SECOND REVISION TO

PROPOSED

CHAPTER 377, LIQUEFIED NATURAL GAS

OF TITLE 12, N.J.A.C.

STATE OF NEW JERSEY,
DEPARTMENT OF LABOR AND INDUSTRY,
Bureau of Engineering and Safety,
Trenton, New Jersey

March 1, 1973

This Second Revision represents changes to Proposed Chapter 136, Liquefied Natural Gas of Title 12, N.J.A.C. dated August 20, 1971. This Second Revision has been made in response to comments made at the Public Hearing held January 5, 1972.

This Second Revision has also been revised by the Bureau for promulgation under the proposed New Jersey Occupational Safety and Health Act and assigned a new Chapter number under that program.

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FOREWORD

With the enactment of the Williams Steiger Occupational Safety and Health Act of 1970, Public Law 91-596, Federal regulations under Section 6 of the Act have been promulgated as 29 CFR Part 1910 - Occupational Safety and Health Standards.

Since the New Jersey Department of Labor and Industry is the authorized agency under the Section 18(b) agreement provided for in the Federal Act, it is appropriate that this Department have regulations on subjects not covered by the Federal regulatory program where there is an urgent compelling need for such regulations due to local conditions. Such is the case with regard to liquefied natural gas. The gas utilities and the gas transmission pipeline companies have found it economically feasible and necessary to establish liquefied natural gas facilities in this State. Since this type of installation represents an unusual fire and explosion hazard to employees it is appropriate that regulations on the proper installation of such facilities be available. Therefore, it is with this purpose that this Chapter of the New Jersey Administrative Code has been promulgated.

This Chapter 377, Liquefied Natural Gas of Title 12, N.J.A.C. is based upon, in part, Liquefied Natural Gas, NFPA No. 59 A-1972.

This Chapter is promulgated by the Commissioner of Labor and Industry of the State of New Jersey, under authority vested in him by Section 7(b) of the Occupational Safety and Health Act, P.L. 1972, Chapter , N.J.S.A. 34:6A, as follows:

> "Where, in the discretion of the Commissioner, it is determined necessary and proper to promulgate a rule where no Federal Standard exists or where a rule more comprehensive or effective than a federal standard is regarded necessary by the Commissioner to better protect the safety and health of the employees of this State, the Commissioner may promulgate, modify, or revoke any occupational safety and health rule in the following manner...."

This same statute provides authority for the Commissioner to grant exceptions from the requirements of the Chapter in accordance with Section 12, as follows:

> "Any affected employer or owner may apply to the Commissioner for a variance from a rule promulgated under this Act. Affected employees and their representatives shall be given notice of each such application and an opportunity to participate in a hearing. The Commissioner shall issue such variance order or rule if he determines on the record, after opportunity for an inspection where appropriate and a hearing, that the proponent of the variance has demonstrated by a preponderance of the evidence that the conditions, practices, means, methods, operations or processes used or proposed to be used by an employer or owner will provide

employment and places of employment to affected employees which are as safe and healthful as those which would prevail if he complied with the rule. The order or variance rule so issued shall prescribe the conditions the employer must maintain, and the practices, means, methods, operations, and processes which he must adopt and utilize to the extent they differ from the rule in question. Such an order or variance rule may be modified or revoked upon application by an employer, owner, employees, or by the Commissioner on his own motion, in the manner prescribed for issuance under this Section 11 or 12."

Prior to promulgation this Chapter was submitted to the Advisory Committee and Public Hearing in accordance with the requirements of the Occupational Safety and Health Act.

All standards and publications, other than Chapters 300 through 499 of Title 12, N.J.A.C., referenced in this Chapter are available for inspection or purchase in accordance with Appendix C. Chapters 300 through 499 of Title 12, N.J.A.C. referenced in this Chapter are available in accordance with the back cover of this publication.

SUBCHAPTER 1
GENERAL PROVISIONS

12:377-1.1 TITLE AND CITATION.

This regulation shall be known and may be cited as Chapter 377, Liquefied Natural Gas of Title 12, N.J.A.C.

12:377-1.2 PURPOSE.

The purpose of this Chapter is to provide reasonable standards for the storage, handling, charging, transfer, vaporization, and liquefaction of liquefied natural gas for the protection of the health and safety of all employees.

12:377-1.3 SCOPE.

1.3.1 This Chapter shall apply to places of employment subject to the Occupational Safety and Health Act, P.L. 1973, Chapter , N.J.S.A. 34:6A where liquefied natural gas is stored, handled, charged, liquefied or vaporized.

1.3.2 This Chapter shall not apply to:

(a) Liquefied petroleum gas.

(b) The transportation of liquefied natural gas.

12:377-1.4 EFFECTIVE DATE.

This Chapter shall take effect on

12:377-1.5 VALIDITY.

1.5.1 Nothing in this Chapter shall be construed to prevent the enforcement of other Chapters of Title 12, N.J.A.C., which prescribe more restrictive requirements.

1.5.2 Should any section, paragraph, sentence, or word of this Chapter be declared for any reason to be invalid, such decision shall not affect the remaining portions of this Chapter.

12:377-1.6 EXISTING INSTALLATIONS.

1.6.1 Installations within the scope of this Chapter, which were installed on or before the effective date of this Chapter, may be continued in service unless the continued operation of such equipment and installations constitute a serious and substantial threat to the health and safety of employees.

1.6.2 Maintenance of existing equipment shall be in accordance with this Chapter. Such equipment as may be replaced shall be replaced with equipment in accordance with this Chapter.

12:377-1.7 COMPLIANCE.

1.7.1 All equipment subject to this Chapter shall be maintained in a safe operating condition and shall conform to this Chapter.

1.7.2 Only a qualified person shall install, remove, connect, disconnect, fill, refill, or use in any manner any liquefied natural gas container or system.

1.7.3 Only a qualified person shall operate a liquefied natural gas system.

12:377-1.8 APPROVAL.

1.8.1 Each liquefied natural gas system shall be approved.

1.8.2 Valves, safety relief devices, gauges, regulators and other accessories shall be approved for liquefied natural gas service.

12:377-1.9 BUILDINGS AND STRUCTURES.

Buildings and structures shall be designed and constructed in accordance with Chapter 396, Workplace Design of Title 12, N.J.A.C.

12:377-1.10 PLAN FILING.

Plan filings for liquefied natural gas projects shall be in accordance with Chapter 308, Plan Filing of Title 12, N.J.A.C.

SUBCHAPTER 2
DEFINITIONS

ACI. American Concrete Institute, Box 4754, Redford Station, Detroit, Michigan, 48219.

AGA. American Gas Association, 1515 Wilson Boulevard, Arlington (Rosslyn), Virginia.

ANSI. American National Standards Institute, 1430 Broadway, New York, 10018.

API. American Petroleum Institute, 1801 K Street, N.W. Washington, D.C.

Approved. Acceptable to the Commissioner. Devices having been tested and accepted for a specific purpose by a nationally recognized testing agency may be deemed to be acceptable.

ASME. American Society of Mechanical Engineers, 345 East 47th Street, New York, 10017.

ASTM. American Society for Testing and Material, 1916 Race Street, Philadelphia, Pa., 19103.

Barrel. 42 U.S. gallons or 5.615 cubic feet.

Berm. Earthen material or other material piled against the side of the container and sloped away from the container at a natural angle of repose or material retained by an acceptable slope stabilization method or a retaining wall.

Building. A structure enclosed within exterior walls or fire walls built, erected and framed of component structural parts designed for the housing, shelter, enclosure and support of individuals, animals or property of any kind.

Bunkering. The loading of a ship's bunker or tank with fuel oil for use in connection with propulsion or auxiliary equipment.

Bureau. Bureau of Engineering and Safety Division, Division of Workplace Standards, Department of Labor and Industry, State of New Jersey.

Charging and filling. Are used interchangeably and have the same meaning.

CGA. Compressed Gas Association, 500 Fifth Avenue, New York, New York, 10036.

Commissioner. The Commissioner of Labor and Industry of the State of New Jersey or his authorized representative.

Component.

primary component. Components include those which may be stressed to a significant level, those whose failure would permit leakage of the LNG being stored, those exposed to a temperature between -60 F. and -270 F. and those subject to thermal shock. Primary components shall include, but will not be limited to the following parts of a single wall tank or of the inner tank in a double-wall tank, shell plates, bottom plates, roof plates, knuckle plates, compression rings, shell stiffeners, manways and nozzles including reinforcement, shell anchors, pipe, tubing, forging, and bolting.

secondary component. Components include those which will not be stressed to a significant level, those whose failure will not result in leakage of the LNG being stored or those exposed to the boil-off gas and those having a design metal temperature of -60 F. or higher.

Container. A metallic or concrete vessel for storing liquefied natural gas. Such a container may be aboveground, partially belowground or totally belowground.

aboveground container. A metallic or concrete container in which all or a portion of the liquid is above the surrounding grade.

belowground container. A metallic or concrete container in which the maximum liquid level is below the surrounding grade.

bermed container. A metallic or concrete container in which the maximum liquid level is below a backfilled berm.

frozen ground container. A container in which the maximum liquid level is below the surrounding grade. Such a container is constructed essentially of natural materials, such as earth and rock, and dependent upon the freezing of water-saturated earth materials with appropriate methods for its tightness or impervious nature.

prestressed concrete container. A concrete container is considered to be prestressed when the forces created by the different loadings or loading combinations do not exceed allowable stresses in the concrete under any temperature condition. Circumferential prestressing or both circumferential and vertical prestressing may be required to meet these requirements.

Cryogenic gas. A gas liquefied by ultra-low temperatures usually from -150 F., to almost absolute zero -459 F.

Deriming (defrosting or deicing). The removal by heating and evaporation, sublimation, or solution, of accumulated constituents which form solids, such as water or carbon dioxide, for the low-temperature process equipment.

Dike. A compacted earth, concrete or metal structure used to define an impounding area.

Employee. An employee of an employer who is employed in a business of his employer which affects commerce.

Employer. A person engaged in business in New Jersey affecting commerce who has employees, but does not include the United States or any political subdivision of the State.

Fail-safe. Design features which provide for the safe shut-down of that portion of the plant effected by a malfunction, such as an interruption of an energy source or failure of a control device.

Fired equipment. Any equipment in which the combustion of fuels takes place, including among others, fired boilers, fired heaters, internal combustion engines, certain integral heated vaporizers, the primary heat source for remoted heated vaporizers, gas fired oil foggers, fired regeneration heaters and flared vent stacks.

Fixed-length dip tube. A pipe that has a fixed open end inside a container at a designated elevation that is intended to show a liquid level.

Flame spread rating. The flame spread rating of materials as determined in accordance with Surface Burning Characteristics of Building Materials, NFPA No. 255 - 1972.

G. The normal or standard constant of gravity. At sea level, G equals 32.2 ft/sec./sec.

Gallon. A U. S. gallon or 231 cubic inches.

Gas. Natural gas in the gaseous state.

Ignition source. Any item or substance capable of an energy release of type and magnitude sufficient to ignite any flammable mixture of gases or vapors which could exist at the site.

Important building. A building normally occupied by employees during working hours.

Impounding area. An area which may be defined through the use of berms, dikes, or topography at the site for the purpose of containing any accidental spill of LNG or flammable refrigerant.

Liquefied gas. A gas which under the charged pressure, is partially liquid at a temperature of 70° F. or less.

Liquefied natural gas. A fluid in the liquid state which is composed predominantly of methane and which may contain minor quantities of ethane, propane, nitrogen and other components normally found in natural gas.

LNG. Abbreviation for "liquefied natural gas".

Maximum allowable operating pressure. The maximum operating pressure permitted.

Maximum allowable working pressure. The design pressure.

Mechanical Inspection Bureau. Mechanical Inspection Bureau, Division of Labor Standards, New Jersey Department of Labor and Industry, John Fitch Plaza, Box 1503, Trenton, New Jersey 08625.

Nationally recognized testing agency. A laboratory, such as the Underwriters' Laboratories, Inc., U. S. Bureau of Mines, Factory Mutual Laboratories, or American Gas Association Laboratories that lists, labels, or both lists and labels equipment or materials.

NFPA. National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110.

N.J.A.C. New Jersey Administrative Code.

Place of employment. Any building or other premises occupied by an employer in or about which an employee customarily is suffered or permitted to work.

Plan filing. Delivery in person or by mail of applications, project data form, fee; and when required, drawings and other related data to the offices of the Bureau of Engineering and Safety for approval and deposit in its record.

Portable container. A portable cylinder constructed in accordance with the USDOT Regulations - 1972.

Property line. The line of adjoining property or the nearest side of any public way.

Process plant. All systems required to condition, liquefy, or vaporize natural gas in all areas of application as identified under the scope of this Chapter.

Psia. Pounds per square inch absolute.

Psig. Pounds per square inch gauge.

Public way. A thoroughfare designated for public use by lawful procedure.

Qualified person. A person selected and directed by an employer to perform a specific task or duty involving liquefied natural gas, who has the degree of competence to accomplish the work in a safe manner.

Refrigerant. Any chemical substance such as propane, ethylene, or methane used to reduce the temperature of other liquid or gaseous substances.

Shall. Indicates a mandatory requirement.

Structure. An assembly of materials forming a construction for occupancy or use including among others, buildings, stadiums, gospel and circus tents, reviewing stands, platforms, stagings, observation towers, radio towers, storage tanks, trestles, piers, wharves, open sheds, coal bins, shelters, fences, and display signs.

