Tentative Interim Amendment

NFPA 57

Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code

2002 Edition

Reference: 2.12.1.2
TIA 02-1 (NFPA 57)

Pursuant to Section 5 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 57, Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code, 2002 edition. The TIA was processed by the Vehicular Alternative Fuel Systems Committee, and was issued by the Standards Council on October 3, 2002, with an effective date of October 23, 2002.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a proposal of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process.

1. Replace proposed text from NFPA 57 ROP, Log 57-12 with the following:

2-12.1.2 Vehicular fuel containers shall be permitted to be located within or below the driver or passenger compartment provided all connections to the container(s) are external to, or sealed and vented from, the compartment.

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NFPA 57

Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code

2002 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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NFPA 57

Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code

2002 Edition

This edition of NFPA 57, *Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code*, was prepared by the Technical Committee on Vehicular Alternative Fuel Systems and acted on by NFPA at its May Association Technical Meeting held May 19–23, 2002, in Minneapolis, MN. It was issued by the Standards Council on July 19, 2002, with an effective date of August 8, 2002, and supersedes all previous editions.

This edition of NFPA 57 was approved as an American National Standard on July 19, 2002.

Origin and Development of NFPA 57

In 1990 the Technical Committee on Compressed Natural Gas Vehicular Fuels petitioned the NFPA Standards Council to expand the scope of the committee to cover LNG vehicular fuel systems in addition to CNG systems and for permission to begin work on a new standard. This request was approved, and this standard was developed by the committee, which changed its name to the Technical Committee on Natural Gas Vehicular Fuel Systems to reflect its increased responsibilities.

The first edition of NFPA 57 was issued in 1996. Since that time, the committee name was changed to the Technical Committee on Vehicular Alternative Fuel Systems. The second edition added a new chapter covering LNG fuel systems on commercial marine vessels and pleasure craft.

The 2002 edition contains minor revisions to conform to the 2000 edition of the NFPA *Manual of Style*. There were minor changes made to clarify existing requirements. Most of these changes were made to Chapter 2, Vehicle Fuel Systems (now Chapter 4), particularly to Section 2.12, Installation (now Section 4.12).

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Committee Scope: This Committee shall have primary responsibility for documents on fire and explosion hazards associated with compressed natural gas (CNG) and liquefied natural gas (LNG) engine fuel systems on vehicles of all types and for refueling stations and associated storage. The Committee shall coordinate its documents with the Committee on the National Fuel Gas Code with respect to natural gas piping within the scope of that Committee, with the Committees on Industrial Trucks, Fire Safety for Recreational Vehicles, and Marine Fire Protection with respect to engine fuel systems and refueling stations within their scopes, and with the Liquefied Natural Gas Committee with respect to storage of LNG within its scope.

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

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

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Contents

Chapter 1 Administration 57– 4
1.1 Scope 57– 4
1.2 Purpose. (Reserved) 57– 4
1.3 Retroactivity 57– 4
1.4 Equivalency 57– 4
1.5 Qualification of Personnel 57– 4
1.6 Metric Practice 57– 4
1.7 Enforcement 57– 4

Chapter 2 Referenced Publications 57– 4
2.1 General 57– 4
2.2 NFPA Publications 57– 4
2.3 Other Publications 57– 4

Chapter 3 Definitions 57– 5
3.1 General 57– 5
3.2 NFPA Official Definitions 57– 5
3.3 General Definitions 57– 5

Chapter 4 Vehicle Fuel Systems 57– 7
4.1 Application 57– 7
4.2 Materials 57– 7
4.3 Vehicular Fuel Containers 57– 7
4.4 Pressure Relief Devices 57– 7
4.5 Pressure Gauges 57– 8
4.6 Pressure Regulators 57– 8
4.7 Pipe, Tubing, and Fittings 57– 8
4.8 Valves 57– 8
4.9 Pumps and Compressors 57– 8
4.10 Vaporizers 57– 8
4.11 Component Qualification 57– 8
4.12 Installation 57– 9
4.13 System Testing 57–11

Chapter 5 LNG Fueling Facilities 57–11
5.1 Application 57–11
5.2 General Facility Design 57–11
5.3 LNG Cargo Transport Unloading 57–12
5.4 LNG Vehicle Fuel Dispensing Systems 57–12
5.5 Piping Systems and Components 57–13
5.6 Safety and Relief Valves 57–13
5.7 Corrosion Control 57–13
5.8 Stationary Pumps and Compressors 57–13
5.9 Vaporizers 57–13
5.10 LNG-to-CNG Systems 57–14
5.11 Instrumentation 57–14
5.12 Electrical Equipment 57–14
5.13 Maintenance 57–14

Chapter 6 Installation Requirements for ASME Tanks 57–16
6.1 Scope 57–16
6.2 General Requirements 57–16
6.3 Containers 57–16
6.4 Container Foundations and Supports 57–17
6.5 Container Installation 57–17
6.6 Product Retention Valves 57–17
6.7 Inspection 57–17
6.8 Testing and Purging of LNG Containers 57–18
6.9 Piping 57–18
6.10 Container Instrumentation 57–18
6.11 Pressure Control 57–18

Chapter 7 Fire Protection, Safety, and Security 57–19
7.1 General 57–19
7.2 Fire Protection 57–19
7.3 Ignition Source Control 57–19
7.4 Personnel Safety and Training 57–19
7.5 Security 57–19
7.6 Hazard Detection 57–19
7.7 Parking of LNG Vehicles 57–19
7.8 Warning Signs 57–19

Chapter 8 Commercial Marine Vessels and Pleasure Craft 57–20
8.1 Scope 57–20
8.2 Installation of Fuel Supply Containers 57–20
8.3 Installation of Pressure Gauges 57–20
8.4 Labeling 57–20
8.5 Operation 57–20
8.6 Fire Protection for Vessels 57–20
8.7 LNG Fueling Systems 57–21
8.8 Marine Service Stations 57–21
8.9 Engine Rooms or Compartments 57–21
8.10 Tank Rooms or Compartments 57–22
8.11 Vent Masts 57–23
8.12 Deluge Systems 57–23
8.13 Alarm Systems 57–23
8.14 Safety Equipment 57–23
8.15 Safety Training 57–23

Annex A Explanatory Material 57–23

Annex B Sample Ordinance Adopting NFPA 57 57–25

Annex C Informational References 57–25

Index 57–26

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NFPA 57

Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code

2002 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex E lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the appropriate technical committee.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1* Scope. This code shall apply to the design, installation, operation, and maintenance of liquefied natural gas (LNG) engine fuel systems on vehicles of all types, to their associated fueling (dispensing) facilities, and to LNG to CNG facilities with LNG storage in ASME containers of 70,000 gal (265 m^3) or less.

1.1.1 This code shall include marine, highway, rail, off-road, and industrial vehicles.

1.1.2 Vehicles that are required to comply with federal motor vehicle safety standards covering the installation of LNG fuel systems on vehicles and that are certified by the manufacturer as meeting these standards shall not be required to comply with Chapter 4, except 4.12.8.

1.2 Purpose. (Reserved)

1.3 Retroactivity. The provisions of this code are considered necessary to provide a reasonable level of protection against loss of life and property from fire and explosion. They reflect the conditions and the state of the art prevalent at the time the code was issued. Unless otherwise noted, it is not intended that the provisions of this code be applied to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of this document, except in those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or adjacent property.

1.4 Equivalency. The provisions of this code are not intended to prevent the use of any material, method of construction, or installation procedure not specifically prescribed by this code, provided any such alternative is acceptable to the authority having jurisdiction *(see Chapter 3)*. The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claims made regarding the safety of such alternatives.

1.5 Qualification of Personnel. In the interest of safety, all persons employed in handling LNG shall be trained in proper handling and operating procedures, which the employer shall document. This documentation shall be available for inspection by the authority having jurisdiction upon reasonable notice.

1.6 Metric Practice. Metric units in this code are based on IEEE/ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern System.*

1.7 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority. *(See Annex B for sample wording for enabling legislation.)*

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 30A, *Automotive and Marine Service Station Code,* 1996 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 1998 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 1999 edition.

NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code,* 1998 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG),* 1996 edition.

NFPA 70, *National Electrical Code®,* 1999 edition.

NFPA 80, *Standard for Fire Doors and Fire Windows,* 1999 edition.

NFPA 220, *Standard on Types of Building Construction,* 1999 edition.

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials,* 1996 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft,* 1998 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards,* 1995 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 11 West 42nd Street, 13th floor, New York, NY 10036.

ANSI Z87-1, *Practice for Occupational and Educational Eye and Face Protection,* 1991.

ANSI Z89-1, *Personal Protection — Protective Headwear for Industrial Workers,* 1997.

2.3.2 API Publication. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 1996.

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2.3.3 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME B31.3, *Process Piping*, 1996.

ASME *Boiler and Pressure Vessel Code.*

2.3.4 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

IEEE/ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern System*, 1987.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 1996.

2.3.5 CGA Publications. Compressed Gas Association, 1725 Jefferson Davis Highway, Arlington, VA 22202-4100.

CGA S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, 1994.

CGA S-1.3, *Pressure Relief Device Standards — Part 3 — Compressed Gas Storage Containers*, 1995.

CGA 341, *Standard for Insulated Cargo Tank Specifications for Cryogenic Liquids*, 1995.

2.3.6 ICBO Publication. International Conference of Building Officials, 5360 Workman Mill Road, Whittier, CA 90601.

ICBO, *Uniform Building Code*, 1997.

2.3.7 NACE Publication. National Association of Corrosion Engineers, 1440 South Creek Drive, Houston, TX 77084.

NACE RP 0169, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*, 1996.

2.3.8 SSPC Publications. Steel Structures Painting Council, 4516 Henry Street, Pittsburgh, PA 15213.

SSPC-PA 1, *Shop, Field and Maintenance Painting*, 1991.

SSPC-PA 2, *Measurement of Dry Paint Thickness with Magnetic Gages*, 1991.

SSPC-SP 6, *Commercial Blast Cleaning*, 1991.

2.3.9 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Regulations of the U.S. Department of Transportation (DOT).

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.6 Shall. Indicates a mandatory requirement.

3.2.7 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 ANSI. American National Standards Institute.

3.3.2 ASME. American Society of Mechanical Engineers.

3.3.3* Building. A structure with two sides permanently and predominantly (80 percent) open and a roof designed for ventilation and dispersion of gas shall be regarded as outdoors and not a building.

3.3.4 Combustible Material. A material that, in the form in which it is used and under the conditions anticipated, will ignite, burn, support combustion, or release flammable vapors when subjected to fire of heat, when tested in accordance with ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.*

3.3.5 Container. A vessel used to store or transport LNG.

3.3.5.1 Cargo Transport Container. A mobile unit designed to transport LNG.

3.3.5.2 Fueling Facility Container. Primary storage for vehicular fueling.

3.3.5.3 Vehicular Fuel Container. Fuel storage on board the vehicle.

3.3.6 Container Appurtenances. Items connected to container openings needed to make a container a gastight entity. These include, but are not limited to, pressure relief devices; shutoff, backflow check, excess flow check, and internal valves; liquid level gauges; pressure gauges; and plugs.

3.3.7 Design Operating Pressure. The pressure at which the LNG equipment or container is designed to operate during normal use.

3.3.8 Dike. A structure used to establish an impounding area.

3.3.9 DOT. U.S. Department of Transportation.

3.3.10 Engine Compartment. An engine space on a marine vessel that is too small for an individual to enter and service the engine(s).

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3.3.11 Engine Room. An engine space on a marine vessel that is large enough for an individual to enter and service the engine(s).

3.3.12 ESD (Emergency Shutdown Device). A device that permits the closing of LNG from one point to another within the fueling facility from either local or remote locations.

3.3.13 Fail-Safe. A term used to describe design features that provide for the maintenance of safe operating conditions in the event of a malfunction of control devices or an interruption of an energy source.

3.3.14 Fixed Liquid Level Device. A device that indicates when the container is filled to its maximum permitted filling volume.

3.3.15 Flame Spread Rating. The flame spread rating of materials as determined in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials.* [**59A:**1-3]

3.3.16 Fuel Dispenser System. All the pumps, meters, piping, hose, and controls used for the delivery of LNG to, and the removal of vapor from, a vehicle.

3.3.17 Fueling Connector. A device, including shutoff valves, that connects the fueling dispenser hose or arm to the vehicle fuel filling system for the transfer of LNG or vapor.

3.3.18 Fueling Facility. A facility that dispenses LNG into vehicles for use as engine fuel.

3.3.19 Fueling Receptacle. The mating part of the fueling connector mounted on a vehicle.

3.3.20 G. The normal or standard constant of gravity. At sea level, G equals approximately 32.2 ft/sec/sec (9.81 m/sec/sec).

3.3.21 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 that could occur at the site.

3.3.22 Impounding Area. An area that can be defined through the use of dikes or the topography at the site for the purpose of containing any accidental spill of LNG or flammable refrigerants.

3.3.23* Limited Combustible Material. A building construction material not complying with the definition of noncombustible material, which, in the form in which it is used, has a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg).

3.3.24* Liquefied Natural Gas (LNG). A fluid in the liquid state that is composed predominantly of methane and that can contain minor quantities of ethane, propane, nitrogen, or other components normally found in natural gas.

3.3.25 Maximum Allowable Working Pressure. The maximum gauge pressure to which the equipment or container can be subjected without exceeding the allowable design stress.

3.3.26 Maximum Filling Volume. The maximum filling volume of a liquid at its maximum permissible level.

3.3.27 Noncombustible Material. A material that, in the form in which it is used and under the conditions anticipated, does not conform to the definition of *combustible material.*

3.3.28 Point of Transfer. The point where a connection or disconnection is made during transfer of LNG from one container to another.

