Design and Construction of LPG Installations

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Foreword

This standard provides minimum requirements for the design and construction of installations for the storage and handling of liquefied petroleum gas (LPG) at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, and tank farms. This standard takes into consideration the specialized training and experience of operating personnel in the type of installation discussed. In certain instances, exception to standard practices are noted and alternative methods are described.

This standard does not include information on the production or use of liquefied petroleum gas.

It is not intended that this standard be retroactive or that it take precedence over contractual agreements. Wherever practicable, existing codes and manuals have been used in the preparation of this standard.

This standard requires the purchaser to specify certain details and features. Although it is recognized that the purchaser may desire to modify, delete, or amplify sections of the standard, it is strongly recommended that such modifications, deletions, and amplifications be made by supplementing this standard rather than by rewriting or incorporating sections of this standard into another complete standard.

As used in this standard, “shall” denotes a minimum requirement to conform to the specification. “Should” denotes a recommendation or that which is advised but not required to conform to the specification. “Shall consider” directly before a design or construction factor (such as a force or safety) indicates that the factor’s effects and significance shall be evaluated using good engineering judgment-through an examination or test if appropriate-and the design may or may not be adjusted accordingly.

Suggested revisions are invited and should be submitted to API, Standards Department, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, standards@api.org.

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1 Scope

1.1 General

This standard covers the design, construction, and location of liquefied petroleum gas (LPG) installations at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, or tank farms. It also addresses the use of storage vessels, loading and unloading systems, piping, and related equipment.

1.2 Refrigerated Storage

Design and construction considerations specific to refrigerated storage are covered in Section 11 of this standard.

1.3 Pressurized Storage

Design and construction considerations specific to pressure vessel storage are covered in Section 4 of this standard.

1.4 Numerical Units Used

In this standard, numerical values are presented in the U.S. Customary (USC) units.

1.5 Excluded Items

1.5.1 This standard does not apply to the design, construction, or relocation of frozen earth pits, underground storage caverns or wells, and underground or mounded storage tanks.

1.5.2 This standard does not apply to the following installations.

a) Those covered by NFPA 58 and NFPA 59.

b) U.S. Department of Transportation (DoT) containers.

c) Gas utility company facilities; refinery process equipment; refinery and gas plant processing equipment; and transfer systems from process equipment before upstream LPG storage.

d) Those tanks with less than 2000 gallons of storage capacity.

1.6 Retroactivity

The provisions of this standard are intended for application to new installations. This standard can be used to review and evaluate existing storage facilities. However, the feasibility of applying this standard to facilities, equipment, structures, or installations that were already in place or that were in the process of construction or installation before the date of this publication, must be evaluated on a case-by-case basis considering individual circumstances and sites.

1.7 Characteristics of LPG

LPG is customarily handled in a liquid state achieved by its liquefaction under moderate pressure or refrigeration. Upon release of the pressure or warming of the refrigerated liquid, LPG is readily converted into the gaseous phase at normal ambient temperature.

1.8 Safety

The safety of LPG storage installations is enhanced by the employment of good engineering practices, such as those recommended by this standard, during design and construction.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Recommended Practice 500, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1and Division 2*

API Recommended Practice 505, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2*

API 510, *Pressure Vessel Inspection Code: In-service Inspection, Rating, Repair, and Alteration*

API Standard 520, *Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries*

API Standard 521, *Guide for Pressure-Relieving and Depressuring Systems*

API Recommended Practice 551, *Process Measurement Instrumentation*

API Standard 607, *Fire Test for Soft-Seated Quarter-Turn Valves*

API Standard 625, *Tank Systems for Refrigerated Liquefied Gas Storage*

API Recommended Practice 752, *Management of Hazards Associated with Location of Process Plant Permanent Buildings*,

API Recommended Practice 1102, *Steel Pipelines Crossing Railroads and Highways*

API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*

API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

API Recommended Practice 2218, *Fireproofing Practices in Petroleum and Petrochemical Processing Plants*

API Publication 2510A, *Fire Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities*

API Specification 6FA, *Specification for Fire Test for Valves*

API, *MPMS, Chapter 5—Metering*

ASME B16.4 [1] , *Gray Iron Threaded Fittings Classes 125 and 250*

ASME B16.9, *Factory-Made Wrought Steel Buttwelding Fittings*

ASME B16.47, *Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard*

ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*

[1] ASME International, 3 Park Avenue, New York, New York 10016, www.asme.org.

ASME B31.4, *Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols*

ASME *BPVC, Section II—Materials*

ASME *BPVC, Section VIII—Rules of Construction for Pressure Vessels, Division 1 and Division 2*

ASTM A516M/A516 [2] , *Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service*

DOT [3] , *Transportation Safety Act of 1974*, Part 173, Section 315

NBBI [4] , *National Board Inspection Code, Part 1, Installation*

NBBI, *National Board Inspection Code, Part 2, Inspection*

NBBI, *National Board Inspection Code, Part 3, Repairs and Alterations*

NFPA 15, *Standard for Water Spray Systems for Fire Protection*

NFPA 24, *Standard for Installations of Private Service Mains and their Appurtenances*

NFPA 30 [5] , *Flammable and Combustible Liquids Code*

NFPA 58, *Storage and Handling of Liquefied Petroleum Gases*

NFPA 59, *Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants*

NFPA 59A, *Production, Storage and Handling of Liquefied Natural Gas (LNG)*

NFPA 70, *National Electrical Code*

UL 1709 [6] , *Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel*

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1
aboveground container
a container all or part of which is exposed above grade.

3.2
auto-refrigeration
the chilling effect of vaporization of pressurized LPG when it is released or vented to a lower pressure.

3.3
container
a refrigerated tank, pressure vessel, or refrigerated pressure vessel for storage of LPG.

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[2] ASTM International,100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
[3] U.S. Department of Transportation. The Act is available from the U.S. Government Printing Office, Washington, D.C. 20402.
[4] National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue Columbus, Ohio 43229-1183.
[5] National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269–9101.
[6] Underwriters Laboratories, 333 Pfingsten Road, Northbrook, Illinois 60062, www.ul.com.

3.4
installations
tanks, vessels, pumps, compressors, accessories, piping, and all other associated equipment required for the receipt, transfer, storage, and shipment of LPG.

3.5
liquefied petroleum gas (LPG or LP-gas)
any material in liquid form that is composed predominantly of any of the following hydrocarbons or of a mixture thereof: propane, propylene, butanes (normal butane or isobutane), and butylenes.

