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STANDARDS

for the

Storage and Handling of LIQUEFIED PETROLEUM GASES at UTILITY GAS PLANTS

MAY

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NATIONAL FIRE PROTECTION ASSOCIATION
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NATIONAL FIRE PROTECTION ASSOCIATION

INTERNATIONAL

Executive Office: 60 Batterymarch St., Boston 10, Mass.

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes over a hundred and eighty national and regional societies and associations (list on outside back cover) and fifteen thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

This pamphlet is one of a large number of publications on fire safety issued by the Association; a complete list is available without charge on request. The standards, prepared by the technical committees of the National Fire Protection Association and adopted in the annual meetings of the Association, are intended to prescribe reasonable measures for minimizing losses of life and property by fire. All interests concerned have opportunity through the National Fire Protection Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

NFPA standards are purely advisory as far as the Association is concerned, but are widely used by law enforcing authorities in addition to their general use as guides to fire-safety.

Definitions

The official NFPA definitions of shall, should and approved are:

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations, or that which is advised but not required.

APPROVED refers to approval by the authority having jurisdiction.

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters.

Approved Equipment

The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The standards are prepared, as far as practicable, in terms of required performance, avoiding specifications of materials, devices or methods so phrased as to preclude obtaining the desired results by other means. The suitability of devices and materials for installation under these standards is indicated by the listings of nationally recognized testing laboratories, whose findings are customarily used as a guide to approval by agencies applying these standards. Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada and the Factory Mutual Laboratories test devices and materials for use in accordance with the appropriate standards, and publish lists which are available on request.

Standards for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants

NFPA No. 59 — 1954

This edition of the Standards supersedes the 1949 Edition. It incorporates the changes recommended by the NFPA Committee on Gases and adopted at the NFPA Annual Meeting in Washington, D. C., May 17–21, 1954.

Public utilities have been concerned about the shortage and steadily increasing demands for gas. To meet the problem, the utilities have increasingly turned to liquefied petroleum gas as a stand-by means to meet peak load requirements. The NFPA Standards on Liquefied Petroleum Gases (NFPA No. 58) as prepared by the Committee on Gases and published in NFPA-NBFU pamphlets No. 58 were used as a general guide until separate standards were adopted in 1949.

To facilitate the preparation of these standards, the cooperation of the American Gas Association was secured. This resulted in the formation of a special committee under the sponsorship of the American Gas Association, made up of utility engineers, specialists in gas plant construction, and engineers of the liquefied petroleum gas industry. The standard is thus the result of the joint efforts of the AGA Committee and the NFPA Committee on Gases.

CONTENTS

Correction Nos. 58 and 59

In the NFPA Standards for Liquefied Petroleum Gas, Nos. 58 and 59, 1954 editions, reference is made to the 1952 edition of Standard No. 58 for conversion of relief valve ratings flow-rated in LP gas to air ratings. In future printings of these pamphlets, correction will be made by insertion of the following in place of the reference to the 1952 edition, Pamphlet 58. This appears at the end of Appendix A of Standard No. 58 and also at the end of Appendix A in Standard No. 59.

Container Type				
100	125	150	175	200
1.162	1.142	1.113	1.078	1.010

Standards for the Storage and Handling of Liquefied Petroleum Gases at Utility Plants

NFPA No. 59—1954

Introduction.

These standards recommend basic requirements. The principal purpose of these standards is to outline methods for protection of persons and property by providing in a condensed form a standard of reference to serve as a guide to all persons concerned with the construction and operation of liquefied petroleum gas equipment at utility gas plants.

The term "liquefied petroleum gases" as used in these standards shall mean and include any material which is composed predominantly of any of the following hydrocarbons, or mixtures of them; propane, propylene, butanes (normal butane or isobutane), and butylenes.

In the interest of safety, it is important that persons engaged in handling liquefied petroleum gases understand the properties of these gases and that they be thoroughly trained in safe practices for the handling and distribution of these products.

Under moderate pressure the gases liquefy, but upon relief of the pressure readily change into a gas. Advantage of this characteristic is taken by the industry, and the gases are shipped and stored under pressure as liquids. The escape of liquid into the atmosphere normally results in instantaneous vaporization, with the volume of gases being between 200 and 300 times the volume of escaping liquid. When in the gaseous state these gases are heavier than air and have a lower limit of combustibility than natural or manufactured gas.

In the case of pure product at atmospheric pressure and below 31° F., normal butane is a liquid. Propane is a liquid at atmospheric pressure at temperatures below minus 44° F. and normally does not present a flammable liquid hazard.

Commercially available butane and propane may have different liquefying points from those given above because they normally contain various percentages of other hydrocarbon products.

SECTION 1. GENERAL REQUIREMENTS.

11. Application of Rules.

110. The following standards are intended to apply to utility gas companies for the design, construction, location, installation, and operation of liquefied petroleum gas systems.

111. When operations involving container charging or transportation of liquefied petroleum gas in liquid form are carried out on the same property, these operations shall conform to NFPA Standards for the Storage and Handling of Liquefied Petroleum Gases, No. 58.

112. Installations having an aggregate water capacity not exceeding 2,000 gallons shall conform to NFPA Standards for the Storage and Handling of Liquefied Petroleum Gases, No. 58.