System. An assembly of equipment consisting of but not limited to storage containers, loading and unloading facilities, liquefication equipment, vaporizers, pumps, compressors, safety devices, valves, piping, purification equipment and odorization equipment.

TEMA. Tubular Exchanger Manufacturers Association, 331 Madison Avenue, New York, New York 10553.

Transport. A tank truck, tank trailer, tube trailer or tank semi-trailer that transports LNG.

USDOT. United States Department of Transportation, Hazardous Materials Regulations Board, Washington, D.C., 20590.

USDOT Regulations. Code of Federal Regulations, Title 49, Parts 171-190, Hazardous Material Regulations.

Vacuum-relieving device. A device to automatically admit gas or air or vapor into a space at a pressure below atmospheric.

Vaporizer. A heat exchanger that converts liquid LNG to gaseous LNG by utilization of any form of heat.

SUBCHAPTER 3
PLANT FACILITIES

12:377-3.1 PLANT SITE.

3.1.1 Installations shall be protected as needed against forces of nature, such as flash floods, landslides, tidal action, or streams backing up.

3.1.2 The plant facility consisting of LNG storage container, refrigerant storage vessels, impounding areas, other hazardous materials storage areas, other process equipment areas and buildings housing process or control equipment shall be enclosed by one continuous enclosure or several independent enclosures.

3.1.3 The plant facility shall be:

(a) Enclosed with an industrial type manproof fence at least 6 feet high, or

(b) Within an approved fenced area.

(c) The fences covered in 3.1.3 (a) and (b) shall be provided with at least two egress gates remotely located from each other when the travel distance exceeds 20 feet, except when the travel distance is 20 feet or less only one exit shall be required. Access shall be provided so that fire fighting equipment can readily be brought to the site.

3.1.4 At least one all weather vehicular road shall be provided to and around the plant site, which may be the all weather fire lane of 9.4.10.

3.1.5 The site shall provide for the containment of spilled liquid hydrocarbons. All liquid hydrocarbon spillage shall be confined to the limits of the plant property.

12:377-3.2 BUILDINGS AND STRUCTURES.

3.2.1 Buildings or structural enclosures in which LNG, flammable refrigerants, and flammable gases are handled shall be of light weight noncombustible construction with non load bearing walls.

3.2.2 If rooms containing such fluids are located within or attached to buildings in which such fludis are not handled, such as control rooms or shops, the common walls shall be limited to no more than two in number, shall be designed to withstand a static pressure of at least 100 pounds per square foot, have no windows, doors or other communicating openings, and shall have a fire resistance rating of at least one hour.

3.2.3 Such buildings or structural enclosures shall be ventilated to minimize the possibility of hazardous accumulations of flammable gases or vapors in accordance with the following:

(a) A continuously operating mechanical ventilation system, or

(b) A combination gravity ventilation system and normally off mechanical ventilation system which is energized by suitable combustible gas detectors in the event combustible gas is detected, or

(c) A dual rate mechanical ventilation system with the high rate energized by suitable gas detectors in the event flammable gas is detected.

(d) A gravity ventilation system composed of a combination of wall openings and roof ventilators.

3.2.4 The ventilation rate in mechanical ventilation systems shall be at least 1 cubic foot per minute of air per square foot of floor area.

3.2.5 Basements and depressed floor levels shall not be permitted.

3.2.6 If vapors heavier than air are present, a suitable part of the ventilation shall be from the lowest level exposed to such vapors.

3.2.7 Floors and platforms above the main operating level shall be of open grate construction, if needed for ventilation.

12.377-3.3 PROCESS EQUIPMENT, GENERAL.

3.3.1 Equipment shall be installed in the open as much as possible for ease of operation, certainty of ventilation, and to facilitate fire protection and extinguishment.

3.3.2 Equipment and pipe supports whose stability is essential to plant safety shall be adequately protected against fire or escaping cold liquid, or both.

3.3.3 The discharge of combustible gases or liquids from relief devices shall be directed into a closed system or to a point of safe disposal.

3.3.4 In those cases where air may be injected into the natural gas stream, provision shall be made to prevent a flammable mixture from occurring under any operating condition.

3.3.5 The process, vaporization and LNG transfer equipment areas shall be graded and drained in a manner that will minimize the possibility of accidental discharge of LNG endangering other equipment, adjoining property or from reaching waterways.

3.3.6 Process equipment containing LNG, refrigerants, or flammable gases shall be located at least 100 feet from a source of ignition, a property line or from control rooms, offices, shops and other important buildings.

3.3.7 Fired equipment and other sources of ignition shall be located at least 100 feet from any diked area or container drainage system.

12:377-3.4 DEPRESSURIZING EQUIPMENT.

3.4.1 Depressurizing equipment shall be provided for systems containing substantial quantities of gases and liquids.

3.4.2 The discharge from depressurizing equipment shall be directed to a safe disposal location for gases and liquids.

3.4.3 Emergency controls to effect depressurization shall be conspicuously marked with their function designated and shall be at a safe location so as to be accessible under emergency conditions.

3.4.4 Process plant elements subject to upsets which can cause overpressuring of piping or vessels, or both, shall be analyzed to ascertain that adequate piping connects all vessels to a properly sized relief valve designed to prevent any overpressuring. If the interconnecting piping at any plant element is found to be too small to carry away generated vapors, then that element itself shall be equipped with a pressure relieving device. Disposal of the vapors and liquids released shall be to a safe location.

12:377-3.5 PROCESS VESSELS.

3.5.1 Process containers shall be arranged so that spilled hydrocarbon products do not flow into natural water courses.

3.5.2 Any vessel designed for a working pressure of 15 psig or more shall comply with Chapters 90 through 99, Rules and Regulations of the Mechanical Inspection Bureau of Title 12, N.J.A.C.

3.5.3 Shell and tube heat exchangers shall follow the Standards of the Tubular Exchanger Manufacturers Association, TEMA-5th Edition. The shells and internals of all exchangers shall be pressure tested, inspected and stamped in accordance with Chapters 90 through 99, Rules and Regulations of the Mechanical Inspection Bureau of Title 12, N.J.A.C.

12:377-3.6 PUMPS, COMPRESSORS AND ENGINES.

3.6.1 Pumps and compressors shall be constructed of materials suitable for the temperature and pressure conditions which might be encountered.

3.6.2 Valving shall be installed so that each pump or compressor can be isolated for maintenance. Where pumps or centrifugal compressors are installed for operation in parallel, each discharge shall be equipped with a check valve.

3.6.3 Pumps and compressors shall be provided with a pressure relieving device on the discharge to limit the pressure to the maximum safe working pressure of the pump casing or downstream equipment, unless the casing and downstream piping are designed for the maximum shut off pressure.

3.6.4 Each pump shall be provided with an adequate vent or relief valve or both which will prevent over-pressuring the pump case during the maximum rate of cool down.

3.6.5 The foundations and sumps for cryogenic pumps shall be designed and constructed to prevent frost heaving.

3.6.6 Pumps used for transfer of liquids at temperatures below - 20 F shall be provided with suitable means for precooling to reduce effect of thermal shock.

3.6.7 Installation of gas fired combustion engines or turbines shall conform to Stationary Combustion Engines and Gas Turbines, NFPA No. 37-1970.

12:377-3.7 BOIL-OFF VAPOR SYSTEM.

3.7.1 A boil-off and flash gas handling system shall be installed for the safe disposal of vapors generated in process equipment and LNG containers.

3.7.2 LNG containers designed to operate at or near atmospheric pressure shall have their boil-off and flash gases discharged through a system designed to prevent accumulation of combustible mixtures at ground level or near a source of ignition. The boil-off venting system shall be designed so that it cannot normally inspirate air during operation. A vacuum breaker shall be installed for emergency use to prevent collapse of vessel in the event the internal pressure is reduced below atmospheric.

3.7.3 LNG containers designed to operate at pressures significantly above atmospheric pressure shall utilize a closed system or discharge to a safe location. The discharge shall utilize a control which is separate from container relief valves.

3.7.4 Provision shall be made to introduce gas into the container in the event a vacuum is experienced, if the gas so introduced will not create a combustible mixture within the container. A vacuum breaker or relief valve shall be installed for emergency conditions only.

3.7.5 Boil off gas evolved during storage or in loading or unloading operations shall be returned to the storage container, ship or barge, sent to a distribution pipeline; or sent to a suitably designed vent stack or flare.

3.7.6 Facilities for depressurizing equipment containing gases and liquids in case of fire or failure of the equipment shall be provided. A safe disposal location for gases and liquids shall be provided.

3.7.7 Emergency controls to effect the depressurization shall be conspicuously marked with their function designated and shall be accessible under emergency conditions.

3.7.8 The discharge of flammable liquids or gases from relief devices shall be directed into a closed system or to a point of safe atmospheric disposal respectively. If a header is provided to collect flammable gases from relief valves within the process, it shall be connected to a suitable vent or flare stack.

12:377-3.8 COLD BOXES.

3.8.1 Where a cold box is used, provision shall be made for an adequate foundation and insulation.

3.8.2 Consideration shall be given to the migration of subzero temperatures into the adjacent soil thereby affecting foundation integrity.

3.8.3 The cold box structure and its contents shall be constructed of materials which do not support combustion.

3.8.4 The cold box shall be provided with protection against overpressure.

3.8.5 Cold box insulations shall be provided with a noncombustible gas purge, for use when the cold box is being put into or taken out of service. If a combustible mixture is detected within the cold box insulation at any time, a noncombustible gas shall be introduced until the mixture is outside of the flammable limits.

12:377-3.9 SOIL PROTECTION FOR CRYOGENIC EQUIPMENT.

LNG containers, coldboxes, piping and pipe supports, and other cryogenic apparatus shall be properly designed and constructed to prevent damage to the container from freezing or frost heaving in the soil, or suitable means shall be provided to prevent damaging forces from developing.

12:377-3.10 ODORIZING GASES.

3.10.1 Since odorants are removed during the liquefaction process, the gas shall be effectively odorized before gas enters the distribution system.

3.10.2 The odorized gas shall possess a distinctive and readily detectable odor in accordance with Section 14:443-4c of the Regulations of the Department of Public Utilities, Board of Public Utility Commissioners.

12:377-3.11 DAMAGE FROM VEHICLES.

3.11.1 LNG systems shall be protected from physical damage, such as vehicular traffic.

3.11.2 Definite vehicular traffic patterns shall be established which will keep traffic in the important areas of the plant to a minimum. No spark ignition vehicle shall be allowed in hazardous (Class I, Group D) locations unless precautions have been taken to assure no hazard exists.

12:377-3.12 REFRIGERANTS.

Installation of storage tanks for liquefied hydrocarbon refrigerants shall conform to Chapter 368, Liquefied Petroleum Gas of Title 12, N.J.A.C. or Chapter 366, Flammable or Combustible Liquids of Title 12, N.J.A.C.

12:377-3.13 AIR INJECTION.

In those cases where air may be introduced into the plant system, provision shall be made to prevent a flammable mixture from occurring under any operating condition.

SUBCHAPTER 4
STATIONARY STORAGE FACILITIES

12:377-4.1 GENERAL.

4.1.1 LNG containers shall be located outside of buildings.

4.1.2 The installation of frozen ground containers shall not be permitted.

4.1.3 Prior to initial operation, containers shall be inspected to assure compliance with the engineering design, and with the material, fabrication, assembly, and test requirements of this Chapter.

4.1.4 A qualified person representing the owner shall be responsible for the inspection of 4.1.3.

4.1.5 The maximum allowable working pressure shall include a suitable factor of safety above the operating pressure and the maximum allowable vacuum.

4.1.6 Storage containers for LNG shall be designed for the minimum temperature of the LNG product to be stored when it is at atmospheric pressure.

4.1.7 All materials used in intimate contact with LNG shall be physically, chemically and thermally compatible with LNG.

4.1.8 The density of the liquid shall be assumed at the actual weight per cubic foot at the minimum storage temperatures, except that in no case shall the density assumed be less than 29.3 pounds per cubic foot.

4.1.9 Seismic, wind and snow loads shall be in accordance with 1.9.

4.1.10 Any exposed insulation shall be noncombustible, a vapor barrier, water free and shall resist dislodgment by fire hose streams. When an outer shell is used to retain loose insulation, the shell shall be constructed of steel or concrete. Exposed weatherproofing shall have a flame spread rating not greater than 25.

4.1.11 Container supports shall have a fire-resistance rating of not less than 2 hours and be designed to withstand the low temperature effects of LNG spillage.

4.1.12 Secure anchorage of the entire container shall be provided. Secure anchorage of internal containers shall be provided to compensate for uplift due to maximum differential pressure between the inside and outside of the container as limited by the relief devices.

12:377-4.2 MARKING OF LNG CONTAINERS.

4.2.1 Each container shall be identified by the attachment of a nameplate in an accessible place marked with the following information:

(a) Builder's name and date built.

(b) Nominal liquid capacity, barrels or gallons.

(c) Design pressure in appropriate units for methane gas at top of container.

(d) Maximum permissible density of liquid to be stored.

(e) Maximum level to which container may be filled with stored liquid.

(f) Maximum level to which container may be filled with water for test, if applicable.

(g) Minimum temperature in degrees Fahrenheit for which the container was designed.

4.2.2 All storage containers shall have all penetrations marked with the function of the penetration. Marking shall be by color coding, labels or other permanent means. Consideration shall be given to "frosting" and identification shall not be lost from such effect.

