.2 These provisions are in addition to those specified in Section 3-2.

3-4.1.3 Liquid transfer systems are covered in Chapter 4.

3-4.1.4 Engine fuel systems used inside buildings are covered in Section 3-6.

3-4.1.5 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 be equipped as provided in Section 2-3 (*see 2-3.3 and Table 2-3.3.2*). They shall also comply with the following:

(a) Containers shall be marked as provided in 2-2.6.

(b) Containers with water capacities greater than 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall be equipped with shutoff and excess-flow valves as provided in 2-3.3.2 (Column 3, Table 2-3.3.2). The installation of excess-flow valves shall take into account the type of valve protection provided for the container in accordance with 2-2.4.1.

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

(d) Containers having water capacities greater than 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] 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 so as 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 3-2.7 for liquid piping or for vapor piping for pressures above 125 psig (0.9 MPa gauge). [*See 3-2.7.1(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 be installed in accordance with 3-2.7.10. Hose length may exceed that specified by 3-2.7.10(b), but shall be as short as practicable, 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 so as 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 so as to minimize the possibility of the ignition of combustibles.

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

(a) Filling containers on roofs is prohibited. See 4-3.1.1(b).

3-4.2.7 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 which must be lighted and proved before the main burner can be turned on, or

(2) An approved electric ignition system.

(b) The provisions of 3-4.2.7 are not 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 2½ lb (1 kg).

3-4.3 Buildings Under Construction or Undergoing Major Renovation.

3-4.3.1 Containers may be used 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 may be used 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 3-4.3.9.

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

3-4.3.3 For temporay 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, may be used, provided they are designed and installed so as 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 may 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 may be altered by the authority having jurisdiction if compliance is impractical.

3-4.3.9 Storage of containers awaiting use shall be in accordance with Chapter 5.

3-4.4 Buildings Undergoing Minor Renovation When Frequented by the Public.

3-4.4.1 Containers may be used 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 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall not be left unattended.

(b) During the hours of the day when the building is not open to the public, containers may be used 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 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall not be left unattended.

3-4.5 Buildings Housing Industrial Occupancies.

3-4.5.1 Containers may 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 may 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 practicable, provided containers and heaters comply with and are used in accordance with 3-4.3.

3-4.6 Buildings Housing Educational and Institutional Occupancies.

3-4.6.1 Containers may 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.

3-4.7.1 Containers may 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 tem-

porarily out of service, provided the containers and heaters comply with and are used 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] may 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 may 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 may 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 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] may be used in buildings as part of approved self-contained torch assemblies or similar appliances other than mobile cooking appliances.

3-4.9 Permanent Installations Using Portable Containers on Roofs.

3-4.9.1 Containers may be 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 not be 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 which 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) Containers shall not be refilled on roofs.

(e) The container valve outlet shall be tightly plugged and the provisions of 2-2.4.1 shall be complied with during movement of containers within a building. 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. Freight or passenger elevators may be used when not occupied by the public.

(f) Piping shall be in accordance with 3-4.2.3, provided, however, that hose shall not be used for connecting to containers.

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

3-4.10 Liquid Piped into Buildings or Structures.

3-4.10.1 Liquid LP-Gas piped into buildings in accordance with 3-2.6.1(d)(1) shall comply with 3-2.7.

3-4.10.2 Liquid LP-Gas piped into buildings in accordance with 3-2.6.1(d)(2) from containers located and installed outside the building or structure in accordance with 3-2.2 and 3-2.3 shall comply with the following:

(a) Liquid piping shall not exceed ¾ in. I.P.S. and shall comply with 3-2.6 and 3-2.7. If approved by the authority having jurisdiction, copper tubing complying with 2-4.3.1(c)(1) and with a maximum outside diameter of ¾ in. may 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 practicable and shall comply with 2-4.6, 3-2.7.8 and 3-2.7.10.

(e) Hydrostatic relief valves shall be installed in accordance with 3-2.8.

(f) Provision shall be made so that the release of fuel when any section of piping or appliances are disconnected shall be minimized by use of one of the following methods:

(1) An approved automatic quick-closing coupling which 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 3-9.

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.

3-5.2.1 LP-Gas appliances shall be installed in accordance with this standard and other national standards which may apply. These include:

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

(b) NFPA 37, *Stationary Combustion Engines and Gas Turbines.*

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

(d) NFPA 501C, *Recreational Vehicles* (ANSI A119.2).

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

(f) NFPA 86A, *Ovens and Furnaces.*

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

(h) NFPA 302, *Motor Craft* (Pleasure and Commercial).

(i) NFPA 61B, *Grain Elevators and Bulk Handling Facilities.*

3-6 Engine Fuel Systems.

3-6.1 Application.

3-6.1.1 This section 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 section 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 3-9 for systems on vehicles for purposes other than for engine fuel.

3-6.1.2 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, structures or on roofs under certain conditions*).

3-6.1.3 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.

3-6.1.4 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.

3-6.2 General Purpose Vehicle Engines Fueled by LP-Gas.

3-6.2.1 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.

3-6.2.2 Containers.

(a) Containers designed, fabricated, tested and marked (or stamped) in accordance with the regulations of the US Department

of Transportation (DOT);[1] or the *Rules for Construction of Unfired Pressure Vessels*, Section VIII, Division I, ASME *Boiler and Pressure Vessel Code*, applicable at the date of manufacture shall be used as follows:

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

(2) Containers fabricated to earlier editions of Regulations, Rules or Codes may be continued in use in accordance with 1-2.4.1. (*See Appendices B and C.*)

(3) Containers which have been involved in a fire shall have been requalified for continued service before being reused in accordance with the code under which they were constructed.

(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 B.*)

(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 shall be constructed for at least a 312.5 psig (2.1 MPa gauge) design pressure. (*See TIA 58-83-1.*)

(7) Welding for the 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.

(b) Containers shall comply with 3-6.2.2(a) or shall be designed, fabricated, tested and marked using criteria which 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 3-6.2.2(c)(1) through (12). The markings specified shall be on a metal name plate attached to the container, and so located as to remain visible after the container is installed.

(1) Service for which the container is designed; i.e., above ground.

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[1]Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply. Available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

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

(3) Water capacity of container in lb or US 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 m^3) 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 m^3) water capacity.

(f) Containers covered in this section shall be equipped for filling into the vapor space and shall not have more than two plugged openings.

(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.

(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 may be on valves.

3-6.2.3 Container Appurtenances.

(a) Container appurtenances (such as valves and fittings) shall comply with Section 2-3 and 3-6.2.3(a)(1) through (6). 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 back flow 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 4-5.2.3. 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 internal type spring loaded pressure relief valves conforming with applicable requirements of the "Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas," UL 132; Standards for Safety Relief Valves of the Factory Mutual Research Corporation; 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 2-3.2.5. These relief valves shall be plainly and permanently marked with (1) the pressure in psig (MPa) 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 internal pressure relief valves in accordance with DOT regulations (*see Appendix D 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 June 30, 1983 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 over-filling prevention device may 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.

3-6.2.4 Carburetion Equipment.

(a) Carburetion equipment shall comply with 3-6.2.4(b) through (e) or shall be designed, fabricated, tested and marked using criteria which 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 which 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).

(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 may serve this purpose, if effective.

(4) Engine exhaust gases may 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 which 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.

3-6.2.5 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 B36.10, *Wrought-Steel and Wrought Iron Pipe*.

b. Steel pipe; ANSI B125.1, *Welded and Seamless Steel Pipe* (ASTM A53).

c. Steel pipe; ANSI B125.30, *Seamless Carbon Steel Pipe for High Temperature Service* (ASTM A106).

d. Steel pipe; ANSI B125.2, *Black and Hot Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses* (ASTM A120).

e. Brass pipe; ANSI H27.1, *Seamless Red Brass Pipe* (ASTM B43).

f. Copper pipe; ANSI H26.1, *Seamless Copper Pipe* (ASTM B42).

(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 A539, *Electric-Resistance Welded Coiled Steel Tubing for Gas and Oil Lines*, with a minimum wall thickness of 0.049 in.

b. Copper tubing; Type K or L, ANSI H23.1, *Seamless Copper Water Tube* (ASTM B88).

c. Copper tubing; ANSI H23.5, *Seamless Copper Tube for Air Conditioning and Refrigeration Field Service* (ASTM B280).

d. Brass tubing; ANSI H36.1, *Seamless Brass Tube* (ASTM B135).

(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 may be screwed, welded or brazed. Tubing joints in steel, brass or copper tubing shall be flared, soldered or 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) Soldering or 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 minimum bursting pressure 1,750 psig (12 MPa gauge) [350 psig (2.4 MPa gauge) working pressure] and shall be marked with "LP-Gas" or "LPG" and with the working pressure in psig at not greater than 10-ft (3-m) intervals.

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 1-3.1.1.

3-6.2.6 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 may 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. So as 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 at the point where it is installed.

(e) Containers shall be installed with as much road clearance as practicable. 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 3-6.2.6(e)*]:

(1) Containers installed between axles shall comply with 3-6.2.6(e)(3) or be not lower than the lowest of the following points and surfaces:

a. The lowest point forward of the container on:

(i) the lowest structural component of the body;

(ii) the lowest structural component of the frame or subframe, if any;

(iii) the lowest point on the engine;

(iv) the lowest point on the transmission (including the clutch housing or torque converter housing, as applicable) [Part 1, Figure 3-6.2.6(e)], and

b. not lower than a surface defined by two intersecting planes, the first plane being defined by the following three points:

(i) the intersection of (a) a vertical plane parallel to and midway between the axles of the vehicle and (b) the lowest point of the vehicle intercepted by that plane [Point A, Part 2, Figure 3-6.2.6(e)];

(ii) the perpendicular projection from the center of the end of the axle of the front right wheel to a horizontal plane surface beneath and in contact with the front right tire (Point BR, Part 2), and

(iii) the perpendicular projection from the center of the end of the axle of the front left wheel to a horizontal plane surface beneath and in contact with the front left tire (Point BL, Part 2),

and the second plane being defined by

(iv) said intersection (Point A);

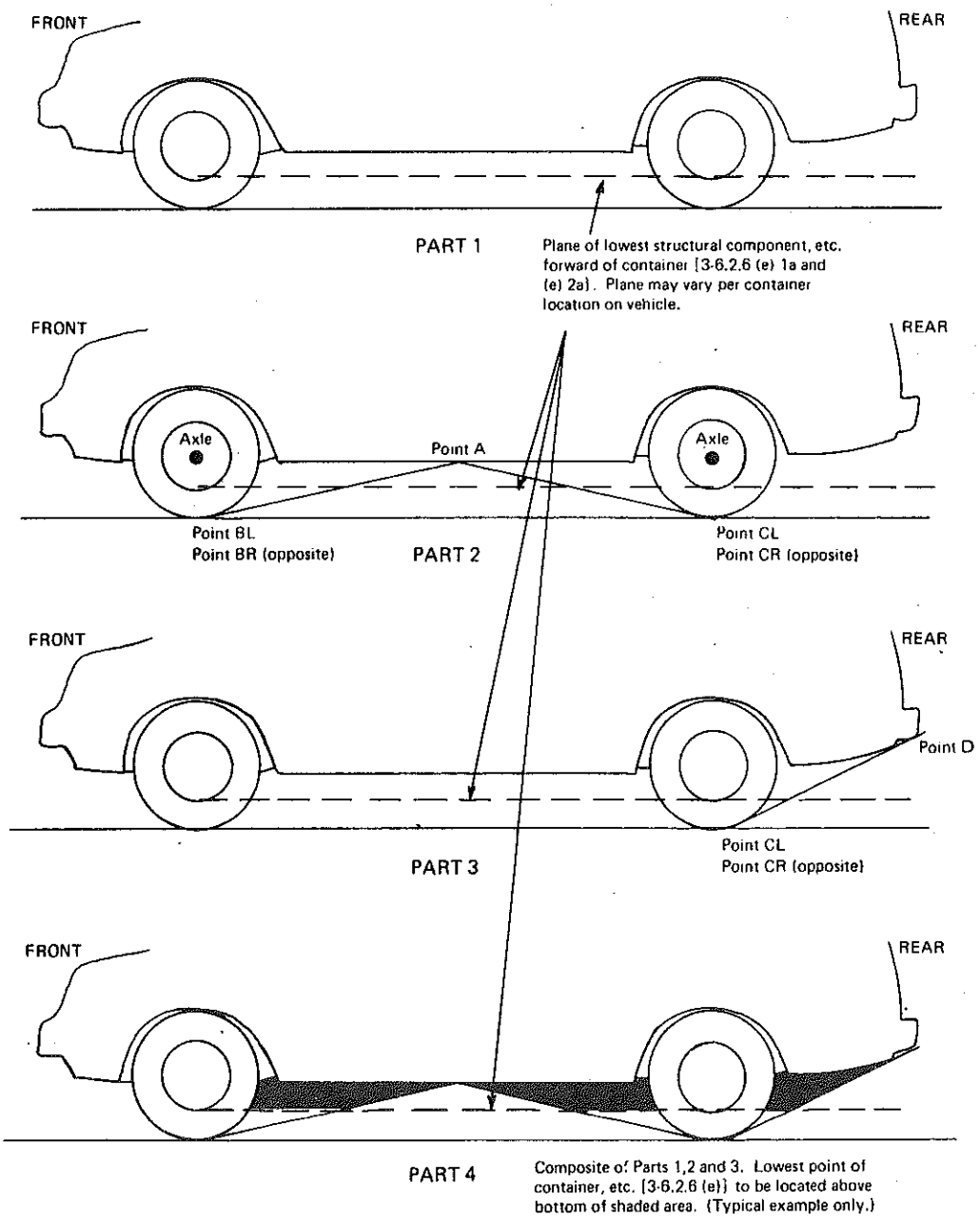

Figure 3-6.2.6(e) Container Installation Clearances

(v) the perpendicular projection from the center of the end of the axle of the rear right wheel to a horizontal plane surface beneath and in contact with the rear right tire (Point CR, Part 2), and

(vi) the perpendicular projection from the center of the end of the axle of the rear left wheel to a horizontal plane surface beneath and in contact with the rear left tire (Point CL).

c. Where there are two or more rear axles, the projections shall be made from the frontmost one of them.

(2) Containers installed behind the rear axle and extending below the frame shall comply with 3-6.2.6(e)(3) or be not lower than the lowest of the following points and surfaces:

a. The lowest point on

(i) the lowest structural component of the body, forward of the container;

(ii) the lowest point, forward of the container, on the engine;

(iii) the lowest point, forward of the container, on the transmission (including the clutch housing or torque converter housing, as applicable) (Part 1), and

b. not lower than a surface defined by the following three points:

(i) the perpendicular projection from the center of the end of the axle of the right rear wheel to a horizontal plane surface beneath and in contact with the right rear tire (Point CR);

(ii) the perpendicular projection from the center of the end of the axle of the rear left wheel to a horizontal plane surface beneath and in contact with the rear left tire (Point CL);

(iii) the initial point of structural interference rearward of either rear tire to ground (Point D, Part 3).

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

(3) Containers may be installed within the space in which the original manufacturer of the vehicle installed the LP-Gas container. Where an LP-Gas container is substituted for the container for a fuel other than LP-Gas which had been installed by the original manufacturer of the vehicle, the LP-Gas container must fit within the space in which the original fuel container was installed.

(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 3-6.2.2(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) Pressure relief valve installations shall comply with the following requirements:

(1) The relief valve discharge on fuel containers on vehicles other than passenger cars shall be directed upward within 15 degrees of vertical so that any gas released will not impinge upon containers or part of the vehicle, or on adjacent persons or vehicles or discharge inside of the passenger compartment. On passenger cars, the relief valve discharge on fuel containers shall be directed upward within 45 degrees of vertical so that gas may not be discharged inside of the passenger or luggage compartment and so that any gas released will not impinge upon a container, part of the vehicle or on an adjacent vehicle.