113. When reference is made to gas in these standards it shall refer to liquefied petroleum gases in either the liquid or gaseous state.

114. The term "containers" includes all vessels such as tanks, cylinders or drums used for storing liquefied petroleum gases.

115. The term "systems" as used in these standards refer to an assembly of equipment consisting essentially of liquefied petroleum gas unloading equipment, container or containers, major devices such as vaporizers, relief valves, excess flow valves, regulators, etc., and interconnecting piping. Such systems shall include any unloading equipment, storage equipment or interconnecting piping up to the outlet of the first stage regulator, vaporizer or mixing device, whichever is the last unit before the liquefied petroleum gas enters other plant equipment or distribution lines.

12. Odorizing Gases.

120. All liquefied petroleum gases shall be effectively odorized by an approved agent of such character as to indicate positively, by a distinctive odor, the presence of gas down to concentration in air of not over one-fifth the lower limit of combustibility; provided, however, that odorization is not required if harmful in the use or further processing of the liquefied petroleum gas, or if odorization will serve no useful purpose as a warning agent in such use or further processing.

NOTE: The lower limits of combustibility of the more commonly used liquefied petroleum gases are: Propane, approximately 2 per cent; Butane, approximately 1½ per cent. These figures represent volumetric percentages of gas in a gas-air mixture in each case.

13. Testing and Listing of Equipment.

130. In systems utilizing containers of over 2,000 gallons water capacity, each container valve, excess flow valve, gauging device, relief device directly connected on the liquefied petroleum gas container and direct fired vaporizer shall have its correctness as to design, construction, and performance determined by:

(a) Testing and Listing by Underwriters' Laboratories, Inc., or

(b) Testing and Listing by a nationally recognized agency for liquefied gas use, or

(c) The authority having jurisdiction.

14. Damage from Vehicles.

140. Where damage to liquefied petroleum gas systems from vehicular traffic is a possibility, precautions against such damage shall be taken.

15. Lighting.

150. Adequate lights shall be provided to illuminate storage containers, control valves and other equipment.

SECTION 2. CONTAINERS.

21. Requirement for Construction and Original Test of Containers.

210. Containers shall be designed, constructed and tested in accordance with the Unfired Pressure Vessel Code sponsored by either the American Society of Mechanical Engineers (ASME) or the American Petroleum Institute and the American Society of Mechanical Engineers (API-ASME) or in accordance with the rules of the authority under which the containers are installed, provided such rules conform with the rules of the ASME Code or the API-ASME Code. (See Paragraph 412.)

(a) Containers constructed according to the 1949 and earlier editions of the ASME Code need not comply with the paragraphs U-2 to U-10 inclusive and U-19. Containers constructed according to paragraph U-70 are not authorized.

(b) Containers constructed according to API-ASME Code need not comply with the Section I or with appendix to Section I of said Code. Paragraphs W-601 to W-606 in-

clusive in the 1943 and earlier editions of said Code do not apply.

211. The provisions of Paragraph 210 shall not be construed as prohibiting the continued use or reinstallation of containers constructed and maintained in accordance with the NFPA Standards for the Storage and Handling of Liquefied Petroleum Gases, No. 58, in effect at the time of fabrication.

22. Capacity of Liquid Containers.

220. Liquid storage containers capable of storing any of the liquefied petroleum gases as defined in these standards shall not exceed 30,000 standard U. S. gallons water capacity.*

23. Design Working Pressure and Classification of Storage Containers.

230. Storage containers shall be designed and classified as follows:

Container Type	For Gases with Vapor Press. Not to Exceed lb. per sq. in. Gauge at 100° F.	Minimum Design Working Pressure of Container lb. per sq. in. gauge	
		1949 and earlier edition of ASME Code (Par. U-68, U-69)	1949 edition of ASME Code (Par. U-200, U-201); 1950 and 1952 editions of ASME Code; all editions of API-ASME Code
80*	80*	80*	100*
100	100	100	125
125	125	125	156
150	150	150	187
175	175	175	219
200**	215	200	250

*New storage containers of the 80 type have not been authorized since December 31, 1947.

**Container type may be increased by increments of 25. The minimum design working pressure of containers shall be 100% of the container type designation when constructed under 1949 or earlier editions of the ASME Code (Par. U-68 and U-69). The minimum design working pressure of containers shall be 125% of the container type designation when constructed under: (1) the 1949 ASME Code (U-200 and U-201), (2) 1950 and 1952 editions of the ASME Code, and (3) all editions of the API-ASME Code.

NOTE: Because of low soil temperature usually encountered, and the insulating effect of the earth, the average vapor pressure of products stored in underground containers will be materially lower than when stored aboveground. This reduction in actual operating pressure therefore provides a substantial corrosion allowance for these containers when installed underground.

231. The shell or head thickness of any container shall not be less than 3/16 inch.

24. Markings on Containers.

240. Each container shall be marked as specified in the following:

(a) With a marking identifying compliance with, and other markings required by the rules of the code under which the container is constructed; or with the stamp and other markings required by the National Board of Boiler & Pressure Vessel Inspectors.

Underground: Container and an accessible name plate.
Aboveground: Container.

(b) With notation as to whether system is designed for underground or aboveground installation.

Underground: Container and an accessible name plate.
Aboveground: Container.