3.6
mounded tank or vessel
a tank or vessel located above or partially above the general grade level but covered with earth, sand, or other suitable material.

3.7
pressure vessel
a vessel in accordance with ASME BPVC Section VIII for storage of LPG at pressures exceeding 15 psig.

3.8
primary liquid container
the container in continuous contact with product, i.e.: 1) the refrigerated container of the single containment tank; 2) the refrigerated or non-refrigerated container of the pressure vessel; and 3) the inner refrigerated container of the double containment tank, or full containment tank.

3.9
refrigerated tank storage
storage in a tank at a pressure below 15 psig and at an artificially maintained temperature necessary to maintain a liquid state.

3.10
refrigerated vessel
Vessel using both pressure exceeding 15 psig and artificially maintained low temperature to maintain the LPG in liquid state.

3.11
secondary liquid container
the container in contact with product only in event of a failure of primary liquid container, i.e.: 1) the bund walls for single containment tanks and pressure vessels; and 2) the outer container of double and full containment tanks.

3.12
tank
tank is synonymous with “refrigerated tank,” a container used for storing LPG.

3.13
tank system
equipment designed for the purpose of storing refrigerated LPG consisting of one or more containers together with all other necessary components within the scope of this standard.

3.14
underground container
A tank or vessel where all parts are completely buried below the general grade of the facility.

3.15
upstream LPG storage
LPG storage container at or near well head for the exploration, production, recovery, handling, processing, treatment, or disposal, or transmission of LPG or any associated substances.

3.16
vessel
vessel is synonymous with “pressure vessel.”

4 Design of LPG Pressure Vessels

4.1 Applicable Design Construction Codes

4.1.1 Vessels for pressurized storage shall meet the requirements of the ASME BPVC Section VIII, Division 1 or 2.

4.1.2 When complete rules for any specific design are not given, the manufacturer, subject to the approval of the purchaser, shall provide a design as safe as would be provided in the currently applicable code listed in 4.4.1.

4.2 Design Pressure and Temperature

4.2.1 The design pressure of LPG pressure vessels shall not be less than the vapor pressure of the stored product at the maximum product design temperature. The additional pressure resulting from the partial pressure of non-condensable gases in the vapor space and the hydrostatic head of the product at maximum fill shall be considered. Ordinarily, the latter considerations and the performance specifications of the relief valve require a differential between design pressure and maximum product vapor pressure that is adequate to allow blowdown of the pressure relief valve (see API Standard 520).

4.2.2 Both a minimum design temperature and a maximum design temperature shall be specified. In determining a maximum design temperature, consideration shall be given to factors such as ambient temperature, solar input, and product run down temperature. In determining a minimum design temperature, consideration shall be given to the factors noted in the preceding sentence as well as the auto-refrigeration temperature of the stored product when it flashes to atmospheric pressure.

4.2.3 ASME BPVC Section VIII, Division 1 UCS-66(b) and Division 2, 3.11.2.5 provide adjustment curves that allow the impact test exemption temperatures to be reduced in increasing measure as pressures are reduced. Conservative application of those adjustment curves in conjunction with LPG vapor pressure curves allow the following auto-refrigeration conclusion. The reduced auto-refrigeration temperature will not mandate impact testing of the vessel material for LPG storage vessels that satisfy the requirements in 4.2.3.1 through 4.2.3.5.

4.2.3.1 Design pressure is 200 psig or greater.

4.2.3.2 Service conditions will not involve more than 5 psi partial pressure of non-condensable gases such as nitrogen.

4.2.3.3 Normalized or quench and tempered materials or as rolled A516 including Gr 55, Gr 60, Gr 65 or Gr 70 are employed.

4.2.3.4 The thickness of the vessel does not exceed 4 in.

4.2.3.5 Satisfying the above criteria will ensure that the allowable minimum design metal temperature (MDMT) of the vessel material will be less than the adiabatic flash temperature of the LPG. When the vessel is re-pressurized, this must be done slowly to allow the temperature to increase as the pressure is increased.

4.3 Design Vacuum

LPG pressure vessel design shall consider vacuum effects and be designed accordingly. Where an LPG pressure vessel is not designed for full vacuum, some alternatives in order of preference are shown in 4.3.1 through 4.3.3.

4.3.1 Design for partial vacuum condition. This alternative is applicable when the vacuum conditions are caused by ambient temperature conditions. The design external pressure shall be equal to 14.7 psi minus the minimum vapor pressure of the product at the minimum ambient temperature. In this situation, no additional protection against vacuum is needed.

4.3.2 Design for partial vacuum with a vacuum relief valve and a connection to a reliable supply of hydrocarbon gas. This alternative may compromise product quality.

4.3.3 Design for partial vacuum with a vacuum relief valve that admits air to the pressure vessel. This alternative, under some conditions, may present a hazard from the presence of air in the LPG storage vessel, and this hazard shall be considered in the design of the facility.

4.4 Materials of Construction

4.4.1 All materials of construction shall meet the requirements of Section II of the ASME BPVC.

4.4.2 Low-melting-point materials of construction, such as aluminum and brass, shall not be used for LPG pressure vessels.

4.5 Vessel Connections

4.5.1 The number of penetrations in any pressure vessel shall be minimized, particularly those located below the working liquid level (i.e. below the vapor space).

4.5.2 Flange connections shall be a minimum of ASME class 150. All fittings shall be a minimum of NPS $^{3}/_{4}$.

4.5.3 Refer to Section 8 for piping requirements.

4.6 Previously Constructed Vessels

API 510 or NBIC Code shall be used for inspection, rating, repair, and/or alteration when an existing pressure vessel is to be relocated or reused in a new service.

5 Siting Requirements and Spill Containment

5.1 Siting

5.1.1 General

5.1.1.1 Site selection is meant to minimize the potential risk to adjacent property presented by the storage facility and the risk presented to the storage facility by a fire or explosion on adjacent property. The following factors shall be considered in site selection.

a) Proximity to populated areas.

b) Proximity to public ways.

c) Risk from adjacent facilities.

d) Storage quantities.

e) Present and predicted development of adjacent properties.

f) Topography of the site, including elevation and slope.

g) Access for emergency response.

h) Availability of needed utilities.

i) Requirements for the receipt and shipment of products.

j) Local codes and regulations.

k) Prevailing wind conditions.