(2) Pressure relief valve discharge lines shall be metallic and have a melting point over 1500°F (816°C). Discharge lines and adaptors shall be sized, located and secured so as to minimize the possibility of physical damage and to permit required pressure relief valve discharge capacity. When the relief valve discharge must be piped away from the container, the relief valve shall be fitted with an approved break-away type adaptor or designed such that in the event of excessive stress the piping will break away without impairing the function of the relief valve. Flexible metal hose or tubing used shall be able to withstand the pressure from the relief vapor discharge when the relief valve is in full open position. A means shall be provided (such as loose fitting caps) to minimize the possibility of the entrance of water or dirt into either the relief valve or its discharge piping. The protecting means shall remain in place except when the relief valve operates. In this event, it shall permit the relief valve to operate at required capacity.

(3) Relief valve adaptors installed directly in the relief valve to deflect the flow upward shall be metallic and have a melting point over 700°F (371°C).

3-6.2.7 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 may be accomplished by 3-6.2.7(a)(1) or (2).

(1) Locating the container, including its appurtenances, in an enclosure which 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 which is vented outside the vehicle.

a. 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 which 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 which 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 3-6.2.3(a)(2), and fixed liquid level gauging device to the outside of the vehicle.

(c) Container pressure relief valve installation shall comply with 3-6.2.6(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.

3-6.2.8 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 chaffing.

(c) Fuel line piping which 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) Exposed parts of the piping system shall either be of corrosion-resistant material or adequately protected against exterior corrosion.

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

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

(g) A hydrostatic relief valve 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 which 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).

3-6.2.9 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 3-6.2.6(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 3-6.2.4(d).

(d) Vaporizers shall be securely fastened in position.

3-6.3 Industrial (and Forklift) Trucks Powered by LP-Gas.

3-6.3.1 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 Including Type Designations and Areas of Use*.

3-6.3.2 ASME and DOT fuel containers shall comply with 3-6.2.2 and 3-6.2.3(a)(1) through (7).

(a) Portable containers may 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, may 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.

3-6.3.3 The container relief valve shall be vented upward within 45 degrees of vertical and otherwise comply with 3-6.2.6(i).

3-6.3.4 Gas regulating and vaporizing equipment shall comply with 3-6.2.4(b)(1) through (5) and 3-6.2.4(c), (d) and (e).

3-6.3.5 Piping and hose shall comply with 3-6.2.5(a) through (d) except that hose 60 in. (1.5 m) in length or less need not be of stainless steel wire braid construction.

3-6.3.6 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 Including Type Designations and Areas of Use*, and with the following:

(a) Refueling of such trucks shall be accomplished as follows:

(1) Trucks with permanently mounted containers shall be refueled out-of-doors.

(2) Exchange of removable fuel containers preferably should be done out-of-doors, but may 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 may 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 may 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.

3-6.4 General Provisions for Vehicles Having Engines Mounted on Them.

3-6.4.1 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 any readily portable mobile unit, whether the engine is used to propel it or is mounted on it for other purposes.

3-6.4.2 Gas vaporizing, regulating, and carburetion equipment to provide LP-Gas as a fuel for engines shall be installed in accordance with 3-6.2.8 and 3-6.2.9.

(a) In the case of industrial trucks (including forklift trucks) and other engines on vehicles operatng 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 3-6.2.4(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.

3-6.5 Engine Installation Other Than on Vehicle.

3-6.5.1 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.

3-6.5.2 Portable engines, except as provided in 3-6.5.1, may 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 3-6.2.4(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 3-6.2.4(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.

3-6.5.3 Piping and hose shall comply with 3-6.2.5(a) through (d).

3-6.5.4 Gas regulating, vaporizing and carburetion equipment shall comply with 3-6.2.4(b)(1) through (5), 3-6.2.4(c) and 3-6.2.4(e).

3-6.5.5 Installation of piping, carburetion, vaporizing and regulating equipment for the engine fuel system shall comply with 3-6.2.8 and 3-6.2.9.

3-6.5.6 Engines installed or operated exclusively outdoors shall comply with 3-6.5.3, 3-6.5.4 and 3-6.5.5.

(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.

3-6.6 Garaging of Vehicles.

3-6.6.1 Vehicles with LP-Gas engine fuel systems mounted on them and general purpose vehicles propelled by LP-Gas engines may 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.

3-7 Vaporizer Installation.

3-7.1 Application.

3-7.1.1 This section applies to the installaton of vaporizing devices covered in 2-5.4. It does not apply to engine fuel vaporizers, or to integral vaporizing-burners such as those used for weed burners or tar kettles.

3-7.2 Installation of Indirect-Fired Vaporizers.

3-7.2.1 Indirect-fired vaporizers shall comply with 2-5.4.2, and shall be installed as provided in 3-7.2.2 through 3-7.2.9.

3-7.2.2 Indirect vaporizers may be installed out-of-doors, in buildings used exclusively for gas manufacturing or distribution, or in separate structures constructed in accordance with Section 7-2. Any such buildings shall be well ventilated near the floor line and roof.

3-7.2.3 Indirect vaporizers may also be installed in structures attached to, or rooms within, buildings not used for gas manufacturing or distribution, provided such attached structures or rooms comply with Section 7-3, and that there are no openings of any sort from the vaporizer room into the building or structure of which it is a part.

3-7.2.4 The housing for the vaporizer covered by 3-7.2.2 or 3-7.2.3 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 and shall discharge vertically upward.

3-7.2.5 The device supplying the heat necessary for producing steam, hot water, or other heating medium may be installed out-of-doors, in a separate building, or in a structure attached to, or room within, another gas manufacturing or distributing building (but not buildings used for other purposes), provided:

(a) The housing provided shall comply with either Section 7-2 or 7-3, and shall be well ventilated near the floor line and roof.

(b) The heat supplying device, if out-of-doors, or the housing in which it is installed, shall be located with respect to other LP-Gas facilities and operations as required by Section 3-8. If the heat supplying device is gas-fired and is packaged with the vaporizer, or installed within 15 ft (5 m) of the vaporizer, it shall be subject to the provisions of 3-7.3 covering installation of direct gas-fired vaporizers.

Exception: The requirements of 3-7.2.5 are not applicable to domestic water heaters supplying heat for domestic system vaporizers.

3-7.2.6 The heating medium piping into and from the vaporizer shall be provided with a suitable means for preventing the flow of gas into a heating system which is supplying heat to areas other than the LP-Gas facility in the event of a tube rupture in the vaporizer. If the device supplying the heat to the vaporizer is for that purpose only, the device, or the piping to and from the device, shall contain a relief valve, vented to the outside, to relieve excessive pressure in the event of a tube rupture in the vaporizer.

3-7.2.7 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 the pilot light should fail.

3-7.2.8 Vaporizers may be an integral part of a fuel storage container, directly connected to either the liquid or vapor space, or to both. A limit control shall be provided to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, or 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 1980 Code equivalent — see Note 1 of Table 2-2.2.2).

3-7.2.9 Atmospheric vaporizers employing heat from the ground or surrounding air shall be installed as follows:

(a) Buried underground, or

(b) Located inside a building close to the point of entry of the supply pipe, provided the capacity of the unit does not exceed one quart (0.9 L).

(c) Vaporizers of less than one quart (0.9 L) capacity, not equipped with pressure relief valves [*see 2-5.4.2(e)*], may be installed provided one of the authorities listed in 1-3.1.1 certifies that it is safe without such a valve.

(d) Vaporizers designed primarily for domestic service shall be protected against tampering and physical damage.

3-7.3 Installation of Direct Gas-Fired Vaporizers.

3-7.3.1 Direct gas-fired vaporizers shall comply with 2-5.4.3, and shall be installed as provided in 3-7.3.2 through 3-7.3.6.

3-7.3.2 Direct gas-fired vaporizers may be installed out-of-doors or in separate structures constructed in accordance with Section 7-2. Any such buildings shall be well ventilated near the floor line and roof.

3-7.3.3 Direct gas-fired vaporizers may also be installed in structures attached to, or in rooms within, a gas manufacturing or distributing structure (but not buildings used for other purposes), provided:

(a) The housing provided shall comply with Section 7-3, and shall be well ventilated near the floor line and roof.

(b) The wall separating it from all other compartments or rooms containing LP-Gas vaporizers, pumps and central gas mixing devices shall have no openings.

3-7.3.4 The housing for the vaporizer covered in 3-7.3.2 and 3-7.3.3 shall not have unprotected drains 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 and shall discharge vertically upward.

3-7.3.5 Direct gas-fired vaporizers may be connected to the liquid space or to both the liquid and the vapor space of the container, but in any case there shall be a manually operated shutoff valve in each connection at the container, to permit completely shutting off all flow of vapor or liquid.

3-7.3.6 Direct gas-fired vaporizers of any capacity shall be located in accordance with Table 3-7.3.6.

Table 3-7.3.6

Exposure	Mimimum Distance Required
Container	10 ft (3 m)
Container shutoff valves	15 ft (5 m)
Point of transfer	15 ft (5 m)
Nearest important building or group of buildings or line of adjoining property which may be built upon (except buildings in which vaporizer is installed. See 3-7.3.2 and 3-7.3.3).	25 ft (7.6 m)
Gas-air mixing (*see 3-7.7*)	

3-7.4 Installation of Direct Gas-Fired Tank Heaters.

3-7.4.1 Gas-fired tank heaters shall comply with 2-5.4.5, and shall be installed as follows:

(a) The container heated by a direct gas-fired tank heater shall be located in accordance with Table 3-7.4.1 with respect to the nearest important building, group of buildings, or line of adjoining property which may be built upon.

Table 3-7.4.1

Container Water Capacity	Minimum Distance Required
500 gal or less	10 ft (3 m)
501 to 2000 gal	25 ft (7.6 m)
2001 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

(b) Direct gas-fired tank heaters shall be attached to aboveground containers only.

(c) 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."

3-7.5 Installation of Vaporizing-Burners.

3-7.5.1 Vaporizing-burners shall comply with 2-5.4.6 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 3-7.5.1.

Table 3-7.5.1

Container Water Capacity	Minimum Distance Required
500 gal or less	10 ft (3 m)
501 to 2000 gal	25 ft (7.6 m)
Over 2000 gal	50 ft (15 m)

For SI Units 1 gal = 3.785 L

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

3-7.6 Installation of Waterbath Vaporizers.

3-7.6.1 Waterbath vaporizers shall comply with 2-5.4.4 and shall be installed as follows:

(a) If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class 1, Group D locations, the unit shall be treated as indirect-fired and installed in accordance with 3-7.2.

(b) All others shall be treated as direct-fired vaporizers and installed in accordance with 3-7.3.

3-7.7 Installation of Gas-Air Mixers.

3-7.7.1 Gas-air mixing equipment shall be located at least 25 ft (7.6 m) from a direct-fired vaporizer when the mixer is installed outdoors. If the mixer is installed in a building, the building shall comply with the provisions of Chapter 7 and no direct-fired vaporizer is to be located within the same building enclosure. Such a structure shall be located at least 25 ft (7.6 m) from a direct-fired vaporizer.

3-7.7.2 Listed vaporizer-mixers in a common cabinet having a direct-fired type vaporizer shall be installed outdoors in accordance with the distance provisions in 3-7.3. Listed vaporizer-mixers not in a common cabinet having an indirect-fired type vaporizer may be installed in a building or structure complying with Chapter 7 provided there is no source of ignition in such building or structure.

3-8 Ignition Source Control.

3-8.1 Application.

3-8.1.1 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.

3-8.1.2 Liquefied petroleum gas storage containers do not require lightning protection (*see NFPA 78, Lightning Protection Code*).

3-8.1.3 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 (*see NFPA 77, Recommended Practice on Static Electricity*).

3-8.2 Electrical Equipment.

3-8.2.1 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 3-8.2.2.

3-8.2.2 Fixed electrical equipment and wiring installed within classified areas specified in Table 3-8.2.2 shall comply with Table 3-8.2.2 and shall be installed in accordance with NFPA 70, *National Electrical Code*. This provision does not apply to fixed electrical equipment at residential or commercial installations of LP-Gas systems or to systems covered by Section 3-9.

3-8.2.3 Electrical equipment installed on LP-Gas cargo vehicles shall comply with 6-1.1.5.

3-8.3 Other Sources of Ignition.

3-8.3.1 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.

3-8.3.2 Open flames (except as provided for in Section 3-7), cutting or welding, portable electric tools and extension lights capable of igniting LP-Gas shall not be permitted within classified areas specified in Table 3-8.2.2 unless the LP-Gas facilities have been freed of all liquid and vapor, or special precautions observed under carefully controlled conditions.

Table 3-8.2.2

Part	Location	Extent of Classified Area[1]	Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D[2]
A	Storage Containers Other Than DOT Cylinders.	Within 15 feet in all directions from connections, except connections otherwise covered in Table 3-8.2.2.	Division 2
B	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 3-8.2.2)	Division 2
C	Gage Vent Openings Other Than Those On DOT Cylinders.	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
D	Relief Device Discharge Other Than Those on DOT Cylinders.	Within direct path of discharge.	Division 1 Note: Fixed electrical equipment should preferably not be installed.
		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

1 The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

2 See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

3 When 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.

(Continued)

Part	Location	Extent of Classified Area[1]	Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D[2]
E	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 abovegrade.	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 3-8.2.2)	Division 2
F	Service Station Dispensing Units.	Entire space within dispenser enclosure, and 18 inches horizontally from enclosure exterior up to an elevation 4 ft. above dispenser base. Entire pit or open space beneath dispenser.	Division 1
		Up to 18 inches abovegrade within 20 ft. horizontally from any edge of enclosure. *Note:* For pits within this area, see Part G of this table.	Division 2

1 The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

2 See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

4 Where specified for the prevention of fire or explosion during normal operation, ventilation is considered adequate where provided in accordance with the provisions of this standard.

(Continued)

Part	Location	Extent of Classified Area[1]	Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D[2]
G	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
H	Special Buildings or rooms for storage of portable containers.	Entire room.	Division 2
I	Pipelines and connections containing operational bleeds, drips, vents or drains.	Within 5 ft. in all directions from point of discharge.	Division 1
		Beyond 5 ft. from point of discharge, same as Part E of this table.	

[1] The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

[2] See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

(Continued)

Part	Location	Extent of Classified Area[1]	Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D[2]
J	Container Filling:		
	Indoors with adequate ventilation[4]	Within 5 feet in all directions from connections regularly made or disconnected for product transfer.	Division 1
		Beyond 5 feet and entire room.	Division 2
	Outdoors in open air	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 3-8.2.2)	Division 2

[1] The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

[2] See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

[4] Where specified for the prevention of fire or explosion during normal operation, ventilation is considered adequate where provided in accordance with the provisions of this standard.