12:377-4.3 FOUNDATIONS.

4.3.1 LNG containers shall be supported on suitable foundations.

4.3.2 Sufficient soil investigations shall be made to determine the adequacy of the intended site.

4.3.3 The design of metal containers operating at any pressure shall comply with Appendix Q, Paragraphs Q.9 through Q9.4 of Design and Construction of Large, Welded, Low Pressure Storage Tanks, API Standard 620-1970.

4.3.4 Flotation forces which may exist due to the difference in density between the LNG and the displaced ground shall be considered and suitable anchorage shall be provided, if necessary.

4.3.5 Foundations shall be designed so that in the event of either an external or internal release of LNG the foundation can withstand the subcooling effect of an exposure to LNG or cold vapor to the extent the container structure can retain its integrity.

4.3.6 The foundations for LNG containers and any other foundations on the freezing zone shall be properly designed and constructed to prevent damage to the foundation from freezing or frost heaving.

4.3.7 The soil used shall not lose its bearing quality when saturated with liquid.

4.3.8 Foundations for large LNG containers shall be provided with bench marks and reference marks 180 degrees apart to check for settling of containers.

4.3.9 The maximum settlement of the shell shall not exceed 2 inches and the maximum differential settlement of the bottom shall be less than 1/2 inch in 30 feet.

12:377-4.4 METAL CONTAINERS FOR OPERATION AT 15 PSIG OR LESS.

4.4.1 Welded containers designed for not more than 15 psig shall comply with Design and Construction of Large, Welded, Low Pressure Storage Tanks, API Std. 620-1970. Appendix Q of this standard shall also apply.

4.4.2 The maximum allowable working pressure shall be at least 10 percent above the operating pressure.

4.4.3 The insulation, support system, internal lines, and inner tank supports shall comply with 4.5.4, 4.5.5, 4.5.6, and 4.5.7.

12:377-4.5 METAL CONTAINERS FOR OPERATION ABOVE 15 PSIG.

4.5.1 Inner Tank:

(a) The inner tank shall comply with Chapters 90 through 99, Rules and Regulations of the Mechanical Inspection Bureau of Title 12, N.J.A.C.

(b) The inner tank shall be of welded construction and shall conform to the requirements of Division 1 Unfired Pressure Vessel Code, ASME-1971.

(c) Any of the materials authorized for minus 260 F service by the Unfired Pressure Vessel Code, ASME-1971 are acceptable.

(d) In the case of vacuum insulation, the design pressure shall be the sum of the required working pressure, 15 psig for vacuum allowance and the hydrostatic head of LNG. In the case of non-vacuum insulation, the design pressure shall be the sum of the required working pressure and the hydrostatic head of LNG.

4.5.2 Outer Jacket:

(a) The outer jacket shall be of welded construction.

(b) Any of the carbon steels authorized in the UCS Section of the Unfired Pressure Vessel Code, ASME-1971 are acceptable, if suitable for anticipated ambient temperatures.

(c) In the case of vacuum insulation, the jacket shell shall be designed by the procedures outlines in UG-28, UG-29 and UG-30 of the Unfired Pressure Vessel Code, ASME-1971 using an external pressure of not less than 7.5 psi (differential). ASME Code Case 1290 may also be used. Spun heads which meet the tolerance provisions of UG-81 may be designed by the procedures outlined in UG-33 of the ASME Code using an external pressure of not less than 7.5 psi. Heads and spherical jackets which are formed in segments and are assembled by welding shall be designed using an external pressure of 15 psi.

(d) In the case of nonvacuum insulation and a positive pressure purge, the jacket shall be designed for adequate structural support of the inner tank and the insulation and the maximum positive pressure of the purge gas.

(e) The jacket shall be equipped with a relief device or devices to release internal pressure. The discharge area shall be at least 0.00024 square inches per lb. of water capacity of the inner tank but the area need not exceed 300 square inches. The device or devices shall function at a pressure not exceeding the ASME internal design pressure of the jacket, or 25 psi, whichever is less.

(f) When it is possible that the jacket temperature may go below its design temperature because of conduction from cold lines, thermal barriers shall be provided between the lines and the jacket.

4.5.3 Insulation:

(a) The space between the inner tank and the jacket shall be filled with insulation that is compatible with LNG and natural gas and does not form a flammable mixture even if any concentration of air is present. The insulation shall be such that a fire external to the jacket will not cause deterioration to the insulation thermal conductivity by melting or settling.

(b) Consideration shall be given to the external pressure created by the insulation and from a dry gas purge, if utilized. The inner tank shall be designed to withstand this loading without collapse.

4.5.4 Support System Stresses: Stress concentration from the support system shall be minimized by the use of pads or load rings. Consideration shall be given to the expansion and contraction of the inner tank and the support system shall be designed so that thermal stresses imparted to the inner tank shall be minimized.

4.5.5 Internal Lines:

(a) Internal lines shall be those between the inner tank and the jacket in the insulation space.

(b) Internal lines shall be designed for the pressure rating of the inner tank with allowance for the thermal stresses created by the -260 F temperature including both line contraction and contraction movement of inner tank. No bellows or threaded joints shall be permitted within the insulation space.

(c) Lines shall be of materials satisfactory for -260 F as determined by the Unfired Pressure Vessel Code, ASME-1971.

4.5.6 Support of Inner Tank Within Jacket:

(a) The inner tank shall be supported essentially concentrically within the jacket by either a metallic or a non-metallic system which is capable of sustaining the maximum loading of 4.5.6(b) or 4.5.6(c).

(b) For shipping shop-built containers, the supports shall be designed for the maximum number of g's to be encountered times the empty weight of the inner tank.

(c) For operating loads, the supports shall be designed for total weight of the inner tank plus the maximum lading. Appropriate seismic factors shall be included. The weight of liquid stored shall be assumed to be the maximum density of the specified liquid within the range of operating temperatures except that in no case shall the minimum weight used be less than 29.3 lbs/ cu. ft.

(d) The allowable design stress in support members shall be the lesser of 1/3 the tensile strength or 5/8 of the yield strength at room temperature. For threaded members the minimum area at the root of the threads shall be used.

12.377-4.6 CONCRETE CONTAINERS AT ANY OPERATING PRESSURE.

4.6.1 Container Structure:

(a) The design of concrete containers shall be consistent with Building Requirements for Reinforced concrete ACI 318-1963 and the Design and Construction of Circular Prestressed Concrete Structures, ACI 344-19xx.

(b) Allowable stresses for normal design considerations shall be based upon room temperature strength values.

(c) Reinforcing bars under tension in locations which may reach LNG temperatures shall be designed to the following allowable stresses:

#4 and smaller	-	12,000 psi
#6	-	10,000 psi
#8 and larger	-	8,000 psi

(d) Steel wire or strands used as unstressed reinforcement shall be designed with an allowable stress as follows:

Crack control applications	-	30,000 psi
Other applications	-	80,000 psi

(e) External forces imposed upon the container by backfill restraint shall be considered.

4.6.2 Materials Subject to LNG Temperatures.

(a) Concrete shall be as specified by Recommended Practice for Measuring, Mixing, and Placing of Concrete, ACI 614-1959; Minimum Requirements for Thin-Section Precast Concrete Construction, ACI 525-1963; and Building Code Requirements for Reinforced Concrete, ACI 318-1963.

(b) Aggregate shall be as specified in Concrete Aggregates, ASTM C33-1969. Aggregate shall be dense, physically and chemically sound to provide a high strength and durable concrete.

(c) Pneumatic mortar shall be as specified in Shotcreting, ACI 506-1966.

(d) High tensile strength elements for prestressed concrete shall be as specified by the Hard-Drawn Steel Spring Wire, ASTM A 227-1968; Uncoated Stress-Relieved Wire for Prestressed Concrete, ASTM A 421-1965; and Uncoated Wire Stress Relieved Strands for Prestressed Concrete, ASTM A 416-1968. In addition, any material acceptable for service at LNG temperature, such as those materials specified as primary components in Design and Construction of Large, Welded, Low Pressure Storage Tanks, API Std. 620-1970 or any material shown by test acceptable for LNG service may be used.

(e) Reinforcing steel for reinforced concrete shall be specified in Deformed Billet-Steel Bars for Concrete Reinforcement, ASTM A 615-1968; Cold-Drawn Steel Wire for Concrete Reinforcement, ASTM A 82-1966; and Welded Steel Wire Fabric for Concrete Reinforcement, ASTM A 185-1969.

(f) Non-structural metallic barriers incorporated in and functioning compositely with prestressed concrete in direct contact with LNG during normal operations, may be of any metal classified for either primary components or secondary components in Appendix Q of Design and Construction of Large, Welded, Low Pressure Storage Tanks, API Std. 620-1970, provided that the composite section is prestressed such that no significant tensile stresses are developed under any design loading condition.

(g) Non-structural metallic barriers incorporated in and functioning compositely with prestressed concrete, serving primarily as moisture barriers for internally insulated tanks, may be of any metal classified for either primary component or secondary component service in API Std. 620-1970, or of steel conforming to Cold-Rolled Carbon Steel Sheets, Commercial Quality, ASTM A 366-1968, provided that the composite section is prestressed such that no significant tensile stresses are developed under any design loading condition.

4.6.3 Annular Space. The insulation, support system, internal lines and inner tank supports shall comply with 4.5.4, 4.5.5, 4.5.6 and 4.5.7.

4.6.4 Inspection and Tests.

(a) Concrete LNG containers shall be tested in accordance with the applicable provisions of Building Code Requirements for Reinforced Concrete, ACI 318-1963 and Design and Construction of Circular Prestressed Concrete Structures, ACI 344-19xx.

(b) Concrete LNG containers shall be inspected in accordance with Concrete Inspection, ACI 311-1964.

(c) Metal components shall be constructed and tested in accordance with the applicable provisions set forth in Design and Construction of Large, Welded, Low-Pressure Storage Tanks, API Std. 620-1970.

(d) Other materials used in the construction of concrete LNG containers shall be subjected to approved inspection and tests.

12:377-4.7 PRESSURE OR VACUUM RELIEF VALVES.

4.7.1 Relief valves shall be provided on all LNG containers to protect them from overpressure or underpressure.

4.7.2 Pressure relief devices shall have a relieving capacity sufficient to prevent overpressure from one or more of the following conditions which will evolve gas at the greatest rate.

(a) Fire exposure in accordance with 4.7.4.

(b) Loss of refrigeration.

(c) Operational upset, such as failure of a control device.

(d) Vapor displacement and flash vaporization during filling.

(e) Drop in barometric pressure.

4.7.3 Vacuum relief devices shall have a relieving capacity sufficient to prevent underpressure from one or more of the following:

(a) Withdrawal of liquid at the maximum rate.

(b) Withdrawal of vapor at the maximum compressor suction rate.

(c) Rise in barometric pressure.

(d) Reduction of vapor pressure resulting from the introduction of subcooled LNG into the vapor space.

4.7.4 When a container is exposed to an open fire, heat is transferred to the stored liquid. Additional heat is simultaneously transferred through the parts of the container not exposed to fire due to the high difference between the normal ambient temperature and the stored liquid temperature. The minimum total heat influx during a possible fire exposure of an insulated container shall be computed by the formula:

$$H = 1560\ C_1 A^{0.82} + Hn$$

where:

H = Total heat influx, Btu per hour.

C_1= Conductance of the insulation, Btu/hr/sq.ft./°F. (The value of C increases with temperature and a mean value for the range from -260 F and +1660 F should be used.)

A - Total exposed wetted surface area, sq. ft.

Hn= Total normal heat gain to the stored liquid without fire exposures and at maximum ambient temperatures, Btu per hour.

4.7.5 If the insulation system, including any jacketing material, is such that it will disappear or deteriorate in an exposure fire, a higher heat gain will occur. This requires special consideration depending upon the extent of loss of the insulating properties. If only a part of the insulation is lost, the heat gain may be estimated by the formula:

$$H = (34{,}500 - 360\ C_2)\ A^{0.82} + Hn$$

In this case the value of C_2 should be the mean value for the range from -260 F and + 100 F.

4.7.6 The required relief valve capacity shall be computed by the formula:

$$Qa = 3.09 \frac{H}{L} \frac{T}{M}$$

where:

Qa = Required flow capacity of air, cu. ft. per hour at 60 F and 14.7 psia.

H = Total heat influx, Btu per hour from the appropriate formula.

L = Latent heat of vaporization of the stored liquid, Btu per lb.

T = Absolute temperature of the gas at the relief valve inlet, deg. R.

M = Molecular weight of the gas.

12:377-4.8 MAXIMUM FILLING VOLUME.

4.8.1 The maximum filling volume of an LNG container shall be in accordance with Figure 4.8.1. The liquid capacity shall be the volume of liquid to its maximum permissible level.

4.8.2 After filling a container, the gas pressure may be less than the maximum allowable working pressure. Expansion of the liquid will occur when the liquid subsequently warms and the pressure rises to the maximum allowable working pressure. The operator shall limit the maximum filling volume to avoid overfilling when this expansion occurs.

4.8.3 For containers with maximum allowable working pressures less than about 2 psig, the correction for maximum filling volume may be omitted.

4.8.4 Example: A container designed for a maximum allowable working pressure of 65 psig has the relief valve set at 65 psig. After filling, the gas pressure at the top is 20 psig. From Figure 4.8.1, the maximum filling volume is 94.3 percent of the liquid capacity.