3.3.29 Pressure Relief Device. A device that is designed to open in order to prevent a rise of internal fluid pressure in excess of a specified value due to emergency or abnormal conditions and that can be of the reclosing or other type, such as one having a rupture disk or fusible plug that requires replacement after each use.

3.3.30 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code.*

3.3.31 Space.

3.3.31.1 Accommodation Space. Space on a marine vessel designed for living purposes.

3.3.31.2 Control Space. Those spaces on a marine vessel in which the vessel's radio, main navigation equipment, or the emergency source of power is located or in which the fire control equipment, other than fire-fighting control equipment, is centralized.

3.3.31.3 Gas-Dangerous Space. An enclosed or semi-enclosed space on a marine vessel in which there is piping containing natural gas, fuel containers, or the engine room or compartment.

3.3.31.4 Gas-Safe Space. A space on a marine vessel that is not a gas-dangerous space.

3.3.31.5 Service Space. A space on a marine vessel outside the cargo area that is used for a galley, pantry containing cooking appliances, locker or storeroom, workshop except those in machinery spaces, and similar spaces and trunks to those spaces.

3.3.32 Tank Compartment. A space on a marine vessel that is dedicated for fuel containers but is too small for an individual to enter and service the fuel containers.

3.3.33 Tank Room. A space on a marine vessel dedicated for fuel containers that is large enough for an individual to enter and service the fuel containers.

3.3.34 Vaporizer. A device other than a container that receives LNG in liquid form and adds sufficient heat to convert the liquid to a gaseous state, or a device used to add heat to LNG.

3.3.34.1 Ambient Vaporizer. A vaporizer that derives heat for vaporization from a naturally occurring heat source such as the atmosphere, seawater, or geothermal waters. If the naturally occurring heat source is separated from the actual vaporizing heat exchanger and a controllable heat transport medium is used between the heat source and the vaporizing exchanger, the vaporizer shall be considered to be a remote heated vaporizer.

3.3.34.2 Heated Vaporizer. A vaporizer that derives heat for vaporization from the combustion of fuel, electric power, or waste heat, such as from boilers or internal combustion engines.

3.3.34.2.1 Integral Heated Vaporizer. A vaporizer, including submerged combustion vaporizers, in which the heat source is integral to the actual vaporizing exchanger.

3.3.34.2.2 Remote Heated Vaporizer. A vaporizer in which the primary heat source is separated from the actual vaporizing exchanger and an intermediate fluid (e.g., water, steam, isopentane, and glycol) is used as the heat transport medium.

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3.3.35 Vehicle. A device or structure for transporting persons or things, a conveyance, including automobiles, trucks, marine vessels, and railroad trains.

3.3.36 Vehicular Fuel. Fuel stored on board a vehicle.

3.3.37 Water Capacity. The amount of water at 60°F (16°C) required to fill a container.

3.3.38 Weather Deck. The deck of a marine vessel that is always exposed to weather.

Chapter 4 Vehicle Fuel Systems

4.1 Application.

4.1.1 This chapter applies to the design, installation, inspection, and testing of LNG fuel supply systems for vehicle engines.

4.1.2 This chapter shall not apply to LNG railroad fuel tenders that are required to comply with applicable U.S. Department of Transportation (DOT) (Federal Railroad Administration) regulations.

4.2 Materials.

4.2.1 All metallic materials used, except fusible links, shall have a minimum melting point of 1500°F (816°C).

4.2.2 All metallic material shall be listed per ASME B31.3, *Process Piping,* and ASME *Boiler and Pressure Vessel Code,* or API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* Appendix Q. These materials shall not be used below the minimum design temperature established in these referenced standards.

4.2.3 The use of dissimilar metal junctions shall be minimized. If such a junction cannot be avoided, good corrosion protection practice shall be employed to reduce the effect of such a materials combination on the long-term corrosion behavior of the junction.

4.2.4 All materials shall be selected or installed to minimize corrosion or to protect the material from corrosion. Stainless steels that do not resist chloride-induced pitting/corrosion cracking and sensitization-induced corrosion resistance reduction shall not be used. The use of all copper–zinc and copper–tin alloy families shall be restricted to those alloys that are metallurgically inhibited to prevent accelerated metallurgical deterioration from external environmental sources.

4.2.5 Brazing filler material shall have a melting point exceeding 1000°F (538°C).

4.2.6 Oxy–fuel gas welding shall not be permitted.

4.2.7 Furnace butt-welded steel products shall not be used.

4.3 Vehicular Fuel Containers.

4.3.1 Design. Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the Regulations of DOT Specification 4L or the "Rules for the Construction of Unfired Pressure Vessels," ASME *Boiler and Pressure Vessel Code,* applicable at the date of manufacture.

4.3.1.1 Those parts of LNG containers that are normally in contact with LNG or cold LNG vapor shall be physically and chemically compatible with LNG and suitable for service at −260°F (−162°C).

4.3.1.2 Container appurtenances shall have a rated working pressure not less than the maximum allowable working pressure of the container.

4.3.1.3 For vacuum insulation, the inner tank, outer tank, and internal lines shall be tested for vacuum leaks.

4.3.2 Container Filling. Containers shall be equipped with a device or devices that provide an indication of when the container is filled to the maximum allowable liquid level.

4.3.3 Structural Integrity. The fully pressurized container, when filled to its maximum filling volume with LNG, together with valves, enclosures, and all other items that normally are mounted and attached thereto, and mounted by its normal means of attachment, shall be capable of withstanding without loss of contents a static force, in the six principal directions, equal to eight times the weight of the container plus its contents. The container, the plumbing, and the mounting attachments shall withstand the effects of shock, vibration, and acceleration encountered in normal service.

Exception: Marine vessels shall be capable of withstanding forces appropriate for the vessel.

4.3.4* Container Shutoff Valves. The container shall be equipped with shutoff valves that allow for its complete isolation from the rest of the vehicular fuel system. Container shutoff valves shall be labeled as to their function. (Decals or stencils shall be acceptable.) Normally closed automatic shutoff valves that are held open by electric current, pneumatic or hydraulic pressure, or a combination thereof, or manually operated shutoff valves shall be permitted to be used to meet this requirement.

4.3.5 Heat Leak. The construction of the container shall be such that the unrelieved pressure inside the container shall not exceed the maximum allowable working pressure of the container within a 72-hour period after the container has been filled to maximum filling volume with LNG stabilized at the designed operating pressure and the temperature equilibrium has been established. The ambient temperature during the 72-hour period shall be 70°F (21°C).

4.3.6 Reuse. Containers complying with 4.3.1 shall be permitted to be reused, reinstalled, or continued in use. A container shall be determined to be suitable for continued service prior to reuse.

4.3.7 Repair. Repair or alteration of containers shall comply with the code under which the container was fabricated.

4.3.8 Markings. The container shall have the following permanent identification markings; decals or stencils shall be acceptable:

(1) The total water capacity of the container in gallons
(2) A label or labels placed in a visible location near the vehicle fill connection identifying it as an LNG connection, indicating the maximum allowable working pressure of the LNG tank, and stating the LNG fuel composition limits if any apply
(3) Markings to designate whether all inlets and outlets, except the relief valves and gauging devices, communicate with vapor or liquid space
(4) All penetrations marked with the function of the penetration and identification shall not be obscured by frost.

4.4 Pressure Relief Devices.

4.4.1 Containers shall be equipped with the pressure relief devices or pressure control valves required by the code under

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which the containers were designed and fabricated, and the relief devices shall be sized for simultaneous conditions of fire and loss of vacuum. Pressure relief devices shall be sized in accordance with CGA Standards S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, and S-1.3, *Pressure Relief Device Standards — Part 3 — Compressed Gas Storage Containers.*

4.4.2 The pressure relief devices and pressure control valves shall communicate directly with the vapor space of the container.

4.4.3 All safety relief devices on vehicular fuel containers that discharge to the atmosphere shall vent outside of the vehicle. All discharge lines and outlets shall be installed as follows:

(1) Pressure relief discharge lines shall be suitable for the pressure and temperature of the discharged fluid.
(2) Discharge lines and adapters shall be sized, located, and secured so as to permit the required relief discharge capacity and to minimize the possibility of physical damage.
(3) The discharge lines shall be able to withstand the pressure of the relief vapor discharge when the relief device is in the full-open position.
(4) A means shall be provided (e.g., loose-fitting caps) to minimize the possibility of the entrance of water or dirt into either the relief device or its discharge line and to drain any water that accumulates in the discharge line. The means of protection shall remain in place except when the relief device operates. In this event, the means of protection shall permit the relief device to operate at required capacity.
(5) The outlet of the discharge line shall be fitted with a device or configured to prevent the formation or accumulation of any ice that could prevent the relief device from operating at required capacity.
(6) The relief valve discharge from fuel containers on vehicles shall be directed upward or at an angle within 90 degrees from vertical or downward within 45 degrees of vertical, shall not impinge directly on the vehicular fuel container(s), the exhaust system, or any other part of the vehicle, and shall not be directed into the interior of the vehicle.
(7) The discharge line from pressure relief devices on all buses shall be located at the rear of the vehicle, directed upward, and extended to the top of the vehicle roof.
(8) Secondary relief devices designed to prevent rupture of the container upon failure of the primary relief device shall not be required to be piped away from the tank.

4.4.4 Pressure relief devices and pressure control valves shall be so designed that the possibility of tampering is minimized. Externally set or adjusted valves shall be provided with a means of sealing the adjustment.

4.5 Pressure Gauges.

4.5.1 Containers equipped with pressure gauges shall have the gauges connected to the container at a point above the maximum liquid level.

4.5.2 Pressure gauges shall be designed for the pressure and temperature conditions to which they can be subjected, with a minimum burst pressure safety factor of 4.

4.5.3 Dials shall be graduated to indicate at least 1.2 times the pressure at which the pressure relief device incident to the pressure gauge is set to function.

4.5.4 A gauge opening shall not exceed 0.055 in. (No. 54 drill size) (1.4 mm) at the inlet connection.

4.6 Pressure Regulators. The engine pressure regulator inlet and each chamber shall have a design operating pressure not less than the maximum allowable working pressure of the container.

4.7 Pipe, Tubing, and Fittings. Pipe, tubing, and fittings shall be in accordance with ASME B31.3, *Process Piping.*

4.8 Valves.

4.8.1 Valves, valve packing, gaskets, and seats shall be suitable for the intended service.

4.8.2 All parts of container shutoff valves, except gaskets, packing, and seats, that come in contact with the fuel shall be stainless steel, brass, or copper.

4.8.3 Extended bonnet valves shall be installed with their stem packing seals in such a position as to prevent leakage or malfunction due to freezing. If the extended bonnet in a cryogenic liquid line is installed at an angle greater than 45 degrees from the upright vertical position, evidence of satisfactory service in the installed position shall be demonstrated.

4.9 Pumps and Compressors.

4.9.1 Pumps and compressors shall be provided with a pressure relief device to limit the discharge pressure to the maximum safe working pressure of the casing and downstream piping and equipment, unless these are designed for the maximum discharge pressure of the pumps or compressors.

4.9.2 Each pump shall be provided with a vent, relief valve, or both, that prevents overpressuring the pump case.

4.9.3 Pumps used for transfer of LNG shall be provided with suitable means for precooling to reduce the effect of thermal shock and overpressure.

4.10 Vaporizers.

4.10.1 Vaporizers shall have the capacity to vaporize completely the LNG and heat the vapor to the safe design temperature of the downstream components prior to entry of the vapor into the pressure regulator when the vaporizer is subjected to the maximum vehicular fuel flow rate.

4.10.2 Vaporizers shall be marked permanently at a readily visible point to indicate the maximum allowable working pressure of the fuel-containing portion of the vaporizer.

4.10.3 Vaporizers shall be designed for a working pressure at least equal to the maximum discharge pressure of the pump or the pressurized system that supplies them, whichever is greater.

4.10.4 The discharge valve of each vaporizer, if provided, its piping components, the relief valves installed upstream of the discharge valve, the vaporizer piping, and related components shall be suitable for operation at a LNG temperature of −260°F (−162°C).

4.10.5 Engine exhaust gases shall not be used as a direct source of heat to vaporize fuel. If the engine exhaust is used, it shall be used via an indirect heating system.

4.11 Component Qualification.

4.11.1 The following subsystems and components, if used, shall be recommended by the manufacturer for the intended service:

(1) Vehicular fuel containers
(2) Fuel quantity gauging systems

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(3) Pressure relief devices
(4) Pressure measurement devices
(5) Valves
(6) Pressure regulators
(7) Vaporizers
(8) Pumps
(9) Engine fuel delivery equipment
(10) Vehicle fueling receptacles
(11) Electrical equipment related to the LNG system

4.11.2 Components in the engine compartment shall be compatible with the liquids and gases to which they will be exposed throughout the range of temperatures to which they will be subjected. Those components that normally will be in contact with LNG shall be suitable for service over a temperature range of –260°F to 250°F (–162°C to 121°C). Those components that normally will not be in contact with LNG shall be suitable for service over a range of –40°F to 250°F (–40°C to 121°C).

4.11.3 Components outside the engine compartment that normally will be in contact with LNG shall be suitable for service over a temperature range of –260°F to 180°F (–162°C to 82.2°C). Other components that normally will not be in contact with LNG shall be suitable for service over a temperature range of –40°F to 180°F (–40°C to 82.2°C).

4.12 Installation.

4.12.1 Vehicular Fuel Containers and Container Appurtenances.

4.12.1.1 Vehicular components or subsystems that can fail on exposure to LNG temperature and create a safety hazard shall be protected from LNG exposure.

4.12.1.2 Vehicular fuel containers shall be permitted to be located within the driver or passenger compartment provided all connections to the container(s) are external to, or sealed and vented from, the compartment.