SI Conversions for Table 3-8.2.2

18 in = 256 mm
4 ft = 1.2 m
5 ft = 1.5 m
15 ft = 5 m
20 ft = 6 m

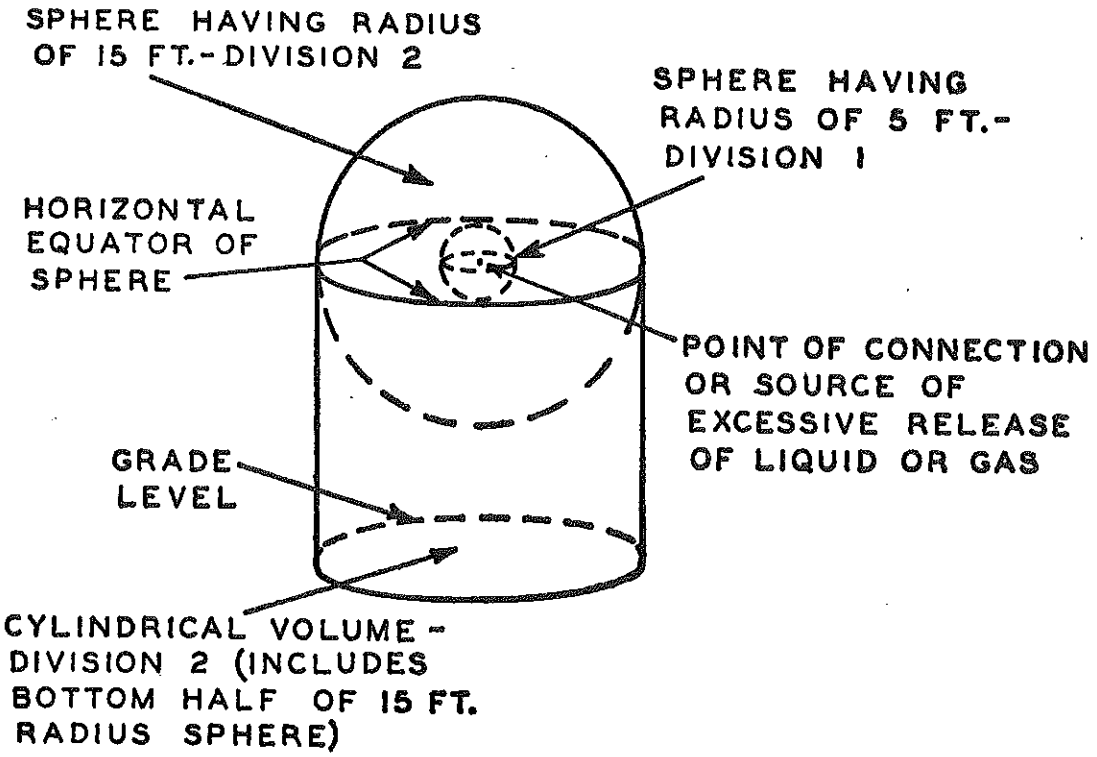

Figure 3-8.2.2
(See Table 3-8.2.2)

3-8.4 Control of Ignition Sources During Transfer.

3-8.4.1 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 3-8, 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 4-3.2.1.

(2) Engines installed in buildings as provided in 3-6.3.

(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 which have been heated have cooled before the transfer is started.

(c) Sources of ignition, such as pilot lights, burners, electrical appliances, and engines, located on the vehicle being refueled shall be turned off during the filling of any LP-Gas container on the vehicle.

3-8.4.2 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 driers 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.

3-9 LP-Gas Systems on Vehicles (Other Than Engine Fuel Systems.)

3-9.1 Application.

3-9.1.1 This section applies to non-engine fuel systems on commercial, industrial, construction and public service vehicles such as trucks, semitrailers, trailers, portable tar kettles, mobile laboratories, clinics and mobile cooking units (such as catering and canteen vehicles). LP-Gas systems on such vehicles may be either vapor-withdrawal or liquid-withdrawal type. Included are provisions for installations served by exchangeable (removable) container systems and by permanently mounted containers.

3-9.1.2 This section does not apply to:

(a) Systems installed on mobile homes.

(b) Systems installed on recreational vehicles [*see 3-1.1.4(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.

3-9.1.3 LP-Gas engine fuel systems on the vehicles covered by Section 3-9 and those cited in 3-9.1.2 are covered by Section 3-6.

3-9.2 Construction, Location, Mounting and Protection of Containers and Systems.

3-9.2.1 Containers shall comply with Section 2-2 and appurtenances used to equip them for service shall comply with Section 2-3. In addition, 3-9.2.1(a) through (g) 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 3-9.2.2) 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 3-9.2.3(c).

(e) LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200 gal (0.8 m^3) 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 m^3) 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.

(g) Containers designed for stationary service only, and not in compliance with 2-3.4, shall not be used.

3-9.2.2 Containers utilized for the purposes covered by this section shall not be installed, transported or stored (even temporarily) inside any vehicle covered by Section 3-9, except as provided in 3-9.2.3(d), Chapter 6 or as provided by applicable DOT regulations. The LP-Gas supply system, including the containers, may 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.

3-9.2.3 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 3-6.2.6(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 ve-

hicle 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 3-2.3.1(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 overturned or similar vehicular accident. In the case of permanently mounted containers, this provision may 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 as may be necessary to ensure safe operation shall be provided for containers and systems mounted on the outside of the vehicle.

(d) Containers mounted on the interior of passenger-carrying vehicles shall be installed in compliance with 3-6.2.7. Pressure relief valve installations for such containers shall comply with 3-6.2.6(i).

3-9.2.4 Containers installed on portable tar kettles alongside the kettle, or on the vehicle frame, 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 3-9.2.3(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 3-9.2.7(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 3-8.4.2(b).

3-9.2.5 Container appurtenances shall be installed in accordance with 3-9.2.5(a) through (f).

(a) Container pressure relief devices shall be located and installed as follows:

(1) Except as provided in 3-9.2.3(d), pressure relief devices on portable containers installed inside cabinets or recesses complying with 3-9.2.2 may discharge within the enclosure.

(2) Relief device discharge outlets on containers installed on the outside of the vehicle shall be located:

a. Outside of enclosed spaces, at least 3 ft (1 m) horizontally away from any opening into the vehicle below the level of such discharge, and as far as practicable from sources of ignition.

b. In such a manner as to minimize the possibility of impingement of escaping gas upon a container, vehicle parts, or on other vehicles in adjacent lines of traffic.

(3) Pressure relief device discharge lines shall be metallic and have a melting point over 1500°F (816°C). Relief valve adaptors installed directly in the relief valve to deflect the flow upward shall be metallic and have a melting point over 700°F (371°C). Discharge lines and adaptors shall be sized, located and secured so as to permit sufficient pressure relief device relieving capacity. Flexible metal hose or tubing used shall be able to withstand the pressure from the relief device vapor discharge when the relief device is in full open position.

(4) On vehicles used outdoors or in industrial locations, means shall be provided (such as loose fitting caps) to minimize the possibility of the entrance of water or dirt into either the relief device or its discharge piping. The protecting means shall remain in place except when the relief device operates. In this event, it shall permit the relief device to operate at sufficient capacity.

(b) The filling, withdrawal and equalizing connections of containers shall be equipped in compliance with 2-3.3.1 through 2-3.3.3 (*see "Used as Fuel on Vehicles," Column 5 of Table 2-3.3.2*).

(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 may be designed, constructed and fitted for filling in either the vertical or horizontal position or, if of the portable universal type [*see 2-3.4.1(c)(2)*], in either position. The container shall be in the appropriate position when filled or, if of the portable universal type, may 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 may be on valves.

(f) Containers from which only vapor is to be withdrawn shall be installed and equipped with suitable connections to minimize the possibility of the accidental withdrawal of liquid.

3-9.2.6 Regulators shall comply with 2-5.1 and 2-5.8 and shall be installed in accordance with 3-2.5. 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 is not required if the regulator is located in a recess or cabinet as provided for in 3-9.2.2.

3-9.2.7 Piping shall comply with Section 2-4 as to material and design and shall be installed in accordance with 3-2.7, except that steel tubing shall have a minimum wall thickness of 0.049 in. Paragraphs 3-9.2.7(a) through (j) shall also apply to piping systems on vehicles covered by Section 3-9.

(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 3-2.7.8(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 jursidiction.

(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 chaffing.

(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 2-4.7.1, shall be installed in isolated sections of liquid piping as provided in 3-2.8.

(i) Piping systems, including hose, shall be tested and proven free of leaks in accordance with 3-2.9.

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

3-9.3 Equipment Installation.

3-9.3.1 Equipment for installation on vehicles shall comply with Section 2-5 as to design and construction, and shall be installed in accordance with 3-2.10, 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 3-9.2.3(c).

3-9.4 Appliance Installation.

3-9.4.1 The term "appliances" as used in this subsection shall include any commercial or industrial gas consuming device except engines.

3-9.4.2 All gas consuming devices (appliances), other than engines, installed on vehicles shall be approved as provided in 2-6.2, shall comply with 2-6.3, 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 2-6.3.5(a) except those covered in 3-4.2.7(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 or certified as components of the appliance.

(d) For installations on vehicles not intended for human occupancy, unvented-type gas-fired heating appliances may be used to protect the cargo. Provision shall be made to provide air for combustion [*see 3-9.4.2(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 so as to be readily accessible whether the vehicle is loaded or empty.

(2) Appliances shall be so constructed or otherwise protected as 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.

3-9.5 General Precautions.

3-9.5.1 Containers on vehicles shall be filled or refilled as provided by 4-2.2.2. See 2-2.1.3 for requalification requirements for continued use or reinstallation.

3-9.5.2 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.

3-10 Fire Protection.

3-10.1 Application.

3-10.1.1 This section includes 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.[1] Planning shall consider the safety of emergency personnel.

3-10.2.3 Except as provided in 3-10.2.4 or 3-10.2.5, fire protection shall be provided for installations having storage containers with an aggregate water capacity of more than 4000 gal (15 m^3) subject to exposure from a single fire. The mode of such protection shall be arrived at through competent fire safety 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 3-2.2.7.*)

(a) 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 which 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.

3-10.2.4 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.

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[1]The National Fire Protection Association, American Petroleum Institute and National LP-Gas Association publish material, including visual aids, useful in such planning.

3-10.2.5 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.

3-10.2.6 Suitable roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

3-10.2.7 Each industrial plant, distributing plant and distributing point shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 20 lb of dry chemical with a B:C rating.

3-10.2.8 LP-Gas fires shall not normally be extinguished until the source of the burning gas has been shut off or can be shut off.

3-10.2.9 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[1], 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[2].

3-10.3.2 If mounding is utilized, the provisions of 3-2.3.7 shall constitute adequate protection.

3-10.3.3 If burial is utilized, the provisions of 3-2.3.8 shall constitute adequate protection.

3-10.3.4 If water spray fixed systems are used, they shall comply with NFPA 15, *Water Spray Fixed Systems for Fire Protection*. Such systems shall be automatically actuated by fire responsive devices and also have a capability for manual actuation.

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[1]For LP-Gas fixed storage facilities of 60,000 gal (227 m³) water capacity or less, a competent fire safety analysis (*see 3-10.2.3 and 3-10.2.5*) could indicate that applied insulating coatings are quite often the most practical solution for special protection.

[2]It is recommended that insulation systems be evaluated on the basis of experience or listings by an approved testing laboratory.

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, *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 this transfer involves connections and disconnections in the transfer system, or the venting of LP-Gas to the atmosphere. Included are provisions covering operational safety, location of transfer operations 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 3-8. 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 competent personnel meeting the provisions of 1-6.1.1. At least one qualified person shall remain at or near 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.

4-2.2.1 Containers shall be filled only by the owner or upon the owner's authorization.

4-2.2.2 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.*)

4-2.2.3 DOT specification cylinders authorized as "single trip," "nonrefillable," or "disposable" containers shall not be refilled with LP-Gas.

4-2.2.4 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 not be 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 Liquid transfer may be accomplished by pressure differential, by gravity or by the use of pumps or compressors complying with Section 2-5.

4-2.3.2 Compressors used for liquid transfer normally shall take suction from the vapor space of the container being filled and dicharge into the vapor space of the container from which the withdrawal is being made.

4-2.3.3 Transfer systems using positive displacement pumps shall comply with 2-5.2.2.

4-2.3.4 Transfer hose equipped with a shutoff valve at the discharge end, so that the hose normally contains liquid (called "wet hose" by the industry), shall be protected against excessive hydrostatic pressure by the use of hydrostatic relief valves. (*See 3-2.8.*)

NOTE: When hose is to be used for liquid transfer, this arrangement is recommended.

4-2.3.5 The provisions of 3-2.7.9 shall apply.

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 ½ in. (12 mm) internal diameter shall not be used for making connections to individual containers being filled indoors.

4-2.3.8 During the time the 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 car is connected as required by DOT Regulations.

(b) A wheel at each end of car shall be blocked on the rails.

4-3 Location of Transfer Operations.

4-3.1 General.

4-3.1.1 Liquid shall be transferred into containers, including containers mounted on vehicles, only outdoors or in structures especially designed for this purpose.

(a) Structures housing transfer operations or converted for such use after December 31, 1972 shall comply with Chapter 7.

(b) The transfer of liquid into containers on the roofs of structures is prohibited.

4-3.2 Containers in Stationary Installations.

4-3.2.1 Containers located outdoors in stationary installations (*see definition*) in accordance with Section 3-2, and equipped with appurtenances for filling at, or adjacent to, the container may be filled at that location, provided that a cargo vehicle is used for the delivery which complies with Chapter 6 as to construction and method of operation.

4-3.2.2 If the point of transfer (*see definition*) is not located at the container, it shall be located in accordance with 4-3.3.

4-3.3 Containers in Nonstationary Installations.

4-3.3.1 This subsection includes provisions for filling of portable containers not a part of a stationary installation (*see definition*), including containers mounted on vehicles (including recreational vehicles) and industrial and agricultural equipment.

4-3.3.2 The point of transfer (*see definition*) or the nearest part of a structure housing transfer operations, whichever is closer, shall be located in accordance with Table 4-3.3.2 with respect to various types of exposures.

(a) If the point of transfer is a component of a system covered by Sections 3-6 or 3-9 or part of a system installed in accordance with standards referenced in 3-1.1.3, Parts 1, 2 and 3 of Table 4-3.3.2 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 4-4.1.1(d), the distances in Table 4-3.3.2 shall be doubled.

(c) If the point of transfer is housed in a structure complying with Chapter 7, the distances in Table 4-3.3.2 may be reduced provided either the exposing wall(s) or the exposed wall(s) complies with 7-3.1.1(a).

Table 4-3.3.2[1]

Distance Between Point of Transfer and Exposures

Part	Exposure	Min. Horizontal Distance, Feet (Meters)
1.	Buildings[2] with fire resistive walls[3]	10 (3)
2.	Buildings[2] with other than fire resistive walls	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 which 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 Distributing Points	10 (3)
	(b) From points of transfer in all other locations	25 (7.6)
7.	Driveways	5 (1.5)
8.	Mainline railroad track centerlines	25 (7.6)
9.	Containers[4] other than those being filled	10 (3)

[1]Table 4-3.3.2 is not applicable to the transfer operations covered in 4-3.2.1.

[2]"Buildings," for the purpose of this Table, include structures such as mobile homes, recreational vehicles, modular homes, tents and box trailers at construction sites.

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

[4]Not applicable to filling connections at the storage container or to dispensing units of 2000 gal (7.6 m^3) water capacity or less when used for filling containers not mounted upon vehicles.

4-3.4 Cargo Vehicles.

4-3.4.1 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. In the case of distributing points, such as LP-Gas service stations, the truck or transport shall not be parked on a public way.

4-4 Venting LP-Gas to the Atmosphere.

4-4.1 General.

4-4.1.1 LP-Gas, in either liquid or vapor form, normally shall not be vented to the atmosphere except under the following conditions:

(a) 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.

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

(c) LP-Gas may be vented for the purposes described in 4-4.1.1(a) and (b) within structures designed for container filling as provided in 4-3.1.1 and Chapter 7.

(d) 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 4-3.3.2 as to location of such transfer operations.*)

4-4.2 Purging.

4-4.2.1 Venting of gas from containers for purging or for other purposes shall be accomplished as follows:

(a) If indoors, containers may be vented only in structures designed and constructed for container filling in accordance with 4-3.1.1 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 back-flow check valve.