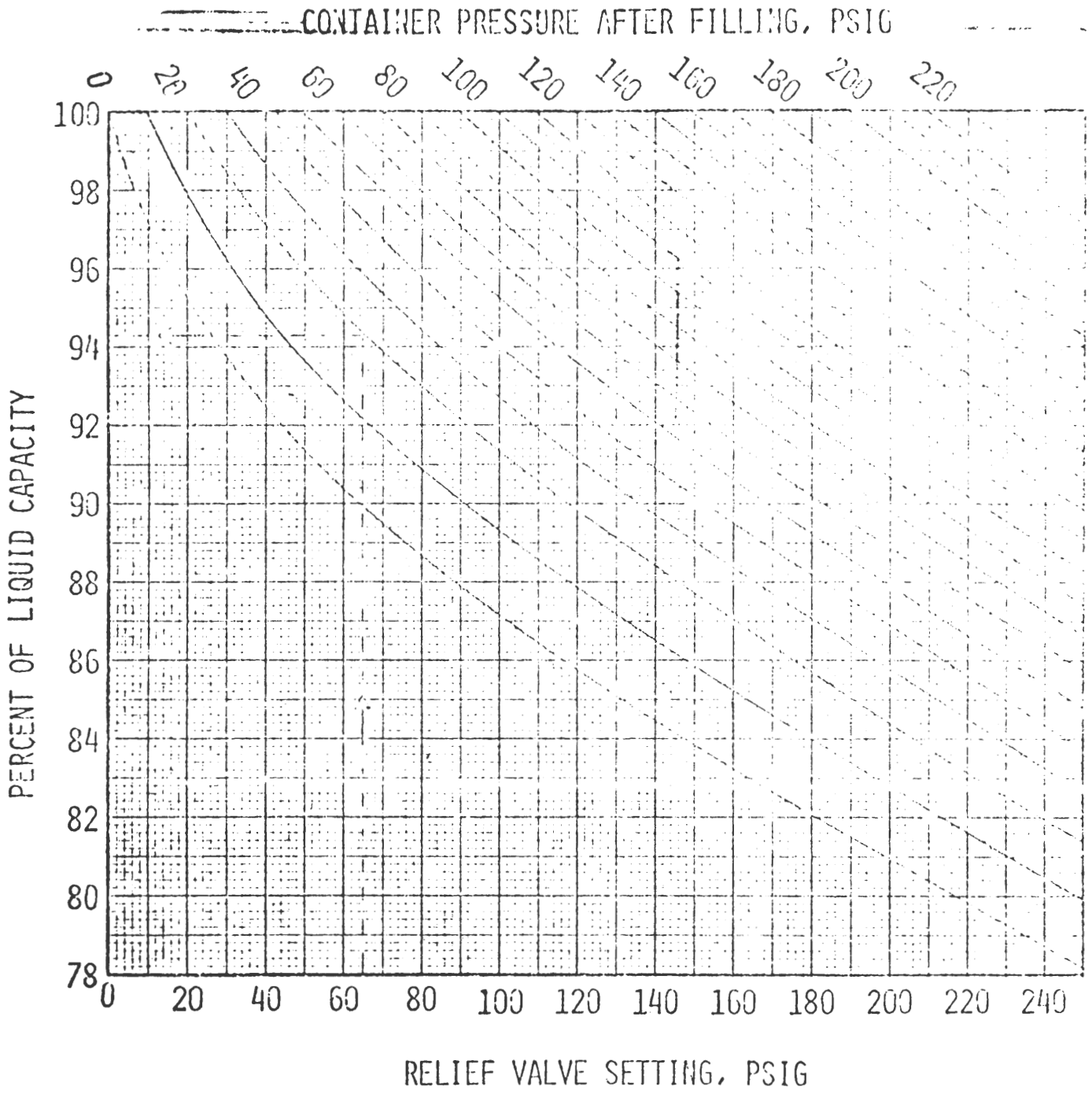

Figure 4.8.1
Maximum Filling Volume for Pressure Containers

12:377-4.9 INSTALLATION OF ABOVEGROUND LNG CONTAINERS.

4.9.1 The minimum distance from an aboveground LNG container to the nearest important building or group of buildings not associated with the LNG facility, or to property lines shall be in accordance with Table 4.9.1.

TABLE 4.9.1

WATER CAPACITY PER CONTAINER	DISTANCE TO PROPERTY LINE OR NEAREST IMPORTANT BUILDING OR GROUP OF BUILDINGS Feet
less than 500 gallons	10
500 to 2,000 gallons	50
Over 2,000 to 30,000 gallons	100
Over 30,000 to 70,000 gallons	125
Over 70,000 to 100 M gallons	160
Over 100 M to 500 M gallons	250
Over 500 M to 1,050M gallons	300
Over 25 M to 50 M barrels	350
Over 50 M to 100 M barrels	400
Over 100 M to 500 M barrels	500
Over 500 M to 1MM barrels	600

4.9.2 The minimum clear distance between aboveground LNG containers shall be not less than one half of the sum of the diameters of adjacent containers.

4.9.3 Every aboveground container shall be a bermed container or the container shall be provided with a dike.

4.9.4 Each dike shall be designed so that spilled LNG will not hydraulically jump the dike.

4.9.5 A diked area for an aboveground container shall have a capacity of 100 percent of the contents of the container assuming a full container. Not more than one LNG container shall be installed in a diked area.

4.9.6 The surface of the diked area shall slope away from the tank.

4.9.7 Dikes shall be constructed of compacted earth, concrete, solid masonry, metal or other suitable material. They may be independent of the container or they may be mounded, integral to, or constructed against the container. They shall be designed to withstand the full hydrostatic head of impounded LNG, the effect of rapid cooling to the temperature of the liquid to be confined, any fire exposure and natural forces, such as earthquake, wind and rain. Thin wall outer shells of double wall tanks shall not be considered as dikes.

4.9.8 The dike wall height and the distance from the storage container to the dike shall be determined in accordance with Figure 4.9.8.

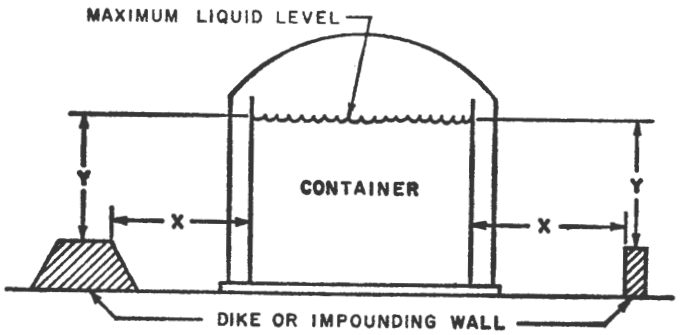

Figure 4.9.8
Dike or Wall Proximity to Container

Notes to Figure

Dimension "X" shall equal or exceed 0.6 times dimension "Y".

Dimension "X" is the distance from the inner wall of the container to the closest face of the dike.

Dimension "Y" is the distance from the maximum liquid level in the container to the top of the dike.

4.9.9 Provision shall be made to clear rain or other water from the impounding area. Automatically controlled sumps are permitted if equipped with an automatic cut off device which shall prevent their operation when exposed to LNG temperatures. Piping, valves, and fittings whose failure could permit liquid to escape from the impounding area shall be suitable for continuous exposure to LNG temperatures.

4.9.10 Buildings shall not be located within a diked area surrounding an LNG container.

4.9.11 Only transfer pumps, associated piping and equipment described in 4.9.9, shall be located inside the diked area.

4.9.12 Transport or tank car loading or unloading facilities shall comply with 8.4.11.

4.9.13 Sources of ignition, such as direct fired vaporizers, boilers and compressor rooms shall be located at least 100 feet from the top of the dike or the top of the berm surrounding a LNG container.

4.9.14 The ground within a diked area enclosing an aboveground LNG container and the ground outside of such a diked area and within 25 feet of same shall be kept clear of readily ignitable material, such as weeds and long grass.

4.9.15 Aboveground LNG containers shall be arranged so that spilled hydrocarbon products do not flow into natural water courses.

4.9.16 At least two remotely located, substantial stairs shall be provided as a means of egress from diked areas.

12:377-4.10 INSTALLATION OF BELOWGROUND LNG CONTAINERS.

4.10.1 The minimum distance from a belowground LNG container to the nearest important building or group of buildings not associated with the LNG facility, or to property lines shall be in accordance with Table 4.9.1.

4.10.2 The minimum clear distance between belowground LNG containers shall be not less than one fourth the sum of the diameters of adjacent containers.

4.10.3 Transport or tank car loading or unloading facilities shall be at least 100 feet from the edge of a belowground LNG container.

4.10.4 Sources of ignition, such as direct fired vaporizers, boilers, and compressor rooms, shall be located 100 feet from the edge of a belowground LNG container.

4.10.5 Buildings or roadways shall not be constructed over any belowground LNG container. Barriers shall be provided to prevent access to the roof structures.

4.10.6 The ground within 50 feet of a belowground LNG container shall be kept clear of readily ignitable material, such as weeds and grass.

4.10.7 The foundation for the belowground concrete container and any other foundation in the freezing zone shall be properly designed and constructed to prevent damage from freezing or frost-heaving.

12:377-4.11 TESTING OF LNG CONTAINERS.

4.11.1 LNG containers shall be leak tested by a method appropriate to the design, construction, and operating pressure of the container and in accordance with the applicable construction standard or code. All leaks shall be repaired.

4.11.2 LNG containers shall be pressure tested to at least 1-1/4 times the maximum allowable working pressure.

4.11.3 Shop fabricated and tested LNG containers shall be leak tested to a minimum of the design pressure after installation and prior to filling the container with LNG.

4.11.4 The inner tank, outer jacket and all internal lines for insulation obtained by vacuum means shall be tested for leaks by an appropriate procedure.

4.11.5 The inner tank, outer jacket, and all internal lines for insulation accomplished by nonvacuum means shall be pneumatically tested for leaks.

4.11.6 After acceptance tests are completed, there shall be no field welding on the LNG containers, except upon saddle plates or brackets, as otherwise provided for by the standard under which the container was fabricated.

4.11.7 A permanent record of all tests shall be retained and made available to the Bureau upon request.

12:377-4.12 CONTAINER PURGING PROCEDURES.

4.12.1 Purging of large vessels shall follow the principles of Gas Engineer's Handbook, AGA-1970 or Cleaning Petroleum Storage Tanks, API RP 2015-1968.

4.12.2 Prior to placing an LNG container into service, the air shall be displaced by a procedure considered acceptable by the references of 4.12.1.

4.12.3 Prior to taking a container out of service, the natural gas in the container shall be purged from the container in a safe manner using a procedure considered acceptable by the references of 4.12.1.

4.12.4 During purging operations the oxygen content of the container shall be determined by the use of an acceptable oxygen analyzer.

4.12.5 Any work performed inside the container shall be in accordance with Chapter 389, Work in Confined Spaces of Title 12, N.J.A.C.

12:377-4.13 COOL DOWN PROCEDURE.

4.13.1 Temperature monitoring devices for cool down procedures shall be provided in accordance with 7.3.1.

4.13.2 Cool down of an LNG container shall be limited to a rate and distribution pattern that will assure thermal stresses are within allowable limits during the cool down period.

4.13.3 During initial cool down of the tank, particular attention shall be given to tank penetrations to insure proper performance of expansion bends or joints.

12:377-4.14 PRESSURE AND VACUUM CONTROL.

4.14.1 Provision shall be made to maintain the internal pressure and vacuum of LNG containers within the limits set by the design specifications by releasing or admitting gas as needed. Factors which shall be considered in sizing such pressure control means shall include:

(a) For Pressure:

(1) Loss of refrigeration

(2) Operational upset, such as failure of a control device

(3) Vapor displacement and flash vaporization during filling

(4) Drop in barometric pressure

(b) For Vacuum:

(1) Withdrawal of liquid at the maximum rate

(2) Withdrawal of vapor at the maximum compressor suction rate

(3) Rise in barometric pressure

(4) Reduction in vapor pressure resulting from the introduction of sub-cooled LNG into the vapor space

4.14.2 Provision for admission and release of gas required in 4.14.1 may be by any means compatible with the gas handling facilities in the plant.

4.14.3 In addition to the pressure control means provided for in 4.14.1, LNG containers shall be equipped with adequate direct acting pressure relief valves and vacuum relief valves (vacuum breakers) communicating directly with the atmosphere and having capacities calculated for any likely combination of the factors listed in 4.14.1(a) and 4.14.1(b). Pressure relief valves shall also consider discharge which can accompany fire exposure.

SUBCHAPTER 5
VAPORIZATION FACILITIES

12:377-5.1 CLASSIFICATION.

5.1.1 Integral heated vaporizers shall be classified as those heated vaporizers in which the heat source is integral to the actual vaporizing exchanger. This classification includes submerged combustion vaporizers.

5.1.2 Remote heated vaporizers shall be classified as those heated vaporizers in which the primary heat source is separated from the actual vaporizing exchanger and an intermediate fluid (e.g. water, steam, isopentane, or glycol) is used as the heat transport medium.

5.1.3 Ambient vaporizers shall be classified as those vaporizers which derive their heat from naturally occurring heat sources such as the atmosphere, sea water, or geothermal waters. If the temperature of the naturally occurring heat source exceeds 212 F. the vaporizers shall be considered to be a remote heated vaporizer.