4.12.1.3 A container shall be located in a place and in a manner so as to minimize the possibility of damage to the container and its appurtenances. Containers located in the rear of vehicles, where protected by bumpers or vehicular structure, shall be considered to be in conformance with this requirement. If fuel or container vent piping containing fuel is installed within 8 in. (200 mm) of engine or exhaust system components that exceed 250°F (121°C), it shall be shielded against direct heating.

4.12.1.4 Container markings shall be visible after the container's permanent installation on a vehicle. A portable lamp and mirror shall be permitted to be used when reading markings.

4.12.1.5 Container valves, appurtenances, and connections shall be protected to prevent damage due to incidental contact with foreign objects.

4.12.1.6 No part of the container or its appurtenances shall protrude beyond the sides or top of any vehicle where the container can be struck or punctured. Non-roof-mounted containers shall not be mounted ahead of the front axle or beyond the rear bumper on motor vehicles.

4.12.1.7 Containers shall be installed to provide as much road clearance as practical. The minimum clearance from the road to the container, its housing, or its fittings, whichever is lowest, shall not, with the vehicle loaded to its gross weight rating, be less than that defined by the vehicle manufacturer's own design. This clearance shall be measured as follows:

(1) Containers installed between axles shall comply with 4.12.1.7(3) or shall not be lower than the lowest point on a structural component of the body, frame or subframe, if any, engine, or transmission (including the clutch housing or torque converter housing) forward of the container.
(2) Containers installed behind the rear axle and extending below the frame shall comply with 4.12.1.7(3) or shall not be lower than both of the following:
  (a) The lowest point of a structural component of the body, engine, or transmission (including clutch housing or torque converter housing) forward of the container
  (b) The lowest point of those lines extending rearward from each wheel at the point where the wheels contact the ground directly below the center of the axle to the lowest and most rearward structural interference (e.g., bumper, frame). Where there are two or more rear axles, the projections shall be made from the rearmost axle.
(3) Where an LNG container is substituted for the fuel container installed by the original manufacturer of the vehicle (whether or not that fuel container was intended for LNG), the LNG container either shall fit within the space in which the original fuel container was installed or shall comply with 4.12.1.7 (1) or (2).

4.12.1.8 Containers shall be mounted securely to prevent their jarring loose, slipping, or rotating. Containers shall be secured to the vehicle body, bed, or frame by means capable of withstanding the loads defined in 4.3.3.

4.12.1.9 The container weight shall not be supported by outlet valves, manifolds, or other fuel connections.

4.12.1.10 The mounting system shall minimize fretting corrosion between the container and the mounting system.

4.12.1.11 Containers shall not be installed so as to affect adversely the operating characteristics of the vehicle.

4.12.1.12 Vehicular fuel systems shall be equipped with at least one manual or automatic fuel shutoff valve. Manual valves shall be readily accessible, operable without tools, and labeled as to their function.

4.12.1.13 Where a container is installed above the operator or passenger compartment of a vehicle the requirements of 4.12.1.13(A) through (C) shall apply:

(A) The container and its piping, fittings, and valves shall be protected from damage by the following:

(1) A guard rail or similar device that is designed to absorb the impact of a collision with a stationary object when the vehicle is moving either forward or backward at 5 mph (8 km/hr). The guard rail or similar device shall be free of projections that could damage the container or its valves and fittings.
(2) A shield designed to absorb impacts that can occur during loading, unloading, or use of the vehicle. The shield shall be free of projections that could damage the container or its valves and fittings.

(B) The top of the container and any CNG piping, fitting, valve, housing, guardrail, or shield shall not be more than 13.5 ft (4.12 m) above the road surface.

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(C) The cylinder shall be protected from accidental contact with overhead electrical wiring by metallic or nonmetallic covers.

4.12.2 Containers Mounted in the Interior of Vehicles.

4.12.2.1 Containers mounted in the interior of vehicles in an enclosure communicating directly with the driver or passenger compartments shall be installed so that any fuel released from the container appurtenances shall be vented to the outside of the vehicle. The enclosures shall not contain any sources of ignition capable of igniting natural gas. This shall be permitted to be accomplished as follows:

(1) By locating the container, including its appurtenances, in an enclosure that is mounted securely to the vehicle, is gastight with respect to the driver or passenger compartment, and is vented to the outside of the vehicle
(2) By enclosing the container appurtenances and their connections in a structure that is mounted securely on the container, is gastight with respect to the driver or passenger compartment, and is vented to the outside of the vehicle

4.12.2.2 Containers shall be installed and fitted so that no gas from fueling operations can be released inside the passenger compartment by permanently installing the fueling receptacle outside the passenger compartment of the vehicle in a location protected from physical damage and dislodgment.

4.12.2.3 Enclosures, structures, seals, and conduits used to vent enclosures shall be fabricated of materials designed to resist damage, blockage, or dislodgment caused by the movement of articles carried in the vehicle or by the closing of luggage compartment enclosures or vehicle doors and shall require the use of tools for removal.

4.12.2.4 Where a container is installed in a closed compartment and the LNG is not odorized, a continuously monitoring natural gas detection system shall be installed within the compartment. It shall sound an alarm and visually indicate within the vehicle when a gas concentration of not more than 20 percent of the lower flammability limit is present.

4.12.3 Pipe, Tubing, and Fittings.

4.12.3.1 Manifolds connecting fuel containers shall be fabricated and installed to minimize vibration and shall be installed in a protected location or shielded to minimize damage from unsecured objects.

4.12.3.2 Piping and tubing shall be installed, supported, protected, and secured in such a manner as to minimize the possibility of damage, corrosion, or breakage due to expansion, contraction, vibration, strains, or wear and to preclude any loosening while in transit.

4.12.3.3 Piping and tubing passing through a panel or structural member shall be protected by grommets or similar devices that shall snugly fit the piping or tubing and the hole in the panel or structural member.

4.12.3.4 Piping or tubing that passes through the floor of a vehicle shall be installed to enter the vehicle through the floor directly beneath, or adjacent to, the container. If a branch line is required, the tee connection shall be located in the main fuel line under the floor and outside the vehicle.

4.12.3.5 There shall be no fuel connection between a tractor and trailer or other over-the-road vehicle units.

4.12.3.6 A pressure relief valve shall be installed in each section of piping or tubing in which LNG can be isolated between shutoff valves so as to relieve the pressure that can develop from trapped fuel to a safe atmosphere. The pressure relief valve shall not have a setting greater than the maximum allowable working pressure of the line it protects.

4.12.4 Valves.

4.12.4.1 Valves shall be mounted securely and shielded or installed in a protected location to prevent damage from vibration, shock, and unsecured objects.

4.12.4.2 Valves shall be installed so that their weight is not placed on, or supported by, the attached lines.

4.12.4.3 A positive shutoff valve shall be installed in the fuel supply line. The shutoff valve shall close automatically and prevent the flow of fuel to the engine when the ignition switch is off or in the accessory position and when the engine is not running and the ignition switch is on.

4.12.4.4 Where multiple fuel systems are installed on a vehicle, automatic valves shall be provided to shut off the fuel that is not being used.

4.12.4.5 The vehicular fueling system shall be equipped with a backflow check valve to prevent the return flow of LNG from the container(s) to the filling connection. Such a check valve shall be permitted to be integral to another component in the system, such as the vehicular fueling connector.

4.12.5 Pressure Regulators.

4.12.5.1 Automatic pressure regulating equipment shall be installed on fuel delivery systems that have operating pressures that exceed the engine operating pressure requirements between the vehicular fuel container and the engine to regulate the pressure of the fuel delivered to the engine.

4.12.5.2 Pressure regulating equipment shall be installed so that its weight is not placed on, or supported by, the attached lines.

4.12.6 Pressure Gauges.

4.12.6.1 A pressure gauge located within a driver or passenger compartment shall be installed in such a manner that no gas flows through the gauge in the event of gauge failure.

4.12.6.2 Gauges shall be mounted securely, shielded, and installed in a protected location to prevent damage from vibration and unsecured objects.

4.12.7 Electrical Wiring.

4.12.7.1 Wiring shall be installed, supported, and secured in a manner to prevent damage due to vibration, shock, strains, wear, or corrosion.

4.12.7.2 All conductors shall be sized for the maximum anticipated load and shall be protected by overcurrent protection devices.

4.12.8 Labeling.

4.12.8.1 A vehicle equipped with an LNG fuel system shall bear a durable label located at the fueling connection receptacle that shall include the following:

(1) Identification as an LNG-fueled vehicle
(2) The maximum allowable working pressure of the vehicular fuel container

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4.12.8.2 Each LNG-fueled vehicle shall be identified with a weather-resistant, diamond-shaped label located on an exterior vertical or near-vertical surface on the lower right rear of the vehicle (or on the trunk lid of a vehicle so equipped, but not on the bumper or tailgate of any vehicle), inboard from any other markings. The label dimensions shall be approximately 4¾ in. × 3¼ in. (120 mm × 83 mm). The marking shall consist of a border and the abbreviation "LNG" in minimum 1-in. (25-mm) high letters of silver or white reflective luminous material centered within the diamond on a blue background.

4.12.9 Fueling Receptacle.

4.12.9.1 The fueling receptacle on the vehicular fuel system shall be firmly supported and shall meet all the following requirements:

(1) Receive the fueling connector and accommodate the service pressure of the vehicle fuel system
(2) Incorporate a means to minimize the entry of dust, water, and other foreign material
(3) Be suitable for any corrosive conditions that are anticipated

4.12.9.2 The fueling receptacle shall be mounted to withstand a breakaway force such that the breakaway device specified in 5.4.4 operates before the receptacle separates from the vehicular fuel system. The receptacle shall be installed in accordance with the manufacturer's instructions.

4.13 System Testing.

4.13.1 Cold Test and Pressure Test. After the system has been completely assembled, all fittings and connections shall be tested for leaks while pressurized to the maximum operating pressure. Liquid nitrogen or LNG shall flow through the system at least as far as LNG flows when the system is in operation.

4.13.2 When a vehicle is involved in an accident or fire causing damage to the LNG fuel system container, the system, container, or both shall be inspected, repaired, or removed and retested before being restored to service.

Chapter 5 LNG Fueling Facilities

5.1 Application. This chapter applies to the design, siting, construction, installation, spill containment, and operation of containers, pressure vessels, pumps, vaporization equipment, buildings, structures, and associated equipment used for the storage and dispensing of LNG as an engine fuel for vehicles of all types.

5.2 General Facility Design.

5.2.1 General.

5.2.1.1 LNG fueling facilities that are permitted to be unattended shall be designed to secure all equipment from tampering.

5.2.1.2 Storage and transfer equipment at unattended facilities shall be secured to prevent tampering.

5.2.1.3 Operating instructions identifying the location and operation of emergency controls shall be posted conspicuously in the facility area.

5.2.1.4 LNG fueling facilities transferring LNG during the night shall have permanent, adequate lighting at points of transfer and operation.

5.2.1.5 Designers, fabricators, and constructors of LNG fueling facilities shall be competent in the design, fabrication, and construction of LNG containers, cryogenic equipment, loading and unloading systems, fire protection equipment, and other components of the facility. Supervision shall be provided for the fabrication, construction, and acceptance tests of facility components to the extent necessary to ensure that facilities are structurally sound, suitable for the service, and otherwise in compliance with this code.

5.2.2 Siting.

5.2.2.1 LNG tanks and their associated equipment shall not be located where exposed to failure of overhead electric power lines operating over 600 V.

5.2.2.2 If other combustible or hazardous liquids can encroach on the LNG fueling facility, means shall be provided to protect that facility.

5.2.2.3 Fired equipment shall be located in accordance with Table 6.5.1 from any impounding area or container drainage system.

5.2.2.4 Points of transfer shall be located not less than 25 ft (7.6 m) from the nearest important building not associated with the LNG facility, from the line of adjoining property that can be built upon, or from fixed sources of ignition.

5.2.3 LNG Spill Containment.

5.2.3.1 Site preparation shall include provisions for retention of spilled LNG within the limits of plant property and for surface water drainage. [**59A:**2-1.2]

5.2.3.2 Enclosed drainage channels for LNG shall be prohibited. [**59A:**2-2.2.3]

5.2.3.3* Impounding areas, if provided to serve LNG transfer areas, shall have a minimum volumetric capacity equal to the greatest volume of LNG or flammable liquid that could be discharged into the area during a 10-minute period from any single accidental leakage source or a lesser time period based on demonstrable surveillance and shutdown provisions acceptable to the authority having jurisdiction. [**59A:**2-2.2.2]

5.2.3.4 Flammable liquid storage tanks shall not be located within an LNG container impoundment area.

5.2.3.5 Impounding areas serving LNG containers shall have a minimum volumetric holding capacity, V, including any useful holding capacity of the drainage area and with allowance made for the displacement of snow accumulation, other containers, and equipment, in accordance with 5.2.3.5(A) and (B).

(A) For impounding areas serving one or more than one container with provisions made to prevent low temperature or fire exposure resulting from the leakage from any one container served from causing subsequent leakage from any other container served, the volume of the dike shall be the total volume of liquid in the largest container served, assuming the container is full.

(B) For impounding areas serving more than one container without provisions made in accordance with 5.2.3.5(A), the volume of the dike shall be the total volume of liquid in all containers served, assuming all containers are full.

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5.2.3.6 Provisions shall be made to clear rain or other water from the impounding area. Automatically controlled sump pumps shall be permitted if equipped with an automatic cut-off device that prevents 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. If gravity drainage is employed for water removal, provisions shall be made to prevent the escape of LNG by way of the drainage system.

5.2.4 Indoor Fueling.

5.2.4.1 Buildings reserved exclusively for an LNG fueling facility shall be of Type I or Type II construction in accordance with NFPA 220, *Standard on Types of Building Construction.* Windows and doors shall be located so as to permit ready egress in case of emergency.