(c) With the water capacity of the container in gallons, U. S. Standard.

Underground: Container and an accessible name plate.
Aboveground: Container.

(d) With the pressure in pounds per square inch for which the container is designed.

Underground: Container and an accessible name plate.
Aboveground: Container.

(e) With the wording "This container shall not contain a product having a vapor pressure in excess of —— lbs. per sq. in. gauge at 100° F." (See Paragraph 230.)

Underground and aboveground: A name plate or tag on filler connection.

(f) With the outside surface area in square feet.

Underground: Container and an accessible name plate.
Aboveground: Container.

(g) With marking indicating the maximum level to which the container may be filled with liquid at temperatures between 20° F. and 130° F. except on containers provided with fixed maximum level indicators. Markings shall be in increments of 20° F.

Aboveground and underground: System name plate or on liquid level gauging device.

25. Location of Containers.

251. Containers shall be located outside of buildings, and each individual container in a group shall be separated by a dis-

tance of at least 5 feet from adjacent containers and shall be located at least 50 feet away from the nearest important building or group of buildings, or line of adjacent property which may be built upon.

(a) When the number of aboveground containers exceeds six, they shall be segregated into groups not exceeding six containers in each group, and such groups shall be separated from each other by at least 25 feet.

(b) When the installation consists of 6 or more containers, they and their loading stations should preferably be located 100 feet or more from buildings occupied for generation, compression or purification of manufactured gas, or from natural gas compressor buildings, or from outdoor installations essential to the maintenance of operation in such buildings, and should be 100 feet or more from aboveground storage of flammable liquids and from any buildings of such construction or occupancy which constitutes a material hazard of exposure to the containers in the event of fire or explosion in said buildings. If the storage containers by necessity are located closer than 50 feet to any such buildings or installations, then the latter shall be protected by walls adjacent to such storage containers or by other appropriate means against the entry of escaped liquefied petroleum gas, or of drainage from the storage container area and its loading points, — all in such a manner as may be required and approved by the authority having jurisdiction.

252. Storage containers shall not be stacked one above the other.

253. Liquefied petroleum gas containers shall not be located within dikes enclosing flammable liquid tanks.

254. The ground within 25 feet of any aboveground container shall be kept clear of readily ignitable material such as weeds and long dry grass.

255. In cases where containers are to be installed in heavily populated or congested areas, the authority having jurisdiction shall determine restrictions of individual tank capacity, total storage, distance to line of adjoining property which may be built on or other reasonable protective methods.

256. Roadways or buildings shall not be constructed over underground liquefied petroleum gas containers.

26. Installation of Storage Containers.

260. Containers installed aboveground shall be provided with substantial masonry or noncombustible structural supports on firm masonry foundations.

261. Aboveground containers shall be supported as follows:

Horizontal containers shall be mounted on saddles in such a manner as to permit expansion and contraction, not only of the container but also of the connected piping. Only two saddles shall be used. Every container shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell. Structural metal supports may be employed when they are protected against fire in an approved manner. Suitable means to prevent corrosion shall be provided on that portion of the container in contact with the foundations or saddles.

262. Field welding where necessary shall be made only on saddle plates or brackets which were applied by manufacturer of container, except as provided by the code under which the container was fabricated.

263. Secure anchorage or adequate pier height shall be provided to protect against container flotation wherever sufficiently high flood water might occur.

264. When flammable liquid storage tanks are in the same general area as liquefied petroleum gas containers, the flammable liquid storage tanks shall be diked or diversion curbs or grading used to prevent accidently escaping flammable liquids from flowing into liquefied petroleum gas container areas.

265. Underground containers shall be adequately protected against corrosion.

266. The container storage area shall be fenced or otherwise protected where necessary and at least two points of access through the fencing shall be provided.

267. Aboveground containers should be kept properly painted or otherwise protected from the elements.

27. Re-installation of Containers.

270. Containers once installed underground or aboveground which have been out of service for more than one year, shall not be reinstalled aboveground or underground, unless they suc-

cessfully withstand hydrostatic pressure retests at the pressure specified for the original hydrostatic test as required by the code under which constructed, and show no evidence of serious corrosion. Reinstallation of containers in all other respects shall be in accordance with all the provisions listed in these standards. (See Paragraph 265. See also Section 5 for relief valve requirements.)

28. Gaskets.

280. Gaskets for use on storage containers shall be fabricated with materials which have a melting point over 1000° F. Aluminum O ring and spiral wound metal asbestos gaskets are recommended. Whenever a flange is opened the gasket should be replaced.

29. Filling Densities.

291. The "filling density" is defined as the per cent ratio of the weight of the liquefied petroleum gas in a container to the weight of water the container will hold at 60° F. The filling densities for storage containers shall not exceed the following:

MAXIMUM PERMITTED FILLING DENSITY

Specific Gravity at 60° F	Aboveground Containers	Underground Containers
.473—.480	41%	42%
.481—.488	42	43
.489—.495	43	44
.496—.503	44	45
.504—.510	45	46
.511—.519	46	47
.520—.527	47	48
.528—.536	48	49
.537—.544	49	50
.545—.552	50	51
.553—.560	51	52
.561—.568	52	53
.569—.576	53	54
.577—.584	54	55
.585—.592	55	56
.593—.600	56	57
.601—.608	57	58
.609—.617	58	59
.618—.626	59	60
.627—.634	60	61

292. The maximum liquid volume in per cent of the total container capacity may be determined for liquefied petroleum gases at any liquid temperature by using the formula shown in Appendix C.

