

Design and Construction of LPG Installations

Downstream Segment

API STANDARD 2510
EIGHTH EDITION, MAY 2001



**American
Petroleum
Institute**

**Helping You
Get The Job
Done Right.SM**

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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

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Design and Construction of LPG Installations

1 Scope

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. This standard covers storage vessels, loading and unloading systems, piping, or and related equipment.

1.1 The size and type of the installation; the related facilities on the site; the commercial, industrial, and residential population density in the surrounding area; the terrain and climate conditions; and the type of LPG handled shall be considered. Generally speaking, the larger the installation and the greater the population density of the surrounding area, the more stringent are the design requirements.

1.2 Design and construction considerations peculiar to refrigerated storage, including autorefrigerated storage, are covered in Section 9 of this standard.

1.3 In this standard, numerical values are presented with U.S. customary units only. These U.S. customary values are to be regarded as the standard values.

pressure, 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 Referenced Publications

The most recent edition or revision of each of the following manuals, codes, recommended practices, publications, standards, and specifications shall form a part of this standard to the extent specified:

API

RP 500	<i>Classification of Locations for Electrical Installations at Petroleum Facilities</i>
RP 505	<i>Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2</i>
RP 520	<i>Sizing, Selection, and Installation of Pres-</i>

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4 Design of LPG Vessels

4.1 APPLICABLE DESIGN CONSTRUCTION CODES

4.1.1 Vessels shall meet the requirements of the ASME Boiler and Pressure Vessel Code, 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 4.1.1.

4.2 DESIGN PRESSURE AND TEMPERATURE

4.2.1 The design pressure of LPG 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 noncondensable 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 RP 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 autorefrigeration temperature of the stored product when it flashes to atmospheric pressure. *ASME Section VIII, Division 1, has special rules for conditions where reduced temperature, as a result of autorefrigeration or ambient temperature, is caused by coincident with a reduction in pressure. In such case it is required to evaluate the material (by impact testing if necessary) at the temperature of the product corresponding to a pressure that stresses the vessel shell to approximately 10% of the ultimate tensile strength of the shell material. When the vessel is*

ambient temperature. In this situation, no additional protection against vacuum is needed.

b. 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.

c. Design for partial vacuum with a vacuum relief valve that admits air to the 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.

4.4 MATERIALS OF CONSTRUCTION

4.4.1 All materials of construction shall meet the requirements of Section II of the ASME Boiler and Pressure Vessel Code.

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

4.5 VESSEL CONNECTIONS

4.5.1 The number of penetrations in any 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 $\frac{3}{4}$.

4.5.3 Refer to Section 8 for piping requirements.

4.6 PREVIOUSLY CONSTRUCTED VESSELS

API 510 shall be used where an existing 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

- j. Local codes and regulations.
- k. Prevailing wind conditions.

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

5.1.1.2 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.

5.1.1.3 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 a pressurized LPG tank and the line of adjoining property that may be developed shall be as shown in Table 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 shells of pressurized LPG tanks or between the shell of a pressurized LPG tank and the shell of any other pressurized hazardous or flammable storage tank shall be as follows:

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

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 tank 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 752 may be used in lieu of the requirements in paragraph a and b.

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

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nearly full. This shall be achieved by locating the pressure relief valve connections as close as practical to the top of the vapor space.

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

7.1.6.4.4 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.

7.1.6.4.5 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 multi-way 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 assure they are in place and locks are operable. The valves shall 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.

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

7.1.6.5.3 Discharge vents shall be protected against mechanical damage.

7.1.6.5.4 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 will not impinge on the tank or adjoining tanks, piping, equipment, and other structures.

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

7.1.6.5.6 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 RP 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 1/8-inch-maximum restriction orifice, plugs, or thermometer wells.

7.1.7.1.2 Shutoff valves shall be located as close to the

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7.1.6.4.5 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 multi-way 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 assure they are in place and locks are operable. The valves shall 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.

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

7.1.6.5.3 Discharge vents shall be protected against mechanical damage.

7.1.6.5.4 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 will not impinge on the tank or adjoining tanks, piping, equipment, and other structures.

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

7.1.6.5.6 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 RP 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 1/8-inch-maximum restriction orifice, plugs, or thermometer wells.

7.1.7.1.2 Shutoff valves shall be located as close to the

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 and the first valve.

8.6 VALVES

8.6.1 Primary Shutoff Valves

8.6.1.1 The primary shutoff valves for a tank (specifically the valves nearest the vessel 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 Std 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

8.7.3 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. 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 vessel 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 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 SCOPE

This section covers the design and construction of facilities that transfer LPG as follows:

- From a pipeline to stationary storage.
- From truck or railcar racks and marine docks to stationary storage.
- From stationary storage to truck or railcar racks or marine docks.
- 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

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 and the first valve.