5.1.4 Process vaporizers shall be classified as those vaporizers which derive their heat from another thermodynamic or chemical process or in such a fashion as to conserve or utilize the refrigeration from the LNG.

12:377-5.2 DESIGN AND MATERIALS OF CONSTRUCTION.

5.2.1 All vaporizers shall be designed, fabricated and inspected in accordance with Chapters 90 through 99, Rules and Regulations of the Mechanical Inspection Bureau of Title 12, N.J.A.C. Because these vaporizers operate over a temperature range of -260 F to 100 F, Section 1 of the ASME Code, Part PUG, are not applicable.

5.2.2 The material of which the vaporizer is constructed shall be suitable for the minimum as well as maximum temperatures to which the vaporizer is exposed.

12:377-5.3 VAPORIZER PIPING AND INTERMEDIATE FLUID PIPING AND STORAGE.

5.3.1 Manifolded vaporizers shall have both inlet and discharge block valves at each vaporizer.

5.3.2 The discharge valve of each vaporizer, all piping, and all relief valves installed upstream of that valve shall be suitable for operation at LNG temperatures (-260 F).

5.3.3 Suitable automatic equipment shall be provided to prevent the discharge of either LNG or revaporized gas into the distribution system at a temperature either above or below the design temperatures of the sendout system.

5.3.4 Isolation of an idle manifolded vaporizer to prevent leakage of LNG into that vaporizer shall be accomplished with two inlet valves and a safe means shall be provided to dispose of the LNG or gas which may accumulate between the valves. Ambient vaporizers having inlets 2 inches in size or less, need not comply with this requirement.

5.3.5 Each heated vaporizer shall be provided with a means to shut off the heat source and pilot from a location at least 50 feet from the vaporizer. The device shall also be operable at its installed location.

5.3.6 A shutoff valve shall be installed on the LNG line to a vaporizer at least 50 feet from the vaporizer except when the vaporizer is closer than 50 feet to the container from which it is supplied, in which case 5.3.8 shall apply.

5.3.7 The shutoff valve specified in 5.3.6 shall be operable either manually or from a remote location, and the valve shall be protected from becoming inoperable due to external icing conditions.

5.3.8 An ambient or remote heated vaporizer which is installed within 50 feet of an LNG container shall be equipped with an automatic shutoff valve in the liquid line which will close on loss of pressure (excess flow), on abnormal high temperature (fire), or low temperature. At attended facilities, remote operation of this valve shall be from a point at least 50 feet from the vaporizer.

5.3.9 If a flammable or toxic intermediate fluid is used for a remote heated vaporizer, shutoff valves shall be provided on both the hot and cold lines of the intermediate fluid system. The controls, such as for valves, shall be located at least 50 feet from the vaporizer.

12:377-5.4 RELIEF DEVICES.

5.4.1 Each vaporizer shall be provided with a safety relief valve providing an effective rate of discharge. The minimum required rate of discharge shall be determined so as to prevent pressures exceeding those allowed by 5.2.1 giving proper consideration to fire exposure.

5.4.2 For exposure to external fire the relief valve capacity shall be calculated as follows:

(a) Obtain the total wetted surface area in the vaporizer, A, by adding the area of the shell in direct contact with the LNG, and the area of heat exchange surface in direct contact with the LNG.

(b) Obtain the discharge rate in cubic feet of air per minute at 60 F and 14.7 psia by substituting the area, A, in the applicable equation given in 4.7.6. The equation of 4.7.4 can be used for vaporizers with external insulation and the equation of 4.7.5 for uninsulated vaporizers.

5.4.3 Relief valves on direct-fired vaporizers shall be so located that they are not subjected to temperature exceeding 140° F during normal operation, unless designed to withstand higher temperatures.

5.4.4 Relief devices shall vent to a safe location.

12:377-5.5 INSTALLATION.

5.5.1 Integral heated vaporizers shall be located at least 100 feet from:

(a) A property line.

(b) Any impounded LNG, flammable refrigerant, flammable liquid or the paths of travel of such fluids between the source of accidental discharge and the impounding area.

(c) LNG, flammable liquid, flammable refrigerant, or flammable gas storage containers or tanks, unfired process equipment containing such fluids, or loading and unloading connections used in the transfer of such fluids.

(d) Control buildings, offices, shops, and other important buildings.

5.5.2 Heaters or heat sources of remote heated vaporizers shall comply with 5.5.1 except, if the intermediate heat transfer liquid is nonflammable and nontoxic, the distances of 5.5.1 may be reduced 50 percent.

5.5.3 Remote heated, ambient, and process vaporizers shall be located at least 100 feet from a property line and any source of ignition.

5.5.4 Vaporizers used in conjunction with LNG containers having a capacity of 70,000 gallons or less shall be located at least 50 feet from property lines or nearest important building or group of buildings.

5.5.5 In multiple heated vaporizer installations, a clearance of at least 10 feet shall be maintained between vaporizers.

5.5.6 Diked areas designed to serve only vaporization process, or LNG transfer equipment areas shall have a capacity at least as equal to the greatest volume of LNG, flammable refrigerant, or flammable liquid which could be discharged into the area during a 10 minute period from any single accidental source.

SUBCHAPTER 6
PIPING SYSTEMS AND COMPONENTS

12:377-6.1 PIPING.

6.1.1 The design and construction of any piping system shall be in accordance with Petroleum Refinery Piping, ANSI B31.3-1966, except as modified by this Subchapter 6.

6.1.2 All materials, such as gaskets or thread compounds, shall be suitable for use with the fluids through the full range of temperature to which they will be subjected.

6.1.3 Spiral weld, furnace lap-weld, and furnace butt-welded pipe shall not be used.

6.1.4 Seamless pipe may be used for process and transfer piping handling LNG, refrigerants, or flammable liquids or gases but, if welded pipe is used, the weld and heat affected zone shall comply with 323.2.2 of Petroleum Refinery Piping, ANSI B31.3-1966.

6.1.5 Threaded nipples and threaded pipe shall be at least Schedule 80.

6.1.6 A liquid line on a storage container, cold box or other major item of insulated equipment external to the outer shell or jacket, whose failure can release a significant quantity of flammable liquid, shall not be made of aluminum, copper or copper alloy unless protected against a two hour fire exposure. This shall not apply to loading arms or hoses. Transition joints may be used.

6.1.7 Malleable iron or cast iron fittings shall not be used in LNG, refrigerant, or flammable gas piping systems. Malleable iron fittings may be used in auxiliary systems, such as oil, water, or air.

6.1.8 Bends shall be permitted provided impact properties are not impaired by the bending operations.

6.1.9 Solid plugs or bull plugs made of at least Schedule 80 seamless pipe shall be used for threaded plugs.

6.1.10 Compression-type couplings shall not be used where they will be subjected to service temperatures below -20 F, unless such couplings are proven by testing at design conditions.

12:377-6.2 PIPING JOINTS.

6.2.1 Care shall be taken to insure the tightness of all bolted connections. Spring washers or other such devices designed to compensate for the contraction and expansion of bolted connections during normal operating cycles shall be used, where required.

6.2.2 Pipe joints shall be welded except threaded joints shall be permitted in 1-1/2 inches nominal diameter or less provided they are seal welded. Where vibration may occur, such joints shall be braced or gusseted.

6.2.3 The number of threaded or flanged joints shall be kept to a minimum and used only where necessary, such as a material transitions, instrument connections, or where required for maintenance.

6.2.4 Metals may be joined for cryogenic service by silver brazing. Silver brazing may be used in joining copper to itself, to copper alloys, and to stainless steel. Dissimilar metals may be jointed by flanges or transition joint techniques which have been proven by test.

6.2.5 Threaded pipe shall not be used in service temperatures below -20 F, except that threaded joints may be used if they shall be seal welded or sealed by other means proven by test.

12:377-6.3 VALVES.

6.3.1 In addition to complying with Section 307 of Petroleum Refinery Piping, ANSI B31.3-1966, valves shall comply with Refrigeration Piping, ANSI B31.5-1966, or Gas Transmission and Distribution Piping Systems, ANSI B31.8-1968 or Pipeline Valves, API Std. 6D-1968, if design conditions fall within their scope.

6.3.2 Extended bonnet valves, with or without bellows seals, shall be used for service temperatures below -50 F.

6.3.3 Extended bonnet valves shall not be installed with stems positioned below the horizontal. All valves shall be proven by test that the packings will not freeze and produce ice build-up causing the valve to become inoperable.

6.3.4 Shutoff valves shall be provided on all LNG, flammable refrigerant, and flammable gas containers, tank and vessel connections, except for relief valves, liquid level gaging devices and those that are blank or plugged. Shutoff valves shall be located as close as practicable to such containers, tanks, and vessels.

6.3.5 The design of an internal valve shall be such that any failure of the penetrating nozzle resulting from external pipe strain will be beyond the shutoff seats of the internal valve itself.

6.3.6 When an internal valve is used on the container discharge line, the line shall be protected with a shutoff valve installed external to the tank but close to the tank. A bellows downstream of the shutoff valve shall be provided so that any pipe failure will be preferentially at that joint.

6.3.7 In the design of the piping system, shutoff or block valves shall be installed as a means of limiting the volume of LNG, flammable refrigerant, or flammable gas that could be discharged in the vicinity of important structures or in the event of a piping system failure.

6.3.8 Sufficient valves shall be provided which can be operated both at the installed location and from a remote location, to permit shutting down the process and transfer systems totally in the event of an emergency.

6.3.9 LNG, flammable refrigerant, and flammable gas container connections larger than one inch in size and through which liquid can escape shall be equipped with at least one of the following:

(a) A valve which closes automatically in the event of fire exposing the valve.

(b) A remotely controlled, quick-closing valve which shall remain closed, except during the operating period.

(c) A check valve on filling connections.

6.3.10 Control devices shall be designed to operate under icing conditions.

6.3.11 Powered operators shall be provided on emergency shutoff valves 8 inches and larger in size. Means for manual operation shall be provided.

12:377-6.4 WELDING.

6.4.1 Qualification and performance of welders shall be in accordance with Sections 327.5 and 6231 of Petroleum Refinery Piping, ANSI B31.3-1966.

6.4.2 When welding impact-tested materials, welding procedures shall be selected that will minimize degradation of the low temperature properties of the pipe material.

6.4.3 When welding attachments to unusually thin pipe, procedures and techniques shall be selected to minimize the danger of burn-throughs.

6.4.4 Oxygen - fuel gas welding shall not be permitted on piping for service temperatures below -20 F. Electric-arc or inert-gas-shielded welding shall be permitted.

6.4.5 Weld identification markings for pipe which will be subjected to service temperatures below -20 F shall be as follows:

(a) All marking shall be made with a material compatible with the basic material or with a round-bottom, low-stress die, except that materials less than 1/4 inch in thickness shall not be die-stamped.

(b) Under some conditions marking materials containing carbon or heavy material compounds can cause corrosion of aluminum. Chalk, wax-base crayons, or marking inks with organic coloring are satisfactory.

12:377-6.5 PIPE SUPPORTS.

6.5.1 Pipe supports whose stability is essential to plant safety shall be protected against fire exposure or escaping cold liquid or both with protection that will endure for 2 hours.

6.5.2 Pipe supports for cold lines shall be designed to prevent excessive heat transfer which can result in piping restraints caused by ice formations or embrittlement of supporting steel. Design of supporting elements shall conform to Section 321 of Petroleum Refinery Piping, ANSI B31.3-1966.

12:377-6.6 IDENTIFICATION OF PROCESS PIPING.

All process, fuel, high pressure steam, fire protection and other piping shall be identified by color-coding, painting, or labeling. Scheme for the Identification of Piping Systems, ANSI A13.1-1956, may be used.

12:377-6.7 TESTING OF PIPING.

6.7.1 Pressure tests shall be conducted in accordance with Section 337 and Chapter 6 of Petroleum Refinery Piping, ANSI B31.3-1966.

6.7.2 Records of pressure, test medium temperature, and ambient temperature shall be maintained for the duration of each test and these records shall be maintained for the life of the facility or until such time as a retest is conducted.

12:377-6.8 PURGING OF PIPING SYSTEMS.

6.8.1 Systems shall be purged of air or gas in a safe manner, such as in accordance with Section 841.285, Gas Transmission and Distribution Piping Systems, ANSI B31.8-1968.

6.8.2 Blow-down and purge connections shall be provided to facilitate fast, effective purging of all process and flammable gas piping.

12:377-6.9 SAFETY AND RELIEF VALVES.

6.9.1 Safety and relief devices shall be so arranged that the possibility of damage to piping or appurtenance is reduced to a minimum. The means for adjusting relief valves set pressure shall be sealed.

6.9.2 A thermal expansion relief valve shall be installed to prevent overpressure in any section of a liquid pipeline which can be isolated by valves.

6.9.3 Thermal expansion relief valves shall be set to discharge above the maximum pressure normally expected in the line but not more than the rated test pressure of the line it protects.

6.9.4 Discharge from such valves shall be directed as to minimize hazard to personnel and other equipment.

SUBCHAPTER 7
INSTRUMENTATION AND ELECTRICAL SERVICES

12:377-7.1 LIQUID LEVEL GAUGES.

7.1.1 Each LNG container shall be equipped with an adequate liquid level gauging device. Density variations shall be considered in the selection of the gauging device. A secondary or backup gauge shall also be provided. At least one of these gauges shall be replaceable without taking the tank out of operation. Glass gauge columns shall not be used.