5.1.1.2 A potential LPG incident, and in context of this publication a more relevant one, is leakage from piping or other components attached to or near a storage tank or vessel followed by ignition, a flash fire or vapor cloud explosion, and a continuing pool fire and pressure (torch) fire.

5.1.1.3 With the exception of spacing, the design features discussed in this standard are intended to prevent a major incident. Spacing is intended to minimize both the potential for small leak ignition and the exposure risk presented to adjacent vessels, equipment, or installations in case ignition occurs. Spacing is not intended to provide protection from a major incident.

5.1.1.4 Safety analysis and dispersion modeling are useful tools in estimating setback distances to limit the exposure risk to adjacent facilities.

5.1.2 Minimum Distance Requirement

5.1.2.1 The minimum horizontal distance between the shell of an LPG pressure vessel and the line of adjoining property that may be developed shall be as shown in Table 1. For minimum distances of refrigerated LPG tanks from property lines, see 11.3.1.

5.1.2.1.1 Where residences, public buildings, places of assembly, or industrial sites are located on adjacent property, greater distances or other supplemental protection shall be provided.

5.1.2.2 The minimum horizontal distance between the shell of an LPG pressure vessel and a) the shell of another LPG pressure vessel; or b) the shell of any other pressurized hazardous material pressure vessel; or c) the shell of a flammable product storage tank shall be as follows:

5.1.2.2.1 Between two spheres, between two vertical vessels, or between a sphere and a vertical vessel, 5 ft or one half of the diameter of the larger vessel, whichever is greater.

5.1.2.2.2 Between two horizontal vessels, or between a horizontal vessel and a sphere or vertical vessel, 5 ft or three quarters of the diameter of the larger vessel, whichever is greater.

5.1.2.3 The minimum horizontal distance between the shell of an LPG pressure vessel and the shell of any other non-pressurized hazardous material or flammable product storage tank shall be the largest of the following, with the exception noted in 5.1.2.3.1.

a) If the other storage is refrigerated, three quarters of the greater diameter.

b) If the other storage is in atmospheric tanks and is designed to contain material with a flash point of 100 °F or less, one diameter of the larger tank.

c) If the other storage is in atmospheric tanks and is designed to contain material with a flash point greater than 100 °F, half the diameter of the larger tank.

d) 100 ft.

5.1.2.3.1 The minimum horizontal distance between shells need not exceed 200 ft.

5.1.2.4 The minimum horizontal distance between the shell of an LPG vessel and a regularly occupied building shall be as follows:

a) If the building is used for the control of the storage facility, 50 ft.

b) If the building is used solely for other purposes (unrelated to control of the storage facility), 100 ft.

c) Compliance with API Recommended Practice 752 may be used in lieu of the requirements in Items a) and b) directly above.

5.1.2.5 The minimum horizontal distance between the shell of an LPG vessel and facilities or equipment not covered in 5.1.2.1 through 5.1.2.4 shall be as follows.

a) For process vessels, 50 ft.

b) For flares or other equipment containing exposed flames, 100 ft.

c) For other fired equipment, including process furnaces and utility boilers, 50 ft.

d) For rotating equipment, 50 ft; except for pumps taking suction from the LPG vessels, 10 ft.

e) For overhead power transmission lines and electric substations, 50 ft. In addition, siting shall be such that a break in the overhead lines shall not cause the exposed ends to fall on any vessel or equipment.

f) For loading and unloading facilities for trucks and railcars, 50 ft.

g) For navigable waterways, docks, and piers, 100 ft.

h) For stationary internal combustion engines, 50 ft.

5.1.2.6 The minimum horizontal distance between the shell of an LPG vessel and the edge of a spill containment area for flammable or combustible liquid storage tanks shall be 10 ft.

NOTE 1 If the spill containment is by the use of dikes or walls, the edge of the spill containment area for the purpose of spacing is defined as the centerline of the dike or wall. If the spill containment is by sloping, grading, or channels, the edge of the spill containment area for the purpose of spacing is defined as the outer edge of the wetted area at the design incident for the spill containment facility.

Table 1—Minimum Horizontal Distance between Shell of an LPG Pressure Vessel and Line of Adjoining Property That May Be Developed

Water Capacity of Each Pressure Vessel (gallons)	Minimum Distance (ft)
2000 to 30,000	50
30,001 to 70,000	75
70,001 to 90,000	100
90,001 to 120,000	125
120,001 or greater	200

NOTE 2 Minimum horizontal distance (spacing) for LPG tanks is covered in 11.3.1.

5.1.3 Siting of LPG Pressure Vessels and Equipment

5.1.3.1 LPG pressure vessels shall not be located within buildings, within the spill containment area of flammable or combustible liquid storage tanks as defined in NFPA 30, or within the spill containment area for refrigerated storage tanks.

5.1.3.2 Compressors and pumps taking suction from LPG pressure vessels shall not be located within the spill containment area of any storage facility unless provisions are made protect the LPG pressure vessel from the potential fire exposure. Examples of such include (a) a submerged-motor, direct-coupled pump with no rotating element outside of the pump containment vessel; (b) a submersible pump inside an LPG tank.

5.1.3.3 Horizontal LPG pressure vessels with capacities of 12,000 gallons or greater shall not be formed into groups of more than six tanks each. Where multiple groups of horizontal LPG vessels are to be provided, each group shall be separated from adjacent groups by a minimum horizontal shell-to-shell distance of 50 ft.

NOTE Horizontal pressure vessels used to store LPG should be oriented so that their longitudinal axes do not point toward other facilities (such as containers, process equipment, control rooms, loading or unloading facilities, or flammable or combustible liquid storage facilities or offsite facilities located in the vicinity of the horizontal pressure vessel).

5.1.3.4 Process equipment containing LPG or LPG vapor shall be located at least 50 ft from any of the following:

— sources of ignition,

— a property line that can be built upon, or

— occupied structures.

5.1.3.5 Fired equipment shall be located at least 50 ft from any LPG spill containment or drainage system.

5.1.3.6 LPG loading and unloading connections shall be at least 50 ft from any of the following:

— sources of ignition,

— process areas,

— storage containers, or

— occupied structures.

5.2 Drainage

5.2.1 The ground under and surrounding an LPG tank or pressure vessel used to store LPG shall be graded to drain any liquid spills to a safe area away from the vessel and piping. The grading shall be at a slope of at least 1 %.