SECTION 3. PIPING, VALVES, GAUGING DEVICES.

31. Piping Materials.

310. Seamless copper, brass, or steel pipe or tubing may be used for sizes ½ in. or under. All piping and pipe fittings over ½ in. size, connected to a storage container, shall be made of steel. All piping or tubing shall be designed and tested after installation at 1½ times the maximum working pressures to which it may be subjected.

311. Piping connections external to the container for sizes over 2 inches nominal pipe diameter shall be welded flanges or straight welded, with the possible exception of piping connections for excess flow valves and for relief valve risers.

312. The use of cast iron valves, pipe and fittings shall be prohibited in piping carrying liquefied petroleum gas in the liquid phase.

313. Valve seat material, packing, gaskets, etc., shall be resistant to the action of liquefied petroleum gas in the liquid phase.

314. All piping, tubing, fittings and the valves shall be tested after assembly and proved free from leaks at not less than normal operating pressures. Test shall not be made with a flame.

315. Provision shall be made for expansion, contraction, jarring and vibration, and for settling.

316. Piping outside buildings may be buried, aboveground, or both, but shall be well supported and protected against physical damage and corrosion.

32. Container Valves and Accessories.

321. All shut-off valves and accessory equipment (liquid or gas) shall be suitable for use with liquefied petroleum gas, and designed for not less than the maximum pressure to which they may be subjected. Valves which may be subjected to container pressure shall have a rated working pressure of at least 250 pounds per square inch gauge. Cast iron valves, piping and fittings shall be prohibited on liquefied petroleum gas containers and their connections.

322. All connections to containers, except safety relief connections and gauging devices shall have shut-off valves located as close to the container as practicable.

323. Excess flow valves where required by these standards shall close automatically at those rated flows of vapor or liquid as specified by the manufacturer. The connections or line including valves, fittings, etc., downstream of an excess flow valve shall have a greater capacity than the rated flow of the excess flow valve.

324. Except as provided in Paragraphs 325 and 342 all liquid and vapor connections on containers except safety relief connections shall be equipped with approved automatic excess flow valves or with back pressure check valves.

325. Openings from a container or through fittings attached directly on the container to which pressure gauge connection is made need not be equipped with an excess flow valve if such openings are not larger than No. 54 drill size.

326. Excess flow and back pressure check valves where required by these standards shall be located inside of the container or at a point outside where the line enters the container; in the latter case, installation shall be made in such a manner that any undue stress beyond the excess flow or back pressure check valve will not cause breakage between the container and such valve.

327. Excess flow valves shall be designed with a by-pass, not to exceed a No. 60 drill size opening to allow equalization of pressures.

328. All inlet and outlet connections except safety valves, liquid level gauging devices and pressure gauges on any container shall be labeled or color coded to designate whether they are connected to vapor or liquid space. Labels may be on valves.

329. Each storage container shall be provided with a suitable pressure gauge.

33. Filler and Discharge Pipes, Manifolds.

330. Piping connections between container and manifold should be designed to provide adequate allowances for contraction, expansion, vibration, and settlement. Compression type couplings shall not be considered suitable for this purpose.

331. It is desirable that liquid manifold connections be located at non-adjacent ends of parallel rows of containers.

332. The use of non-metallic hose is prohibited for interconnecting stationary containers.

333. A good test for determination of piping stresses consists of unbolting piping at a flange and noting whether the flange remains in proper alignment.

334. The filling pipe inlet terminal shall not be located inside a building. Such terminals shall be located not less than 10 feet from any building, and preferably not less than 5 feet from any driveway, and shall be properly supported and protected from physical damage.

335. A shut-off valve shall be provided in liquid piping for each section of pipe containing 500 gallons capacity when the pipe is within 300 feet of storage containers or other important aboveground structures.

336. When the liquid line manifold connecting containers in a group has a volumetric capacity of more than 100 gallons, such container manifolds shall be located not less than 100 feet from the nearest adjacent property owned by others which may be built upon. The manifold piping terminates at the first line valve which may be used to isolate the manifolded containers from any other part of the liquid line system.

337. If more than three storage containers discharge liquid into a manifold whose nominal diameter is greater than 2 inches and if the flow capacity of such manifold is less than the total discharge capacity of the discharge lines from the containers, one of the following for each container shall be provided:

(a) A remotely controlled external shut-off valve in combination with an excess flow valve.

(b) A remotely controlled quick-closing valve which shall remain closed except during operating periods. The mechanism for such valves may be provided with a secondary control equipped with a fusible release (not over 220° F. melting point) which will cause the quick-closing valve to close automatically in case of fire.

34. Liquid Level Gauging Device.

340. Each container shall be equipped with a liquid level gauging device of approved design, for example, a rotary gauge, slip tube, an automatic outage tank, magnetic or fixed tube device. If the liquid level gauging device is a float type or a pressure

differential type, the container shall also be provided with a fixed dip tube, slip tube, rotary gauge or similar device.