(b) When out of doors, 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 stock 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 may be burned off providing such burning is done under controlled conditions remote from combustibles or a hazardous atmosphere.

4-4.3 Emergency Venting.

4-4.3.1 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.

4-5 Quantity of LP-Gas in Containers.

4-5.1 Application.

4-5.1.1 This section includes provisions covering the maximum permissible LP-Gas content of containers and the methods of verifying this quantity.

4-5.2 LP-Gas Capacity of Containers (*see Appendix E*).

4-5.2.1 The maximum LP-Gas content of any container shall be that quantity which equals the maximum permitted filling density given in Table 4-5.2.1.

Table 4-5.2.1

Maximum Permitted Filling Density

	Aboveground Containers		
Specific Gravity at 60°F (15.6°C)	0 to 1200 US Gal (1000 Imp. gal, 4.5 m³) Total Water Cap.	Over 1200 US Gal (1000 Imp. gal, 4.5 m³) Total Water Cap.	Underground Containers all Capacities
.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

4-5.2.2 Filling density is defined as the ratio of the weight of LP-Gas in a container to the weight of water at 60°F (15.6°C) that the container will hold. The maximum permitted filling density shown in Table 4-5.2.1 is in percent of the water weight capacity (WWC) for the specific gravity of the particular LP-Gas, the size of the container and the container location.

4-5.2.3 Determination that the LP-Gas content of a container complies with Table 4-5.2.1 may be either by weight or by volume in accordance with 4-5.3. If by volume, the volume having a weight equal to the maximum permitted filling density shall be calculated by the formula in 4-5.2.3(b). These equivalent volumes are shown in Tables 4-5.2.3(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 4-5.2.3(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 E,* E-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).

4-5.3 Compliance with Maximum Permitted Filling Density Provisions.

4-5.3.1 The maximum permitted filling density for any container, where practical, may be determined by weight.

4-5.3.2 The volumetric method may 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 which 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 specifications 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.

4-5.3.3 When the volumetric method is used, it shall be in accordance with 4-5.3.3(a) through (c).

(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 4-5.2.3(a), (b) and (c).

(c) In the case of containers fabricated after December 31, 1965 with a water capacity of 2,000 gal (7.6 m^3) or less and which are filled at consumer sites, gauging shall comply 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.

4-5.3.4 When containers are to be filled volumetrically by a variable liquid level gauge in accordance with 4-5.3.3(b), provisions shall be made for determining the liquid temperature (*see E-3.1.2*).

Table 4-5.2.3(a)

MAXIMUM PERMITTED LIQUID VOLUME

(Percent of Total Water Capacity)

Aboveground Containers
0 to 1200 Gallons (0 to 4.5 m³)

Liquid Temperature °F (°C)	Specific Gravity												
	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .600
−50 (−45.6)	70	71	72	73	74	75	75	76	77	78	79	79	80
−45 (−42.8)	71	72	73	73	74	75	76	77	77	78	79	80	80
−40 (−40)	71	72	73	74	75	75	76	77	78	79	79	80	81
−35 (−37.2)	71	72	73	74	75	76	77	77	78	79	80	80	81
−30 (−34.4)	72	73	74	75	76	76	77	78	78	79	80	81	81
−25 (−31.5)	72	73	74	75	76	77	77	78	79	80	80	81	82
−20 (−28.9)	73	74	75	76	76	77	78	79	79	80	81	81	82
−15 (−26.1)	73	74	75	76	77	77	78	79	80	80	81	82	83
−10 (−23.3)	74	75	76	76	77	78	79	79	80	81	81	82	83
− 5 (−20.6)	74	75	76	77	78	78	79	80	80	81	82	82	83
0 (−17.8)	75	76	76	77	78	79	79	80	81	81	82	83	84
5 (−15)	75	76	77	78	78	79	80	81	81	82	83	83	84
10 (−12.2)	76	77	77	78	79	80	80	81	82	82	83	84	84
15 (−9.4)	76	77	78	79	80	80	81	81	82	83	83	84	85
20 (−6.7)	77	78	78	79	80	80	81	82	83	84	84	84	85

25 (−3.9)	77	78	79	80	80	81	82	82	83	84	84	85	85
30 (−1.1)	78	79	79	80	81	81	82	83	83	84	85	85	86
35 (1.7)	78	79	80	81	81	82	83	83	84	85	85	86	86
*40 (4.4)	79	80	81	81	82	82	83	84	84	85	86	86	87
45 (7.8)	80	80	81	82	82	83	84	84	85	85	86	87	87
50 (10)	80	81	82	82	83	83	84	85	85	86	86	87	88
55 (12.8)	81	82	82	83	84	84	85	85	86	86	87	87	88
60 (15.6)	82	82	83	84	84	85	85	86	86	87	87	88	88
65 (18.3)	82	83	84	84	85	85	86	86	87	87	88	88	89
70 (21.1)	83	84	84	85	85	86	86	87	87	88	88	89	89
75 (23.9)	84	85	85	85	86	86	87	87	88	88	89	89	90
80 (26.7)	85	85	86	86	87	87	87	88	88	89	89	90	90
85 (29.4)	85	86	87	87	88	88	88	89	89	89	90	90	91
90 (32.2)	86	87	87	88	88	88	89	89	90	90	90	91	91
95 (35)	87	88	88	88	89	89	89	90	90	91	91	91	92
100 (37.8)	88	89	89	89	89	90	90	90	91	91	92	92	92
105 (40.4)	89	89	90	90	90	90	91	91	91	92	92	92	93
110 (43)	90	90	91	91	91	91	92	92	92	92	93	93	93
115 (46)	91	91	92	92	92	92	92	92	93	93	93	94	94
120 (49)	92	92	93	93	93	93	93	93	93	94	94	94	94
125 (51.5)	93	94	94	94	94	94	94	94	94	94	94	95	95
130 (54)	94	95	95	95	95	95	95	95	95	95	95	95	95

*See 4-5.3.3(a).

Table 4-5.2.3(b)

MAXIMUM PERMITTED LIQUID VOLUME

(Percent of Total Water Capacity)

Aboveground Containers Over 1200 Gallons (4.5 m³)

Liquid Temperature °F (°C)	Specific Gravity												
	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .600
−50 (−45.6)	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 4-5.3.3(a).

Table 4-5.2.3(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	99	99	99	99	99	99	99

*See 4-5.3.3(a).

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 distributing points, but not connected for use.

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

5-1.1.2 The provisions of this chapter do not apply to:

(a) 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 so located as to minimize exposure to excessive temperature rise, physical damage or tampering.

5-2.1.2 Containers in storage having individual water capacity greater than 2½ lb (1 kg) [nominal one pound (0.45kg) LP-Gas capacity] 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 which have been in LP-Gas service shall preferably be stored in the open. If stored inside, they shall be considered as full containers for the purposes of determining the maximum quantities of LP-Gas permitted in 5-3.1.1, 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 or plugged.

5-3 Storage Within Buildings.

5-3.1 Storage within Buildings Frequented by the Public.

5-3.1.1 DOT specification cylinders with a maximum water capacity of 2½ lb (1 kg), used with completely self-contained hand torches and similar applications, may be stored or displayed in a building frequented by the public. The quantity of LP-Gas shall not exceed 200 lb (91 kg) except as provided in 5-3.3.

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 a part of the service equipment on highway mobile vehicles are not to be considered in the total storage capacity in 5-3.2.1 provided such vehicles are stored in private garages and carry only one LP-Gas container with an LP-Gas capacity of 100 lb (45 kg) or less per vehicle. Container valves shall be closed.

5-3.3 Storage within Special Buildings or Rooms.

5-3.3.1 The maximum quantity of LP-Gas which may be stored in special buildings or rooms shall be 10,000 lb (4540 kg).

5-3.3.2 Special buildings or rooms for storing LP-Gas containers shall not be located adjoining the line of property occupied by schools, churches, hospitals, athletic fields or other points of public gathering.

5-3.3.3 The construction of all such special buildings, and rooms within, or attached to, other buildings, shall comply with Chapter 7 and the following:

(a) Adequate vents, to the outside only, shall be provided at both top and bottom, 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 3-8.

5-4 Storage Outside of Buildings.

5-4.1 Location of Storage Outside of Buildings.

5-4.1.1 Storage outside of buildings, for containers awaiting use or resale, shall be located in accordance with Table 5-4.1.1 with respect to:

(a) Nearest important building or group of buildings.

(b) Line of adjoining property which 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.

Table 5-4.1.1

Quantity of LP-Gas Stored	Distance to: (a) and (b)	(c) and (d)
500 lb (227 kg) or less	0	0
501 (227+ kg) to 2,500 lb (1134 kg)	0	10 ft (3 m)
2,501 (1134+ kg) to 6,000 lb (2721 kg)	10 ft (3 m)	10 ft (3 m)
6,001 (1721+ kg) to 10,000 lb (4540 kg)	20 ft (6 m)	20 ft (6 m)
Over 10,000 lb (4540 kg)	25 ft (7.6 m)	25 ft (7.6 m)

5-4.2 Protection of Containers.

5-4.2.1 Containers shall be stored within a suitable enclosure or otherwise protected against tampering.

5-4.3 Alternate Location and Protection of Storage.

5-4.3.1 When the provisions of 5-4.1.1 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.

5-5.1 Fire Extinguisher Requirements.

5-5.1.1 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 20 lb dry chemical with a B:C rating. (*Also see NFPA 10.*)

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 Sections 3-6 and 3-9.

(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) Most truck transportation of LP-Gas is subject to regulation by the US 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. Vehicles and procedures under the jurisdiction of DOT shall comply with DOT Regulations.

6-1.1.2 The provisions of this chapter are not applicable to the transportation of LP-Gas on vehicles incident to its use on these vehicles as covered in 3-6.4, 3-6.5, 3-6.6 and Section 3-9.

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 Section 3-6. Fuel systems (including fuel containers) shall be constructed and installed in accordance with Section 3-9. Fuel may be used from the cargo tank of tank trucks, but not from cargo tanks on trailers or semitrailers.

6-1.1.4 No artificial light other than electrical shall be used with the vehicles covered by this chapter. Wiring used shall have adequate mechanical strength and current-carrying capacity with suitable overcurrent protection (fuses or automatic circuit breakers) and shall be properly insulated and protected against physical damage.

6-2 Transportation in Portable Containers.

6-2.1 Application.

6-2.1.1 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 of 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 6-2.2.2 through 6-2.2.9

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.

6-2.2.5 The cargo space of the vehicle shall be isolated from the driver's compartment, the engine and its exhaust system, except as provided in 6-2.2.5(a). Open-bodied vehicles shall be considered as in compliance with this provision. Closed-bodied vehicles having separate cargo, driver's and engine compartments shall be considered as in compliance with this provision.

(a) 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 exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas capacity] transported in open vehicles shall be transported with the relief devices in direct communication with the vapor spaces. 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 of the vehicle shall be transported with the relief device in direct communication with the vapor spaces.

6-2.2.8 Containers having an individual water capacity not exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas capacity] transported in open vehicles may be transported in other than the upright position. 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.

6-2.2.9 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 and/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 6-2.3.2 through 6-2.3.9.

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 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.

6-2.3.6 Containers and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Containers shall be loaded onto a flat vehicle floor or platform, or onto a suitable vehicle frame. In either case, containers shall be securely blocked or held down to minimize movement, relative to each other or to the supporting structure, while in transit.

6-2.3.7 Containers shall be transported with relief devices in communication with the vapor space.

6-2.3.8 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 and/or state law.

6-2.3.9 When portable containers complying with 6-2.3.1 through 6-2.3.8 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.

6-2.4.1 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 20 lb dry chemical with a B:C rating. (*Also see NFPA 10.*)

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 may 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 US Department of Transportation Requirements as specified in the Code of Federal Regulations, CFR 49, and to the Federal Motor Carrier Safety Regulations, Sections 393 and 397, 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, be equipped with appurtenances as provided in Section 2-3 for cargo service, and comply with 6-3.2.1(a):

(a) 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, except that:

(1) If an internal valve meets the provisions of 2-4.5.4 and 3-2.7.9(a)(1), an emergency shutoff valve shall not be required in the cargo container piping.

(2) A back-flow check valve may 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, 6-3.3.1(a) through (e) shall apply:

(a) Pipe shall be wrought iron, steel, brass or copper in accordance with 2-4.2.1(a), (b), (c) or (d).

(b) Tubing shall be steel, brass or copper in accordance with 2-4.3.1(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 may 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 and/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 as to design and construction and shall be installed in accordance with the applicable provisions of 3-2.10. 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 may be mounted on tank trucks, trailers, semitrailers or tractors, and may be driven by the truck or tractor motor power takeoff, by a separate internal combustion engine, or by hand, mechanical, hydraulic or electrical means. 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 3-8.2.

6-3.4.3 The installation of compressors shall comply with the applicable provisions of 3-2.10.1 and 6-3.4.1.

6-3.4.4 The installation of liquid meters shall be in accordance with 3-2.10.5(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. An excess-flow valve may also be used but shall not be the exclusive means of complying with this provision.

6-3.5 Protection of Container Appurtenances, Piping System and Equipment.

6-3.5.1 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 and 6-3.2.2 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.

6-3.6.1 Painting of cargo vehicles shall comply with CFR 49. Placarding and marking shall comply with CFR 49.

6-3.7 Fire Extinguishers.

6-3.7.1 Each tank truck or tractor shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 20 lb dry chemical with a B:C rating. (*Also see NFPA 10*).

6-3.8 Chock Blocks for Liquid Cargo Vehicles.

6-3.8.1 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.

6-3.9.1 The truck engine exhaust system shall comply with Federal Motor Carrier Safety Regulations.

6-3.10 Smoking Prohibition.

6-3.10.1 Truck drivers and their helpers shall not smoke, or allow smoking, around the vehicle on the road, while making liquid

transfers, or making repairs to the truck or trailer in accordance with the Federal Motor Carrier Safety Regulations.

6-4 Trailers, Semitrailers, Movable Fuel Storage Tenders or Farm Carts.

6-4.1 Application.

6-4.1.1 This section applies to all cargo vehicles, other than trucks, which may be parked at locations away from distributing points.

6-4.2 Trailers or Semitrailers Comprising Parts of Section 6-3 Vehicles.

6-4.2.1 When parked, cargo 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 Trailers, Including Movable Storage Tenders or Farm Carts.

6-4.3.1 Trailers, including fuel storage tenders or farm carts, shall comply with 6-4.3.2 through 6-4.3.6. If normally used over public ways they shall comply with applicable state regulations.

6-4.3.2 Cargo containers mounted on such vehicles 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 not be 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 Parked vehicles shall be so positioned that container safety relief valves communicate with the vapor space.

6-4.3.6 Such cargo units shall not be filled on a public way.

6-5 Transportation of Stationary Containers to and from Point of Installation.

6-5.1 Application.

6-5.1.1 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 may be transported partially filled with LP-Gas.

6-5.2 Transportation of Containers.

6-5.2.1 Except as provided in 6-5.2.1(a), containers of 125 gal (0.5 m^3) or more water capacity shall contain no more than 5 percent of their water capacity in liquid form during transportation.

(a) Containers containing more LP-Gas than 5 percent of their water capacity may 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 in good repair on containers filled to no more than five percent of their water capacity may be used for lifting and lowering.

(a) 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 6-5.2.1(a)*].

6-6 Parking and Garaging Vehicles Used to Carry LP-Gas Cargo.

6-6.1 Application.

6-6.1.1 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 out-of-doors shall comply with the following:

(a) Vehicles, except in an emergency and except as provided in 6-6.2.1(b), shall not be left unattended on any street, highway, avenue or alley, provided that this shall not prevent a driver from the necessary absence from the vehicle in connection with his normal duties, nor shall it prevent stops for meals or rest stops during the day or at night.