5.2.2 The drainage system shall be designed to prevent spilled liquid from one LPG tank or pressure vessel from flowing under any other LPG tank or pressure vessel. In addition, the drainage system design shall minimize the risk to piping from spilled LPG.

5.2.3 The spill drainage area shall not contain equipment, except as permitted by this standard.

5.2.4 Walls, dikes, trenches, or channels are permitted to assist in draining the area.

5.3 Spill Containment

5.3.1 Spill containment shall be considered for all locations and provided in locations in which either of the following conditions will result in a significant hazard.

a) The physical properties of the stored LPG make it likely that the liquid LPG will collect on the ground. (This would be the case if the LPG contains significant amounts of butane or pentane.)

b) Climatic conditions during portions of the year make it likely that liquid LPG will collect on the ground.

5.3.2 Provision should be made for safe dispersion of the vapor generated during an LPG spill. Considerations shall include at least location and type of nearby obstructions and ignition sources.

NOTE LPG vapor is normally heavier than air. It is known to follow grade contour and accumulate in low spots similar to the behavior of liquids. Dispersion requires heat input from surroundings or significant air movement.

5.3.3 The effects of thermal shock associated with spilling LPG (such as shock resulting from the auto-refrigeration temperature) shall be considered in the selection of materials for all components including structural supports of a spill containment facility.

5.3.4 If spill containment is to be provided, it shall be by remote impoundment of spilled material or by diking of the area surrounding the LPG tank or pressure vessel. The containment area shall not contain any other equipment, except as permitted by this standard.

5.3.5 If the impounding surface of any spill containment area will not allow rainwater to dissipate within 24 hours, a drainage system shall be installed. Any drainage system provided shall include a valve or shear gate located in an accessible position outside the spill containment area. The valve or shear gate shall normally be kept closed. The drainage system shall be one of the following types.

a) A vapor sealed catch basin within the spill containment area discharging to a closed drainage system outside the spill containment area.

b) A pipe through the dike or wall discharging to a drainage system outside the spill containment area.

5.3.6 The drainage system shall keep the contents of the tank from entering natural water courses and from entering systems incapable of safely containing LPG.

5.4 Remote Impoundment

If remote impoundment is to be used for spill containment, the remote impoundment facility shall be designed according to the requirements given in 5.4.1 through 5.4.4.

5.4.1 Grading of the area under and surrounding the LPG tanks or pressure vessels shall direct any liquid leaks or spills to the remote impoundment area. Grading shall be at a minimum of 1 % slope.

5.4.2 The use of walls, dikes, trenches, or channels to facilitate the draining of the area is permitted.

5.4.3 The remote impoundment area shall be located at least 50 ft from the LPG tanks or pressure vessels draining to it and from any hydrocarbon piping or other equipment.

5.4.4 The holdup of the remote impoundment area shall be at least 25 % of the volume of the largest vessel draining to it. If the material stored in the vessel has a vapor pressure that is less than 100 psia at 100 °F, the holdup for the remote impoundment facility shall be at least 50 % of the volume of the largest vessel draining to it. Larger holdups shall be provided in the remote impoundment facility at locations where the expected vaporization is less than that indicated by the material's vapor pressure because of climatic conditions or the physical properties of the material.

5.5 Diking

If diking around the LPG tanks or pressure vessel is to be used for spill containment, the diked area shall be designed according to the requirements given in 5.5.1 through 5.5.5.

5.5.1 Grading of the area under and surrounding the LPG tanks or pressure vessel shall direct any liquid leaks or spills to the edge of the diked area. Grading shall be at a minimum of 1 % slope. Within the diked area, grading should cause spills to accumulate away from the vessel and any piping located within the diked area.

5.5.2 If an LPG sphere is diked, each sphere shall be provided with its own diked area. If LPG is stored in horizontal pressure vessels, a single diked area may serve a group of vessels, as defined in 5.1.3.3.

5.5.3 The holdup of the diked area shall be at least 25 % of the volume of the largest pressure vessel within it. If the material stored in the pressure vessel has a vapor pressure that is less than 100 psia at 100 °F, the holdup for the diked area shall be at least 50 % of the volume of the largest vessel within it. Larger holdups shall be provided in the diked area at locations where the expected vaporization is less than that indicated by the material's vapor pressure because of climatic conditions or the physical properties of the material.

NOTE Larger holdups may also be provided when more than one vessel is located within the same diked area.

5.5.4 When dikes or walls are used as part of the spill containment system, the minimum height of a dike or wall constructed of earth shall be 1.5 ft and the minimum height of a dike or wall constructed of concrete, masonry, or another erosion-resistant material shall be 1 ft. Provisions shall be made for normal and emergency access into and out of the diked enclosure. Where dikes must be higher than 12 ft or where ventilation is restricted by the dike, provision shall be made for normal operation of valves and access to the top of the LPG tanks or pressure vessels without the need for personnel to enter into the area of the diked enclosure that is below the top of the dike. All earthen dikes shall have a flat top section not less than 2 ft wide.

5.5.5 Any dike or wall enclosure used for LPG containment shall include adequate access provisions (such as stairs for personnel and ramps for vehicles, if required), shall be designed to permit its free ventilation, and shall be constructed to retain the spilled liquid. Enclosures shall be designed to prevent unauthorized access by motor vehicles.

6 Foundations and Supports for LPG Storage Containers and Related Piping

6.1 Applicable Codes, Standards, and Specifications

6.1.1 The materials, principles, methods, and details of design and construction of foundations and supports for LPG storage and containers related piping shall meet the requirements stipulated in the codes, standards and specifications cited in individual sub-sections.

6.1.2 Where applicable local codes are more stringent, the local codes shall apply.

6.2 General Design Requirements

6.2.1 General

The foundation and support structures shall conform to the provisions set forth in 6.2 through 6.4.

6.2.2 Materials

Supporting structures shall be made of one or a combination of the following materials:

a) reinforced masonry;

b) reinforced concrete;

c) prestressed concrete;

d) metal plate, pipe, or structural shapes; and/or

e) other material as justified by design.

NOTE Guidance on the above structural material types can be found in References [3], [4], [9], [15], and [16] in the bibliography.