341. All gauging devices shall be arranged so that the maximum liquid level for butane, for a 50–50 mixture of butane and propane, and for propane, to which the container may be filled is readily determinable.

342. Gauging devices that require bleeding of the product to the atmosphere, such as the rotary tube, fixed tube and slip tube, shall be so designed that the bleed valve maximum opening is not larger than a No. 54 drill size, unless provided with an excess flow valve.

343. Gauging devices shall have a design working pressure of at least 250 pounds per square inch gauge.

344. Length of a fixed tube device shall be designed to indicate the maximum level to which the container may be filled for the product contained. This level shall be based on the volume of the product at 40° F. at its maximum permitted filling density for aboveground containers and at 50° F. for buried containers. Refer to Appendix D for calculating filling point for which tube shall be designed.

345. Gauge glasses of the columnar type shall not be permitted.

35. Hose Specifications.

350. Hose shall be fabricated of materials that are resistant to the action of liquefied petroleum gas.

351. Hose subject to container pressure shall be designed for a bursting pressure of not less than five times the pressure for which the container was designed. Hose connections when made shall be capable of withstanding a test pressure of twice the pressure for which the container is designed.

352. Hose and hose connections located on the low pressure side of regulators or reducing valves shall be designed for a bursting pressure of not less than 125 pounds per square inch but not less than five times the pressure setting of the safety relief devices protecting that portion of the system. There shall be no leakage from assembled hose connections.

36. Drips, Pits and Drains.

360. Where vaporized gas may condense, suitable means shall be provided for re-vaporization or disposal of the condensate.

361. Every effort should be made to avoid the use of pits. If pits are used they shall be fitted with continuous automatic flammable vapor detecting devices equipped with an alarm. No drains or blow-off lines shall be directed into or in proximity to sewer systems used for other purposes.

37. Pumps and Compressors.

370. Each pump and compressor shall be suitable for the liquefied petroleum gas service intended. Each pump and compressor shall be marked with its maximum working pressure.

38. Protection of Container Accessories, Grounding.

380. Valves, regulating, gauging, and other container accessory equipment shall be protected against tampering and physical damage.

NOTE: The use of locks is not usually desirable because it prevents access in case of emergency.

381. All connections on underground containers shall be located within a substantial dome, housing, or manhole and protected by a substantial round cover. (See Paragraph 541.)

382. Aboveground containers shall be electrically grounded in an effective manner. (See Report of NFPA Committee on State Electricity, Pamphlet No. 77.)

SECTION 4. VAPORIZERS.

41. General.

411. Liquefied petroleum gas storage containers shall not be directly heated with open flames.

412. Heating or cooling coils shall not be installed inside of a storage container.

413. Vaporizers shall not be equipped with fusible plugs for pressure relief.

414. Vaporizer houses shall not have drains to sewers or sump pits.

42. Vaporizers Not Directly Heated With Open Flames.

421. Vaporizers constructed in accordance with the requirements of the ASME Unfired Pressure Vessel Code shall be permanently marked as follows:

(a) With the code marking signifying the specifications to which vaporizer is constructed.

(b) With the allowable working pressure and temperature for which the vaporizer is designed.

(c) With the sum of the outside surface area and the inside heat exchange surface area expressed in square feet.

(d) With the name or symbol of the manufacturer, date of manufacture, and serial number.

422. Vaporizers having an inside diameter of 6 inches or less exempted by paragraph U-1(a) of the ASME Unfired Pressure Vessel Code shall have a design working pressure not less than 250 pounds per square inch gauge and need not be permanently marked.

423. Vaporizers shall not be installed in the same room with units furnishing air other than for a liquefied petroleum gas mixing device. Vaporizers may be installed in buildings, rooms, sheds, or lean-tos, other than those in which open flames or fires may exist. Such structures shall be of light fire resistive construction or equivalent, well ventilated near the floor line and at the highest point in the roof.

424. A shut-off valve shall be installed on the liquid line to the liquefied petroleum gas vaporizer unit at least 50 feet away from the vaporizer building.

425. The heating medium lines into and leaving the vaporizer shall be provided with suitable means for preventing the flow of gas into the heat systems in the event of tube rupture in the vaporizer. Vaporizers shall be provided with suitable means to prevent liquid passing from the vaporizers to the gas discharge piping.

426. The device that supplies the necessary heat for producing steam, hot water, or other heating medium shall be separated from all compartments or rooms containing liquefied petroleum gas vaporizers, pumps, and central gas mixing devices by a wall of substantially fire resistive material and vaportight construction.

43. Direct Fired Vaporizers.

430. Each vaporizer shall be marked to show the name of the manufacturer; rated British Thermal Unit input to burners; the area of the heat exchange surface in square feet; and the maximum vaporizing capacity in gallons per hour, and date and serial number.

431. No direct fired vaporizers shall be located closer than 50 feet to line of adjoining property upon which structures may be built. They shall also be located a minimum distance of 50 feet away from any liquefied petroleum gas storage container.

432. No direct fired vaporizer shall be connected to a container that has a storage capacity in gallons, less than 10 times the hourly capacity of the vaporizer in gallons. Vaporizers may be connected to the liquid section or the gas section of the storage container, or both; but in any case there shall be at the container a manually operated valve in each connection to permit complete shutting off, when desired, all flow of gas or liquid from container to vaporizer.