7.1.2 When the LNG container filling rate is greater than one percent per day, the LNG container shall be provided with a high-liquid-level alarm which shall be separate from the liquid level gauging device. The alarm shall be set so that the operator will have sufficient time to stop the flow without exceeding the maximum permissible filling height. The alarm shall be located so that it is audible to personnel controlling the filling. A high-liquid-level flow cutoff device, if used, shall not be considered as a substitute for the alarm.

7.1.3 Each container for refrigerants or flammable process fluids shall be equipped with a liquid level gauging device. If it is possible to overfill the container, as when the refrigerant or intermediate fluids system is a part of the liquefaction system, a high-liquid-level alarm shall be provided in accordance with 7.1.2.

12:377-7.2 PRESSURE OR VACUUM GAUGES.

7.2.1 Each LNG container shall be provided with a pressure gauge connected to the vessel above the maximum intended liquid level.

7.2.2 Pressure gauges shall be located upstream and downstream of process equipment as an aid to the scheduling of deriming operations.

7.2.3 Vacuum-jacketed equipment shall be equipped with instruments for checking the absolute pressure in the annular space.

12:377-7.3 TEMPERATURE INDICATORS.

7.3.1 Temperature monitoring devices shall be provided in the LNG container to assist in controlling temperatures when placing the container into service or as a method of checking and calibrating the liquid level gauges.

7.3.2 Vaporizers shall be provided with indicators to monitor inlet and outlet temperatures of the LNG, vaporized gas, and heating medium fluids, to assure effectiveness of the heat transfer surface.

7.3.3 Temperature indicators shall be located upstream and downstream of process equipment, when trace contaminants in the feed may deposit, as an aid to the scheduling of deriming operations.

7.3.4 Temperature monitoring systems shall be provided where heated foundations supporting cryogenic containers and equipment could be adversely affected by freezing or frost heaving of the ground.

12:377-7.4 EMERGENCY SHUTDOWN.

7.4.1 Instrumentation for liquefaction, storage and vaporization facilities shall be so designed that in the event of a power loss or other abnormality, the system will go into a fail safe condition that can be maintained until the operators can take appropriate action either to reactivate or to secure the system.

7.4.2 Provision shall be made for the shutdown of major items of equipment, such as the compressors for a liquefaction facility, liquid send-out pumps and the vaporizers, from a location remote from the equipment and accessible in an emergency.

12:377-7.5 ELECTRICAL EQUIPMENT.

7.5.1 Electrical installations and equipment shall conform to Chapter 455, Electrical Installations of Title 12, N.J.A.C.

7.5.2 Adequate lighting shall be provided for such operating facilities as walkways and control valves.

7.5.3 Electrical equipment in LNG hazardous areas shall be classified in accordance with the area classifications given in Table 7.5.3.

TABLE 7.5.3

LOCATION	CLASS 1 GROUP D(1)	EXTENT OF CLASSIFIED AREA(2)
LNG STORAGE CONTAINER AREA		
Outdoor aboveground containers. (Other than small containers) (5)	Division 1	Open area between a high type dike and container wall where dike wall height exceeds distance between dike and container walls. See Figure 7.5.3(c).
	Division 2	Within 30 feet in all directions from container walls and roof, plus area inside a low-type diked or impounding area up to the height of the dike impoundment wall. See Figure 7.5.3(b).

TABLE 7.5.3 (Continued)

LOCATION	CLASS I GROUP D(1)	EXTENT OF CLASSIFIED AREA (2)
Outdoor belowground containers.	Division 1	Within any open space between container walls and surrounding grade or berm. See Figure 7.5.3(d).
	Division 2	Within 30 feet in all directions from roof and sides. See Figure 7.5.3(d).
NON-FIRED LNG PROCESS AREAS CONTAINING PUMPS, COMPRESSORS, HEAT EXCHANGERS, VAPORIZERS, PIPELINES, CONNECTIONS, ETC.		
Indoors without ventilation.	Division 1	Entire room and any adjacent room not separated by a gastight partition.
	Division 2	Within 30 feet of the exterior side of any exterior wall or roof that is not vaportight or within 30 feet of any exterior opening.
Indoors with adequate ventilation (3).	Division 2	Entire room and any adjacent room not separated by a gastight partition.
Outdoors in open air at or above grade.	Division 2	Within 30 feet in all directions from this equipment, and within the cylindrical volume between the horizontal equator of the sphere and grade. See Figure 7.5.3(a).
PITS, TRENCHES OR SUMPS LOCATED IN OR ADJACENT TO LNG DIVISION 1 OR 2 AREAS.	Division 1	Entire pit, trench or sump.

TABLE 7.5.3 (Continued)

LOCATION	CLASS I GROUP D(1)	EXTENT OF CLASSIFIED AREA(2)
LNG DISCHARGE FROM RELIEF VALVES	Division 1	Within direct path of relief valve discharge.
LNG OPERATIONAL BLEEDS, DRIPS, VENTS OR DRAINS.		
Indoors without ventilation.	Division 1	Entire room and any adjacent room not separated by a gastight partition.
	Division 2	Within 30 feet of the exterior side of any exterior wall or roof that is not vaportight or within 30 feet of any exterior opening.
Indoors with adequate ventilation. (3)	Division 1	Within 10 feet in all directions from point of discharge.
	Division 2	Beyond 10 feet and entire room.
Outdoors in open air at or above grade	Division 1	Within 10 feet in all directions from point of discharge.
	Division 2	Beyond 10 feet but within 30 feet in all directions from point of discharge.
LNG TANK CAR, TANK VEHICLE, AND CONTAINER LOADING AND UNLOADING OUTDOORS IN OPEN AIR AT OR ABOVE GRADE (4)		
	Division 1	Within 10 feet in all directions from connections regularly made or disconnected for product transfer.
	Division 2	Beyond 10 feet but within 30 feet in all directions from a point where connections are regularly made or disconnected, and within the cylindrical volume between the horizontal equator of the sphere and grade. See Figure 7.5.3(a).

Notes to Table

1. Most of the flammable vapors and gases found within the facilities covered by this Chapter are classified as Group D. Ethylene is Group C. There is available electrical equipment for hazardous locations suitable for both groups.

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

3. Ventilation, either natural or mechanical, is considered adequate when the concentration of the gas in a gas-air mixture does not exceed 25 percent of the lower flammable limit under normal operating conditions.

4. When classifying extent of hazardous area, consideration shall be given to possible variations in the spotting of tank cars and tank vehicles at the unloading points and the effect these variations of actual spotting point may have on the point of connection.

5. Small containers are those that are portable and of less than 200 gallon capacity.

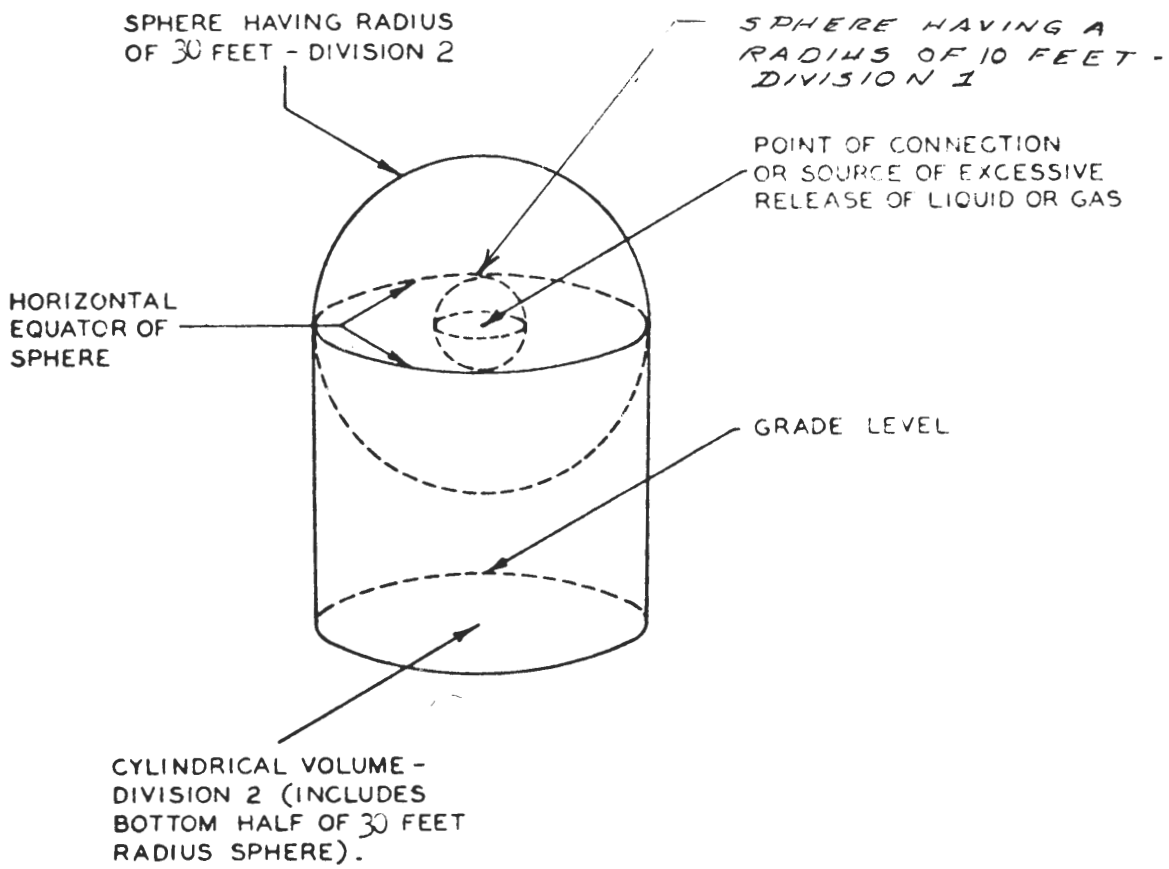

Figure 7.5.3(a)

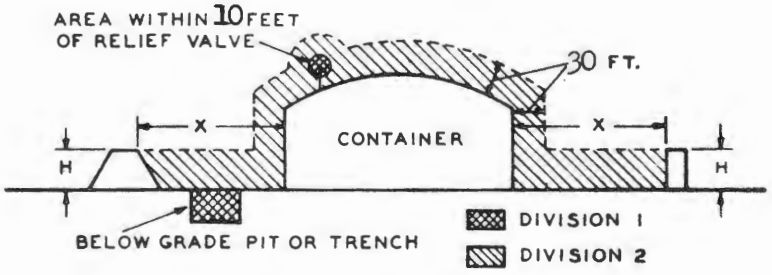

Figure 7,5.3(b)

Dike Height Less than Distance from Container to Dike (H Less than X)

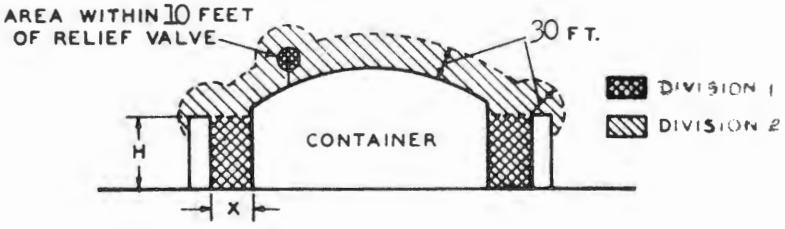

Figure 7.5.3(c)

Dike Height Greater than Distance from Container to Dike (H Greater than X)

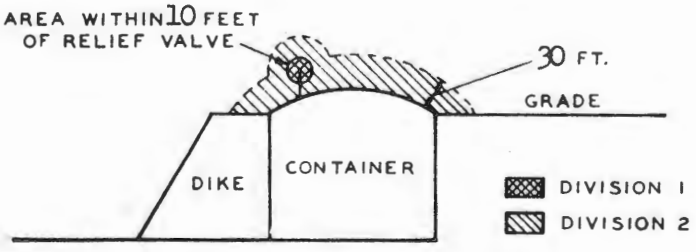

Figure 7.5.3(d)

Container With Liquid Level Below Grade or Top of Dike

12:377-7.6 ELECTRICAL GROUNDING AND BONDING.

7.6.1 Electrical grounding and bonding shall be installed as provided in Static Electricity, NFPA No. 77-1972.

7.6.2 Static protection shall be provided when transports are loaded or unloaded.

7.6.3 If stray currents are present, or if impressed currents are used on the loading and unloading systems (such as for cathodic protection), protective measures to prevent ignition should be taken in accordance with Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents, API RP 2003-1967. Particular attention shall be given to:

(a) Protection of underground lines and structures from accelerated corrosion;

(b) Use of insulating flanges to protect against potential differential at pipe interfaces; and

(c) Bonding of the rail to the fill piping to protect against a potential differential between railcar and pipe.

7.6.4 Although aboveground metallic LNG storage containers do not require lightning protection, ground rods shall be provided for tanks supported on nonconductive foundations for personnel and foundation protection in accordance with Lighting Protection, NFPA No. 78-1968, and Protection Against Ignition Arising Out of Static, Lightning and Stray Currents, API RP 2003-1967.

SUBCHAPTER 8
TRANSFER OF LNG AND REFRIGERANTS

12:377-8.1 GENERAL.

8.1.1 This Subchapter 8 shall apply to the transfer of LNG, refrigerants, and flammable gases between storage containers or tanks and points of receipt or shipment by pipeline, tank car, transport or marine vessel.