6.2.3 Loads and Load Combinations

6.2.3.1 The following loads shall be considered in the design of the support structures and foundations.

a) Static loads during erection plus expected wind, ice, and snow loads during the erection.

b) Static loads during hydrostatic testing plus 25 % of the wind, ice, and snow loads.

c) Static loads during operation (including the load due to fireproofing) plus applicable combinations of wind, ice, snow, and earthquake loads.

d) Loads resulting from expansion and contraction of the container due to internal pressure or temperature changes, or both.

e) Loads resulting from differential settlement across the supporting structures and foundations.

f) Static and dynamic loads during maintenance and operations.

g) Other relevant loads specific to the structure and foundation.

NOTE Guidance on load combinations for design of support structures, piping and foundations can be found in References [6], [7], [8], and [10] in the bibliography.

6.2.3.2 Unless local regulations, standards and codes dictate otherwise, the wind, ice, snow, and earthquake loads shall be determined in accordance with References [6] and [10] in the bibliography.

6.2.4 Support Structures

6.2.4.1 Loads on Supporting Structures

The loads and load combinations for design of support structures are presented in 6.2.3.

6.2.4.2 Support Design

6.2.4.2.1 The design of supports for vessels shall include provisions for expansion and contraction due to internal pressure, shrinkage, and temperature changes.

6.2.4.2.2 Flexibility shall be provided in the attached piping to avoid imposing excessive stress on vessel nozzles and associated piping as a result of vessel movement.

NOTE Guidance on additional materials regarding the design of supports for vessels is provided in Reference [8] in the bibliography.

6.2.4.3 Pressure retaining portions of storage containers should typically not contact concrete or masonry supports or concrete or masonry fireproofing, since these contact points may be sites for external corrosion. If such contact points are present, they should be identified for routine inspection.

6.2.5 Shell Loads

In the design of container supports, special attention shall be given to the loads imposed on the shell. Consideration shall be given to the following.

a) Secondary forces resulting from service temperatures or changes in temperatures.

b) Test and operating pressures.

c) Liquid loads, both with and without pressure applied.

d) Loads due to piping reactions.

e) Normal supporting loads.

f) Environmental loads due to snow, ice, wind, and seismic conditions.

g) Loads due to liquid sloshing (in earthquake zones).

6.2.6 Diagonal Members

Diagonal members, such as those used for bracing vertical columns, shall not be attached directly to a vessel unless adequate provisions are made for the resulting loads in the design of the vessel.

6.2.7 Saddles

When a horizontal tank is supported by saddles, the features specified in 6.2.7.1 through 6.2.7.4 shall be incorporated in the design.

6.2.7.1 Horizontal containers shall be supported at two locations.

6.2.7.2 Consideration shall be given to the placement of supports to obtain the most desirable stress distribution in the container shell.

6.2.7.3 The shape of the saddles shall conform to the fabricated shape of the containers to the steel pad attached to the container.

6.2.7.4 Doublers or reinforcing plates may be installed between the container shell and the supports to avoid external corrosion of the shell, provide for wear caused by temperature-induced movement, or reduce the stress in the shell at the support points. If such plates are used, they shall be continuously welded to the container shell after any free moisture is removed from under the plates. A threaded weep hole shall be provided at the low point of each plate. Where corrosion plates are used, the plates shall extend beyond the limits of the supporting saddles to aid in distributing the support loads. The thickness of corrosion plates shall not be included in calculating the stress at the horn of the saddle.

NOTE Guidance on the design of saddles for horizontal steel tanks can be found in Reference [5] in the bibliography.

6.2.8 Vertical Container Skirts

6.2.8.1 Where vertical containers are supported by skirts, the skirts shall be provided with a single opening for inspection or access. The opening shall be as small as practicable.

6.2.8.2 Skirt openings shall be reinforced when required to prevent buckling or overstressing of the skirt as a result of imposed loads as covered in 6.3.1.

NOTE Guidance on additional material regarding the design of skirts is provided in Reference [8] in the bibliography.

6.3 Foundation Design

6.3.1 Loads

The loads and load combinations for foundation design are presented in 6.2.3.

6.3.2 Soil Information

The design of the foundation shall be based on the results of geotechnical engineering investigation from a Geotechnical engineer experienced in the foundation design. The allowable soil bearing, pile capacities, and settlement estimates and other foundation design parameters shall be provided in the geotechnical report for foundation design.

NOTE Guidance on soil/geotechnical investigation can be found in Reference [9] in the bibliography.

6.3.3 Shallow Foundations vs Deep Foundations

Foundations can be designed to be either supported directly on competent or improved soil as shallow foundations or supported on piles when poor soils are identified in the site to minimize the differential foundation settlement.

NOTE Guidance on design of shallow and deep foundations can be found in Reference [9] in the bibliography.

6.3.4 Settlement of Foundation

The size and depth of the foundation shall be designed to limit settlement of the container to prevent excessive stresses in the container and connected piping. The type and size of the foundation shall be determined such that the settlements are within the respective allowable settlements of the container/structure to be supported. For multi-legged vessels or spheres, special attention shall be given to the differential settlement between the individual supports.

NOTE 1 Tank or pressure vessel/structure settlement should be monitored during the hydrostatic test.

NOTE 2 Guidance on the foundation settlements can be found in References [1], [2], and [14] in the bibliography. The foundation settlements shall also be within the Settlement Criteria set by the manufacturers.

6.3.5 Bottom of Foundation

The base of the foundation shall be below the frost line as applicable. Potential scour or settlement from external sources such as nearby sewers or lines having the potential for leakage or washout shall be mitigated.

6.3.6 Foundations for Multiple Containers

6.3.6.1 Continuous footings may be used for multiple container installations. In such instances, the loading of footings shall be calculated for various probable combinations of loads, such as the load that occurs when adjacent containers are full and the load that occurs when alternate containers are full.

6.3.6.2 Continuous piers shall not be used for multiple containers installations without the incorporation of special drainage provisions.

6.3.7 Anchorage

6.3.7.1 Anchorage to concrete foundation shall be designed per Reference [3] in the bibliography.

6.3.7.2 In areas where there is a risk of flooding, the container shall be anchored to the foundation or support to prevent floating in case of a flood. Anchorage shall not restrict vessel movements resulting from expansion and contraction of the container due to temperature changes and internal pressure.

6.3.7.4 Anchorage to the foundation or support shall be provided to resist any uplifting forces resulting from internal pressure in the container.

6.4 Corrosion Protection

6.4.1 Supports and their members shall be positioned to prevent the accumulation of water. Where this positioning is impractical, adequate drainage openings shall be provided to prevent such accumulation.

6.4.2 Enclosed spaces in which water might accumulate during construction or operation shall be provided with drainage openings.