433. Vaporizers may be installed in buildings, rooms, housings, sheds, or lean-tos used exclusively for vaporizing or mixing of liquefied petroleum gas. All vaporizer housing structures shall be of light fire resistive construction, well ventilated near the floor line and the highest point of the roof.

434. When vaporizers and mixing equipment are installed in structures that house other facilities, the vaporizers and mixing equipment room shall be separated from the other parts of the building with fire resistive, vaportight walls.

435. Vaporizers shall be provided with suitable automatic means to prevent liquid passing from the vaporizer to the gas discharge piping of the vaporizer.

436. Vaporizers shall be provided with a means for turning off the gas to the main burner and pilot from a remote location.

437. Vaporizers shall be equipped with automatic safety devices to shut off the flow of fuel to main burners and pilot, if the ignition device should fail.

438. Pressure control equipment which is a pertinent part of the vaporizer, if located within 10 feet of the vaporizer, shall be separated from the open flame by a substantial vaportight, fire resistive partition or partitions.

439. No direct fired vaporizer shall raise the product pressure over the designed working pressure of the vaporizer equipment.

44. Electrical Connections and Open Flames.

441. In vaporizer houses, except those housing direct fired vaporizers, gas mixing rooms and similar locations, all electrical installations shall be in accordance with the requirements of the National Electrical Code for Class I, Group D, Division I, hazardous locations.

442. Open flames and other sources of ignition shall not be permitted in vaporizer houses, gas mixing rooms and similar locations. Locations containing direct fired vaporizers are excepted.

SECTION 5. RELIEF DEVICES.

51. General.

All relief device installations shall comply with the following:

510. Relief devices on containers shall be so arranged that the possibility of tampering will be minimized; if the pressure setting or adjustment is external, the relief devices shall be provided with an approved means for sealing the adjustment.

511. Each container relief device shall be plainly and permanently marked with the "Container Type," of the pressure vessel on which the device is designated to be installed, with the pressure in pounds per square inch gauge at which the device is set to start to discharge, with the actual rate of discharge of the device at its full open position in cubic feet per minute of air at 60° F. and atmospheric pressure, and with the manufacturer's name and catalogue number; for example, T-200—250–15,000 AIR — indicating that the device is suitable for use on a Type 200 container, that it is set to start to discharge at 250 pounds per square inch gauge, and that its rate of discharge at full open position (See 532 and 533) is 15,000 cubic feet per minute of air as determined in Appendix A.

512. Connections to which relief devices are attached, such as couplings, flanges, nozzles, and discharge lines for venting, shall have internal dimensions that will not restrict the net relief area.

513. The size of the relief device outlet connection shall not be smaller in diameter than the nominal size of the relief outlet connection and shall not appreciably restrict flow through the relief.

514. All container relief devices shall be located on the containers and shall be connected with the vapor space of the container.

515. No shut-off valve shall be installed between the relief device and the container, equipment, or piping to which the relief device is connected except that a shut-off valve may be used where the arrangement of this valve is such that full required capacity flow through the relief device is always afforded.

NOTE: The above exception is made to cover such cases as a three-way valve installed under two relief devices, each of which has the required rate of discharge. The installation will allow either of the reliefs to be closed but does not allow both reliefs to be closed at the same time. Another exception to this may be where two separate reliefs are installed with individual shut-off valves. In this case the two shut-off valve stems shall be mechanically inter-connected in a manner which will allow full required flow of one relief at all times.

516. Relief device discharge vents shall be installed in a manner which will provide protection against physical damage and such discharge pipes shall be fitted with loose raincaps. Return bends and restrictive pipe fittings shall not be permitted.

517. If desired, discharge lines from two or more relief devices located on the same unit, or similar lines from two or more different units, except those located on storage containers, may be run into a common discharge header, provided that the cross sectional area of such header be at least equal to the sum of the cross sectional area of the individual discharge lines, and that the setting of relief devices is the same.

518. Discharge from a relief device shall not terminate in any building, beneath any building, or in any other kind of confined area.

519. The discharge from all relief devices, except those installed between shut-off valves, shall be piped to a point not less than three feet above the highest point of any building within 50 feet.

52. Testing Relief Devices.

520. Frequent testing of relief devices, as would be required where there is a probable increase or decrease in the releasing pressure of the device due to clogging, sticking, corrosion or exposure to elevated temperatures, is not necessary for such devices on liquefied petroleum gas containers for the following reasons:

(a) The gases are so-called "sweet gases," *i.e.*, they have no corrosive effect on metals; the devices are constructed

of materials not readily subject to corrosion and are protected against the weather when installed in pressure vessels. Further, the temperature variations are not sufficient to bring about any permanent set of spring mechanisms.

(b) Therefore the testing and inspecting of relief devices to check relief pressure settings is required only at about five-year intervals.

53. On Aboveground Containers.

530. Every container shall be provided with spring loaded relief valves or their equivalent.

531. The discharge from the relief devices shall be vented away from the container, and unobstructed to the open air in a manner to prevent any impingement of escaping gas upon the container, adjacent containers, piping and other equipment. The vents shall be fitted with loose fitting rain caps. Suitable provision shall be made to prevent any liquid or condensate that may accumulate inside the relief device or its vent from rendering the relief device inoperative. If a bottom drain is used, a means shall be provided to protect the container, adjacent containers, piping of equipment against impingement of flame resulting from ignition of product escaping from the drain. The vent piping shall extend upward at least 7 feet above the top of the container.