8.1.2 Transfer facilities shall comply with the appropriate requirements covered in other Subchapters of this Chapter, such as siting, piping systems, and instrumentation.

8.1.3 The bulk transfer of LNG into stationary storage containers shall:

(a) Be compatible in temperature and specific gravity with the LNG already in the container, or

(b) Be introduced by a means to prevent stratification such as by means of mechanical agitation, or an inlet nozzle designed to promote liquid mixing, or

(c) Be introduced so that the warmer liquid is above the stored liquid.

12:377-8.2 PIPING SYSTEM.

8.2.1 Isolation valves shall be installed so that each transfer system can be isolated at its extremities.

8.2.2 A piping system used for periodic transfer of a cold fluid shall be provided with suitable means for precooling before use.

8.2.3 Check valves shall be provided as required in transfer systems to prevent backflow and shall be located as close as practical to the point of connection to any system from which backflow might occur.

12:377-8.3 PUMP AND COMPRESSOR CONTROL.

8.3.1 In addition to a locally mounted device for shutdown of the pump or compressor drive, a readily accessible remotely located device shall be provided to shut down the pump or compressor in emergency. Remotely located pumps and compressors, used for loading tank cars, transports and marine vessels, shall be provided with controls at the loading area and at the pump or compressor site for stopping.

8.3.2 Signal lights shall be provided at the loading or unloading area to indicate when a remotely located pump or compressor used for loading or unloading is idle or in operation.

12:377-8.4 MARINE SHIPPING AND RECEIVING.

8.4.1 Any pier or dock used for the transfer of LNG and refrigerants shall be constructed in accordance with Piers and Wharves, NFPA No. 87-1968.

8.4.2 Piers and docks used for the transfer of LNG and refrigerants shall be used for no other purpose during such transfer. Ship refueling shall not be performed when LNG or refrigerants are being transferred, unless such refueling is accomplished by pipeline from the shore.

8.4.3 Vehicular traffic shall be prohibited on the pier or dock during transfer of LNG or refrigerants. Suitable warning signs or barricades shall be used to indicate when transfer operations are in progress.

8.4.4 Pipelines shall be located on the dock or pier so that they are not exposed to damage. Provisions shall be made for thermal movement of the lines.

8.4.5 Isolation valving and bleed connections shall be provided at the loading or unloading manifold for both liquid and vapor return lines so that hoses and arms can be blocked off, drained and depressured before disconnecting. Valves shall be located at the point of hose or arm connection to the manifold. Bleeds or vents shall discharge to a safe area.

8.4.6 In addition to the isolation valves at the manifold, each vapor return and liquid transfer line shall be provided with a readily accessible isolation valve located on shore near the approach to the pier or dock. Where more than one line is involved, the valves shall be grouped in one location. Valves shall be identified as to their service. Valves 8 inches and larger in size shall be equipped with powered operators. Means for manual operation shall be provided.

8.4.7 Pipelines used for liquid unloading only shall be provided with a check valve located at the manifold adjacent to the manifold isolation valve.

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

8.4.9 Manifold areas shall be suitably graded or otherwise protected so that leaks or spills will not accumulate in the manifold area or spill overboard into the water.

8.4.10 LNG and flammable refrigerant loading and unloading connections shall be at least 100 feet from uncontrolled sources of ignition, process areas, storage containers, control buildings, offices, shops and other important buildings.

12:377-8.5 TRANSPORT AND TANK CAR LOADING AND UNLOADING.

8.5.1 Transfer shall be made only into tank cars approved for the specific service.

8.5.2 Tank vehicles and tank cars under the jurisdiction of the USDOT, including those in interstate commerce, shall comply with Hazardous Materials Regulations, USDOT-1972.

8.5.3 Tank vehicles not under the jurisdiction of the USDOT shall comply with LNG Tank Vehicles - Insulated Tank Truck for Cold Liquefied Gases, CGA-341-1970.

8.5.4 A rack structure, if provided, shall be constructed of noncombustible material, such as steel or concrete.

8.5.5 A transport loading and unloading area shall be of sufficient size to accommodate the vehicles without excessive movement or turning.

8.5.6 A stationary pump or compressor used for transfer shall be at least 15 feet from any loading or unloading area.

8.5.7 Transfer piping, pumps and compressors shall be located so that they are safe from damage by rail or vehicle movements.

8.5.8 Isolation valving and bleed connections shall be provided at the loading or unloading manifold for both liquid and vapor return lines so that hoses and arms can be blocked off, drained of liquid and depressured before disconnecting. Bleeds or vents shall discharge to a safe area.

8.5.9 In addition to the isolation valving at the manifold, an emergency valve shall be provided in each liquid and vapor line at least 25 feet but not more than 100 feet from each loading or unloading area. These valves shall be readily accessible for emergency use. A single valve may be installed in a common line to multiple loading or unloading areas.

8.5.10 Pipelines used for liquid unloading only shall be provided with a check valve at the manifold adjacent to the manifold isolation valve.

12:377-8.6 PIPELINE SHIPPING AND RECEIVING.

8.6.1 Isolation valves shall be provided at all points where LNG and refrigerant transfer systems connect into pipeline systems.

8.6.2 Provisions shall be made to assure that transfers into pipeline delivery systems will not exceed the pressure or temperature limitations of the pipeline system.

12:377-8.7 LOADING OR UNLOADING OPERATIONS.

8.7.1 At least one qualified person shall be in constant attendance while loading or unloading is in progress.

8.7.2 Sources of ignition, such as welding, flames and unclassified electrical equipment shall not be permitted in loading or unloading areas while transfer is in progress.

8.7.3 Loading and unloading areas shall be posted with "No Smoking" signs.

8.7.4 Prior to transfer, gauge readings shall be obtained or inventory established to insure that the receiving vessel will not be overfilled. Levels shall be checked during transfer operations.

8.7.5 The transfer system shall be checked prior to use to see that valves are properly lined up. Transfer operations shall be commenced slowly and, if any unusual variance in pressure or temperature occurs, transfer shall be stopped, until the cause has been determined and corrected. Pressure and temperature condition shall be observed during the transfer operation.

8.7.6 Bleed or vent connections shall be provided so that loading arms and hoses can be drained and depressured prior to disconnecting. These bleeds or vents shall discharge to a safe area.

8.7.7 Gas or liquid may be vented to the atmosphere to assist in transferring the contents of one container to another if vented to a safe location.

8.7.8 No significant repair shall be done on the transfer system while transfer is taking place.

8.7.9 Tank car and transport loading and unloading facilities shall be located on property under the control of the LNG plant owner.

8.7.10 Grading for drainage shall be such that any liquid spills will be directed away from valve manifold, pump, rack structure, and vehicle loading areas. Drainage shall not be to ditches leading off plant property.

8.7.11 While tank car or transport loading or unloading operations are in progress, rail and vehicle traffic shall be prohibited within 100 feet of LNG facilities and refrigerants.

8.7.12 Tank car or transport loading or unloading areas shall be located at least 100 feet from property lines, important buildings, LNG process areas, storage container dikes or berms and sources of ignition.

8.7.13 Prior to connecting a tank car, the tank car shall be chocked and brakes set, the derailer or switch properly positioned and warning signs or lights placed as required. They shall not be removed or reset until transfer is completed and the car disconnected.

8.7.14 Unless required for transfer operations, the transport's engine shall be shut off. Brakes shall be set and wheels chocked prior to connecting for unloading or loading. The engine shall not be started until the transport has been disconnected and any released vapors have dissipated.

8.7.15 Prior to loading a tank car or transport, a check shall be made to assure that there is a slight positive pressure in the container and that it does not contain air or oxygen. If air or oxygen is present, the tank car or transport shall not be loaded until suitably purged.

8.7.16 A transport loading and unlaoding area shall be level, paved, and of sufficient size to accommodate the transport without excessive movement or turning. A transport shall be positioned prior to loading or unloading so that it can exit the area without backing when the transfer operation is complete.

12:377-8.8 HOSES AND ARMS.

8.8.1 Hose or arm used for transfer shall be suitable for the temperature and pressure conditions encountered. Hoses shall be approved for the service and shall be designed for a bursting pressure of not less than five times the working pressure.

8.8.2 Flexible metallic hose or pipe and swivel joints shall be used where operating temperatures will be below -60 F.

8.8.3 Provisions shall be made for adequately supporting the loading hose or arm.

8.8.4 Couplings used for connection of a hose or arm shall be suitable for operating conditions and shall be satisfactory for frequent coupling and uncoupling conditions.

8.8.5 Hoses shall be tested at least annually to the maximum pump pressure or relief valve setting and shall be visually inspected before each use for damage or defects.

SUBCHAPTER 9
FIRE PROTECTION AND SAFETY

12:377-9.1 GENERAL.

9.1.1 Detailed plans shall be made to cover emergency procedures, emphasizing shutdown, cutting off gas supply and liquid flow into the plant, isolation of various portions of the equipment, depressurizing, and other applicable steps to insure that the escape of gas or liquid is promptly cut off or reduced as much as possible, whether or not fire has occurred.

9.1.2 Emergency controls shall be conspicuously marked with their designated function, and located insofar as possible to be readily accessible in emergencies.

12:377-9.2 IGNITION SOURCE CONTROL.

9.2.1 The use of non-process open flame within the plant fence shall be prohibited, except as provided in 9.2.2 and 9.2.3.

9.2.2 Smoking shall be in accordance with Chapter 398, Smoking of Title 12, N.J.A.C. Smoking may be permitted in designated areas.

9.2.3 Welding and cutting operations shall be in accordance with Chapter 435, Welding and Cutting of Title 12, N.J.A.C.

9.2.4 Fired equipment, excluding vaporizers, located in a building, shall be separated from all compartments or rooms containing process equipment handling LNG or high pressure gas by a wall of substantially noncombustible material and vaportight construction.

9.2.5 Fired equipment, excluding vaporizers, may be installed in a room or enclosure without any minimum distance limitation from process equipment if the room or enclosure is suitably protected by a mechanical ventilation system which will prevent entry of flammable gases or vapors.

12:377-9.3 LEAKAGE CONTROL.

9.3.1 Leakage control shall be in accordance with 3.1.5.

9.3.2 The plant area shall be graded and confined by dikes, curbs or topography so that any possible liquid spill cannot escape the plant property.

9.3.3 All outlets adjacent to storage vessels whereby liquid could escape under gravity head shall be equipped with valves which can be operated manually and by remote controls.

9.3.4 Areas in which liquid may escape shall be graded so that spilled liquid will drain away from important equipment and into an impounding basin or area as remote as possible from the storage tank and plant facilities.

9.3.5 A slope of one percent shall be considered adequate to insure such drainage.

9.3.6 Provisions shall be made to prevent spilled liquid from entering public sewers, or water courses which drain onto the property of others.

9.3.7 Readily accessible and properly designated block valves shall be located to assist in emergency fire control.

9.3.8 Pipe lines delivering gas from the plant to distribution mains shall have check valves to prevent back flow into the plant.

12:377-9.4 FIRE PROTECTION EQUIPMENT.

9.4.1 A continuously monitoring flammable gas detection system shall be installed at all locations where vapor leakage could present a significant hazard.

9.4.2 Detectors shall be located near pump and compressor stations, vaporizers and transport or tank car loading stations. The detectors shall sound an alarm when they sense a level of 25 percent of the lower flammable limit.

9.4.3 Sensor stations located in critical areas such as at compressors, pumps and vaporizers shall shut down the equipment and sound an alarm when the station senses 50 percent of the lower flammable limit.

9.4.4 An adequate supply of water shall be available for fire protection purposes. Water shall be supplied at a rate not less than 1,500 gpm at a pressure of at least 60 psig and shall be either permanently under pressure or supplied by a self-priming pump.

9.4.5 Controls for water pumps shall be located in the control room and adjacent to the main gate.

9.4.6 A complete hydrant system in the process area shall be provided to include hydrants, hoses, hose houses, piping and fire pump, if required, to deliver water at the required rate and pressure.

9.4.7 In storage locations a water deluge system shall be provided for each aboveground LNG tank to cool the tank against exposure from fire involving an adjacent tank.

9.4.8 An approved extinguishing system shall be provided for LNG transfer equipment, the compressor house, pumps and vaporizers.

9.4.9 Portable dry chemical extinguishers having at least a 20 BC rating shall be provided at strategic locations, such as loading and unloading racks, process areas, compression rooms, and other areas where small leaks from packing glands and flanges may occur. The distance to an extinguisher shall not exceed 75 feet.

9.4.10 A fire lane shall be kept open to and around a LNG installation at all times.

12:377-9.5 WASTE GAS DISPOSAL.

9.5.1 Purging procedures shall be developed which will minimize the presence of a combustible mixture in plant piping or equipment when a system is being placed into or taken out of operation.

9.5.2 Emergency depressuring means shall be provided. Portions of the plant which can be isolated from storage tanks or other sources of supply shall be depressurized by venting to the atmosphere through upward pointing vent stacks.

12:377-9.6 WATCH AND COMMUNICATION SERVICE.

9.6.1 At least one qualified person shall be on duty at all times in the LNG facility when transfer, vaporization by other than ambient means, or refrigeration operations are being performed.

9.6.2 Communications shall be provided so that the qualified person can be in contact with other remotely located personnel who are associated with critical operations. Communications may be by means of telephone, public address systems or radio.

12:377-9.7 PERSONAL PROTECTIVE EQUIPMENT.