(b) Vehicles shall not be parked in congested areas. Such vehicles may 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 m^3) 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 4-5.1.

6-6.2.3 Vehicles are 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 and/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 4-5.1.

(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 includes 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, except for those previously constructed under the provisions of 5-3.3. Also, see 1-2.4.1.

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 m^2) for each 50 cu ft (1.4 m^3) 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 utilizing air inlets and outlets arranged to provide air movement across the floor as uniformly as practical and in accordance with 7-2.2.1(a) or (b). The bottom of such openings shall not be more than 6 in. (152 mm) above the floor.

(a) When mechanical ventilation is used, air circulation shall be at least at the rate of one cu ft per minute per sq ft (0.4 $m^3/s/m^2$) 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, outlet and inlet openings shall be provided, each having a total free area of at least one sq in. (645 mm^2) for each sq ft (0.1 m^2) of floor area.

7-2.3 Structure or Building Heating.

7-2.3.1 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 3-8, Ignition Source Control*), or by electrical appliances installed in the building, if they are listed for Class I, Group D, Division 2 locations, in accordance with NFPA 70, *National Electrical Code* (*see Table 3-8.2.2*).

7-3 Attached Structures or Rooms Within Structures.

7-3.1 Construction of Attached Structures.

7-3.1.1 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, as determined by 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 which shall be equipped with 1½ hour (B) fire doors. See NFPA 80, *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 m^2).

(b) The provisions of 7-3.1.1(a) may 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 7-2.3.1.

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 sufficient exposed area to permit explosion venting as provided in 7-3.2.1(a). The building in which the room is located shall not have a basement or unventilated crawl space and the room shall comply with the following:

(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 m^2) for each 50 cu ft (1.4 m^3) 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 as determined by 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 which shall be equipped with 1½-hour (B) fire doors. See NFPA 80, *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 m^2).

(c) The provisions of 7-3.2.1(b) may be waived if the building within which the room is located is occupied by operations or processes having a similar hazard.

(d) Ventilation and heating shall comply with 7-2.2.1 and 7-2.1.1.

Appendix A Properties of LP-Gases

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

A-1 Approximate Properties of LP-Gases.

A-1.1 Source of Property Values.

A-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 commerical 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 A-1.2.1 for computation method used*). Since these are average values, the inter-relationships between them (i.e., lb per gal, specific gravity, etc.) will not cross-check perfectly in all cases.

A-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 commerical 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, iso-butane 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.

A-1.2 Approximate Properties of LP-Gases.

A-1.2.1 The principal properties of Commercial Propane and Commercial Butane are shown in Table A-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.

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

Vapor Pressure in psig at:	Commercial Propane NLPGA Av.	Commercial Butane NLPGA Av.
70°F	132	17
100°F	205	37
105°F	216	41
130°F	300	69
Specific Gravity of Liquid at 60°F	0.509	0.582
Initial Boiling Point at 14.7 psia, Degrees F	-51	15
Weight per Gallon of Liquid at 60°F, lb.	4.24	4.81
Specific Heat of Liquid, Btu/lb. at 60°F	0.588	0.549
Cu. ft of Vapor per Gallon at 60°F	36.39	31.26
Cu. ft of Vapor per Pound at 60°F	8.58	6.51
Specific Gravity of Vapor (Air = 1) at 60°F	1.52	2.01
Ignition Temperature in Air, Degrees°F	920-1120	900-1000
Maximum Flame Temperature in Air, Degrees°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	185	167
(b) Btu per Gallon	785	808
Total Heating Values after Vaporization:		
(a) Btu per Cubic Foot	2,516	3,280
(b) Btu per Pound	21,591	21,221
(c) Btu per Gallon	91,547	102,032

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

Vapor Pressure in kPa gage at:	Commercial Propane	Commercial Butane
20°C	930	103
40°C	1 550	285
45°C	1 720	345
55°C	2 070	462
Specific Gravity	0.509	0.582
Initial Boiling Point at atm, pressure, °C	-46	-9
Weight per cubic meter of liquid at 15.56°C, kg	509	582
Specific Heat of Liquid, kilojoule per kilogram, at 15.56°C	1.366	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	0.534	0.410
Specific Gravity of Vapor (Air = 1) at 15.56°C	1.52	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	9.60
Latent Heat of Vaporization at Boiling Point:		
(a) Kilojoule per kilogram	430	388
(b) Kilojoule per litre	219	226
Total Heating Value after Vaporization:		
(a) Kilojoule per cubic metre	93 470	121 280
(b) Kilojoule per kilogram	50 020	49 140
(c) Kilojoule per litre	25 430	28 100

Appendix B 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.

B-1 Scope.

B-1.1 Application.

B-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 B-2.1.1*). The water capacity of such cylinders may not be more than 1,000 lb (454 kg).

B-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 C.

B-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.

B-2 LP-Gas Cylinder Specifications.

B-2.1 Publishing of DOT Cylinder Specifications.

B-2.1.1 DOT Cylinder specifications are published under Title 49, *Code of Federal Regulations*, Parts 171-190, available from US 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.

B-2.2 DOT Specification Nomenclature.

B-2.2.1 The specificaion 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 B-2.2.3.*)

B-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.

B-2.2.3 The term "service pressure" is analagous 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 5/4 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 (5/4 times which must not exceed 300 psig) is 300 divided by 5/4, or 240 psig. Thus commercial propane requires at least 240 psig service pressure cylinder.

B-2.3 Dot Cylinder Specifications Used for LP-Gas.

B-2.3.1 A number of different specifications were approved by ICC, and since 1967 by DOT, 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.

B-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.

B-2.3.3 The DOT cylinder specifications most widely used for the LP-Gases are shown in Table B-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 B-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.

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

B-3.1 Application.

B-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.

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

B-3.2.1 DOT cylinders may not be refilled, continued in service or transported unless they are properly qualified or requalified for LP-Gas service in accordance with DOT regulations.

B-3.2.2 A careful examination must be made 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 which might render it unfit for service. The following disposition is to be made of rejected cylinders:

(a) Containers subjected to fire must be requalified, reconditioned or repaired in accordance with B-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 must be retested in accordance with B-3.2.4(a) or (b) and, if necessary, repaired in accordance with B-3.3.1.

B-3-2.3 All containers, including those apparently undamaged, must 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.

B-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 may 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 which pass the retest, and the visual examination required with it (*see B-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 which 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 B-3.3.1.

(b) The simple hydrostatic test may be used to requalify containers for 7 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 B-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 which pass the test, and the visual examination required with it (*see B-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 repaied in accordance with B-3.3.1.

(c) The recorded visual examination may be used to requalify containers for 5 years before the next qualification is due provided the container has been used exclusively for LP-Gas commerically free from corroding components. Inspection is to be made by a competent person, using as a guide Compressed Gas Association "Standards for the Visual Inspection of 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 which 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 which leak, show serious denting or gouging, or excessive corrosion must either be scrapped or repaired in accordance with B-220.

B-3.3 Repair of DOT Cylinder Specification Containers.

B-3.3.1 Repair of DOT cylinders must 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 C 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.

C-1 General.

C-1.1 Application.

C-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.

C-1.1.2 DOT (ICC) specification portable tank containers and cargo tanks are basically 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 m^3) or more water capacity] cargo containers in which the container serves as a stress member in lieu of a frame.

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

C-1.2.1 ASME type containers of approximately 12,000 gal (45.4 m^3) 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 ulitmately resulted in the development of cargo containers for tank trucks and the wide use of ASME containers ranging in size from less than 25 gal (0.1 m^3) to 120,000 gal (454 m^3) water capacity.

C-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.

C-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.

C-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.

C-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).*]

C-2 Design of Containers for LP-Gas.

C-2.1 ASME Container Design.

C-2.1.1 When ASME containers were first used to store LP-Gas, the properties of the CP grades of the principal constituents were available, but the average properties for the commercial grades of propane and butane were not. Also there was no experience as to what temperatures and pressures to expect for product stored in areas with high atmospheric temperatures. A 200 psi (1.4 MPa) design pressure was deemed appropriate for propane (the CP grade of which has a vapor pressure of 176 psi (1.2 MPa) at 100°F (37.8°C) and 80 psi (0.6 MPa) for butane (CP grade has vapor pressure of 37 psi (0.6 MPa) at 100°F (37.8°C). These containers were built with a 5:1 safety factor (*see C-1.2.3*).

C-2.1.2 Pressure vessel codes, following boiler pressure relief valve practice, require that the pressure relief valve start-to-leak setting be the design pressure of the container. In specifying pressure relief valve capacity, however, they stipulate that this relieving capacity be adequate to prevent the internal pressure from rising above 120 percent of the design pressure under fire exposure conditions.

C-2.1.3 Containers built in accordance with C-2.1.1 were entirely adequate for the commercial grades of the LP-Gases (the vapor pressure of propane at 100°F (37.8°C) is 205 psi (1.43 MPa); the

vapor pressure of butane at 100°F (37.8°C) is 37 psi (0.26 MPa)). However, as they were equipped with pressure relief valves set to start-to-leak at the design pressure of the container, these relief valves occasionally opened on an unusually warm day. Since any unnecessary release of a flammable gas is potentially dangerous, and giving weight to recommendations of fire prevention and insurance groups as well as to the favorable experience with API-ASME containers (*see C-2.2.1*), relief valve settings above the design pressure [up to 250 psi (1.7 MPa) for propane and 100 psi (0.7 MPa) for butane] were widely used.

C-2.1.4 In determining safe filling densities for compressed liquefied gases, DOT (ICC) uses the criterion that the container shall not become liquid full at the highest temperature the liquid may be expected to reach due to the normal atmospheric conditions to which the container may be exposed. For containers of more than 1,200 gal (4.5 m^3) water capacity, the liquid temperature selected is 115°F (46°C). The vapor pressure of the gas to be contained at 115°F (46°C) is specified by DOT as the minimum design pressure for the container. The vapor pressure of CP propane at 115°F (46°C) is 211 psig (1.4 MPa gauge), and of commercial propane, 243 psig (1.5 MPa gauge). The vapor pressure of both normal butane and commercial butane at 115°F (46°C) is 51 psig (0.4 MPa gauge).

C-2.1.5 The ASME Pressure Vessel Code editions generally applicable to LP-Gas containers, and the design pressures, safety factors and exceptions to these editions for LP-Gas use, are shown in Table C-2.1.5. These reflect the use of the information in C-2.1.1 through C-2.1.4.

Table C-2.1.5

Year ASME Code Edition Published	Design Pressure, psi (Pascals) Butane	Propane	Safety Factor
1931 through 46[2]	100[1] (0.7)	200 (1.4)	5:1
1949 Par. U-68 & U-69[2]	100 (0.7)	200 (1.4)	5:1
1949 Par. U-200 & U-201[2]	125 (0.9)	250 (1.7)	4:1
1952 through 80	125 (0.9)	250[3] (1.7)	4:1

[1] Until December 31, 1947, containers designed for 80 psi (0.6 MPa) under prior (5:1 safety factor) codes were authorized for butane. Since that time, either 100 psi (0.7 MPa) (under prior codes) or 125 psi (0.9 MPa) (under present codes) is required.

[2] Containers constructed in accordance with 1949 and prior editions of the ASME Code were not required to be in compliance with paragraphs U-2 to U-10 inclusive, or with paragraph U-19. Construction in accordance with paragraph U-70 of these editions was not authorized.

[3] Higher design pressure [312.5 psi (2.2 MPa)] is required for small ASME containers used for vehicular installations (such as forklift trucks used in buildings or those installed in enclosed spaces) because they may be exposed to higher temperatures and consequently develop higher internal pressure.

C-2.2 API-ASME Container Design.

C-2.2.1 The API-ASME Code was first published in 1931 (*see C-2.1.4*). Based on petroleum industry experience using certain material quality and inspection controls not at that time incorporated in the ASME Code, the 4:1 safety factor was first used. Many LP-Gas containers were built under this code with design pressures of 125 psi (0.9 MPa) [100 psi (0.7 MPa) until December 31, 1947] for butane and 250 psi (1.7 MPa) for propane. Containers constructed in accordance with the API-ASME Code were not required to comply with Section 1, or the appendix to Section 1. Paragraphs W-601 through W-606 of the 1943 and earlier editions were not applicable to LP-Gas containers.

C-2.2.2 The ASME Code, by changing from the 5:1 to the 4:1 safety factor through consideration of the factors described in C-2.1.1 through C-2.1.4, became nearly identical in effect to the API-ASME Code by the 1950's. Thus, the API-ASME Code was phased out and construction was not authorized after July 1, 1961.

C-2.3 Design Criteria for LP-Gas Containers.

C-2.3.1 To prevent confusion in earlier editions of NFPA 58, the nomenclature "container type" was used to designate the design pressure of the container to be used for various types of LP-Gases. With the adoption of the 4:1 safety factor in the ASME Code and the phasing out of the API-ASME Code, the need for "container type" ceased to exist. Table C-2.3.1 makes it possible to compare older containers which may have carried this designation with the new containers complying with 2-2.2.2 and Table 2-2.2.2 in this standard.

Table C-2.3.1 Vapor Pressure, Design Pressures and Container Type

As Shown in Table 2-2.2.2		Design Press. Earlier Codes		
Maximum Vapor Press. at 100°F (37.8°C)	Design Press. Present ASME Code[1]	API-ASME	ASME[2]	Container Type
80 (.6)	100 (.7)	100 (.7)	80 (.6)	80 (.6)
100 (.7)	125 (.9)	125 (.9)	100 (.7)	100 (.7)
125 (.9)	156 (1.1)	156 (1.1)	125 (.9)	125 (.9)
150 (1.0)	187 (1.3)	187 (1.3)	150 (1.0)	150 (1.0)
175 (1.2)	219 (1.5)	219 (1.5)	175 (1.2)	175 (1.2)
215 (1.5)	250 (1.7)	250 (1.7)	200 (1.4)	200 (1.4)
215 (1.5)	312.5 (2.2)	312.5 (2.2)	—	250 (1.7)

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

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

C-2.4 DOT (ICC) Specifications Utilizing ASME or API-ASME Containers.

C-2.4.1 DOT (ICC) Specifications for portable tank containers and cargo tanks require ASME or API-ASME construction for the container proper (*see C-1.1.2*). Several such specifications were written by the ICC prior to 1967 and DOT has continued this practice.

C-2.4.2 ICC Specifications written prior to 1946, and to some extent through 1952, used ASME containers with a 200 psig (1.4 MPa gauge) design pressure for propane and 80 psig (.6 MPa gauge) for butane [100 psig (.7 MPa guage) after 1947] with a 5:1 the safety factor. During this period and until 1961, ICC Specifications also permitted API-ASME containers with a 250 psig (1.7 MPa gauge) design pressure for propane and 100 psig (.7 MPa gauge) for butane [125 psig (.9 MPa gauge) after 1947].

C-2.4.3 To prevent any unnecessary release of flammable vapor during transportation (*see C-2.1.3*), the use of safety relief valve settings 25 percent above the design pressure was common for ASME 5:1 safety factor containers. To eliminate confusion, and in line with the good experience with API-ASME containers, the ICC permitted the rerating of these particular ASME containers used under its specifications to 125 percent of the originally marked design pressure.

C-2.4.4 DOT (ICC) Specifications applicable to portable tank containers and cargo tanks currently in use are listed in Table C-2.4.4. New construction is not permitted under the older specifications. However, these older containers may continue to be used provided they have been maintained in accordance with DOT (ICC) Regulations.