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9.5.1.1 Hose shall be fabricated of materials resistant to LPG in both liquid and vapor form. If wire braid is used for reinforcement, it shall be made from corrosion-resistant material such as stainless steel.

9.5.1.2 The correctness of design, construction, and performance of hose shall be determined. Only hose listed by Underwriters Laboratories or another nationally recognized testing laboratory shall be used for LPG transfer applications. Hose used in marine applications shall be approved by the U.S. Coast Guard.

9.5.1.3 Hose, hose connections, and flexible connectors used for transferring LPG liquid or vapor at pressures in excess of 5 psig shall conform to the criteria specified in 9.5.1.3.1 through 9.5.1.3.3.

9.5.1.3.1 Hose shall be designed for a minimum working pressure of 350 psig and a minimum bursting pressure of 1750 psig. Hose shall be marked "LPG" or "LP-gas" at intervals of not more than 10 ft.

9.5.1.3.2 After the installation of connections, hose assemblies shall be tested to a pressure not less than 700 psig.

9.5.1.3.3 Hose assemblies shall be visually inspected before each use for damage or defects. Hose assemblies shall be tested at least annually at whichever is greater, the maximum pump discharge pressure or the relief valve setting.

9.5.2 Hose Protection

Hose shall be protected from the elements and physical damage. Particular attention shall be given to the prevention of potentially damaging ice formation on the corrugations of metallic hose.

9.5.3 Support of Loading Arms or Hoses

Provisions shall be made for adequately supporting the loading hose or arm. The weight of ice formations on unusu-

mobile tanks shall be equipped with a blowdown or bleeder valve. The valve shall enable the emptying of the hose or pipe connection(s) after the block valves on each side of the hose or pipe connection(s) have been closed. The blowdown or bleeder valve shall be sized and installed so that venting does not create a hazard.

9.7 MARKING OF VALVES IN LOADING AND UNLOADING SYSTEMS

When more than one product is handled at a loading or unloading rack, the lines shall be marked or designated so that the operator can identify the various lines and valves without having to trace them to their source or destination.

9.8 METERING EQUIPMENT USED IN LOADING AND UNLOADING

When liquid meters are used to measure the volume of LPG that is being transferred from one container to another or that is being transferred to or from a pipeline, the meters and accessory equipment shall be installed in accordance with the procedures stipulated by API RP 551, and Chapter 5 of the *API Manual of Petroleum Measurement Standards*.

9.9 LPG ODORIZATION

If specified, a stationary LPG storage facility designed to transfer LPG to tanks, trucks, railroad tank-cars, or marine containers through loading racks or docks shall have equipment that enables the addition of odorant as specified by NFPA 58 and the Transportation Safety Act of 1974, Part 173, Section 315.

10 Fire Protection

10.1 GENERAL

Fire protection provisions shall be based on a safety analysis of local conditions, exposure from or to other sites, availability of a water supply, and effectiveness of fire brigades and fire departments. The analysis shall include possible but

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- b. If the other storage is in atmospheric tanks and is designed to contain material with a flash point of 100F 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 100F, half the diameter of the larger tank.
- d. 100 ft.

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

11.3.2 Siting of Refrigerated LPG Tanks

Refrigerated LPG tanks shall not be located within buildings, within the spill containment areas of other flammable or combustible liquid storage tanks as defined in NFPA 30, or within the spill containment areas of pressurized storage tanks.

11.3.3 Spill Containment

11.3.3.1 Refrigerated LPG tanks shall be provided with spill containment facilities. To prevent the accumulation of flammable material under or near a refrigerated LPG tank, the ground under and surrounding the tank shall be graded to drain any spills to a safe area away from the tank.

11.3.3.2 Spill containment shall be provided by the remote impoundment of spilled material or by the diking of the area surrounding the vessel.

11.3.4 Remote Impoundment

11.3.4.1 If remote impoundment is to be used for spill containment, the remote impoundment facility shall be designed according to the guidelines given in 11.3.4.2 through 11.3.4.5.

11.3.4.2 The grading of the area under and surrounding the vessels shall direct any leaks or spills to the remote impoundment area. The grading shall be a minimum of 1% slope.

11.3.4.3 Toe walls, dikes, trenches, or channels may be used to assist in draining the spilled product from the area of the tank to a remote impoundment area. However, the use of trenches or channels shall be minimized.

11.3.5.2 The grading of the area under and surrounding the vessel shall direct any leaks or spills to the edge of the diked area. The grading shall be a minimum of 1% slope. Within the diked area, the grading shall cause spills to accumulate away from the vessel and any piping located within the diked area.