9.7.1 The employer shall provide the necessary protective equipment appropriate to the hazard and the employee shall be required to utilize them.

9.7.2 Where exposure to cold equipment, vapor or liquid can occur, employees shall be equipped with special clothing, including gloves and footwear, designed to prevent the freezing of body tissue.

9.7.3 Self-contained breathing apparatus shall be available at all times.

12:377-9.8 ACCESS FACILITIES FOR LNG CONTAINERS.

9.8.1 Stairways and platforms shall be provided for LNG containers to allow access to operating valves and instruments. Auxiliary structures to service instruments, connections and access openings shall be provided.

9.8.2 Stairways and platforms shall comply with Chapter 331, Fixed Industrial Stairs of Title 12, N.J.A.C.

12:377-9.9 STANDBY POWER.

9.9.1 An emergency standby power system shall be installed to provide power for critical equipment and emergency lighting.

9.9.2 The standby system shall be sized to permit continued operation of the boil-off vapor control system and the fire-fighting system.

12:377-9.10 SAFETY TRAINING PROGRAM.

Employees shall be trained so that they are qualified to perform their duties such as operation, maintenance, or emergency procedures.

APPENDIX A

AVAILABILITY OF REFERENCED STANDARDS AND PUBLICATIONS

A.1 AVAILABILITY FOR INSPECTION.

A copy of each of the standards and publications referenced in this chapter is on file and may be inspected at the following office of the Bureau of Engineering and Safety between the hours of 9:00 A.M. and 4:00 P.M. on normal working days:

State of New Jersey
Department of Labor and Industry
Bureau of Engineering and Safety, Room 1103
Trenton, New Jersey

A.2 AVAILABILITY BY PURCHASE.

Copies of the referenced standards and publications may be purchased from the organizations listed below. The abbreviations preceding these standards and publications have the following meaning and are the organizations issuing the standards and publications listed.

ACI	American Concrete Institute Box 4754, Redford Station Detroit, Michigan 48219
AGA	American Gas Association 1515 Wilson Boulevard Arlington (Rosslyn), Virginia
ANSI	American National Standards Institute 1430 Broadway New York, New York 10018
API	American Petroleum Institute 1801 K Street, N.W. Washington, D.C.
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, New York 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, Pa. 19103
CGA	Compressed Gas Association 500 Fifth Avenue New York, New York 10036
NFPA	National Fire Protection Association 60 Batterymarch Street Boston, Massachusetts 02110

NJAC	New Jersey Administrative Code Division of Administrative Procedure Department of State 10 North Stockton Street Trenton, New Jersey 08608
NJDPU	New Jersey Department of Public Utilities 1100 Raymond Boulevard Newark, New Jersey 07102
TEMA	Tubular Exchangers Manufacturers Association 331 Madison Avenue New York, New York 10553
USDOT	United States Department of Transportation Hazardous Materials Regulations Board Publications available from Superintendent of Documents U. S. Government Printing Office Washington, D. C. 20204

No. and Edition	Title	Price/Copy
ACI 311-1964	Concrete Inspection	$ 1.00
ACI 318-1963	Building Requirements for Reinforced Concrete	3.00
ACI 344-19xx	Design and Construction of Circular Prestressed Concrete Structures, Committee Report	Not known
ACI 506-1966	Shotcreting	1.20
ACI 525-1963	Thin-Section Precast Concrete Construction	1.00
ACI 614-1959	Recommended Practice for Measuring, Mixing and Placing of Concrete	1.00
AGA-1970	Gas Engineers Handbook	Not known
ANSI A13.1-1956	Scheme for the Identification of Piping Systems	2.00
ANSI B31.3-1966	Petroleum Refinery Piping	5.00
ANSI B31.5-1966	Refrigeration Piping	4.00
ANSI B31.5a-1968	Addenda to ANSI B31.5-1966	0.50

No. and Edition	Title	Price/Copy
ANSI B31.8-1968	Gas Transmission and Distribution Piping Systems	$ 8.00
ANSI B31.8b-1969	Supplement to ANSI B31.8	2.00
API RP 2003-1967	Protection Against Ignition Arising Out of Static Lightning and Stray Currents	1.00
API RP 2015-1968	Cleaning Petroleum Storage Tanks	1.00
API Std. 6D-1968	Pipeline Valves (Steel Gate, Plug, Ball and Check Valves)	1.00
API Std. 620-1970	Design and Construction of Large, Welded, Low Pressure Storage Tanks	3.00
ASME-1971	Unfired Pressure Vessel Code	16.50
ASTM A 82-1966	Cold-drawn Steel Wire for Concrete Reinforcement	1.50
ASTM A 185-1969	Welded Steel Wire Fabric for Concrete Reinforcement	1.50
ASTM A 227-1968	Hard Drawn Steel Spring Wire	1.50
ASTM A 366-1968	Cold-Rolled Carbon Steel Sheets, Commercial Quality	1.50
ASTM A 416-1968	Uncoated Seven Wire Stress Relieved Strands for Prestressed Concrete	1.50
ASTM A 421-1965	Uncoated Stress-Relieved Wire for Prestressed Concrete	1.50
ASTM A 615-1968	Deformed Billet-Steel Bars for Concrete Reinforcement	1.50
ASTM C 33-1969	Concrete Aggregates	1.50
CGA-341-1970	LNG Tank Vehicles Insulated Tank Truck for Cold Liquefied Gases	2.00
NFPA No. 37-1970	Stationary Combustion Engines and Gas Turbines	0.50

No. and Edition	Title	Price/Copy
NFPA No. 77-1972	Static Electricity	$ 1.00
NFPA No. 78-1968	Lightning Protection Code	1.25
NFPA No. 255-1972	Surface Burning Characteristics of Building Materials	0.50
N.J.A.C. 12:90 through 99-1962	Rules and Regulations of Mechanical Inspection Bureau	No Charge
NJDPU	Regulations of Department of Public Utilities, Board of Public Utility Commissioners	No Charge
TEMA-5th Edition	Standard on Shell and Tube Heat Exchangers	10.00
USDOT-1972	Code of Federal Regulations Title 49, Parts 171-190 Hazardous Materials Regulations	3.75

APPENDIX B

CROSS-INDEX OF STATE OCCUPATIONAL SAFETY AND HEALTH REGULATIONS WITH THE U.S. DEPARTMENT OF LABOR REGULATORY PROGRAM

The listings in the left hand column of the following table are the sections of the Federal Occupational Safety and Health Regulations as published in the Federal Register on October 18, 1972. The Chapters of the New Jersey Administrative Code on the same subjects are listed in the right hand column opposite the Federal reference.

29 CFR Part 1910		Chapter of N.J.A.C.	
Subpart B - Federal Standards			
.12	Construction work	12:310	Construction Safety Code
.13	Ship repairing	12:311	Ship Repairing
.14	Shipbuilding	12:312	Shipbuilding
.15	Shipbreaking	Not within scope of State Program	
.16	Longshoring	" " " " " "	
Subpart C - Reserved			
Subpart D - Walking-Working Surfaces			
.21	Definitions	Incorporated in appropriate Chapters listed below	
.22	General requirements	" " " "	
.23	Guarding floor and wall openings	12:330	Floor and Wall Openings
.24	Fixed industrial stairs	12:331	Fixed Industrial Stairs
.25	Portable wood ladders	12:332	Portable Wood Ladders
.26	Portable metal ladders	12:333	Portable Metal Ladders
.27	Fixed ladders	12:334	Fixed Ladders
.28	Scaffolding	12:335	Scaffolds and Mobile Ladders Stands
.29	Mobile ladder stands	12:335	" " " "
.30	Other working surfaces	See subordinate listings	
.30(a)	Dockboards	12:406	Industrial Trucks
.30(b)	Forging machine areas	12:420	Forging Machinery
.30(c)	Veneer machinery	12:416	Woodworking Machinery
Subpart E - Means of Egress			
.35	Definitions	12:340	Means of Egress
.36	General requirements	12:340	" " "
.37	Means of egress	12:340	" " "
.38	Specific means of egress	12:340	" " "
Subpart F - Powered Platforms, Manlifts and Vehicle-Mounted Work Platforms			
.66	Platforms for building maintenance	12:345	Platforms for Building Maintenance
.67	Vehicle-mounted work platforms	12:346	Vehicle-Mounted Work Platforms
.68	Manlifts	12:469	Elevators and Other Lifts

29 CFR Part 1910		Chapter of N.J.A.C.	
	Subpart G - Occupational Health and Environmental Control		
.93	Air contaminants	12:350	Threshold Limit Values
.93a	Asbestos	12:351	Asbestos
.94	Ventilation	12:360	Local Exhaust Systems
.95	Occupational noise exposure	12:361	Occupational Noise Exposure
.96	Ionizing radiation	12:362	Radiation
.97	Nonionizing radiation	12:362	"
	Subpart H - Hazardous Materials		
.101	Compressed gases	12:365	Comp. Liq., and Cry. Gases
.102	Actylene	12:365	" " " " "
.103	Hydrogen	12:365	" " " " "
.104	Nitrous oxide	12:365	" " " " "
.105	Nitrous oxide	12:365	" " " " "
.106	Flam. and comb. liquids	12:366	Flam. and Comb. Liquids
.107	Spray finishing	12:366	" " " "
.108	Dip tanks	12:366	" " " "
.109	Explosives and blasting agents	12:367	Explosives and Blasting Agents
.110	Liquefied petroleum gases	12:368	Liquefied Petroleum Gas
.111	Anhydrous ammonia	12:365	Comp., Liq., and Cry. Gases
.112	(Reserved)	-	
.113	(Reserved)	-	
	Subpart I - Personal Protective Equipment		
.132	General requirements	12:380	Personal Protective Equipment
.133	Eye and face protection	12:380	" " "
.134	Respiratory protection	12:380	" " "
.135	Head protection	12:380	" " "
.136	Foot protection	12:380	" " "
.137	Electrical devices	12:380	" " "
	Subpart J - General Environmental Controls		
.141	Sanitation	12:385	Sanitation
.142	Temporary labor camps	12:386	Temporary Labor Camps
.143	Nonwater disposal system	12:385	Sanitation
.144	Marking physical hazards	12:387	Phys. Haz. & Accident Prev. Markings
.145	Accident prevention signs & tags	12:387	" " " " "
.146	(Reserved)	-	
	Subpart K - Medical and First Aid		
.151	Medical services and first aid	12:390	Medical and First Aid
.152	(Reserved)	-	

29 CFR Part 1910		Chapter of N.J.A.C.	
Subpart L - Fire Protection			
.156	Definitions	12:395	Fire Protection
.157	Portable fire extinguishers	12:395	" "
.158	Standpipe and hose systems	12:395	" "
.159	Automatic sprinkler systems	12:395	" "
.160	Fixed dry chemical extinguishing systems	12:395	" "
.161	Carbon dioxide extinguishing systems	12:395	" "
.162	(Reserved)	-	
.163	Local fire alarm signaling systems	12:395	" "
.164	(Reserved)	-	
Subpart M - Compressed Gas and Compressed Air Equipment			
.166	Inspection of cylinders	12:365	Comp., Liq., and Cry. Gases
.167	Safety relief devices for cylinders	12:365	" " " " "
.168	Safety relief devices for cargo and portable tanks	12:365	" " " " "
.169	Air receivers	12:365	" " " " "
Subpart N - Material Handling and Storage			
.176	Handling materials	12:405	General Storage
.177	Indoor general storage	12:405	" "
.178	Industrial trucks	12:406	Industrial Trucks
.179	Overhead and gantry cranes	12:407	Overhead and Gantry Cranes
.180	Crawler, locomotive and truck cranes	12:408	Crawler, Locomotive & Truck Cranes
.181	Derricks	12:409	Derricks
Subpart O - Machinery and Machine Guarding			
.211	Definitions	Incorporated in appropriate Chapters listed below	
.212	General requirements	12:415	Guards for All Machines
.213	Woodworking machinery	12:416	Woodworking Machinery
.214	Cooperage machinery	12:416	" "
.215	Abrasive wheel machinery	12:417	Abrasive Wheels
.216	Mills and calendars	12:418	Mills and Calendars
.217	Mechanical presses	12:419	Mechanical Presses
.218	Forging machines	12:420	Forging Machinery
.219	Transmission apparatus	12:421	Mechanical Power Trans. Guarding
Subpart P - Hand and Portable Powered Tools and Other Hand Held Equipment			
.241	Definitions	12:430	Portable Powered Tools
.242	Hand and portable powered	12:430	" " "
.243	Guarding of portable powered tools	12:430	" " "
.244	Other portable tools and equipment	12:430	" " "

29 CFR Part 1910		Chapter of N.J.A.C.	
	Subpart Q - Welding, Cutting and Brazing		
.251	Definitions	12:435	Welding and Cutting
.252	Welding, cutting and brazing	12:435	" " "
	Subpart R - Special Industries		
.261	Pulp, paper & paperboard mills	12:440	Pulp, Paper & Paperboard Mills
.262	Textiles	12:441	Textiles
.263	Bakery equipment	12:442	Bakeries
.264	Laundry machinery & operations	12:443	Laundries
.265	Sawmills	12:444	Sawmills
.266	Pulpwood logging	12:445	Pulpwood Logging
.267	Agricultural operations	12:446	Agriculture
	Subpart S - Electrical		
.308	Application	12:455	Electrical Installations
.309	National electrical code	12:455	" "