Table C-2.4.4

Spec. Number	ASME Construction			API-ASME Construction		
	Design Pressure, psig		Safety Factor	Design Pressure, psig		Safety Factor
	Propane	Butane		Propane	Butane	
ICC-50[1]	200[3]	100[3]	5:1	250	125	4:1
ICC-51[1]	250	125	4:1	250	125	4:1
MC-320[2, 4]	200[3]	100[3]	5:1	250	125	4:1
MC-330[2]	250	125	4:1	250	125	4:1
MC-331[2]	250	125	4:1	250	125	4:1

[1]Portable Tank Container.
[2]Cargo Tank
[3]Permitted to be rerated to 125 percent of original ASME Design Pressure.
[4]Require DOT Exemption.

For SI Units
100 psig = .7 MPa gauge; 125 psig = .9 MPa gauge;
200 psig = 1.4 MPa gauge; 250 psig = 1.7 MPa gauge

C-3 Underground ASME or API-ASME Containers.

C-3.1 Use of Containers Underground.

C-3.1.1 ASME or API-ASME containers are used for underground or partially underground installation in accordance with 3-2.3.8 or 3-2.3.9. The temperature of the soil is normally low so that the average liquid temperature and vapor pressure of product stored in underground containers will be lower than in aboveground containers. This lower operating pressure provides a substantial corrosion allowance for underground containers.

C-3.1.2 Containers listed to be used interchangeably for either installation aboveground or underground must comply as to pressure relief valve rated relieving capacity and filling density with aboveground provisions when installed aboveground [*see 2-3.2.4(a)*]. When installed underground the pressure relief valve rated relieving capacity and filling density may be in accordance with underground provisions (*see D-2.3.1*), provided all other underground installation provisions are met. Partially underground containers are considered as aboveground insofar as loading density and pressure relief valve rated relieving capacity are concerned.

Appendix D Pressure Relief Devices

(This Appendix contains mandatory provisions.)

D-1 Pressure Relief Devices for DOT (ICC) Cylinders.

D-1.1 Source of Provisions for Relief Devices.

D-1.1.1 The requirements for relief devices on DOT cylinders are established by the Bureau of Explosives with DOT approval. Complete technical information as to these requirements will be found in the Compressed Gas Association (CGA) Pamphlet S-1.1, Pressure Relief Device Standards, Part 1 - Cylinders for Compressed Gases.

D-1.2 Essential Requirements of LP-Gas Cylinder Relief Devices.

D-1.2.1 CGA Pamphlet S-1.1 provides that LP-Gas cylinders shall be equipped with fusible plugs, spring-loaded pressure relief valves, or a combination of the two. Fusible plugs are not permitted on cylinders used in certain vehicular installations [*see 3-6.2.3(a)(4)*]. The provisions of D-1.2.2 through D-1.2.4 outline the generally accepted industry practice in the use of fusible plugs and pressure relief devices on LP-Gas cylinders.

D-1.2.2 If fusible plugs constitute the only relief devices the plugs used shall comply with the flow capacity requirements of CGA S-1.1 with a nominal melting or yield point of 165°F (74°C) [not less than 157°F (69.5°C) nor more than 170°F (77°C)]. For cylinders over 30 in. (774 mm) long (exclusive of neck), a plug is required in each end of the cylinder.

D-1.2.3 If a spring-loaded pressure relief valve(s) constitutes the only relief device, the valves used shall comply with the flow capacity requirements of CGA S-1.1, with the set pressure not less than 75 percent nor more than 100 percent of the minimum required test pressure of the cylinder. For example, the test pressure for a 240 psig (1.6 MPa gauge) service pressure is 480 psig (3.2 MPa gauge); 75 percent of this is 360 psig (2.5 MPa gauge). In practice, such valves are set at 375 psig (2.6 MPa gauge).

D-1.2.4 If fusible plugs and spring-loaded pressure relief valves are used in combination, this combined use shall be in accordance with CGA S-1.1, or in substance as follows:

(a) If 100 percent of the relief device capacity is provided by the pressure relief valve, the supplementary fuse plug may be of any convenient size provided the total plug area does not exceed 0.25 sq in. (1.6 cm^2), and may have a melting point of more than 170°F (77°C) [usually a nominal yield point of 212°F (100°C), with the upper limit not to exceed 220°F (104°C)]. Combination devices are required at one end of a cylinder only, or may be separated and installed at opposite ends.

(b) If at least 70 percent of the relief device capacity is provided by the pressure relief valve, the balance of the capacity requirement shall be supplied by a 165°F (74°C) nominal yield point fusible plug in accordance with D-1.2.2. Combined devices are required at one end of a cylinder only or may be separated and installed at opposite ends.

D-2 Pressure Relief Devices for ASME Containers.

D-2.1 Source of Provisions for Relief Devices.

D-2.1.1 Capacity requirements for relief devices are in accordance with the applicable provisions of Compressed Gas Association (CGA) Pamphlet S-1.2, Pressure Relief Device Standards, Part 2 - Cargo and Portable Tanks for Compressed Gases; or with CGA Pamphlet S-1.3, Safety Relief Device Standards, Part 3 - Compressed Gas Storage Containers.

D-2.2 Spring-Loaded Pressure Relief Valves for Aboveground and Cargo Containers.

D-2.2.1 The minimum rate of discharge for spring-loaded pressure relief valves is based on the outside surface of the containers on which the valves are installed. Paragraph 2-2.6.5(g) provides that new containers shall be marked with the surface area in sq ft. The surface area of containers not so marked (or not legibly marked) may be computed by use of the applicable formula:

(a) Cylindrical container with hemispherical heads:

Surface area = overall length × outside diameter × 3.1416.

(b) Cylindrical container with other than hemispherical heads:

Surface area = (overall length + 0.3 outside diameter) × outside diameter × 3.1416.

NOTE: This formula is not precise, but will give results with limits of practical accuracy in sizing relief valves.

(c) Spherical containers:

Surface area = outside diameter squared × 3.1416.

D-2.2.2 The minimum required relieving capacity in cu ft per minute of air at 120 percent of the maximum permitted start-to-leak pressure (or Flow Rate CFM Air), under standard conditions of 60°F (15.6°C) and atmospheric pressure [14.7 psia (0.1 MPa absolute)], shall be as shown in Table D-2.2.2 for the surface area in sq ft of the container on which the pressure relief valve is to be installed. The flow rate may be interpolated for intermediate values of surface area. For containers with a total outside surface area exceeding 2,000 sq ft, the required flow rate shall be calculated, using the formula: Flow Rate CFM Air = $53.632 \times A^{0.82}$ where A = total outside surface area of container in sq ft.

D-2.3 Spring-Loaded Pressure Relief Valves for Underground or Mounded Containers.

D-2-3.1 In the case of containers installed underground or mounded, the pressure relief valve relieving capacities may be as small as 30 percent of those specified in Table D-2.2.2 provided the container is empty of liquid when installed, that no liquid is placed in it until it is completely covered with earth, and that it is not uncovered for removal until all liquid has been removed.

D-2.3.2 Containers partially underground must have pressure relief valve relieving capacitites in accordance with 2-3.2.4.

D-2.4 Provisions for Fusible Plugs.

D-2.4.1 Fuse plugs, supplementing spring-loaded pressure relief valves, and complying with 2-3.2.4(e), are permitted only with aboveground stationary containers of 1,200 gal (4.5 m^3) or less water capacity. They shall not be used on larger containers nor on portable or cargo containers of ASME construction. The total fusible plug discharge area is limited to 0.25 sq in. (1.6 cm^2) per container.

D-2.5 Pressure Relief Valve Testing.

D-2.5.1 Frequent testing of pressure relief valves on LP-Gas containers is not considered necessary for the following reasons:

(a) The LP-Gases are so-called "sweet gases" having no corrosive or other deleterious effect on the metal of the containers or relief valves.

(b) The relief valves are constructed of corrosion-resistant materials, and are installed so as to be protected against the weather. The variations of temperature and pressure due to atmospheric conditions are not sufficient to cause any permanent set in the valve springs.

(c) The required odorization of the LP-Gases makes escape almost instantly evident.

Table D-2.2.2

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

(d) Experience over the years with the storage of LP-Gases has shown a good safety record on the functioning of pressure relief valves.

D-2.5.2 Since no mechanical device can be expected to remain in operative condition indefinitely, it is suggested that the pressure relief valves on containers of more than 2,000 gal (7.6 m^3) water capacity be tested at approximately 10-year intervals. Some types of valves may be tested by the use of an external lifting device having an indicator to show the pressure equivalent at which the valve may be expected to open. Others must be removed from the container for testing, requiring that the container first be emptied.

Appendix E Liquid Volume Tables, Computations and Graphs

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

E-1 Scope.

E-1.1 Application.

E-1.1.1 This appendix explains the basis for Table 4-5.2.1, includes the LP-Gas liquid volume temperature correction table, Table E-3.1.3, and describes its use. It also explains the methods of making liquid volume computations to determine the maximum permissible LP-Gas content of containers in accordance with Tables 4-5.2.3(a), (b) and (c).

E-2 Basis for Determination of LP-Gas Container Capacity.

E-2.1 The basis for determination of the maximum permitted filling densities shown in Table 4-5.2.1 is the maximum safe quantity which will assure that the container will not become liquid full when the liquid is at the highest anticipated temperature.

(a) For portable containers built to DOT specifications and other aboveground containers with water capacities of 1,200 gal or less, this temperature is assumed to be 130°F.

(b) For other aboveground uninsulated containers with water capacities in excess of 1,200 gal, including those built to DOT portable or cargo tank specifications, this temperature is assumed to be 115°F.

(c) For all containers installed underground, this temperature is assumed to be 105°F.

E-3 Liquid Volume Correction Table.

E-3.1 Correction of Observed Volume to Standard Temperature Condition (60°F and equilibrium pressure).

E-3.1.1 The volume of a given quantity of LP-Gas liquid in a container is directly related to its temperature, expanding as temperature increases and contracting as temperature decreases. Standard conditions, often used for weights and measures purposes and, in some cases, to comply with safety regulations, specify correction of the observed volume to what it would be at 60°F.

E-3.1.2 To correct the observed volume to 60°F, the specific gravity of LP-Gas at 60°F in relation to water at 60°F (usually referred to as "60°F/60°F"), and its average temperature must be known. The specific gravity normally appears on the shipping papers. The average liquid temperature may be obtained as follows:

(a) Insert a thermometer in a thermometer well in the container into which the liquid has been transferred and read the temperature after the completion of the transfer [*see E-3.1.2(c) as to proper use of a thermometer*].

(b) If the container is not equipped with a well, but is essentially empty of liquid prior to loading, the temperature of the liquid in the container from which liquid is being withdrawn may be used. Otherwise, a thermometer may be inserted in a thermometer well or other temperature sensing device installed in the loading line at a point close to the container being loaded, reading temperatures at intervals during transfer and averaging. [*See E-3.1.2(c)*].

(c) A suitable liquid should be used in thermometer wells to obtain an efficient heat transfer from the LP-Gas liquid in the container to the thermometer bulb. The liquid used should be noncorrosive and should not freeze at the temperatures to which it will be subjected. Water should not be used.

E-3.1.3 The volume observed or measured is corrected to 60°F by use of Table E-3.1.3. The column headings, across the top of the tabulation, list the range of specific gravities for the LP-Gases complying with 1-2.1.1. Specific gravities are shown from 0.500 to 0.590 by 0.010 increments, except that special columns are inserted for chemically pure propane, iso-butane and normal butane. To obtain a correction factor, follow down the column for the specific gravity of the particular LP-Gas to the factor corresponding with the liquid temperature. Interpolation between the specific gravities and temperatures shown may be used if necessary.

E-3.2 Use of Liquid Volume Correction Factors, Table E-3.1.3.

E-3.2.1 To correct the observed volume in gal for any LP-Gas (the specific gravity and temperature of which is known) to gal at 60°F, Table E-3.1.3 is used as follows:

(a) Obtain the correction factor for the specific gravity and temperature as described in E-3.1.3.

(b) *Multiply* the gal observed by this correction factor to obtain the gal at 60°F.