5.2.4.2* Deflagration venting shall be provided only in the exterior walls or the roof. Vents shall consist of any one, or a combination of, the following:

(1) Walls of light material
(2) Lightly fastened hatch covers
(3) Lightly fastened, outward-opening doors in exterior walls
(4) Lightly fastened walls or roof

5.2.4.3 Ventilation shall be by a continuous mechanical ventilation system or by a mechanical ventilation system activated by a continuously monitoring natural gas detection system when a gas concentration of not more than one-fifth of the lower flammable limit is present. In either case, the system shall shut down the fueling system in the event of failure of the ventilation system.

5.2.4.4* The ventilation rate shall be at least 1 ft^3/min/12 ft^3 (1 m^3/min/12 m^3) of room volume.

5.2.4.5 Reactivation of the fueling system shall be by manual restart conducted by trained personnel.

5.2.4.6 A gas detection system shall be provided in all buildings containing LNG and shall activate an alarm when a maximum of 20 percent of the lower flammable limit is reached. The alarm shall be clearly audible and visible both inside and outside the affected area.

5.2.4.7 Dispensing equipment located inside or attached to buildings used for other purposes shall comply with 5.2.4.7(A) through (E).

(A) The dispensing room shall have a minimum of one external wall. Interior walls or partitions shall be continuous from floor to ceiling, shall be anchored securely, and shall have a fire resistance rating of at least 2 hours.

(B) The interior finish of the dispensing room shall be constructed of noncombustible or limited-combustible materials.

(C) In the interior walls of the dispensing room, doors shall be listed as 1.5-hour self-closing fire doors and shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows.*

(D) A ventilation system for a dispensing room within or attached to another building shall be separated from any ventilation system for the other building.

(E) Access to the dispensing room shall be from outside the primary structure only.

Exception: Access from within the primary structure shall be permitted where such access is made through a barrier space having two vapor-sealing, self-closing fire doors having a fire resistance rating equal to that of the wall.

5.2.4.8 Access doors or fire doors shall be kept unobstructed at all times. Appropriate signs and markings and the words "WARNING — NO SMOKING" shall be clearly legible in bright red letters at least 1 in. (25 mm) high on a white background.

5.2.4.9 LNG piping entering a building shall be provided with shutoff valves located outside the building.

5.2.4.10 Buildings and rooms used for storage or dispensing shall be classified in accordance with Table 5.12.1 for installations of electrical equipment.

5.3 LNG Cargo Transport Unloading.

5.3.1 Section 5.3 applies to the transfer of LNG between cargo transport containers and fueling facility containers.

5.3.2 When transfers are made into fueling facility containers, the LNG shall be transferred at a pressure that shall not overpressurize the receiving tank.

5.3.3 The transfer piping shall have isolation valves at both ends. On facility containers with a capacity greater than 2000 gal (7.6 m^3), one remotely operated valve, automatic closing valve, or check valve shall be used to prevent backflow.

5.3.4 If the fueling facility tank or transfer equipment is located in a remote area, operating status indicators, such as those that indicate container level, shall be provided in the unloading area.

5.3.5 At least one qualified person shall be in continuous attendance and shall have an unobstructed view of the transfer point while unloading is in progress.

5.3.6 Sources of ignition shall not be permitted in the unloading area while transfer is in progress.

5.3.7 Bleed or vent connections shall be provided so that loading arms and hoses can be drained and depressurized prior to disconnection if necessary. The connections shall relieve to a safe area.

5.3.8 Prior to connection, a cargo transport vehicle's wheels shall be rendered immobile.

5.3.9 The cargo transport vehicle's engine shall be shut off while the transfer hose or piping is being connected or disconnected. If required for LNG transfer, the engine shall be permitted to be started and used during the liquid transfer operations.

5.3.10 The LNG cargo transport unloading connection shall be at least 1.5 ft (0.46 m) from a storage container.

5.4 LNG Vehicle Fuel Dispensing Systems.

5.4.1 The dispensing device shall be protected from vehicle collision damage.

5.4.2 An emergency shutdown system (ESD) shall be provided that includes a shutoff valve for stopping liquid supply and shutting down transfer equipment. An actuator, distinctly marked for easy recognition with a permanently affixed, legible sign, shall be provided near the dispenser and also at a safe, remote location.

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5.4.3 The maximum delivery pressure at the vehicle tank inlet shall not exceed the maximum allowable pressure of the vehicle fuel tanks.

5.4.4 Hose and arms shall be equipped with a shutoff valve at the fuel end and a breakaway device to minimize release of liquid and vapor in the event that a vehicle pulls away while the hose remain connected. Such a device shall be installed and maintained in accordance with the manufacturer's instructions.

5.4.5 When not in use, hose shall be secured to protect it from damage.

5.4.6 Where a hose or arm of nominal 3 in. (76 mm) diameter or larger is used for liquid transfer or where one of nominal 4 in. (100 mm) diameter or larger is used for vapor transfer, an emergency shutoff valve shall be installed in the piping of the transfer system within 10 ft (3.0 m) from the nearest end of the hose or arm. Where the flow is away from the hose, a check valve shall be permitted to be used as the shutoff valve. Where either a liquid or vapor line has two or more legs, an emergency shutoff valve shall be installed either in each leg or in the feed line before the legs.

5.4.7 Bleed or vent connections shall be provided so that loading arms and hose can be drained and depressurized prior to disconnection if necessary. These bleed or vent connections shall lead to a safe point of discharge.

5.4.8 A fueling connector and mating vehicle receptacle shall be used for reliable, safe, and secure transfer of LNG or gas vapor to or from the vehicle with minimal leakage.

5.4.9 The fueling connector either shall be equipped with an interlock device that prevents release while the line is open or shall have self-closing ends that automatically close upon disconnection.

5.4.10 The transfer of LNG into vehicular fuel supply containers shall be performed in accordance with the manufacturer's instructions. The dispenser manufacturer's instructions shall be posted at the dispensing device.

5.4.11 The provisions of Section 5.4 shall not apply to dispensing from vehicle-mounted tanks located at commercial and industrial facilities used in connection with their business where the following conditions are met:

(1) An inspection of the premises and operations has been made and approval granted by the authority having jurisdiction.
(2) The vehicle-mounted container shall comply with CGA 341, *Standard for Insulated Cargo Tank Specifications for Cryogenic Liquids*, or the requirements of DOT.
(3) The dispensing hose shall not exceed 50 ft (15 m) in length.
(4) Nighttime deliveries shall be made only in lighted areas.

5.5 Piping Systems and Components. Piping shall be in accordance with Section 6.9.

5.6 Safety and Relief Valves.

5.6.1 Pressure relieving safety devices shall be so arranged that the possibility of damage to piping or appurtenance is reduced to a minimum. The means for adjusting relief valve set pressure shall be sealed. [**59A:**6-8.1]

5.6.2 A thermal expansion relief valve shall be installed as required to prevent overpressure in any section of a liquid or cold vapor pipeline that can be isolated by valves. [**59A:**6-8.2]

5.6.2.1 Thermal expansion relief valves shall be set to discharge above the maximum pressure normally expected in the line but less than the rated test pressure of the line it protects. [**59A:**6-8.2.1]

5.6.2.2 Discharge from thermal expansion relief valves shall be directed so as to minimize hazard to personnel and other equipment. [**59A:**6-8.2.2]

5.7 Corrosion Control.

5.7.1 Underground and submerged piping shall be protected and maintained in accordance with the principles of the National Association of Corrosion Engineers Standard RP 0169, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems.* [**59A:**6-9.1]

5.7.2 Austenitic stainless steels and aluminum alloys shall be protected to minimize corrosion and pitting from corrosive atmospheric and industrial substances during storage, construction, fabrication, testing, and service. These substances include, but are not limited to, chlorides and compounds of sulfur or nitrogen. Tapes or other packaging materials that are corrosive to the pipe or piping components shall not be used. Where insulation materials can cause corrosion of aluminum or stainless steels, suitable inhibitors or waterproof barriers shall be utilized. [**59A:**6-9.2]

5.7.3 Corrosion protection of all other materials shall be in accordance with the requirements of Steel Structures Painting Council Specifications SSPC-PA 1, *Shop, Field and Maintenance Painting*; SSPC-PA 2, *Measurement of Dry Paint Thickness with Magnetic Gages*; and SSPC-SP 6, *Commercial Blast Cleaning.*

5.8 Stationary Pumps and Compressors.

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

5.8.2 Foundations and sumps for cryogenic pumps shall be designed and constructed to prevent frost heaving.

5.8.3 Operation of all pumps and compressors shall cease when the facility's Emergency Shutdown Device (ESD) system is initiated.

5.8.4 Each pump shall be provided with an adequate vent or relief valve that will prevent overpressurizing of the pump case under all conditions including the maximum possible rate of cooldown.

5.8.5 Compression equipment handling flammable gases shall be provided with vents from all points, including distance pieces, where gases can normally escape. Vents shall be piped outside of buildings to a point of safe disposal. [**59A:**3-2.7]

5.9 Vaporizers.

5.9.1 Multiple vaporizers shall be manifolded such that both inlet and discharge block valves are installed on each vaporizer.

5.9.2 If the intermediate fluid used with a remote heated vaporizer is flammable, shutoff valves shall be provided on both the hot and cold lines of the intermediate fluid system.

5.9.3 A low temperature switch or other accepted means shall be installed on the vaporizer discharge to eliminate the possibility of LNG entering CNG containers and other equipment not designed for LNG temperatures.

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5.9.4 Relief valves on heated vaporizers shall be located so that they are not subjected to temperatures exceeding 140°F (60°C) during normal operation unless they are designed to withstand higher temperatures.

5.9.5 The combustion air required for the operation of integral heated vaporizers or the primary heat source for remote heated vaporizers shall be taken from outside an enclosed structure or building.

5.9.6 Vaporizers for purposes other than pressure building coils or LNG-to-CNG systems shall be in accordance with NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG).*

5.9.7 Installation of internal combustion engines or gas turbines shall conform to NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.*

5.10 LNG-to-CNG Systems.

5.10.1 Section 5.10 applies to the design, construction, installation, and operation of equipment used to produce CNG from LNG. The process shall be permitted to be accomplished by pumping LNG to high pressure and vaporizing it or by compressing vapor from an LNG tank.

5.10.2* CNG storage containers and equipment located downstream of CNG containers are not covered by this code.

5.10.3 In addition to the emergency shutdown systems described in Section 4.11 of NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code,* the emergency shutdown system also shall shut off the liquid supply and power to the LNG transfer equipment necessary for producing CNG from LNG.

5.10.4 Compressors, vaporizers, and CNG storage cylinders shall not be located inside the facility impoundment area.

Exception: Ambient and remotely heated vaporizers shall be permitted to be located inside the facility impoundment area.

5.10.5 Transfer piping, pumps, and compressors shall be protected from vehicle collision damage.

5.11 Instrumentation.

5.11.1 Pressure Gauging. Pressure gauges shall be installed on each pump and compressor discharge.

5.11.2 Temperature Instruments.

5.11.2.1 Vaporizers and heaters shall be provided with instrumentation to monitor outlet temperatures.

Exception: Ambient pressure–building coil vaporizers that are fed with liquid from, and return vapor to, a container.

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

5.11.3 Emergency Shutdown Device (ESD). Instrumentation for LNG fueling facilities shall be designed so that, in the event of a power or instrumentation failure, the system shall go into a fail-safe condition that can be maintained until the operators can take appropriate action to either reactivate or secure the system. All ESDs shall be manually reset.

5.12 Electrical Equipment.

5.12.1 Electrical equipment and wiring shall be as specified by and shall be installed in accordance with NFPA 70, *National Electrical Code®*, and shall meet the requirements of Class I, Group D, Division or Zone as specified in Table 5.12.1.

Exception: Electrical equipment on internal combustion engines installed in accordance with NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.

5.12.2 Each interface between a flammable fluid system and an electrical conduit or wiring system, including process instrumentation connections, integral valve operators, foundation heating coils, canned pumps, and blowers, shall be sealed or isolated to prevent the passage of flammable fluids to another portion of the electrical installation.

5.12.3 Each seal, barrier, or other means used to comply with 5.12.2 shall be designed to prevent the passage of flammable fluids through the conduit, stranded conductors, and cables.

5.12.4* A primary seal shall be provided between the flammable fluid system and the electrical conduit wiring system. If the failure of the primary seal would allow the passage of flammable fluids to another portion of the conduit or wiring system, an additional approved seal, barrier, or other means shall be provided to prevent the passage of the flammable fluid beyond the additional device or means in the event that the primary seal fails. [**59A:**7-6.5]

5.12.5 Each primary seal shall be designed to withstand the service conditions to which it is expected to be exposed. Each additional seal or barrier and interconnecting enclosure shall meet the pressure and temperature requirements of the condition to which it could be exposed in the event of failure of the primary seal, unless other approved means are provided to accomplish this purpose.

5.12.6 Unless specifically designed and approved for the purpose, the seals specified in 5.12.2 through 5.12.4 are not intended to replace the conduit seals required by Sections 501-5(a), (b), (c), and (d) of NFPA 70, *National Electrical Code.*

5.12.7 Where primary seals are installed, drains, vents, or other devices shall be provided for monitoring purposes to detect flammable fluids and leakage.

5.12.8 Static protection shall not be required when cargo transport vehicles or marine equipment are loaded or unloaded by conductive or nonconductive hose, flexible metallic tubing, or pipe connections through or from tight (top or bottom) outlets where both halves of metallic couplings are in contact. [**59A:**7-7.2]

5.13* Maintenance.

5.13.1 A preventive maintenance program shall be in place and shall include a schedule of written procedures for regular test and inspection of facility systems and equipment.

5.13.2 Each component in service, including its support system, shall be maintained in a condition that is compatible with its operation or safety purpose by repair, replacement, or other means.