7 Container Accessories, Including Pressure and Vacuum-Relieving Devices

7.1 Mandatory Equipment

7.1.1 General

Containers shall be fitted with the equipment described in 7.1.2 through 7.1.8. Equipment shall be suitable for use with LPG and designed for at least the maximum service conditions to which it may be subjected.

7.1.2 Liquid-level Gauging Equipment

Each LPG container shall be provided with liquid-level gauging equipment as specified in 7.1.2.1 through 7.1.2.4.

7.1.2.1 Each container shall be equipped with a reliable level-indicating system. The need for a second, independent level-indicating system shall be determined by a safety analysis.

7.1.2.2 An independent high-level alarm shall be provided. The alarm shall be set to give the operator sufficient time to stop the flow before the maximum permissible filling height is exceeded (see 7.1.3). The alarm shall be located so that it is audible and visible to the operating personnel controlling the filling operation.

7.1.2.3 For containers that cannot be removed from service, provisions shall be included for testing, repairing, and replacing primary gauges and alarms while the tank is in service.

7.1.2.4 In containers that have a high-level cutoff, the cutoff device shall be in addition to and independent of the high-level alarm specified in 7.1.2.2.

7.1.3 Maximum Liquid Level

The maximum permissible filling height of an LPG containers shall be set to provide adequate vapor space to accommodate any thermal expansion that may occur after filling is completed. The maximum filling height shall be set so that when a tank filled to that level at the minimum anticipated storage temperature the thermal expansion of the liquid will not cause the LPG level to exceed 98 % of the liquid full level.

7.1.4 Level Gauges

Columnar glass level gauges shall not be used. Reflex and see-through level gauges shall be equipped with a ball check valve or a similar protective device.

7.1.5 Pressure Gauge

On each container a suitable pressure gauge should be considered. When used it should be connected to the vapor space.

7.1.6 Pressure- and Vacuum-Relieving Devices

7.1.6.1 General

Each container shall be provided with one or more spring-loaded or pilot-operated pressure relief valves. The pressure relief valve or valves shall be set to discharge as required by the ASME code. Pilot-operated pressure relief devices shall be designed so that the main valve will open automatically and protect the tank if the pilot valve fails. Pilot-operated valves shall be provided with a backflow preventer if the possibility exists that the internal pressure can drop below the relief valve backpressure. Containers that may be damaged by internal vacuum shall be provided with vacuum-relieving devices. Weight and lever pressure-relieving devices shall not be used.

7.1.6.2 Pressure Relief Valve Flow Capacities

Pressure relief valves installed on LPG containers shall be designed to provide adequate flow capacity to protect the tank during fire exposure. Other causes of tank overpressure, such as overfilling and introduction of material with a higher vapor pressure in a common piping system, shall be considered in determining design flow capacity. Pressure relief valves shall be designed and sized in accordance with API Standard 520, Part I and API Standard 521.

7.1.6.3 Pressure Relief Valve Information

Each pressure relief valve shall be marked as required by the applicable ASME code, API standard, or API recommended practice.

7.1.6.4 Pressure Relief Valve Installation

Pressure relief valves shall be installed in accordance with API Standard 520, API Standard 521, and the requirements of 7.1.6.4.1 through 7.1.6.4.5.

7.1.6.4.1 The pressure relief valve shall be installed to provide direct connection to the vapor space and to minimize liquid carry-over during vapor relief, especially when the tank is nearly full. This shall be achieved by locating the pressure relief valve connections as close as practical to the top of the vapor space.

7.1.6.4.2 The possibility of tampering with the adjustment mechanism shall be minimized. If the adjustment mechanism is external, it shall be sealed.

7.1.6.4.3 The inlet and outlet piping for the pressure relief valve shall be designed to pass the rated capacity of the valve without exceeding the allowable pressure-drop limits.

7.1.6.4.4 The pressure relief system shall be protected from the closure of any block valves installed between the tank and the pressure relief valve or between the pressure relief valve and its discharge vent outlet. This protection may be achieved by one of the following procedures.

a) Installing the pressure relief valve without block valves.

b) Providing excess pressure relief valve capacity with multiway valves, interlocked valves, or sealed block valves arranged so that isolating one pressure relief valve will not reduce the capacity of the system to below the required relieving capacity.

c) Locking or sealing the block valves open without installing excess relieving capacity, as follows. The valve seals or locks should be checked routinely to ensure they are in place and locks are operable. The valves shall only be closed by an authorized person who shall remain stationed in audible and visual contact with the vessel, and in a position to correct or arrest potential overpressure events while the valves are closed, and the tank is in operation and shall lock or seal the valves open before leaving. The authorized person shall be able to observe the operating pressure while the valves remain blocked and shall be ready to take emergency action if required.

7.1.6.4.5 The stem of any gate valve installed in the pressure relief system shall be in a horizontal or below-centerline position.

7.1.6.5 Discharge Vents

Discharge vents from the pressure relief valves or common discharge headers shall be designed to meet the requirements of API Standard 520 and API Standard 521 and shall be installed in accordance with the requirements given in 7.1.6.5.1 through 7.1.6.5.5.

7.1.6.5.1 Discharge vents shall lead to the open air or to a flare system. Discharging directly to the atmosphere is unacceptable if liquid LPG might be released into the atmosphere, unless the discharge is through thermal relief valves. Positive design and operational steps shall be taken to prevent the discharge of liquid LPG from atmospheric vents. Such steps include automatic shutdown of filling operations prior to overfilling.

7.1.6.5.2 Discharge vents shall be protected against mechanical damage.

7.1.6.5.3 If discharge vents relieve to the atmosphere, they shall be designed to prevent entry of moisture and condensate. This design may be accomplished by the use of loose-fitting rain caps and drains. Drains shall be installed so that the discharge from the drain will not impinge on the tank or adjoining tanks, piping, equipment, and other structures.

7.1.6.5.4 Discharge vents shall be designed to handle any thrust developed during venting. Discharge shall not be less than 10 ft (3 m) above the operating platform.

7.1.6.5.5 Discharge shall be to an area that has the following characteristics.

a) The area prevents flame impingement on tanks, piping, equipment, and other structures.

b) The area prevents vapor entry into enclosed spaces.

c) The area is above the heads of any personnel on the tank, adjacent tanks, stairs, platforms, or the ground.

7.1.6.6 Pressure Setting

Pressure relief valves shall be tested for correct set pressure before being placed in service. See API Standard 520.