Table E-3.1.3

Liquid Volume Correction Factors

Observed Temperature Degrees Fahrenheit	SPECIFIC GRAVITIES AT 60°F./60°F.												
	0.500	Propane 0.5079	0.510	0.520	0.530	0.540	0.550	0.560	iso-Butane 0.5631	0.570	0.580	n-Butane 0.5844	0.590
	VOLUME CORRECTION FACTORS												
–50	1.160	1.155	1.153	1.146	1.140	1.133	1.127	1.122	1.120	1.116	1.111	1.108	1.106
–45	1.153	1.148	1.146	1.140	1.134	1.128	1.122	1.117	1.115	1.111	1.106	1.103	1.101
–40	1.147	1.142	1.140	1.134	1.128	1.122	1.117	1.111	1.110	1.106	1.101	1.099	1.097
–35	1.140	1.135	1.134	1.128	1.122	1.116	1.112	1.106	1.105	1.101	1.096	1.094	1.092
–30	1.134	1.129	1.128	1.122	1.116	1.111	1.106	1.101	1.100	1.096	1.092	1.090	1.088
–25	1.127	1.122	1.121	1.115	1.110	1.105	1.100	1.095	1.094	1.091	1.087	1.085	1.083
–20	1.120	1.116	1.114	1.109	1.104	1.099	1.095	1.090	1.089	1.086	1.082	1.080	1.079
–15	1.112	1.109	1.107	1.102	1.097	1.093	1.089	1.084	1.083	1.080	1.077	1.075	1.074
–10	1.105	1.102	1.100	1.095	1.091	1.087	1.083	1.079	1.078	1.075	1.072	1.071	1.069
– 5	1.098	1.094	1.094	1.089	1.085	1.081	1.077	1.074	1.073	1.070	1.067	1.066	1.065
0	1.092	1.088	1.088	1.084	1.080	1.076	1.073	1.069	1.068	1.066	1.063	1.062	1.061
2	1.089	1.086	1.085	1.081	1.077	1.074	1.070	1.067	1.066	1.064	1.061	1.060	1.059
4	1.086	1.083	1.082	1.079	1.075	1.071	1.068	1.065	1.064	1.062	1.059	1.058	1.057
6	1.084	1.080	1.080	1.076	1.072	1.069	1.065	1.062	1.061	1.059	1.057	1.055	1.054
8	1.081	1.078	1.077	1.074	1.070	1.066	1.063	1.060	1.059	1.057	1.055	1.053	1.052
10	1.078	1.075	1.074	1.071	1.067	1.064	1.061	1.058	1.057	1.055	1.053	1.051	1.050
12	1.075	1.072	1.071	1.068	1.064	1.061	1.059	1.056	1.055	1.053	1.051	1.049	1.048
14	1.072	1.070	1.069	1.066	1.062	1.059	1.056	1.053	1.053	1.051	1.049	1.047	1.046
16	1.070	1.067	1.066	1.063	1.060	1.056	1.054	1.051	1.050	1.048	1.046	1.045	1.044
18	1.067	1.065	1.064	1.061	1.057	1.054	1.051	1.049	1.048	1.046	1.044	1.043	1.042
20	1.064	1.062	1.061	1.058	1.054	1.051	1.049	1.046	1.046	1.044	1.042	1.041	1.040
22	1.061	1.059	1.058	1.055	1.052	1.049	1.046	1.044	1.044	1.042	1.040	1.039	1.038
24	1.058	1.056	1.055	1.052	1.049	1.046	1.044	1.042	1.042	1.040	1.038	1.037	1.036
26	1.055	1.053	1.052	1.049	1.047	1.044	1.042	1.039	1.039	1.037	1.036	1.036	1.034
28	1.052	1.050	1.049	1.047	1.044	1.041	1.039	1.037	1.037	1.035	1.034	1.034	1.032
30	1.049	1.047	1.046	1.044	1.041	1.039	1.037	1.035	1.035	1.033	1.032	1.032	1.030
32	1.046	1.044	1.043	1.041	1.038	1.036	1.035	1.033	1.033	1.031	1.030	1.030	1.028
34	1.043	1.041	1.040	1.038	1.036	1.034	1.032	1.031	1.030	1.029	1.028	1.028	1.026
36	1.039	1.038	1.037	1.035	1.033	1.031	1.030	1.028	1.028	1.027	1.025	1.025	1.024
38	1.036	1.035	1.034	1.032	1.031	1.029	1.027	1.026	1.025	1.025	1.023	1.023	1.022
40	1.033	1.032	1.031	1.029	1.028	1.026	1.025	1.024	1.023	1.023	1.021	1.021	1.020
42	1.030	1.029	1.028	1.027	1.025	1.024	1.023	1.022	1.021	1.021	1.019	1.019	1.018
44	1.027	1.026	1.025	1.023	1.022	1.021	1.020	1.019	1.019	1.018	1.017	1.017	1.016
46	1.023	1.022	1.022	1.021	1.020	1.018	1.018	1.017	1.016	1.016	1.015	1.015	1.014
48	1.020	1.019	1.019	1.018	1.017	1.016	1.015	1.014	1.014	1.013	1.013	1.013	1.012
50	1.017	1.016	1.016	1.015	1.014	1.013	1.013	1.012	1.012	1.011	1.011	1.011	1.010
52	1.014	1.013	1.012	1.012	1.011	1.010	1.010	1.009	1.009	1.009	1.009	1.009	1.008
54	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.007	1.007	1.006	1.006	1.006
56	1.007	1.007	1.006	1.006	1.005	1.005	1.005	1.005	1.005	1.005	1.004	1.004	1.004
58	1.003	1.003	1.003	1.003	1.003	1.003	1.002	1.002	1.002	1.002	1.002	1.002	1.002
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
62	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.998	0.998	0.998	0.998
64	0.993	0.993	0.994	0.994	0.994	0.994	0.995	0.995	0.995	0.995	0.996	0.996	0.996
66	0.990	0.990	0.990	0.990	0.991	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.993
68	0.986	0.986	0.987	0.987	0.988	0.989	0.990	0.990	0.990	0.990	0.991	0.991	0.991
70	0.983	0.983	0.984	0.984	0.985	0.986	0.987	0.988	0.988	0.988	0.989	0.989	0.989
72	0.979	0.980	0.981	0.981	0.982	0.983	0.984	0.985	0.986	0.986	0.987	0.987	0.987
74	0.976	0.976	0.977	0.978	0.980	0.980	0.982	0.983	0.983	0.984	0.985	0.985	0.985
76	0.972	0.973	0.974	0.975	0.977	0.978	0.979	0.980	0.981	0.981	0.982	0.982	0.983
78	0.969	0.970	0.970	0.972	0.974	0.975	0.977	0.978	0.978	0.979	0.980	0.980	0.981
80	0.965	0.967	0.967	0.969	0.971	0.972	0.974	0.975	0.976	0.977	0.978	0.978	0.979
82	0.961	0.963	0.963	0.966	0.968	0.969	0.971	0.972	0.973	0.974	0.976	0.976	0.977
84	0.957	0.959	0.960	0.962	0.965	0.966	0.968	0.970	0.971	0.972	0.974	0.974	0.975
86	0.954	0.956	0.956	0.959	0.961	0.964	0.966	0.967	0.968	0.969	0.971	0.971	0.972
88	0.950	0.952	0.953	0.955	0.958	0.961	0.963	0.965	0.966	0.967	0.969	0.969	0.970
90	0.946	0.949	0.949	0.952	0.955	0.958	0.960	0.962	0.963	0.964	0.967	0.967	0.968
92	0.942	0.945	0.946	0.949	0.952	0.955	0.957	0.959	0.960	0.962	0.964	0.965	0.966
94	0.938	0.941	0.942	0.946	0.949	0.952	0.954	0.957	0.958	0.959	0.962	0.962	0.964
96	0.935	0.938	0.939	0.942	0.946	0.949	0.952	0.954	0.955	0.957	0.959	0.960	0.961
98	0.931	0.934	0.935	0.939	0.943	0.946	0.949	0.952	0.953	0.954	0.957	0.957	0.959
100	0.927	0.930	0.932	0.936	0.940	0.943	0.946	0.949	0.950	0.952	0.954	0.955	0.957
105	0.917	0.920	0.923	0.927	0.931	0.935	0.939	0.943	0.943	0.946	0.949	0.949	0.951
110	0.907	0.911	0.913	0.918	0.923	0.927	0.932	0.936	0.937	0.939	0.943	0.944	0.946
115	0.897	0.902	0.904	0.909	0.915	0.920	0.925	0.930	0.930	0.933	0.937	0.938	0.940
120	0.887	0.892	0.894	0.900	0.907	0.912	0.918	0.923	0.924	0.927	0.931	0.932	0.934
125	0.876	0.881	0.884	0.890	0.898	0.903	0.909	0.916	0.916	0.920	0.925	0.927	0.928
130	0.865	0.871	0.873	0.880	0.888	0.895	0.901	0.908	0.909	0.913	0.918	0.921	0.923
135	0.854	0.861	0.863	0.871	0.879	0.887	0.894	0.901	0.902	0.907	0.912	0.914	0.916
140	0.842	0.850	0.852	0.861	0.870	0.879	0.886	0.893	0.895	0.900	0.905	0.907	0.910

EXAMPLE: A container has in it 4,055 gal of LP-Gas with a specific gravity of 0.560 at a liquid temperature of 75°F. The correction factors in the 0.560 column are 0.980 at 76°F and 0.983 at 74°F, or, interpolating, 0.9815 for 75°F. The volume of liquid at 60°F is 4,055 × 0.9815, or 3980 gal.

E-3.2.2 To determine the volume in gal of a particular LP-Gas at temperature "t" to correspond with a given number of gal at 60°F, Table E-3.1.3 is used as follows:

(a) Obtain the correction factor for the LP-Gas, using the column for its specific gravity and reading the factor for temperature "t."

(b) *Divide* the number of gal at 60°F by this correction factor to obtain the volume at temperature "t."

EXAMPLE: It is desired to pump 800 gal at 60°F into a container. The LP-Gas has a specific gravity of 0.510 and the liquid temperature is 44°F. The correction factor in the 0.510 column for 44°F is 1.025. Volume to be pumped at 44°F is 800 ÷ 1.025 = 780 gal.

E-4 Maximum Liquid Volume Computations.

E-4.1 Maximum Liquid LP-Gas Content of a Container at Any Given Temperature.

E-4.1.1 The maximum liquid LP-Gas content of any container depends upon the size of the container, whether it is installed avoveground or underground, the maximum permitted filling density and the temperature of the liquid [*see Tables 4-5.2.3(a), (b) and (c).*]

E-4.1.2 The maximum volume "V_t (in percent of container capacity) of an LP-Gas at temperature "t," having a specific gravity "G" and a filling density of "L," is computed by use of the formula:

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

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.

EXAMPLE 1: The maximum liquid content, in percent of container capacity, for an aboveground 500 gal water capacity container of an LP-Gas having a specific gravity of 0.550 and at a liquid temperature of 45°F is computed as follows:

From Table 4-5.2.1, L = 0.47, and from Table E-3.1.3, °F = 1.019

$$\text{Thus } V_{45} = \frac{0.47}{0.550 \times 1.019} = 0.838 \ (83\%), \text{ or } 415 \text{ gallons}$$

EXAMPLE 2: The maximum liquid content, in percent of container capacity, for an aboveground 30,000 gal water capacity container of LP-Gas having a specific gravity of 0.508 and at a liquid temperature of 80°F is computed as follows:

From Table 4-5.2.1, L = 0.45, and from Table E-3.1.3, °F = 0.967

$$\text{Thus } V_{80} = \frac{0.45}{0.508 \times 0.967} = 0.915 \ (91\%), \text{ or } 27{,}300 \text{ gallons}$$

E-4.2 Alternate Method of Filling Containers.

E-4.2.1 Containers equipped only with fixed maximum level gauges or only with variable liquid level gauges, when temperature determinations are not practical, may be filled with either gauge provided the fixed maximum liquid level gauge is installed, or the variable gauge is set, to indicate the volume equal to the maximum permitted filling density as provided in 4-5.3.3(a). This level is computed on the basis that the liquid temperature will be 40°F for aboveground containers, or 50°F for underground containers.

E-4.2.2 The percentage of container capacity which may be filled with liquid is computed by use of the formula shown in E-4.1.2, substituting the appropriate values as follows:

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

t = the liquid temperature. Assumed to be 40°F for aboveground containers or 50°F for underground containers.

L = the loading density obtained from Table 4-5.2.1 for:

(1) the specific gravity of the LP-Gas to be contained.

(2) the method of installation, aboveground or underground, and if aboveground, then:

(a) for containers of 1,200 gal water capacity or less.

(b) for containers of more than 1,200 gal water capacity.

G = the specific gravity of the LP-Gas to be contained.

F = the correction factor. Obtained from Table E-3.1.3, using G and 40°F for aboveground containers or 50°F for underground containers.

EXAMPLE: The maximum volume of LP-Gas with a specific gravity of 0.550 which may be in a 1,000 gal water capacity aboveground container which is filled by use of a fixed maximum liquid level gauge is computed as follows:

t is 40°F for an aboveground container.

L for 0.550 specific gravity, and an aboveground container of less than 1,200 gal water capacity, from Table 4-5.2.1, is 47 percent.

G is 0.550.

F for 0.550 specific gravity at 40°F from Table E-3.1.3 is 1.025.

$$\text{Thus, } V_{40} = \frac{.47}{0.550 \times 1.025} = 0.834\ (83\%), \text{ or } 830 \text{ gallons.}$$

E-4.2.3 Percentage values, such as in the example in E-4.2.2, are rounded off to the next lower full percentage point, or to 83 percent in this example.

E-4.3 Location of Fixed Maximum Liquid Level Gauges in Containers.

E-4.3.1 Due to the diversity of fixed liquid gauges, and the many sizes (from DOT cylinders to 120,000 gal ASME vessels) and types (vertical, horizontal, cylindrical and spherical) of containers in which gauges are installed, it is not possible to tabulate the liquid levels such gauges should indicate for the maximum permitted filling densities [*see Table 4-5.2.1 and 4-5.3.3(a)*].

E-4.3.2 The percentage of container capacity which these gauges should indicate is computed by use of the formula in E-4.1.2. The liquid level this gauge should indicate is obtained by applying this percentage to the water capacity of the container in gal (water at 60°F), then using the strapping table for the container (obtained from its manufacturer) to determine the liquid level for this gallonage. If such a table is not available, this liquid level is computed from the internal dimensions of the container, using data from engineering handbooks.

E-4.3.3 The formula of E-4.1.2 is used to determine the maximum LP-Gas liquid content of a container to comply with Table 4-5.2.1 and 4-5.3.3(a), as follows:

$$\text{Volumetric percentage, or } V_t = \frac{L}{G \times F}, \text{ and}$$

Volume in Gallons = $V_t \times$ Container Gallons Water Capacity, or

$$\text{Vol. in Gal. at t} = \frac{\text{L (Table 4-2)} \times \text{Container Gallons Water Capacity}}{\text{G (Spec. Grav.)} \times \text{F (For G and at temperature t)}}$$

EXAMPLE 1: Assume a 100 gal water capacity container for underground storage of propane with a specific gravity of 0.510. From Table 4-5.2.1, L = 46 percent; from 4-5.3.3(a), t = 50°F; and from Table E-3.1.3, °F for 0.510 specific gravity and a temperature of 50°F is 1.016; or

$$\text{Vol. in Gal. at 50 F} = \frac{.46 \times 100}{0.510 \times 1.016} = 88.7 \text{ gallons}$$

EXAMPLE 2: Assume an 18,000 gal water capacity container for aboveground storage of a mixture with a specific gravity of 0.550. From Table 4-5.2.1, L = 50 percent; from 4-5.3.3(a), t = 40°F; and from Table E-3.1.3, °F for 0.550 specific gravity and 40°F temperature is 1.025; or

$$\text{Vol. in Gal. at 40 F} = \frac{.50 \times 18{,}000}{0.550 \times 1.025} = 15{,}950 \text{ gallons}$$

Appendix F Wall Thickness of Copper Tubing

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

Table F-1 Wall Thickness of Copper Tubing

(Standard Specification for Copper Water Tube, ASTM B88)

Standard Size Inches	Nominal OD Inches	Nominal Wall Thickness Inches Type K	Type L
1/4	0.375	0.035	0.030
3/8	0.500	0.049	0.035
1/2	0.625	0.049	0.040
5/8	0.750	0.049	0.042
3/4	0.875	0.065	0.045

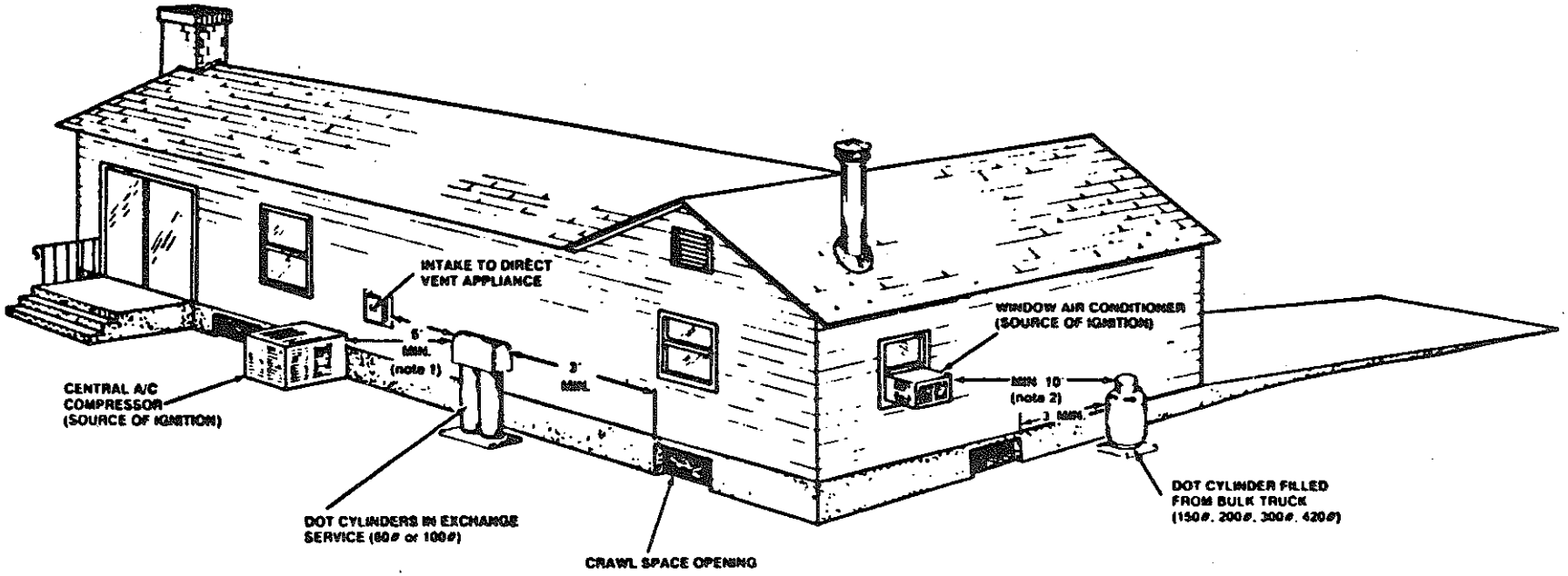
Table F-2 Wall Thickness of Copper Tubing

(Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service, ASTM B280)