5.13.3 If a safety device is taken out of service for maintenance, the component being served by the device shall be taken out of service unless the same safety function is provided by an alternative means.

5.13.4 If the inadvertent operation of a component taken out of service could cause a hazardous condition, that component

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Table 5.12.1 LNG Fueling Facility Electrical Area Classification

Part	Location	Class I, Group D Division or Zone[1]	Extent of Classified Area[2]
A	**LNG Fueling Facility Container Area**		
	Indoors	1	Entire room
	Outdoor, aboveground containers (other than portable)	1	Open area between a high-type dike and container wall where dike wall height exceeds distances between dike and container walls
		2	Within 15 ft (4.6 m) in all directions from container, plus area inside a low-type diked or impounding area up to the height of the dike impoundment wall
	Outdoor, belowground containers	1	Within any open space between container walls and surrounding grade or dike
		2	Within 15 ft (4.6 m) in all directions from roof and sides above grade
B	**Nonfired LNG Process Areas Containing Pumps, Compressors, Heat Exchangers, Piping, Connections Vessels, etc.**		
	Indoors with adequate ventilation	2	Entire room and any adjacent room not separated by a gastight partition, and 15 ft (4.6 m) beyond any ventilation discharge vent or lower
	Outdoors in open air at or above grade	2	Within 15 ft (4.6 m) in all directions from this equipment
C	**Pits, Trenches, or Sumps Located in or Adjacent to Division 1 or 2 Areas**	1	Entire pit, trench, or sump
D	**Discharge from Relief Valves, Drains**	1	Within 5 ft (1.5 m) from point of discharge
		2	Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from point of discharge
E	**Vehicle/Cargo Transfer Area**		
	Indoors with adequate ventilation[3]	1	Within 5 ft (1.5 m) in all directions from point of transfer
		2	Beyond 5 ft (1.5 m) of entire room and 15 ft (4.6 m) beyond ventilation vent
	Outdoors in open air at or above grade	1	Within 5 ft (1.5 m) in all directions from point of transfer
		2	Beyond 5 ft (1.5 m) but within 15 ft (4.6 m) in all directions from the point of transfer

[1]See Article 500 — "Hazardous (Classified) Locations" in NFPA 70, *National Electrical Code*, for definitions of classes, groups, and divisions.
[2]The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.
[3]Ventilation is considered adequate when provided in accordance with the provisions of this code.

shall have a tag attached to its controls bearing the words "Do Not Operate" or a similar warning.

5.13.5 LNG fueling facilities shall be free from rubbish, debris, and other material that present a fire hazard. Grass areas on the LNG fueling facility grounds shall be maintained in a manner that does not present a fire hazard.

5.13.6 Safety and fire protection equipment shall be tested or inspected at intervals not to exceed 6 months.

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5.13.7 Maintenance activities on fire control equipment shall be scheduled so that a minimum of equipment is taken out of service at any one time and fire prevention safety is not compromised. Access routes for movement of fire control equipment to an LNG fueling facility shall be maintained at all times.

Chapter 6 Installation Requirements for ASME Tanks

6.1 Scope. This chapter provides requirements for the installation, design, fabrication, and siting of LNG containers of 70,000-gal (265-m^3) capacity and less and their associated equipment for use in applications such as vehicle refueling facilities and dedicated fuel supply for commercial and industrial applications, which are designed and constructed in accordance with ASME *Boiler and Pressure Vessel Code.* [**59A:**10-1]

6.2 General Requirements. Storage and transfer equipment at unattended facilities shall be secured to prevent tampering. [**59A:**10-2.3]

6.3 Containers.

6.3.1 All piping that is part of an LNG container, including piping between the inner and outer containers, shall be in accordance with either the ASME *Boiler and Pressure Vessel Code,* Section VIII, or ASME B31.3, *Process Piping.* Compliance with this requirement shall be stated on or appended to the ASME *Boiler and Pressure Vessel Code,* Appendix W, Form U-1, "Manufacturer's Data Report for Pressure Vessels." [**59A:**10-3.1]

6.3.2 Internal piping between the inner tank and the outer tank within the insulation space shall be designed for the maximum allowable working pressure of the inner tank, with allowance for the thermal stresses. Bellows shall not be permitted within the insulation space. [**59A:**10-3.2]

6.3.3 Containers shall be double-walled with the inner tank holding LNG surrounded by insulation contained within the outer tank. [**59A:**10-3.3]

6.3.4 The inner tank shall be of welded construction and in accordance with the ASME Code, Section VIII, and shall be ASME-stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors or other agency that registers pressure vessels. [**59A:**10-3.4]

6.3.5 The inner tank supports shall be designed for shipping, seismic, and operating loads. The support system to accommodate the expansion and contraction of the inner tank shall be designed so that the resulting stresses imparted to the inner and outer tanks are within allowable limits. [**59A:**10-3.5]

6.3.6 The outer tank shall be of welded construction and meet the following requirements.

(A) Any of the carbon steels in Section VIII, Part UCS of the ASME *Boiler and Pressure Vessel Code* shall be permitted to be used at temperatures at or above the minimum allowable use temperature in Table 1A of the ASME *Boiler and Pressure Vessel Code,* Section II, Part D.

Exception: Materials with a melting point below 2000°F (1090°C) where the container is buried or mounded.

(B) Where vacuum insulation is used, the outer tank shall be designed according to either of the following:

(1) The ASME Code, paragraphs UG-28, 29, 30, and 33, using an external pressure of not less than 15 psi (100 kPa)
(2) CGA-341, paragraph 3.6.2
(3) Heads and spherical outer tanks that are formed in segments and assembled by welding shall be designed by the ASME *Boiler and Pressure Vessel Code,* Section VIII, paragraphs UG-28, 29, 30, and 33, using an external pressure of 15 psi (100 kPa)

(C) Any portion of the outer tank surface that could be exposed to LNG temperatures shall be suitable for such temperatures or protected from the effects of such exposure.

(D) The outer tank shall be equipped with a relief device or other device to release internal pressure. The discharge area shall be at least 0.00024 $in.^2$/lb (0.07 mm^2/kg) of the water capacity of the inner tank, but the area shall not exceed 300 $in.^2$ (0.19 m^2). Such a device shall function at a pressure not exceeding the internal design pressure of the outer tank, the external design pressure of the inner tank, or 25 psi (172 kPa), whichever is less.

(E) Thermal barriers shall be provided to prevent the outer tank from going below its design temperature. [**59A:**10-3.6]

6.3.7 Container Seismic Design. Shop-built containers designed and constructed in accordance with the ASME *Boiler and Pressure Vessel Code,* and their support system, shall be designed for the dynamic forces associated with horizontal and vertical accelerations as follows:

(1) Horizontal force:

$$V = Z_c \times W$$

where:
Z_c = seismic coefficient from Table 6.3.7
W = total weight of the container and its contents

(2) Design vertical force:

$$P = \frac{2}{3} \times Z_c \times W$$

(3) The seismic coefficient shall be permitted to be calculated in accordance with the nonbuilding structures provisions of the ICBO *Uniform Building Code,* using an Importance Factor I of 1.25. The minimum coefficient from Table 6.3.7 shall be used if the natural period of vibration T is less than 0.3 second. [**59A:**10-3.7.1]

Table 6.3.7 Seismic Coefficient for Shop-Built Containers

Zone	Coefficient, Z_c Acceleration EPA (% G)	Effective Peak Horizontal
1	0.09	7.5
2A	0.17	15.0
2B	0.23	20.0
3	0.34	30.0
4	0.46	40.0

Notes:
1. From UBC Seismic Zone Map, *Uniform Building Code,* 1997.
2. The EPA (% G) is equivalent to the seismic zones, and can be used to determine Z_c in areas where seismic zones are not available.

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6.3.7.1 The container and its supports shall be designed for the resultant seismic forces in combination with the operating loads, using the allowable stresses increase shown in the code or standard used to design the container or its supports. [**59A:**10-3.7.2]

6.3.7.2 The requirements of 6.3.7 shall apply to ASME containers built prior to July 1, 1996, when reinstalled. [**59A:**10-3.7.3]

6.3.8 Each container shall be identified by the attachment of a nameplate or nameplates in an accessible location marked with the information required by the ASME Code and all the following:

(1) Builder's name and date built
(2) Nominal liquid capacity
(3) Design pressure at the top of the container
(4) Maximum permissible liquid density
(5) Maximum filling level
(6) Minimum design temperature [**59A:**10-3.8]

6.3.9 All penetrations on storage containers shall be identified. Markings shall be legible under all conditions. [**59A:**10-3.9]

6.4 Container Foundations and Supports.

6.4.1 LNG container foundations shall be designed and constructed in accordance with recognized structural and geotechnical engineering practices including provisions for seismic loading as specified in 6.3.7. Saddles and legs shall be designed in accordance with recognized structural engineering practice, including for shipping loads, erection loads, wind loads, and thermal loads. Foundations and supports shall be protected to have a fire resistance rating of not less than 2 hours. If insulation is used to achieve this requirement, it shall be resistant to dislodgment by fire hose streams. [**59A:**10-5.1]

6.4.2 Where the LNG storage container is installed in an area subject to flooding, the container shall be secured in a manner that will prevent release of LNG or flotation of the container in the event of a flood. [**59A:**10-5.2]

6.5 Container Installation.

6.5.1 The minimum separation distance between LNG containers and exposures shall be in accordance with Table 6.5.1.

Exception: With the approval of the authority having jurisdiction, such equipment shall be permitted to be located at a lesser distance from buildings or walls constructed of concrete or masonry, but at least 10 ft (3.0 m) from any building openings. [**59A:**10-6.1]

6.5.2 Buried and underground containers shall be provided with means to prevent the 32°F (0°C) isotherm from penetrating the soil. Heating systems shall be installed so that any heating element or temperature sensor used for control can be replaced. [**59A:**4-5.2]

6.5.3* All buried or mounded components in contact with the soil shall be constructed from corrosion-resistant material or protected from corrosion deterioration. [**59A:**10-6.3]

6.5.4 A clear space of at least 3 ft (0.9 m) shall be provided for access to all isolation valves serving multiple containers. [**59A:**10-6.4]

6.5.5 LNG containers of greater than 40-gal (151-L) capacity shall not be located in buildings. LNG containers of any size shall not be permanently installed in buildings.

Exception: LNG vehicle fuel tanks permanently installed on vehicles.

6.6 Product Retention Valves. All liquid and vapor connections, except relief valve and instrument connections, shall be equipped with automatic fail-safe product retention valves. These automatic valves shall be designed to close on the occurrence of any of the following conditions:

(1) Fire detection or exposure
(2) Uncontrolled flow of LNG from the container
(3) Manual operation from a local and remote location

Connections used only for flow into the container shall be permitted to be equipped with two backflow valves, in series, in lieu of the requirements in Section 6.6(1) through (3). The appurtenances shall be installed as close to the container as practicable and so that a break resulting from external strain shall occur on the piping side of the appurtenance while maintaining intact with the valve and piping on the container side of the appurtenance. [**59A:**10-7]

6.7 Inspection.

6.7.1 Prior to initial operation, containers shall be inspected to ensure compliance with the engineering design

Table 6.5.1 Distances from Impoundment Areas to Buildings, Property Lines

Container Water Capacity		Minimum Distance from Edge of Impoundment or Container Drainage System to Buildings, Property Lines		Minimum Distance Between Storage Containers	
gal	m^3	ft	m	ft	m
<125	0.5	0	0	0	0
125–500	0.5–1.9	10	3	3	1
501–2,000	1.9–7.6	15	4.6	5	1.5
2001–15,000	7.6–56.8	25	7.6	5	1.5
15,001–30,000	56.8–114	50	15	5	1.5
30,001–70,000	114–265	75	23	¼ of the sum of the diameters of adjacent containers [5 ft (1.5 m) minimum]	

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and material, fabrication, assembly, and test provisions of the chapter. The operator shall be responsible for this inspection. [**59A:**10-9.1]

6.7.2 Performance of any part of the inspection shall be permitted to be delegated to inspectors who are employees of the operator's own organization, an engineering or scientific organization, or a recognized insurance or inspection company. Inspectors shall be qualified in accordance with the code or standard applicable to the container and as specified in NFPA 59A. [**59A:**10-9.2]

6.8 Testing and Purging of LNG Containers.

6.8.1 LNG containers shall be leak-tested in accordance with the governing construction code or standard. All leaks shall be repaired. [**59A:**10-10.1]

6.8.1.1 Testing shall be performed in accordance with the ASME *Boiler and Pressure Vessel Code.* [**59A:**10-10.1.1]

6.8.1.2 Shop-built containers shall be pressure tested by the manufacturer prior to shipment to the installation site. The inner tank shall be tested in accordance with the ASME Code. The outer tank shall be leak-tested. Piping shall be tested in accordance with Chapter 6 of NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG).* [**59A:**10-10.1.2]

6.8.1.3 Containers and associated piping shall be leak-tested prior to filling the container with LNG. [**59A:**10-10.1.3]

6.8.1.4 Containers shall be shipped with a minimum internal pressure of 10 psi (69 kPa) inert gas. [**59A:**10-10.1.4]

6.8.2 After acceptance tests are completed, there shall be no field welding on the LNG containers. Retesting by a method appropriate to the repair or modification shall be required only where the repair or modification is of such a nature that a retest actually tests the element affected and is necessary to demonstrate the adequacy of the repair or modification.

Exception No. 1: Field welding shall be permitted on saddle plates or brackets provided for the purpose.

Exception No. 2: Field welding shall be permitted where such repairs or modifications comply with the code or standard under which the container was fabricated originally. [**59A**:10-10.2]

6.8.3* Container Purging Procedures. Prior to placing an LNG container into or out of service, the container shall be inerted by an approved inerting procedure.