11.3.5.3 Each refrigerated LPG tank shall be provided with its own diked area. The holdup of the diked area shall be at least 100% of the volume of the tank.

EXCEPTION: More than one tank may be enclosed within the same diked area provided provisions are made to prevent low temperature exposure resulting from leakage from any one tank from causing subsequent leakage from any other tank.

11.3.5.4 When dikes are used as part of the spill containment system, the minimum height shall be 1.5 ft, measured from the inside of the diked area. Where dikes must be higher than 6 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 tank or tanks 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 at least 2 ft wide.

11.4 THERMAL CONSIDERATIONS

The tank foundation shall be designed to prevent 32°F or lower temperatures from penetrating the pad and soil. This limitation shall be accomplished by ventilation, insulation, heating systems, or a combination of these. Heating elements, controls, and temperature sensors shall be designed for easy access and replacement while the tank is in service. Foundation heating systems shall be provided with temperature monitoring and controls. The design of the supporting structure shall consider loads resulting from (a) the thermal gradient across the supporting structure, foundation, and piling due to the temperature of the contents of the vessel and (b) the thermal shock from accidental spills.

11.5 TANK ACCESSORIES

11.5.1 Pressure/Vacuum Relieving Devices

11.5.2 Relief Valve Capacities

Relief devices for tanks designed to conform to API Std 620 shall be designed in accordance with API Std 2000. Relief devices for tanks designed to conform to Section VIII of the ASME Code shall be designed in accordance with API RP 520.

11.5.3 Temperature Indicators

Each tank shall be fitted with thermocouples or equivalent temperature-indicating devices for use during cooldown and operations.

11.5.4 Sampling Connections

If sampling connections are required, they shall be installed on the tank piping rather than on the tank.

11.5.5 Tank Accessory Materials

Low-ductility material such as cast iron, semisteel, malleable iron, and cast aluminum shall not be used in any pressure-retaining accessory parts.

11.6 PIPING REQUIREMENTS

11.6.1 Valves

Shutoff valves and accessory equipment shall be constructed of material suitable for the operating pressure and temperature extremes to which they may be subjected.

11.6.2 Insulation

The insulation shall comprise or contain a vapor barrier and shall be weatherproofed. Insulation and weatherproofing shall be fire retardant. Steel surfaces covered by insulation shall be properly coated to prevent corrosion.

11.6.3 Location

When cold piping is routed below grade, trenches, casing, or other means shall be used to permit expansion and contraction of the piping.

11.6.4 Multiple Product Types

When a storage facility handles more than one type of product, dedicated loading and unloading lines between tanks and racks shall be considered for each type of product.

11.7 REFRIGERATION SYSTEM

11.7.1 LPG Temperature

The refrigeration system shall maintain the LPG at a temperature at which the LPG's vapor pressure does not exceed the tank's design pressure.

11.7.2 Sizing

The sizing of the refrigeration system shall consider the following factors:

- a. Heat flow from the following sources:
 1. The difference between the design ambient temperature and the design storage temperature.
 2. Maximum solar radiation.
 3. Receipt of product that is warmer than the design temperature, if such an operation is expected.
 4. Foundation heaters.
 5. Connected piping.
- b. Vapor displacement during filling and vapor return during product transfer.

11.7.3 Vapor Handling

An alternate handling method shall be provided for an excess in the LPG vapor load resulting from insufficient refrigeration or loss of refrigeration.

11.7.4 Pressure-Relieving Devices

Refer to API RP 520, Parts I and II, for the proper design of pressure-relieving devices and systems for process equipment used in liquefaction and vaporization facilities.

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APPENDIX A—PIPING, VALVES, FITTINGS, AND OPTIONAL EQUIPMENT

A.1 Optional Equipment

A.1.1 GENERAL

Tanks may be fitted with the optional equipment described in A.1.2 through A.1.7. Any optional equipment selected for use shall be suitable for use with LPG and designed for at least the maximum service conditions to which it may be subjected.

A.1.2 SAMPLING CONNECTIONS

Sampling connections may be provided on tanks. As an alternative, the connections on gauging equipment may be used for sampling if they are suitably located. Adequate bracing of small connections and piping in sampling lines shall be provided to minimize vulnerability to mechanical damage. The inlet piping to sample containers shall be double valved. Sample connection locations should not be under the vessel. Connections shall be oriented so that purge vapors do not engulf the operator or approach an ignition source.

A.1.3 AUTOMATIC AND REMOTE DEVICES

Automatic shutoff valves, remotely operated shutoff valves, automatic warning devices, pump shutdown switches, or a combination of these may be used where tanks are operated remotely, where they receive LPG at a high rate of flow, or for other circumstances in which the designer considers it advisable. Fireproofing of the control systems may be required for these devices to be effective during fire exposure. See 8.11 for additional information.