7.1.7 Shutoff Valves

7.1.7.1 Shutoff valves shall conform to the criteria specified in 7.1.7.1.1 through 7.1.7.1.3.

7.1.7.1.1 Shutoff valves shall be provided for all tank connections except the following:

a) Connections on which safety valves are mounted.

b) Connections containing a restriction orifice, plug, or thermometer well where the opening has a maximum diameter of 0.25 in.

7.1.7.1.2 Shutoff valves shall be located as close to the tank as is practical. The preferred location is at the shell nozzle. Shutoff valves shall be readily accessible for operation and maintenance.

7.1.7.1.3 Shutoff valves shall conform to the material and construction requirements of 8.6.

7.1.7.2 All shutoff valves located on nozzles below the maximum liquid level shall be designed to provide a visual indication of the valve position and shall be capable of maintaining an adequate seal under fire conditions. Valves meeting the requirements of API Standard 607 or Specification 6FA have the required fire resistance.

7.1.7.3 When the capacity of the vessel exceeds 10,000 gallons, all shutoff valves on inlet and outlet piping located below the maximum liquid level shall either close automatically or be remotely operable during the first 15 minutes of fire exposure. This may require fireproofing of the control system (see 10.11). These valves shall also be manually operable at the installed location. Check valves installed on dedicated fill lines are suitable for meeting the requirements of this paragraph.

7.1.8 Temperature Indicators

Each tank shall be fitted with a suitable thermometer well.

7.2 Tank Accessory Materials

Ductile (nodular) iron, cast aluminum, malleable iron, and brass shall not be used in any pressure-retaining tank accessories.

8 Flammable Product Piping Requirements

8.1 American Society of Mechanical Engineers Code for Pressure Piping

Piping at facilities covered under this standard shall conform to the provisions of ASME B31.3; except for piping that falls under the exclusion provided in 300.1.3(e) of ASME B31.3 shall be constructed in accordance with the provisions of ASME B31.4. The additional provisions of this section apply to piping constructed in accordance with ASME B31.3.

8.2 Flammable Piping—General

8.2.1 Piping Design Conditions

Determination of piping design pressures and temperatures shall include normal operating conditions, start up and shutdown conditions, auto refrigeration, and temperature effects from the environment.

8.2.2 Piping Manufacture

Piping shall be seamless, electric-resistance-welded, electric fusion welded or submerged-arc-welded pipe. Pipe to be used in piping applications of 2 in. or smaller shall be seamless.

8.2.3 Piping Materials

Pipe materials shall be selected with mechanical properties and chemical composition necessary to ensure the material is compatible with product that it carries.

8.2.4 Piping Joints

Pipe joints shall meet the requirements of 8.2.4.1 through 8.2.4.7.

8.2.4.1 The number of joints of any type between the vessel and the first block valve shall be minimized.

8.2.4.2 Welded joints shall be used where practical.

8.2.4.3 The number of flanged joints shall be minimized.

8.2.4.4 Joints in pipe NPS 2 or larger shall be butt welded or flanged.

8.2.4.5 Joints in pipe smaller than NPS 2 shall be socket-welded, butt-welded, or flanged.

8.2.4.6 Piping gaskets shall be of the self-centering or confined type and shall be resistant to LPG.

8.2.4.7 Threaded connections are not allowed for pipe containing LPG product.

NOTE Threaded connections may be used for connections NPS $1^1/_2$ and smaller at instrumentation and specialty devices which are downstream of a block valve.

8.2.5 Minimum Specifications for Wall Thickness

The pipe wall thickness shall be equal to or greater than that required by ASME B31.3. The minimum requirements specified in 8.2.5.1 and 8.2.5.3 shall also apply.

8.2.5.1 Pipes made from materials subject to brittle-failure, such as carbon steel, shall have the following minimum wall thickness.

a) Nominal pipe size less than NPS 2—Schedule 80.

b) NPS 2 to 5—Schedule 40.

c) NPS 6—Schedule 40.

d) NPS 8 to 12—Schedule 20.

e) NPS 14 or larger—Schedule 10.

8.2.5.2 Pipes made from materials not subject to brittle-failure, such as stainless steel, shall have the following minimum wall thicknesses.

a) NPS $^{3}/_{4}$ or less—Schedule 80S.

b) NPS 1, 1½, or 2—Schedule 40S.

c) NPS larger than 2—Schedule 10S.

8.2.5.3 Nominal pipe sizes 1¼, 2½, 3½, and 5 shall not be used, except if needed for equipment or vessel connections.

8.2.6 Pressure Tubing

Tubing shall be constructed of steel. If tubing will be exposed to a corrosive atmosphere, stainless steel shall be used.

8.3 Fittings

8.3.1 Butt-welding Fittings

Butt-welding fittings shall be made from seamless steel or equivalent material, shall be of at least the same thickness and schedule as the piping, and shall conform to ASME B16.9.

8.3.2 Socket-welding Fittings

Socket-welding fittings smaller than 2 in. such as elbows, tees, and couplings; shall be of forged steel and shall have a working pressure rating of at least 2000 psi.

8.3.3 Packed-sleeve and Resilient-sealed Couplings

Packed-sleeve and resilient-sealed couplings shall not be used.

8.3.4 Flanges

Weld-neck flanges are preferred. Socket-weld flanges NPS 2 and smaller are acceptable. If slip-on flanges are used, they shall be welded both inside and outside. Flanges up to 24 in. shall meet the requirements of ASME B16.5. Flanges with a diameter > 24 in. to 60 in. shall meet the requirements of ASME B16.47 Series A.

8.4 Plugs

Plugs shall be solid and constructed of steel.

8.5 Unions

Unions shall be of forged steel, shall have a working pressure of at least 3000 psi, and shall have ground metal-to-metal seats. Gasket unions shall not be used. Unions shall not be used between the vessel container and the first valve.

8.6 Valves

8.6.1 Primary Shutoff Valves

8.6.1.1 The primary shutoff valves (specifically the valves nearest the container that can shut off flow) shall be made from steel. Valves constructed of free-machining steel similar to AISI Series 1100 and 1200 shall not be used.

8.6.1.2 Union or screwed-bonnet valves shall not be used unless they are equipped with bonnet retainers or the bonnets are tack welded.

8.6.1.3 Valves that are sandwiched between two flanges by long, exposed bolts shall not be used, unless the valves have lug-type bodies that cover the bolts.