6.9 Piping.

6.9.1 All piping that is part of an LNG container and facility associated with the container for handling cryogenic liquid or flammable fluid shall be in accordance with ASME B31.3, *Process Piping.* [**59A:**10-11.1]

6.9.2 The requirements of 6.9.2(A) through (J) shall also apply.

(A) Type F piping, spiral-welded piping, and furnace butt-welded steel products shall not be permitted.

(B) All welding or brazing shall be performed by personnel qualified to the requirements of ASME *Boiler and Pressure Vessel Code,* Section IX.

(C) Oxygen–fuel gas welding shall not be permitted.

(D) Brazing filler metal shall have a melting point exceeding 1000°F (538°C).

(E) All piping and tubing shall be austenitic stainless steel for all services below –20°F (–29°C).

(F) All piping and piping components shall have a minimum melting point of 1500°F (816°C).

Exception No. 1: Gaskets, seats, and packing.

Exception No. 2: Aluminum shall be permitted to be used downstream of a product retention valve in vaporizer service.

(G) Compression-type couplings shall not be used where they will be subjected to temperatures below –20°F (–29°C) unless they meet the requirements of Section 318 of ASME B31.3, *Process Piping.*

(H) Stab-in branch connections shall not be permitted.

(I) Extended bonnet valves shall be used for all cryogenic liquid service. The valves shall be installed such that the bonnet is at an angle of not more than 45 degrees from the upright vertical position.

(J) The level of inspection of piping shall be specified. [**59A:**10-11.2]

6.10 Container Instrumentation.

6.10.1 General. Instrumentation for LNG facilities shall be designed such that, in the event of power or instrument air failure, the system will go into a fail-safe condition that can be maintained until the operators can take action to reactivate or secure the system. [**59A:**10-12.1]

6.10.2 Level Gauging. LNG containers shall be equipped with two independent liquid level devices. One shall be a fixed-length dip tube, and the other shall be a continuous indication from full to empty and shall be maintainable or replaceable without taking the container out of service.

Exception: Containers smaller than 1000 gal (3.8 m^3) shall be permitted to be equipped with a fixed-length dip tube only. [**59A:**10-12.2]

6.10.3 Pressure Gauging.

6.10.3.1 Each container shall be equipped with a pressure gauge connected to the container at a point above the maximum liquid level. The pressure gauge dial shall have a permanent mark indicating the maximum allowable working pressure (MAWP) of the container. [**59A:**10-12.3]

6.10.3.2 Vacuum-jacketed equipment shall be equipped with instruments or connections for checking the pressure in the annular space. [**59A:**10-12.3.2]

6.11 Pressure Control.

6.11.1 Safety relief valves shall be provided to maintain the internal pressure of LNG containers in accordance with the ASME *Boiler and Pressure Vessel Code,* including under conditions resulting from operational upset, vapor displacement, and flash vaporization during filling; flash vaporization resulting from pump recirculation; and fire. The valves shall communicate directly with the atmosphere. They shall be sized in accordance with Section 4-8 of NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG),* or CGA Standard S-1.3, *Pressure Relief Device Standards — Part 3 — Compressed Gas Storage Containers.* [**59A:**10-12.4.1]

6.11.2 Each pressure- and vacuum-safety relief valve for LNG containers shall be able to be isolated from the container for maintenance or other purposes by means of a manual full-opening stop valve. This stop valve (or valves) shall be lockable

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or sealable in the full-open position. Sufficient pressure and vacuum relief valves shall be installed on the LNG container to allow each relief valve to be isolated individually for testing or maintenance while maintaining the full capacities determined in 4-8.1.4 of NFPA 59A. When only one relief device is required, a full-port-opening three-way valve shall be permitted to be used under the relief device and its required spare in lieu of individual valves beneath each relief device. [**59A:**10-12.4.2]

6.11.3 Stop valves under individual safety relief valves shall be locked or sealed when opened and shall not be opened or closed except by an authorized person. [**59A:**10-12.4.3]

6.11.4 Safety relief valve discharge stacks or vents shall be designed and installed to prevent an accumulation of water, ice, snow, or other foreign matter and, if arranged to discharge directly into the atmosphere, shall discharge vertically upward. [**59A:**10-12.4.4]

Chapter 7 Fire Protection, Safety, and Security

7.1 General. This chapter covers fire protection, personnel safety, and training for LNG vehicles, security, LNG fueling facilities for LNG vehicles, and warning signs.

7.2 Fire Protection.

7.2.1 Fire protection shall be provided for all LNG fueling facilities. The extent of such protection shall be determined by an evaluation based on sound fire protection engineering principles, analysis of local conditions, vehicle operations, hazards within the facility, exposure to or from other property, and the size of the LNG containers. Guidance factors for making such an evaluation include the following:

(1) The type, quantity, and location of equipment necessary for the detection and control of fires, leaks, and spills of LNG, flammable refrigerants, and flammable gases or liquids
(2) The methods necessary for the protection of vehicles, equipment, and structures from the effects of fire exposure
(3) The equipment and processes to be incorporated within the emergency shutdown device system
(4) The type, quantity, and location of sensors necessary to initiate automatic operation of the ESD system
(5) The availability and duties of individual facility personnel and the availability of external response personnel during an emergency
(6) The protective equipment and special training required by personnel for emergency duties

7.2.2 The planning for emergency response measures shall be coordinated with the appropriate local emergency agencies.

7.2.3* An emergency response plan shall be prepared to cover the potential emergency conditions that can develop.

7.2.4 The fire protection equipment shall be maintained in accordance with the manufacturer's instructions and the authority having jurisdiction.

7.3 Ignition Source Control.

7.3.1 Smoking and ignition sources shall be prohibited, except in accordance with 7.3.2.

7.3.2 Welding, oxygen–acetylene cutting, and similar operations shall be conducted only when and where specifically authorized and in accordance with the provisions of NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.*

7.3.3 Vehicles and other mobile equipment that constitute a potential ignition source shall be prohibited except where specifically authorized and under constant supervision or when at a transfer point specifically for the purpose of transfer.

7.3.4 Vehicles delivering LNG to the facility or vehicles being fueled from the facility shall not be considered sources of ignition. Vehicles containing fuel-fired equipment — for example, recreational vehicles and catering trucks — shall be considered a source of ignition unless all sources of ignition — such as pilot lights, electric igniters, burners, electrical appliances, and engines — located on the vehicle being refueled are shut off completely before entering an area where ignition sources are prohibited.

7.4* Personnel Safety and Training.

7.4.1 Qualification of Personnel. All persons employed in handling and dispensing LNG shall be trained in proper handling and operating duties and procedures.

7.4.2 Protective clothing, face shield/goggles, and gloves shall be provided for all operators dispensing and handling LNG.

Exception: Where equipment is demonstrated to operate without release of LNG or cold gases.

7.4.3* Training shall be conducted upon employment and every 2 years thereafter. Training shall include the following:

(1) Information on the nature, properties, and hazards of LNG in both the liquid and gaseous phases
(2) Specific instructions on the facility equipment to be used
(3) Information on materials that are compatible for use with LNG
(4) The use and care of protective equipment and clothing
(5) Standard first aid and self-aid instruction
(6) Response to emergency situations such as fires, leaks, and spills
(7) Good housekeeping practices
(8) The emergency response plan as required in 7.2.3
(9) Evacuation and fire drills

7.5 Security. The LNG fueling facility shall provide protection to minimize unauthorized access and damage to the facility. Security procedures shall be posted in readily visible areas near the fueling facility.

7.6 Hazard Detection. Gas leak detection and fire detection shall be installed based on the evaluation required in 7.2.1.

7.7 Parking of LNG Vehicles. LNG vehicles shall be permitted to be parked indoors, provided such facilities or vehicles are equipped to prevent an accumulation of gas in a combustible mixture or the onboard fuel storage tank and fuel system are drained of LNG and purged with inert gas or depressurized.

7.8 Warning Signs. For all LNG fueling facilities, the following signs shall be displayed in bright red letters on a white background, with letters not less than 6 in. (152 mm) high:

(1) No Smoking *or* No Smoking within 25 ft (7.6 m)
(2) Stop Motor
(3) No Open Flames Permitted
(4) Cryogenic Flammable Liquid
(5) Flammable Gas

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Chapter 8 Commercial Marine Vessels and Pleasure Craft

8.1 Scope. This chapter shall apply to all commercial marine vessels and pleasure craft operating on LNG, including new and retrofit construction. The previous chapters of this code shall apply to commercial marine vessels and pleasure craft operating on LNG. The following paragraphs shall not be applicable to commercial marine vessels and pleasure craft operating on LNG: 4.4.3(7), 4.12.1.2, 4.12.1.3, 4.12.1.6, 4.12.1.7, 4.12.2, 4.12.3.4, 4.12.3.5, 4.12.8.2.

8.2 Installation of Fuel Supply Containers.

8.2.1 Fuel supply containers on marine vessels shall be permitted to be located on the weather deck, above accommodation and service space, or below deck adjacent to accommodation and service space, provided all connections to the containers are external to or sealed and vented from these spaces. Containers on the weather deck shall be protected with a housing to prevent damage that can occur due to loading, unloading, direct sunlight, and the general use of the vessel. The housing shall be installed to prevent contact of the housing with the container(s) and to prevent entrapment of materials that could damage the container(s) or its coating. The shelter(s) for storing the containers on the weather deck shall be an enclosure that is constructed of noncombustible or limited-combustible materials and has at least one side predominantly open, facing outboard, and a roof designed for ventilation and dispersal of escaped gas.

8.2.2 Each fuel supply container shall be mounted in a location that minimizes damage from collision. No part of a container or its appurtenances on the weather deck shall protrude beyond the sides or top of the vessel at the point where it is installed.

8.2.3 No portion of a fuel supply container or container appurtenances shall protrude beyond the bow or the stern of the vessel. Container valves shall be protected from physical damage using the vessel structure, valve protectors, or a suitable metal shield.

8.2.4 Each container cradle shall be secured to the vessel frame, either above or below or both, to prevent damage from slippage, loosening, or rotation using a method capable of withstanding a static force in the six principal directions of at least four times the weight of the fully pressurized container(s) or greater as is appropriate for the vessel.

8.2.5 Each fuel supply container shall be secured to its cradle or to the vessel frame in such a manner that it is capable of withstanding a static force applied in the six principal directions of at least four times the weight of the fully pressurized container or greater as is appropriate for the vessel.

8.2.6 The container weight shall not be supported by outlet valves, manifolds, or other fuel connections.

8.2.7 Fuel supply containers located less than 8 in. (200 mm) from the exhaust system shall be shielded against direct heat.

8.2.8 The mounting system shall minimize fretting corrosion between the container and the mounting system.

8.2.9 Fuel supply containers shall not be installed so as to adversely affect the balance of the marine vessel.

8.2.10 A container, where located in a below-deck tank room or tank compartment that is capable of accumulating natural gas, shall be installed so that the pressure relief device for the protection of the container is installed in the same space as the container and the discharge from the pressure relief device is as follows:

(1) Vented to the outside through a metallic tube (vent mast) or hose no smaller than the outlet diameter of the relief device, secured at 12 in. (300 mm) intervals where the tube exceeds 24 in. (610 mm) in length and having a minimum burst pressure of at least one and one-half times the service pressure of the container at 400°F (204°C)
(2) Located so that the vent opening is not blocked by debris or otherwise affected by the elements

8.2.11 A container located in a below-deck tank room or compartment shall be enclosed in a space constructed of materials approved for cryogenic service. The enclosure shall be capable of containing leakage from the fuel tank.

8.3 Installation of Pressure Gauges.

8.3.1 A pressure gauge located within the wheelhouse (bridge) or accommodation or service space shall be installed in such a manner that no gas flows through the gauge in the event of failure.

8.3.2 A pressure gauge installed in the engine room/compartment, fuel tank room/compartment, or other gas-dangerous space shall be equipped with a limiting orifice, a shatterproof dial lens, and a body relief.

8.4 Labeling. Each marine vessel or pleasure craft shall be identified with weather-resistant, diamond-shaped labels located on an exterior vertical surface or near-vertical surface, at a location, as near to eye level as possible, where the vessel is routinely boarded, both port and starboard. Depending on the size of the vessel, other labels should be placed at logical locations to alert persons not familiar with the vessel, such as fire fighters or service personnel, as to the nature of the vessel. The label shall be a minimum of 4 in. (120 mm) long by 3 in. (83 mm) high. The marking shall consist of a border and the letters "LNG" [1-in. (25-mm) minimum height centered in the diamond] of silver or white reflective luminous material on a blue background.

8.5 Operation.

8.5.1 Where LNG is being transferred to or from a marine vessel, the engines shall be turned off.

Exception: Engine operation shall be permitted when necessary to hold the vessel in position while refueling or when, in the opinion of the master, the safety of the vessel is at issue. The master shall be permitted to also elect to operate generators during refueling.

8.5.2 A warning sign with the words "Stop Engines," "No Smoking," and "Flammable Gas" shall be posted at dispensing stations and compressor areas where it is possible to secure a vessel to a dock or anchor buoys. Otherwise, a sign shall be posted with the words "No Smoking" and "Flammable Gas." The location of signs shall be determined by local conditions, but the lettering shall be large enough to be visible and legible from each point of transfer.

8.6 Fire Protection for Vessels. Fire protection for vessels shall be in accordance with NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft.* In addition, the following paragraphs of NFPA 302 shall be revised as follows when used for LNG fuel systems:

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(1) Paragraph 2-5.3.4(b) of NFPA 302, covering blower intake duct openings, shall be revised to change the blower inlet duct opening location from the lower one-third of the compartment to the upper one-third of the compartment.
(2) Subsection 4-1.1 of NFPA 302, general requirements for engine exhaust systems, shall be revised by expanding the exception to make the paragraph not applicable to exhaust cooling water in addition to engine-cooling water.