A.1.4 STAIRS, LADDERS, WALKWAYS, AND PLATFORMS

Suitable stairs, ladders, walkways, and platforms should be provided to allow access to operating valves and equipment.

A.1.5 COMMON DISCHARGE HEADER

Pressure relief valve lines for one or more tanks may be connected to a common discharge header provided the LPG

single emergency situation. Liquid traps in the common header shall be prevented. Other vents, drains, bleeders, and pressure relief devices shall not be tied into the common discharge header if back pressures can develop that may prevent proper functioning of the pressure relief devices on the tank. See API Publ 2510A for additional information.

A.1.6 WATER DRAWOFFS

Facilities for removing water from LPG storage vessels should be provided. These water drawoffs shall be designed to prevent freezing of water within them. See 6.7.4, 6.7.5, and API Publ 2510A for additional information.

A.1.7 WATER FLOOD CONNECTION

Each LPG storage vessel may be provided with a water flood connection. The water flood connection may be provided either into the vapor space of the vessel or directly into the product line to the bottom of the vessel. When the water flood connection is provided on the product line, the possibility of water freezing shall be considered in the design. The water flood connection shall extend outside the spill containment system and shall include (in physical order) a block valve, a check valve, and provision for connection to the water system.

A.2 Location, Installation, and Flexibility of Piping, Valves, and Fittings

A.2.1 RECOMMENDED PRACTICES

A.2.1.1 The practices described in A.2.1.2 through A.2.1.11 concerning location, installation, and flexibility of piping, valves, and fittings are recommended.

A.2.1.2 The design of header piping and tank loading and unloading connections should be as simple as possible. The number of connections to the storage vessel should be minimized. Operating errors increase as the complexity of the pip-

flexibility because of the binding action of the earth. Buried lines should be installed below the frost line and protected from corrosion.

A.2.1.5 Piping should not be laid under concrete floors or slabs. When piping must extend through a concrete wall or below a floor slab, it should be protected by a suitable casing.

A.2.1.6 Lines laid under railroad tracks, highways, access roads, or loading slabs should be installed in accordance with API RP 1102.

A.2.1.7 Interconnected piping between tanks or tank accessories should be installed to permit flexibility in all planes. For example, loading and unloading headers should not be connected to a tank by short, straight rigid piping, regardless of whether the piping is screwed or welded. Equalizing piping should not be connected by short, straight piping between tanks. Vent or relief piping should not have straight piping between adjacent tanks. Piping should include adequate lengths of pipe, with changes in direction obtained by the use of elbows or bends, to provide for possible vertical and horizontal movement of the header relative to the tank.

A.2.1.8 In piping where thermal expansion and contraction are expected to occur, each line should be designed with an adequate expansion bend, angular offset, or other provision to allow for linear movement. Expansion bends may be fabricated from straight lengths of pipe and welding elbows or U-bends. Suitable bellows-type expansion joints, properly anchored and guided, should be used only where space limitations prevent installation of loops or bends.

A.2.1.9 To minimize the amount of material that can be spilled in the event of a line or equipment failure, emergency shutoff valves should be installed in long runs of piping that are used to carry liquids.

A.2.1.10 Low points in piping in which water can accumulate should be avoided to the greatest extent practical. In freezing climates, appropriate freeze protection should be provided where low points cannot be avoided.

A.2.1.11 The second valve in a water drain line should be self-closing (that is, it should be a deadman valve).

A.2.2 REFRIGERATION SYSTEM

A.2.2.1 The vapor load resulting from refrigeration may be handled by one or a combination of the following methods:

- a. Recovery by a liquefaction system.
- b. Use as a fuel.
- c. Use as process feedstock.
- d. Disposal by flaring or another safe method.

Alternative handling methods shall be provided to dispose of vented vapors in case of failure of the normal methods. If compressors are used, castings shall be designed to withstand a suction pressure of at least 121% of the tank design pressure.

A.2.2.2 A refrigerated LPG system should incorporate the following accessories:

- a. An entrainment separator in the compressor suction line.
- b. An oil separator in the compressor discharge line (unless the compressor is a dry type).
- c. A drain and a gauging device for each separator.
- d. A noncondensable gas purge for the condenser.
- e. Automatic compressor controls and emergency alarms to signal at the following times:
 1. When any tank's pressure approaches the maximum or minimum allowable tank working pressure or the pressure at which the vacuum vent will open, or
 2. When excess pressure builds up at the condenser because of a failure of the cooling medium.

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