532. Container relief device shall be set to start to discharge as follows, with relation to the design working pressure of the container:

Containers	*Minimum*	*Maximum*
1949 and earlier Edition of ASME Code: Par. U-68, U-69	110%	125%
1949 edition of ASME Code: Par. U-200, U-201; 1950 & 1952 Editions of ASME Code . . .	88	100
All Editions of API-ASME Code	88	100

533. Relief devices on containers shall be constructed to discharge at not less than the rates shown in Appendix A, before the pressure is in excess of 120 per cent of the maximum permitted start to discharge pressure setting of the devices.

534. In certain locations sufficiently sustained sun temperatures prevail which will require the use of a lower vapor pressure product to be stored or the use of a higher designed pressure vessel in order to prevent the container relief device from opening as a result of these temperatures. As an alternative the

containers may be protected by cooling devices such as water sprays, by shading, or other effective means.

54. On Underground Containers.

540. Relief devices shall meet all conditions outlined for Aboveground Containers but the discharge in this case shall be piped vertically and directly upward to a point at least 7 feet above the ground.

541. Where there is a probability of the manhole or housing becoming flooded, the discharge from regulator vent lines should be above such water level. All manholes or housings shall be provided with ventilated louvers or their equivalent.

55. On Vaporizers.

550. Each vaporizer shall be provided with a relief device providing an effective rate of discharge in accordance with Appendix B.

551. Relief valves on direct fired vaporizers shall be located so that they shall not be subjected to temperatures in excess of 140° F. (See Paragraph 51 for other requirements on relief devices.)

56. Between Shut-Off Valves.

560. A relief device shall be installed between each pair of shut-off valves on liquefied petroleum gas liquid piping so as to relieve into a safe atmosphere. It is recommended that the start to discharge pressure of such relief devices be not in excess of 500 psig.

57. At Discharge of Final Stage Regulators.

570. When the discharge pressure from the final stage regulator is not more than 5 pounds, the low pressure side shall be equipped with a relief device, set to relieve at not less than two times, and not more than three times the discharge pressure but not more than 5 lbs. in excess of the discharge pressure. When the discharge pressure is more than 5 pounds, the relief shall be set to not less than 1¼ times and not more than two times the discharging pressure. Regulator breather vents shall be piped outside the building and equipped with insect-proof terminal screens.

SECTION 6. HANDLING.

61. Transfer of Liquids from Tank Cars or Tank Trucks.

610. At least one attendant shall remain close to the transfer connection from the time the connections are first made until they are finally disconnected, during the transfer of product.

611. The maximum vapor pressure of the product at 100° F. which may be transferred into a container shall be in accordance with Paragraph 230.

612. Precaution shall be exercised to assure that only those gases for which the system is designed, examined, and listed, are employed in its operation, particularly with regard to pressures.

613. Where needed unloading piping or hoses shall be provided with suitable bleeder valves for relieving pressure before disconnection.

614. Pumps or compressors shall be designed and constructed for use with liquefied petroleum gas. When compressors are used they may take suction from a fuel gas supply or from the vapor space of the container being filled and discharge to the vapor space of the container being emptied. When low temperatures so reduce the liquefied petroleum vapor pressure that the compressor will not function satisfactorily, the compressor may take suction directly from the air and discharge through a suitable moisture removing medium to the container being emptied.

62. Tank Car Loading and Unloading Point.

620. The track of tank car siding shall be relatively level.

621. A TANK CAR CONNECTED sign, as covered by I.C.C. (Interstate Commerce Commission) rules, shall be installed at the active end or ends of the siding while the tank car is connected for unloading.

622. While cars are on side-track for unloading, the wheels at both ends shall be blocked on the rail.

623. A man shall be in attendance at all times while the tank car or cars are being unloaded.

624. The pipe line to which the tank car unloading hoses are connected shall be equipped with a back flow check valve to prevent discharge of the liquefied petroleum gas from the receiving container and line in case of rupture of line hose or fittings.

625. The tank car unloading point should be located with due safety consideration to the following:

(a) Proximity to railroad and highway traffic.
(b) The distance of such unloading point from adjacent property.
(c) With respect to buildings on installer's property.
(d) Nature of occupancy.
(e) Topography.
(f) Type of construction of buildings.
(g) Number of tank cars that may be safely unloaded at one time.
(h) Frequency of unloading.

626. Where practical, the distance of the tank car unloading point should conform to the distance in Paragraph 251 except that lesser distances may be used, keeping in mind the above items and upon approval of the authority having jurisdiction.

SECTION 7. FIRE PROTECTION.

71. Fire Protection.

710. The wide range in the size, design, and location of utility plant liquefied petroleum gas installations makes the recommendations of any specific kind or method of fire protection impractical. The planning of effective fire protection should initially be collateral with the protection practices followed in other sections of the particular utility company and should give due consideration to the requirements of the authority having jurisdiction.

711. Gas fires should not be extinguished until the source of the burning gas can be shut off. Remotely operated or remotely located pipe line valves may be advantageously used for fire control under many circumstances (see Paragraphs 335, 337 and 424).