8.7 LNG Fueling Systems. LNG fueling systems shall be in accordance with NFPA 303, *Fire Protection Standard for Marinas and Boatyards.* In addition, the following paragraphs of NFPA 303 shall be revised as follows when using LNG as a fuel:

(1) Subsection 6-3.2 of NFPA 303, covering all boat fueling operations, shall be revised by adding reference to NFPA 57, *Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code.*
(2) Subsection 6-3.4 of NFPA 303, covering securing of fuel storage tanks, shall be revised by adding reference to NFPA 57, *Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code.*
(3) Subsection 6-3.9 of NFPA 303, covering dispensing of fuels, shall be revised by adding reference to NFPA 57, *Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code.*

8.8 Marine Service Stations. Marine service stations for fueling LNG-powered marine vessels shall be in accordance with NFPA 30A, *Automotive and Marine Service Station Code.* In addition, Section 3-1 of NFPA 30A, covering general requirements for the installation of piping systems shall be revised by adding reference to NFPA 57, *Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code.*

8.9 Engine Rooms or Compartments.

8.9.1 In engine rooms and engine compartments, all fuel lines shall be mounted in the overhead to provide the shortest route for leaking gas to flow to the exterior.

8.9.2 The pressure in the fuel lines passing through the engine room or engine compartment shall not exceed the pressure required to operate the engines.

8.9.3 All pressure regulators, except those mounted on the engine(s), shall be located in a tank room or tank compartment.

8.9.4 Ventilation. Engine rooms or compartments shall be provided with positive pressure and passive ventilation. Positive pressure ventilation shall provide a minimum of 30 volumetric exchanges per hour.

(A) The ventilation system shall be capable of handling a combustible mixture, if necessary. The ventilation fans shall take air from the weather deck and discharge it to the weather deck through ducts that shall have a maximum separation from the fans. Multiple discharge ducts shall be used, if practical, to enhance ventilation.

(B) If engine combustion air is taken from the engine room (compartment), the 30 volumetric exchanges per hour shall be in excess of the maximum air volume per hour required by the engines.

8.9.5 Engines.

8.9.5.1 Since LNG engines have a natural gas atmosphere in the crankcase, they shall be provided with blowout plugs to relieve pressure in the event of a crankcase explosion. Blowout plugs shall be located so as to limit risk to the crew.

8.9.5.2 Vessels having the capability shall be permitted to switch to another fuel to maintain power.

8.9.5.3 Engines shall be permitted to be located on the weather deck.

8.9.5.4 Engines on the weather deck shall be protected with a housing to prevent damage that can occur due to loading, unloading, or the general use of the vessel.

8.9.5.5 Shelters for engines installed on the weather deck shall be enclosures constructed of noncombustible or limited-combustible materials that have at least one side predominantly open, facing outboard, and roofs designed for dispersal of escaped gas.

8.9.5.6 An engine or engines on the weather deck shall be mounted in a location to minimize damage from collision. No part of an engine or its appurtenances shall protrude beyond the sides or top of the vessel at the point where it is installed.

8.9.5.7 No portion of an engine on the weather deck shall protrude beyond the bow or stern of the vessel.

8.9.6 Natural Gas Monitoring.

8.9.6.1 Engine Rooms. Engine rooms shall have at least two natural gas detectors placed in the overhead at the fore and aft locations.

8.9.6.2 Monitoring stations shall be located in the engine room, in the wheelhouse (bridge), and in an accommodation or service space, such as a galley, where crew are likely to congregate.

8.9.6.3 When no gas is detected, the monitoring stations shall show a green light.

8.9.6.4 At one-tenth of the lower flammability level (LFL) of the concentration, power ventilation shall activate simultaneously along with a flashing yellow light at each monitoring station accompanied by a klaxon.

8.9.6.5 Should the monitoring system detect a concentration, one-fifth of the LFL, a flashing red light shall activate at each monitoring station accompanied by a siren. When the one-fifth LFL is detected and the alarm system activated, an emergency fuel shutoff shall be activated simultaneously, terminating the flow of natural gas to the engine room. Vessels having the capability shall be permitted to switch to another fuel.

8.9.6.6 A manual override switch shall be mounted in the engine room so that the crew can turn off the alarm and restore natural gas to the engines in the event of a false alarm or other contingency.

8.9.6.7 When the LNG fuel supply is shut down due to loss of ventilation or detection of gas, the master shall ensure that the LNG fuel supply is not used until the leak or other cause of the shutdown is found and corrected.

8.9.7 Engine Compartments. Engine compartments shall be equipped with natural gas detection and intervention equipment in a fashion similar to engine rooms except that a monitoring station shall be placed only at the wheelhouse (bridge). If the vessel is large enough to make a fuel alarm inaudible if no one is manning the wheelhouse (bridge), then a monitoring station shall also be placed in the accommodation or service space.

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8.9.8 Fire Equipment and Systems. LNG-powered marine vessels of all sizes shall carry fire equipment and systems normally required by U.S. Coast Guard, and all of the following:

(1) In addition, engine rooms and engine compartments shall have a 150°F (66°C) thermal switch that shall activate fire-fighting equipment. When the thermal switch is activated, a flashing red light and an audible alarm in the engine room wheelhouse (bridge) and other accommodation space or service space where crew are likely to congregate, such as a galley, shall activate, signaling the possible presence of a fire.
(2) There shall be a 1-minute time delay, after which the engine room or compartment shall be flooded with CO_2 (or other USCG-approved inert gas) for 2 minutes. Simultaneously, the ventilation fans shall be cut off for 2 minutes and then reactivated. Sufficient CO_2 (or other USCG-approved inert gas) should be provided for two cycles.
(3) A manual override switch shall be provided in the engine room or near the engine compartment to allow the response to be terminated in the event of false alarm or other contingency.
(4) Controls shall be provided to allow manual activation of the CO_2 (or other USCG-approved inert gas) system without a delay.

8.10 Tank Rooms or Compartments.

8.10.1 Tank rooms and tank compartments shall be airtight as well as watertight with appropriate fittings used to seal penetrations through the bulkheads for wire or pipes passing through the tank rooms.

8.10.2 The tank rooms shall be provided with positive pressure and passive ventilation.

8.10.3 Ventilation of the tank rooms (compartments) shall be provided at 30 volumetric exchanges per hour minimum.

8.10.4 Air shall be taken from the weather deck and discharged to the weather deck through ducts that have a maximum separation from the fans.

8.10.5 The fans shall be capable of handling a combustible mixture, if necessary.

8.10.6 Multiple discharge ducts shall be used, if practical, to enhance ventilation.

8.10.7 Natural Gas Monitoring.

8.10.7.1 Tank rooms or compartments shall have at least two natural gas sensors placed at or near the ceiling at fore and aft locations.

8.10.7.2 When no gas is detected, the monitoring stations shall show a green light.

8.10.7.3 Two levels of alarm shall be used for signaling the need for intervention.

8.10.7.4 An alarm shall activate when one-tenth of the LFL is detected by a monitor. A flashing yellow light and a klaxon shall be activated in the engine room and in the wheelhouse (bridge), as well as in an accommodation or service space, such as a galley, where crew are likely to congregate. Simultaneously, power ventilation shall activate. On vessels with a tank compartment, a flashing yellow light and an audible signal shall activate in the wheelhouse (bridge). If the vessel is large enough to cause the alarm to be inaudible if no one is manning the wheelhouse (bridge), a second warning station shall activate in an accommodation or service space where crew are likely to congregate.

8.10.7.5 At one-fifth of LFL, a second alarm shall activate, utilizing a flashing red light and a siren. These monitoring stations shall be located as are the monitoring stations for the one-tenth LFL. When the one-fifth LFL warning is activated, an automatic fuel shutoff valve will terminate flow of natural gas from the tank room or compartment, ventilation shall terminate, CO_2 (or other USCG-approved inert gas) shall flood the tank room, and a water deluge system shall be activated. Vessels having the capability shall be permitted to switch to another fuel.

8.10.7.6 A tank compartment shall be permitted to omit a deluge system if a vessel is too small to accommodate the equipment. The judgment shall be made by the authority having jurisdiction.

8.10.7.7 When the LNG fuel supply is shut down due to loss of ventilation or detection of gas, the master shall ensure that the LNG fuel supply is not used until the leak or other cause of the shutdown is found and corrected.

8.10.8 Tank rooms and compartments shall have manual drains to remove the water produced by the deluge system.

8.10.9 A labeled override switch shall be available in a readily accessible location to turn off the tank room or compartment warning system in the event of a false alarm or other contingency and to shut down the CO_2 (or other USCG -approved inert gas) and deluge.

8.10.10 Fire-Fighting Equipment.

8.10.10.1 Tank rooms and compartments shall have a 150°F (66°C) thermal switch, which will activate automatic fire-fighting equipment.

8.10.10.2 When the switch is activated, a red flashing light and an audible alarm shall activate on a fire alarm panel in the wheelhouse (bridge) and in an accommodation or service space (such as a galley) where crew are likely to congregate.

8.10.10.3 Since the tank rooms or compartments are unmanned spaces, alarms shall not be required in those spaces.

8.10.10.4 Ventilation in the tank rooms or compartments shall be terminated simultaneously with the activation of the fire alarm. One minute after the fire alarm is activated, the tank room or compartment shall be flooded with CO_2 (or other USCG-approved inert gas) and a deluge system shall activate to keep the LNG tanks cool and to assist in terminating fire.

8.10.10.5 The tank room or compartment shall be provided with a readily accessible override switch that will allow the crew to terminate the fire-fighting system in the event of a false alarm or other contingency.

8.10.10.6 A deluge system shall be permitted to be omitted from tank compartments on vessels too small to accommodate them. This determination shall be made by the authority having jurisdiction.

8.10.11 Lighting.

8.10.11.1 Tank rooms shall have at least two explosionproof lighting fixtures.

8.10.11.2 Switches and overcurrent protective devices for lighting in the tank room(s) shall be in a gas-safe space.

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8.11 Vent Masts.

8.11.1 All crankcases on natural gas–powered engines shall be vented to a vent mast. Vessels having more than one engine shall be permitted to utilize a manifold.

8.11.2 Relief valves or common vent headers from relief valves shall discharge to a vent mast.

8.11.3 Vent masts shall have the following features:

(1) A vertically upward discharge
(2) A rain cap or other means of preventing the entrance of rain or snow
(3) A height of at least 10 ft (3 m) above the highest working level on the vessel

8.11.4 Relief valve vent masts and engine ventilation vent masts shall not be connected but shall be permitted to terminate at the same location.

8.12 Deluge Systems.

8.12.1 Each deluge system that protects more than one area shall have at least one isolation valve at each branch connection and at least one isolation valve downstream from each branch connection to isolate damaged sections.

8.12.2 Each valved cross connection from the deluge system to the fire main shall be outside of the tank room or compartment.

8.12.3 Each pipe, fitting, and valve for the deluge system shall be made of fire-resistant and corrosion-resistant materials such as galvanized steel or galvanized iron pipe.

8.12.4 Each deluge system shall have a means of drainage to prevent corrosion of the system and freezing of the accumulated water in subfreezing temperatures.

8.12.5 Each deluge system shall have a dirt strainer that is located at the deluge system manifold or pump.

8.12.6 Water to the deluge system shall be supplied by a pump that is reserved for the use of the system.

8.13 Alarm Systems.

8.13.1 Alarm systems shall have a means of indicating which natural gas sensor has been activated.

8.13.2 The fire alarm systems shall have a means of indicating which thermal switch has been activated.

8.13.3 Each audible alarm shall have an arrangement that allows it to be turned off after sounding. For remote group alarms, this arrangement shall not interrupt the alarm's actuation by other faults.

8.13.4 Each visual alarm shall be of the type that can be turned off only after the actuating is corrected.

8.13.5 Each vessel shall have means for testing each alarm.

8.13.6 Gas-safe spaces adjacent to gas-dangerous spaces such as engine rooms and tank compartments shall have positive pressure ventilation systems capable of 30 volumetric exchanges an hour. Their ventilation shall activate whenever an alarm is activated.

8.14 Safety Equipment.

8.14.1 Marine vessels with tank rooms and engine rooms shall have the following:

(1) Three self-contained, pressure demand–type, air-breathing apparatus approved by the Mining Enforcement and Safety Administration (MESA) or the National Institute for Occupational Safety and Health (NIOSH), each having at least a 30-minute capacity
(2) Three spare bottles of air for the self-contained air-breathing apparatus, each having at least a 30-minute capacity
(3) Three explosionproof flashlights
(4) Three helmets that meet ANSI Z89-1, *Personal Protection — Protective Headwear for Industrial Workers*
(5) Three sets of goggles that meet the specification ANSI Z87-1, *Practice for Occupational and Educational Eye and Face Protection*
(6) An air compressor to recharge the bottles for the air-breathing apparatus
(7)*Portable handheld natural gas detectors that shall be provided to aid in evaluating alarms and for making a survey of the vessel. These instruments shall allow locating specific leaks at very low levels of detection and shall be carried by personnel working in a compartment containing gas storage or transmission equipment. A vessel with a tank room shall have at least two of these sensors.

8.14.2 Vessels having engine rooms and tank rooms shall have a portable analyzer that measures oxygen levels in an inert atmosphere.

8.14.3 Before allowing anyone to enter a space that has had a gas leak and repair, the master shall ensure that the space has an oxygen concentration of at least 19.5 percent oxygen by volume and is free of natural gas.

8.14.4 The master shall ensure that the compressed air-breathing equipment is inspected at least once a month by a licensed officer and that the date of inspection and condition of the equipment is placed in the vessel's log.

8.15 Safety Training.

8.15.1 A written safety guide for the vessel and for the safety equipment and procedures shall be provided. The safety guide shall outline all safety systems and equipment and their operation.