8.6.1.4 Ball valves shall meet the requirements of API Standard 607.

8.6.2 Check Valves

Check valves shall be installed on the discharge side of all centrifugal pumps.

8.6.3 Pressure Relief Valves

Pressure relief valves shall be constructed of steel.

8.6.4 Thermal Relief Valves

Suitable thermal relief valves shall be considered on liquid lines that can be blocked between two shutoff valves. Other equipment that can be blocked between shutoff valves shall be provided with protection from overpressure due to thermal expansion of the liquid. Where liquid is trapped in valve cavities, the need for pressure relief shall be considered.

8.7 Location, Installation, and Flexibility of Piping, Valves, and Fittings

8.7.1 Piping shall be provided with adequate flexibility to accommodate the following.

a) Settling of containers or shifting of foundations.

b) Expansion or contraction of containers or piping with changes in temperature.

c) Soil movement.

d) Cooling or heating of unloading connections, vent connections, or loading and unloading headers.

8.7.2 Headers located on piers shall be designed to permit unrestrained movement of the piping in the direction of expansion or contraction except at necessary anchor points.

8.7.3 All water drawoffs shall be extended so that they do not terminate under the vessel. Drain lines shall not be directed into a public sewer or into a drain not designed to contain flammable materials. Double valves shall be provided for upstream block valves, downstream throttling to facilitate valve closure if throttling valve ices up due to auto-refrigeration. When drain lines are supported by any type of support not directly attached to the tank, adequate flexibility shall be provided in the lines to accommodate differential settlement. Stress imposed on the vessel nozzle by the drain lines shall be minimized.

8.7.4 Water drain lines and similar small lines shall be adequately supported or shall be fabricated with sufficient strength to be self-supporting under operating conditions, including the condition of maximum flow reaction thrust. Stress imposed on the container by the drain lines shall be minimized.

8.7.5 Freeze protection shall be considered for all drain lines and potential water collection points. Abnormal operating conditions, such as conditions that might occur during abnormally cold weather, should be considered where water might collect and freeze protection is needed.

9 Loading, Product Transfer, and Unloading Facilities

9.1 General

Section 9 covers the design and construction of facilities that transfer LPG as follows:

a) from a pipeline to stationary storage,

b) from truck or railcar racks and marine docks to stationary storage,

c) from stationary storage to truck or railcar racks or marine docks, and

d) from stationary storage to a pipeline.

9.2 Rates of Loading and Unloading

9.2.1 Sizing

Pumps and loading devices shall be sized to provide rates of flow appropriate to the capacity of the facility. Care shall be taken to ensure that the rates of flow give the operator enough time to follow the course of loading and unloading at all times and to shut down the facility before containers are completely emptied or before they are filled beyond their maximum filling height.

9.2.2 Design

The transfer system shall incorporate a means for rapidly and positively stopping the flow in an emergency. Transfer systems shall be designed to prevent dangerous surge pressures when the flow in either direction is stopped.

9.3 Transfer, Loading, and Unloading Equipment

9.3.1 Pumps

9.3.1.1 Pumps may be centrifugal, reciprocating, gear, submersible or may be another type designed for handling LPG. The design pressure and construction material of the pumps shall be capable of safely withstanding the maximum pressure that could be developed by the product, the transfer equipment, or both. When centrifugal pumps are used, mechanical seals are recommended. Positive displacement pumps shall have a suitable relief device on the discharge side unless other provisions are made for protection of the equipment.

9.3.1.2 When submersible pumps are used, each interface between the LPG system and an electrical conduit or wiring system shall be sealed or isolated to prevent passage of LPG to another portion of the electrical installation. See NFPA 59A for further information.

9.3.2 Compressors

Compressors for loading and unloading LPG shall be designed for the maximum outlet pressure to which they may be subjected. Each centrifugal compressor discharge connection shall be equipped with a check valve. Each centrifugal compressor shall be evaluated for conditions that may cause overpressure, and a relieving device shall be provided if required. Each positive displacement compressor shall be equipped with a pressure-relieving device on the discharge side upstream of the first block valve. A suitably sized scrubber or liquid knockout drum shall be installed immediately upstream of vapor compressors. The scrubber shall be equipped with a high-liquid-level device to shut down the compressor.

9.3.3 Pressure Gauges

Pressure gauges shall be provided in enough locations in the liquid and vapor lines to enable the operator to monitor operating pressure and pressure differentials constantly to ensure safe operation.

9.3.4 Emergency Shutoff Valves

9.3.4.1 Emergency shutoff valves shall be provided in the loading-unloading system for tank cars, trucks, and marine facilities and shall incorporate the following means of closing.

a) Manual shutoff at the installed location.

b) Manual activation from a location accessible during an emergency.

9.3.4.2 A safety analysis shall be the basis for determining the need for the following:

a) Automatic shutoff in the event of an LPG release.

b) Automatic shutoff through thermal (fire) actuation.

9.3.4.3 Installation practices for emergency shutoff valves shall include those specified in 9.3.4.3.1 and 9.3.4.3.2.

9.3.4.3.1 When hose or swivel piping is used for liquid or vapor transfer, an emergency shutoff valve shall be installed in the fixed piping of the transfer system within 20 linear ft of pipe from the end to which the hose or swivel piping is connected. Where the flow is in one direction only, a check-valve may be used in place of an emergency shutoff valve if the check valve is installed in a dedicated storage vessel fill line or vapor return line. When two or more hoses or swivel piping arrangements are used, either an emergency shutoff valve or a check-valve (for unloading lines only) shall be installed in each leg of the piping.

NOTE If check valves are used in place of emergency shutoff valves, the owner/operator should have a program to ensure the reliability of these devices.

9.3.4.3.2 The emergency shutoff valves or backflow check valves shall be installed in the fixed piping so that any break resulting from a pull will occur on the hose or swivel piping side of the connection while the valves and piping on the plant side of the connection remain intact. This may be accomplished using concrete bulkheads or equivalent anchorage or using a weakness or shear fitting.

9.3.4.4 Facility boundary limit block valves and check valves shall be provided if the feed or product is transported by pipeline. If block valves are manually operated, they shall be accessible during an emergency.

9.4 Grounding and Bonding

9.4.1 Static Electricity

Protection from discharge of static electricity is not required when a tank car, a tank truck, or marine equipment is loaded or unloaded through tight (top or bottom) outlets using a conductive or nonconductive hose, flexible