712. Hand or wheeled fire extinguishers designed for gas fires, preferably of the dry powder type, should be available at each strategic location within a liquefied petroleum gas plant for controlling or extinguishing small gas fires which could, if unattended, become major fires.

713. Supplies of water may initially be utilized through hose streams or fog nozzles. If sufficient quantities of water can be

made available, complete water spray protection can be given consideration. The water is used for the sole purpose of cooling equipment, foundations, and piping. It shall not be relied upon for extinguishing gas fires.

714. Fire resistant insulation can be utilized for protecting metal against heat at locations where the water supply is limited or not available.

715. Where standard watchman service is provided it shall be extended to the liquefied petroleum gas installation; such personnel shall be properly trained.

716. Suitable roadways or means of access shall be provided for extinguishing equipment such as wheeled extinguishers or other fire department apparatus.

717. Routine fire drills and inspections should be scheduled and operating personnel thoroughly trained in the use of available fire-fighting equipment and the location and use of all gas and liquid piping and valves.

APPENDIX A.

Minimum Required Rate of Discharge in cubic feet per minute of air at 120% of the maximum permitted start to discharge pressure for safety relief devices to be used on containers other than those constructed in accordance with Interstate Commerce Commission specification.

Surface Area Sq. Ft.	Flow Rate CFM Air	Surface Area Sq. Ft.	Flow Rate CFM Air	Surface Area Sq. Ft.	Flow Rate CFM Air
20	626	170	3620	600	10170
25	751	175	3700	650	10860
30	872	180	3790	700	11550
35	990	185	3880	750	12220
40	1100	190	3960	800	12880
45	1220	195	4050	850	13540
50	1330	200	4130	900	14190
55	1430	210	4300	950	14830
60	1540	220	4470	1000	15470
65	1640	230	4630	1050	16100
70	1750	240	4800	1100	16720
75	1850	250	4960	1150	17350
80	1950	260	5130	1200	17960
85	2050	270	5290	1250	18570
90	2150	280	5450	1300	19180
95	2240	290	5610	1350	19780
100	2340	300	5760	1400	20380
105	2440	310	5920	1450	20980
110	2530	320	6080	1500	21570
115	2630	330	6230	1550	22160
120	2720	340	6390	1600	22740
125	2810	350	6540	1650	22320
130	2900	360	6690	1700	23900
135	2990	370	6840	1750	24470
140	3080	380	7000	1800	25050
145	3170	390	7150	1850	25620
150	3260	400	7300	1900	26180
155	3350	450	8040	1950	26750
160	3440	500	8760	2000	27310
165	3530	550	9470		

Surface Area = Total outside surface area of container in square feet.

When the surface area is not stamped on the name plate or when the marking is not legible, the area can be calculated by using one of the following formulas:

(1) Cylindrical container with hemispherical heads
Area = Overall length × outside diameter × 3.1416

(2) Cylindrical container with semi-ellipsoidal heads
Area = (Overall length + .3 outside diameter) × outside diameter × 3.1416

(3) Spherical container
Area = Outside diameter squared × 3.1416

Flow Rate-CFM Air = Required flow capacity in cubic feet per minute of air at standard conditions, 60° F. and atmospheric pressure (14.7 psia).

The rate of discharge may be interpolated for intermediate values of surface area. For containers with total outside surface area greater than 2000 square feet, the required flow rate can be calculated using the formula, Flow Rate-CFM Air = $53.632\ A^{0.82}$.

Where

A = total outside surface area of the container in square feet.

Values not marked "Air" are flow rated in liquefied petroleum gas and can be converted to their air capacity ratings by applying the air conversion factors given in the table following Appendix A of the 1949 edition of Standard No. 59.

APPENDIX B.

Minimum Required Rate of Discharge for Safety Relief Valves for Liquefied Petroleum Gas Vaporizers (Steam Heated, Water Heated, and Direct Fired.)

The minimum required rate of discharge for relief valves shall be determined as follows:

1. Obtain the total surface area by adding the surface area of vaporizer shell in square feet directly in contact with liquefied petroleum gas and the heat exchange surface area in square feet directly in contact with liquefied petroleum gas.

2. Obtain the minimum required rate of discharge in cubic feet of air per minute, at 60° F. and 14.7 psia from Appendix A for this total surface area.

APPENDIX C.

Method of Calculating Maximum Liquid Volume Which Can Be Placed in a Container at Any Liquid Temperature.

The quantity of liquefied petroleum gas which may be placed in a container is dependent upon the temperature of the liquid and the maximum permitted filling density in addition to the size of the container.

The filling density depends on: The size of tank, whether it is installed aboveground or underground, and the specific gravity of the liquid liquefied petroleum gas at 60° F. placed in the container. Filling density values are given in Paragraph 291. The liquid temperature should be obtained by measuring the temperature of the liquid liquefied petroleum gas in the container with a thermometer placed in a thermometer well installed in the tank.

Knowing the liquid temperature and the filling density, the maximum volume of liquid liquefied petroleum gas which may be placed in a container can be determined as follows:

$$V = \frac{D}{G \times F}$$

Where

V = maximum liquid volume (in per cent of total container capacity) which shall be placed in a container when the liquid temperature is T.