Standard Size Inches	Outside Diam. Inches	Wall Thickness Inches
1/4	0.250	0.030
5/16	0.312	0.032
3/8	0.375	0.032
1/2	0.500	0.032
5/8	0.625	0.035
3/4	0.750	0.042
7/8	0.875	0.045

Appendix G Container Spacing

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

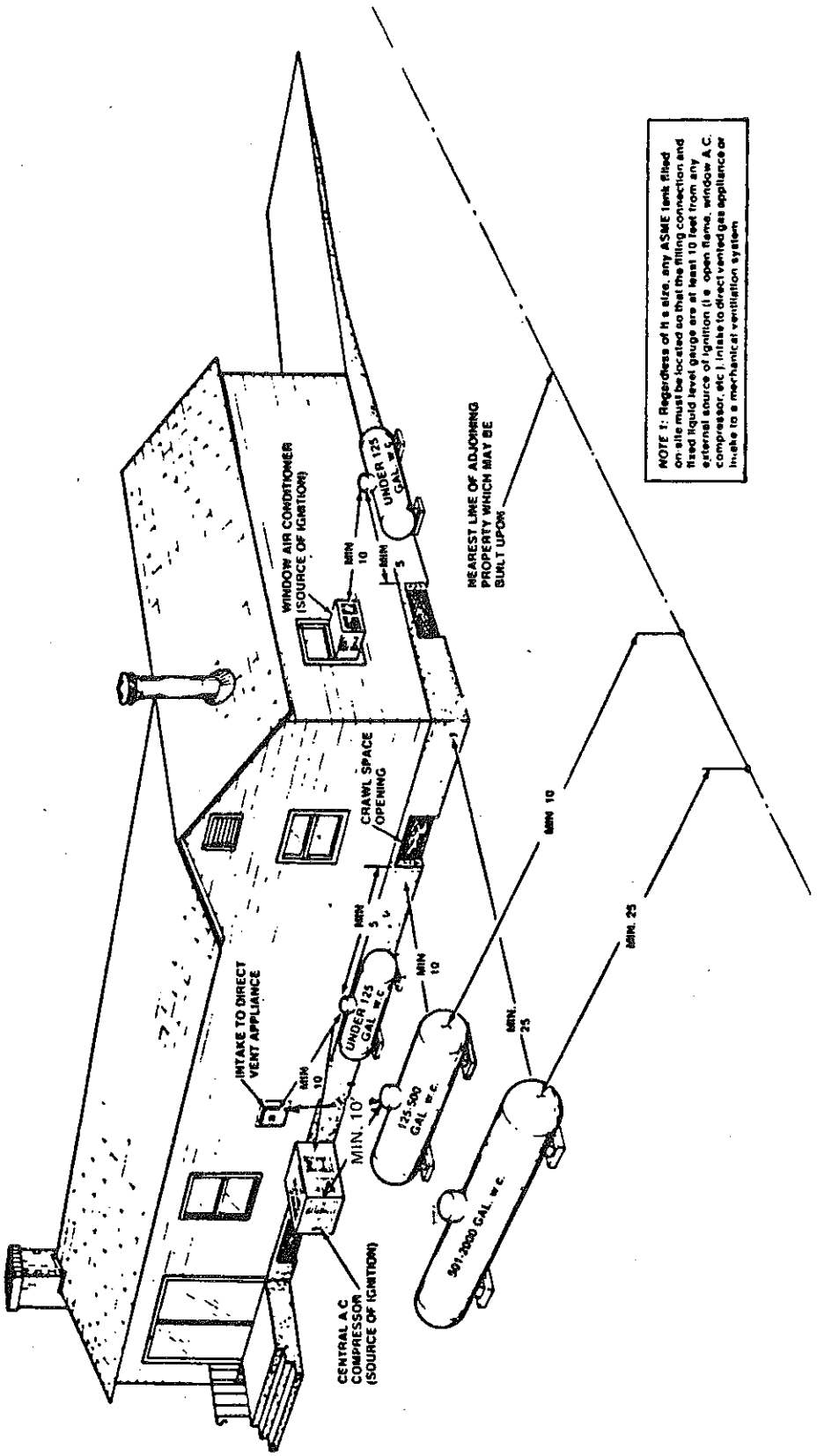


(For SI Units: 1 ft = 0.3048 m)

NOTE 1: 5 foot minimum between relief valve discharge and external source of ignition (air conditioner), direct vent, or mechanical ventilation system (attic fan)

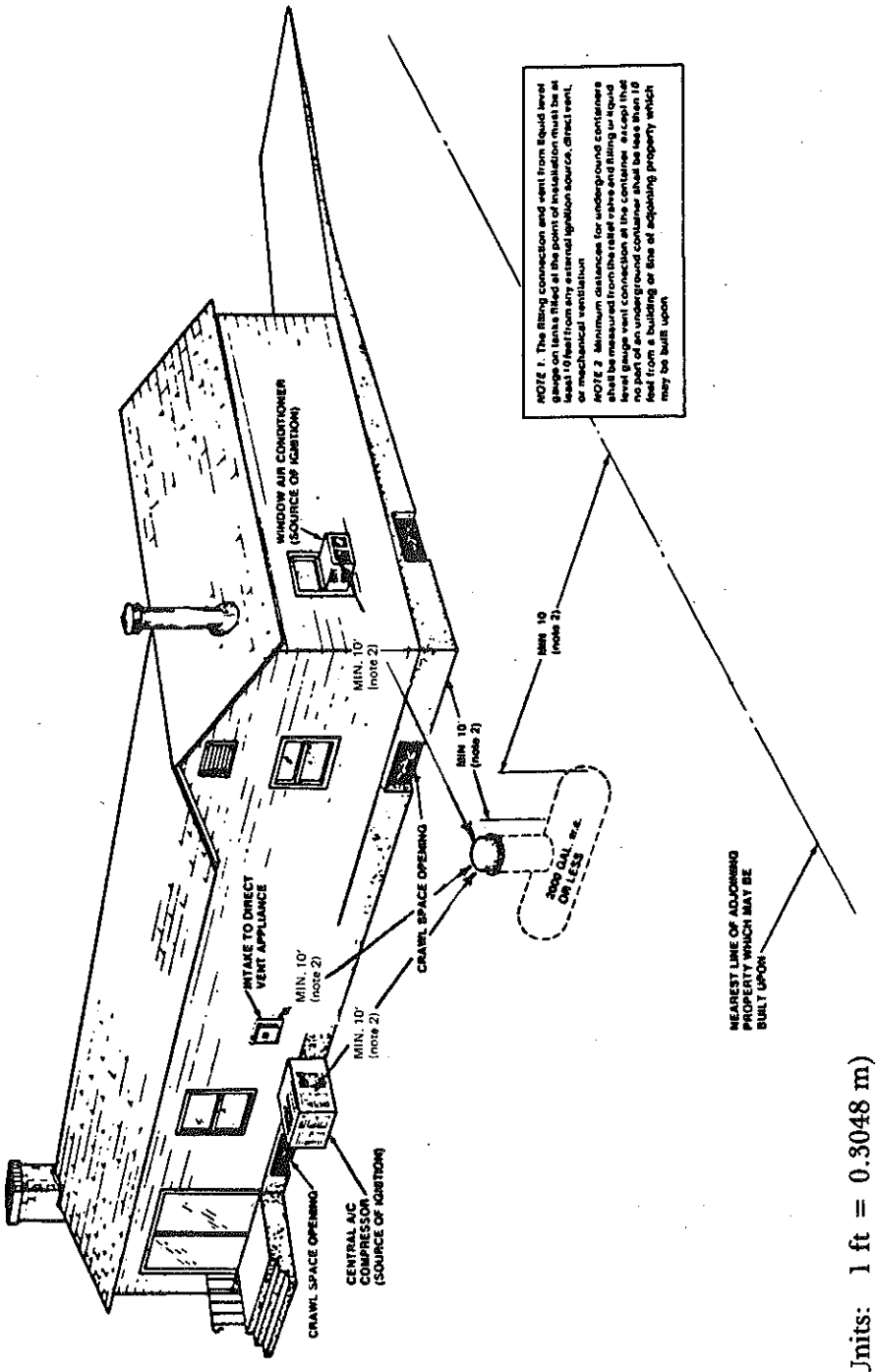
NOTE 2. If the DOT cylinder is filled on-site from a bulk truck, the filling connection and vent valve must be at least 10 feet from any external source of ignition, direct vent, or mechanical ventilation system.

Figure G-1 DOT Cylinders
(This figure for illustrative purposes only; text shall govern.)



(For SI Units: 1 ft = 0.3048 m)

Figure G-2 Aboveground ASME Tanks
(This figure for illustrative purposes only; text shall govern.)



(For SI Units: 1 ft = 0.3048 m)

Figure G-3 Underground ASME Tanks
(This figure for illustrative purposes only; text shall govern.)

Appendix H Referenced Publications

H-1 This portion of the Appendix lists publications referenced within this NFPA document and thus is considered part of the requirements of the document.

H-1.1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1981, *Standard for Portable Fire Extinguishers.*

NFPA 30-1981, *Flammable and Combustible Liquids Code.*

NFPA 321-1982, *Basic Classification of Flammable and Combustible Liquids.*

NFPA 37-1979, *Stationary Conbustion Engines and Gas Turbines.*

NFPA 50-1979, *Bulk Oxygen Systems at Consumer Sites.*

NFPA 50A-1978, *Gaseous Hydrogen Systems at Consumer Sites.*

NFPA 50B-1978, *Liquefied Hydrogen Systems at Consumer Sites.*

NFPA 51-1983, *Oxygen-Full Gas Systems for Welding, Cutting and Allied Presses.*

NFPA 54 (ANSI Z223.1)-1980, *National Fuel Gas Code.*

NFPA 59-1979, *LP-Gases at Utility Gas Plants.*

NFPA 61B-1980, *Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities.*

NFPA 70-1981, *National Electrical Code.*

NFPA 77-1983, *Static Electricity.*

NFPA 78-1980, *Lightning Protection Code.*

NFPA 80-9181, *Fire Doors and Windows.*

NFPA 82-1983, *Incinerators, Waste and Linen Handling Systems and Equipment.*

NFPA 86A-1982, *Ovens and Furnaces.*

NFPA 96-1980, *Removal of Smoke & Gases Laden Vapors from Commercial Cooking Equipment.*

NFPA 251-1979, *Standard Methods of Fire Tests of Buiulding Construction and Materials.*

NFPA 302-1980, *Fire Protection Standard for Motor Craft.*

NFPA 501A-1982, *Firesafety Criteria for Mobile Home Installations, Sites and Communities.*

NFPA 501C-1982, *Firesafety Criteria for Recreational Vehicles.*

NFPA 505-1982, *Powered Industrial Trucks.*

H-1.2 ANSI Publications. The following publications are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI A 58.1-1972, *Building Code Requirements for Minimum Design Loads in Buildings and Other Structures.*

ANSI B 36.10-1979, *Welded and Seamless Wrought Steel Pipe.*

ANSI B 95.1-1977, *Standard Terminology for Pressure Relief Devices.*

H-1.3 ASTM Publications. The following publications are available from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

A-47-1977, *Specification for Malleable Iron Castings.*

A-48-1976, *Specification for Gray Iron Castings.*

A-53-1980, *Specification for Welded and Seamless Pipe, Steel, Black and Hot-Dipped, Zinc Coated.*

A-106-1980, *Specification for Seamless Carbon Steel Pipe for High Temperature Service.*

A-120-1980, *Specification for Welded and Seamless Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized).*

A-395-1980, *Specification for Ferritic Ductile Iron Pressure - Retaining Castings for Use at Elevated Temperatures.*

A-536-1980, *Specification for Ductile Iron Castings.*

A-539-1979, *Specification for Electric - Resistance - Welded Coiled Steel Tubing for Gas and Fuel Oil Lines.*

B-42-1981, *Specification for Seamless Copper Pipe, Standard Sizes.*

B-43-1980, *Specification for Seamless Red Brass Pipe, Standard Sizes.*

B-88-1981, *Specification for Seamless Copper Water Tube.*

B-135-1981, *Specification for Seamless Brass Tube.*

B-280-1980, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.*

D-2513-1980a, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.*

D-2683-1980, *Specification for Socket-Type Polyethylene (PE) Fittings for Outside Diameter-Controlled Polyethylene Pipe.*

D-3261-1978, *Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.*

H-1.4 CGA Publications. The following publications are available from the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

ANSI 748.1 (CGA C-4)-1978, *Method of Marking Portable Compressed Gas Cylinders to Identify the Material Contained.*

Pressure-Relief Device Standards - 1963,

S-1.1, *Cylinders for Compressed Gases.*

S-1.2, *Cargo and Portable Tanks for Compressed Gases.*

S-1.3, *Compressed Gas Storage Containers.*

H-1.5 ASME Publications. The following publication is available from the 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* - 1980.

H-1.6 API Publication. The following publication is available from the American Petroleum Institute, 2101 L ST., NW, Washington, DC 20037.

API-ASME *Code for Unfired Pressure Vessels* - Pre - July 1, 1961.

H-1.7 Federal Regulations. The following publications are available from the US Government Printing Office, Washington, DC.

Code of Federal Regulations, Title 49, Parts 171-190. (Also available from the Associatiion of American Railroads, American Railroads Bldg., 1920 L St. NW, Washington, DC 20036 and American Trucking Assn, Inc., 1916 P. St. NW, Washington, DC 20036.

Code of Federal Regulations, Title 49, Parts 191 and 192.

H-1.8 ICBO Publication. The following publication is available from the International Conference of Building Officials, 5360 S. Workman Mill Rd., Whittier, CA 90601

Uniform Building Code - 1976.

H-1.9 UL Publication. The following publication is available from Underwriters Laboratories, Inc., 333 Pfingston Rd., Northbrook, IL 60062.

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

H-1.10 AWS Publications. The following publication is available from the American Welding Society, 2501 NW 7th St., Miami, FL 33125.

ANSI Z49.1-1973, *Safety in Welding and Cutting.*

H-2 This portion of the appendix lists publications referenced within this NFPA document for information purposes only and thus is not considered part of the requirements of the document.

H-2.1 NLPGA Publications. The following publications are available from the National LP-Gas Association, 1301 W. 22nd St., Oak Brook, IL 60521.

Recommendations for Prevention of Ammonia Contamination of LP-Gas.

Safety Bulletin 118-79, Recommended Procedures for Visual Inspection and Requalification of DOT (ICC) Cylinders in LP-Gas Service.

H-2.2 CGA Publication. The following publication is available from the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

CGA Pamphlet C-6-1980, *Standard for Visual Inspection of Compressed Gas Cylinders.*

H-2.3 API Publication. The following publication is available from the American Petroleum Institute, 2101 L St., NW, Washington, DC 20037.

API Standard 2510-1978, *The Design and Construction of Liquefied Petroleum Gas Installations at Marine and Pipeline Terminals, National Gas Processing Plants, Refineries, Petrochemical Plants and Tank Farms.*

H-2.4 Federal Publication. The following publication is available from the National Technical Information Service, US Dept. of Commerce, Springfield, VA 221612.

BERC/RI-77/1, Spetember 1977, *A New Look at Odorization Levels for Propane Gas, United States Energy & Development Administration, Technical Information Center.*

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Tentative Interim Amendment 58-83-1

to the

Standard for the Storage and Handling of Liquefied Petroleum Gases

NFPA 58–1983

Pursuant to Section 15 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to the 1983 edition of the *Standard for the Storage and Handling of Liquefied Petroleum Gases,* NFPA 58. The TIA was processed by the Committee on Liquefied Petroleum Gases and was approved for release by the Standards Council on October 8, 1982.

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

1. Amend 3-6.2.2 (a) (6) by inserting "and school buses" *between* "trucks" *and* "shall."