8.15.2 Crews shall be trained to operate the LNG-powered vessel and perform repairs.

8.15.3 Training drills shall be conducted monthly.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 For information on on-site storage of LNG in ASME tanks larger than 70,000 gal (265 m^3) and in tanks built to API or other standards, see NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG).*

At the time this code was developed, the use of LNG as an aviation fuel, fueling site liquefaction facilities, and the use of residential LNG fueling facilities were not being considered actively. The committee intends to provide coverage for these applications at the appropriate time.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of

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installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.5 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.3 Building. A structure with more enclosed sides is considered a building.

A.3.3.23 Limited Combustible Material. See NFPA 259, *Standard Test Method for Potential Heat of Building Materials.*

A.3.3.24 Liquefied Natural Gas (LNG). At sufficiently low temperatures, natural gas liquefies. At atmospheric pressure, natural gas can be liquefied by reducing its temperature to approximately –260°F (–162°C). Upon release from containment to the atmosphere, LNG vaporizes and releases gas that, at ambient temperature, has about 600 times the volume of the liquid vaporized. Generally, at temperatures below approximately –170°F (–112°C), this gas is heavier than ambient air at 60°F (15°C). However, as its temperature rises, it becomes lighter than air.

The American Gas Association's *LNG Information Book* contains additional detailed information on the properties of methane and other hydrocarbons that constitute LNG.

A.4.3.4 Shutoff valves should be located as close as practical to the tank outlets and should be protected from damage from collision to the extent possible. Due to the potential for collision damage and fire, the use of design features, such as automatic shutoff valves, shutoff valves located inside the tank assembly, and high G and excess flow shutoffs for such valves, should be considered.

A.5.2.3.3 The potential spill from a fixed container equipped with the valves discussed in Section 6.6 is limited to the volume of the piping system. For transfer operations where the source of a spillage is from a truck unloading, the spill volume is either the 10-minute flow from the truck, assuming design flow, or a lower volume if the truck is equipped with automatic shutoff.

The facility can be arranged so that the container and transfer areas' spill containment can be a common impoundment area. In this case, the volume determined by 5.2.3.3 will usually satisfy both requirements.

A.5.2.4.2 For information on venting of explosions, see NFPA 68, *Guide for Venting of Deflagrations.* Snow loads should be considered where applicable.

A.5.2.4.4 This rate corresponds to five air changes per hour.

A.5.10.2 For information on CNG containers and equipment, see NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code.*

A.5.12.4 Examples of such other means might include a physical interruption of the conduit run and of the stranded conductor(s) through the use of an adequately vented junction box containing terminal strip or busbar connections; an exposed section of MI cable using suitable fittings; or an exposed section of single conductor(s) that are incapable of transmitting gases or vapors. *[See Sections 501-5(a), (b), (c), and (d) of NFPA 70, National Electrical Code.]*

A.5.13 For more information on maintenance of LNG equipment, see AGA Publication *LNG Preventive Maintenance Guide,* AGA Catalog Number X0 1084-IN1.

A.6.5.3 For information on corrosion protection, see NACE RP 0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems.*

A.6.8.3 Many insulating materials that have had prolonged exposure to natural gas or methane retain appreciable quantities of the gas within their pores or interstitial spaces.

A.7.2.3 The emergency response plan should be kept readily available, and it should be updated as necessary to include changes in personnel, equipment, or procedures. The response plan should include, but should not be limited to the following:

(1) The use of an emergency shutdown system to isolate various portions of the equipment and other applicable measures to ensure that the escape of liquid or gas is cut off promptly or reduced as much as possible
(2) Use of fire protection systems
(3) Notification of public authorities and neighboring properties
(4) First aid
(5) Duties of personnel
(6) An evacuation plan

A.7.4 For more information on personnel safety, see AGA Publication *Introduction to LNG for Personnel Safety,* AGA Catalog Number X08614-IN1.

A.7.4.3 For more information on training personnel, see AGA Publication *LNG Plant Operator Training Guide,* AGA Catalog Number X01181-IN1.

A.8.14.1(7) Handheld natural gas detectors aid in evaluating alarms and for making a survey of the vessel. These instruments will allow for the location of specific leaks at very low levels of detection and can be carried by personnel working in a compartment containing gas storage or transmission equipment.

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Annex B Sample Ordinance Adopting NFPA 57

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

B.1 The following sample ordinance is provided to assist a jurisdiction in the adoption of this code and is not part of this code.

ORDINANCE NO. _____

An ordinance of the [jurisdiction] adopting the [year] edition of NFPA [document number], [complete document title] documents listed in Chapter 2 of that [code, standard]; prescribing regulations governing conditions hazardous to life and property from fire or explosion; providing for the issuance of permits and collection of fees; repealing Ordinance No. _____ of the [jurisdiction] and all other ordinances and parts of ordinances in conflict therewith; providing a penalty; providing a severability clause; and providing for publication; and providing an effective date.

BE IT ORDAINED BY THE [governing body] OF THE [jurisdiction]:

SECTION 1 That the [complete document title] and documents adopted by Chapter 2, three (3) copies of which are on file and are open to inspection by the public in the office of the [jurisdiction's keeper of records] of the [jurisdiction], are hereby adopted and incorporated into this ordinance as fully as if set out at length herein, and from the date on which this ordinance shall take effect, the provisions thereof shall be controlling within the limits of the [jurisdiction]. The same are hereby adopted as the [code, standard] of the [jurisdiction] for the purpose of prescribing regulations governing conditions hazardous to life and property from fire or explosion and providing for issuance of permits and collection of fees.

SECTION 2 Any person who shall violate any provision of this code or standard hereby adopted or fail to comply therewith; or who shall violate or fail to comply with any order made thereunder; or who shall build in violation of any detailed statement of specifications or plans submitted and approved thereunder; or failed to operate in accordance with any certificate or permit issued thereunder; and from which no appeal has been taken; or who shall fail to comply with such an order as affirmed or modified by or by a court of competent jurisdiction, within the time fixed herein, shall severally for each and every such violation and noncompliance, respectively, be guilty of a misdemeanor, punishable by a fine of not less than $ _____ nor more than $_____ or by imprisonment for not less than _____ days nor more than _____ days or by both such fine and imprisonment. The imposition of one penalty for any violation shall not excuse the violation or permit it to continue; and all such persons shall be required to correct or remedy such violations or defects within a reasonable time; and when not otherwise specified the application of the above penalty shall not be held to prevent the enforced removal of prohibited conditions. Each day that prohibited conditions are maintained shall constitute a separate offense.

SECTION 3 Additions, insertions, and changes æ that the [year] edition of NFPA [document number], [complete document title] is amended and changed in the following respects:

List Amendments

SECTION 4 That ordinance No. _____ of [jurisdiction] entitled [fill in the title of the ordinance or ordinances in effect at the present time] and all other ordinances or parts of ordinances in conflict herewith are hereby repealed.

SECTION 5 That if any section, subsection, sentence, clause, or phrase of this ordinance is, for any reason, held to be invalid or unconstitutional, such decision shall not affect the validity or constitutionality of the remaining portions of this ordinance. The [governing body] hereby declares that it would have passed this ordinance, and each section, subsection, clause, or phrase hereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, and phrases be declared unconstitutional.

SECTION 6 That the [jurisdiction's keeper of records] is hereby ordered and directed to cause this ordinance to be published. [NOTE: An additional provision may be required to direct the number of times the ordinance is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.]

SECTION 7 That this ordinance and the rules, regulations, provisions, requirements, orders, and matters established and adopted hereby shall take effect and be in full force and effect [time period] from and after the date of its final passage and adoption.

Annex C Informational References

C.1 Referenced Publications. The following documents or portions thereof are referenced within this code for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code*, 1998 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 1996 edition.

NFPA 68, *Guide for Venting of Deflagrations*, 1998 edition.

NFPA 70, *National Electrical Code®*, 1999 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 1998 edition.

C.1.2 Other Publications.

C.1.2.1 AGA Publications. American Gas Association, 1515 Wilson Boulevard, Arlington, VA 22209.

AGA, *LNG Information Book*, 1981.

AGA, *LNG Preventive Maintenance Guide*, 1984.

AGA, *Introduction to LNG for Personnel Safety*, 1986.

AGA, *LNG Plant Operator Training Guide*, 1982.

C.1.2.2 NACE Publication. National Association of Corrosion Engineers, 1440 South Creek Drive, Houston, TX 77084.

NACE RP 0169, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*, 1996.

C.2 Informational References. (Reserved)

C.3 References for Extracts. The following documents are listed here to provide reference information, including title and edition, for extracts given throughout this code as indicated by a reference in brackets [ ] following a section or paragraph. These documents are not a part of the requirements of this document unless also listed in Chapter 2 for other reasons.

NFPA 59A, *Standard for the Production Storage, and Handling of Liquefied Natural Gas (LNG)*, 1996 edition.

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Index

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-A-

Accommodation spaces ..... *see* Spaces
Alarm systems ..... 8.9.8(1), 8.10.7.3 to 8.10.7.5, 8.10.9, 8.10.10.2 to 8.10.10.5, 8.13
Aluminum alloys 5.7.2
ANSI (definition) 3.3.1
Approved (definition) 3.2.1, A.3.2.1
Appurtenances, container ..... *see* Container appurtenances
ASME (definition) 3.3.2
ASME tanks ..... Chap. 6
In buildings 6.5.5
Foundations and supports 6.4
Installation 6.5, A.6.5.3
Instrumentation 6.10
Marking 6.3.8, 6.3.9
Piping 6.9
Pressure control 6.11
Product retention valves 6.6
Purging 6.8.3, A.6.8.3
Seismic design 6.3.5, 6.3.7, 6.4.1
Separation distance 6.5.1
Structure of containers 6.3
Testing and inspection 6.7, 6.8, A.6.8.3
Underground 6.5.2, 6.5.3, A.6.5.3
Authority having jurisdiction (definition) 3.2.2, A.3.2.2

-B-

Bleed connections 5.3.7, 5.4.7
Blowout plugs 8.9.5.1
Buildings
ASME tanks in 6.5.5
Definition 3.3.3, A.3.3.3
Indoor fueling in 5.2.4, A.5.2.4.2, A.5.2.4.4

-C-

Carbon dioxide extinguishing systems ..... 8.9.8(2) to 8.9.8(4), 8.10.7.5, 8.10.9, 8.10.10.4
Cargo transport containers ..... *see* Containers
Code (definition) 3.2.3, A.3.2.3
Cold test, vehicle fuel system 4.13.1
Combustible material
Definition 3.3.4
Limited (definition) 3.3.23, A.3.3.23
Commercial marine vessels ..... *see* Marine vessels, pleasure craft and commercial
Components
Fueling facilities
Maintenance ..... 5.13.2 to 5.13.4
Piping systems 5.5
Vehicle fuel systems
Protection from LNG exposure 4.12.1.1
Qualification of 4.11
Compressed natural gas (CNG) 5.10, A.5.10.2
Compressors 4.9.1, 5.8, 5.10.4, 5.10.5
Container appurtenances
Definition 3.3.6
Installation 4.12.1
Mounted in interior of vehicles 4.12.2
Protection ..... 4.12.1.1, 4.12.1.5 to 4.12.1.13, 8.2.2, 8.2.3
Containers
ASME tanks ..... *see* ASME tanks
Cargo transport
Definition 3.3.5.1
Unloading LNG 5.3
CNG 5.10.2, A.5.10.2
Definition 3.3.5
Drainage system 5.2.2.3
Fueling facility
Definition 3.3.5.2
Transfer of LNG from/to 5.3
Vehicular fuel 4.3, A.4.3.4
Damaged, testing of 4.13.2
Definition 3.3.5.3
Design 4.3.1
Filling 4.3.2
Heat leak 4.3.5
Installation 4.12.1, 8.2
Location ..... 4.12.1.2, 4.12.1.3, 4.12.1.6, 4.12.1.7, 8.2.1 to 8.2.3
Marine vessel fuel systems 8.2
Markings 4.3.8, 4.12.1.4
Mounted in interior of vehicles 4.12.2
Pressure gauges 4.5
Pressure regulators 4.6
Pressure relief devices/valves 4.4, 8.2.10
Protection ..... 4.12.1.1, 4.12.1.5 to 4.12.1.13, 8.2.1 to 8.2.8
Repair 4.3.7
Reuse 4.3.6
Road clearance 4.12.1.7
Shutoff valves 4.3.4, 4.8.2, A.4.3.4
Structural integrity 4.3.3
Control spaces (definition) 3.3.31.2
Copper alloys 4.2.4
Corrosion
ASME tanks 6.5.3, A.6.5.3
Fueling facilities, control in 5.7
Marine vessel deluge systems 8.12.4
Vehicle fuel systems 4.2.3, 4.2.4, 4.12.1.10, 8.2.8

-D-

Damaged systems, testing of 4.13.2
Definitions ..... Chap. 3
Deflagration venting 5.2.4.2, A.5.2.4.2
Deluge systems 8.10.7.6, 8.10.8, 8.10.9, 8.10.10.4, 8.10.10.6, 8.12
Design operating pressure 4.3.5, 4.6
Definition 3.3.7
Detection systems
Fire 7.6
Gas ..... *see* Gas detection systems
Dikes 5.2.3.5
Definition 3.3.8
DOT (definition) 3.3.9

-E-

Electrical equipment and wiring
Fueling facilities 5.12, A.5.12.4
Indoor 5.2.4.10
Vehicle fuel systems 4.12.7
Electric power lines, overhead 5.2.2.1
Emergency controls, fueling facility 5.2.1.3
Emergency response plan 7.2.3, A.7.2.3
Emergency shutdown device ..... *see* ESD (emergency shutdown device)

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Employees ..... 7.2.1(5), 7.2.1(6), A.7.2.3
Qualification of 1.5, 7.4.1
Safety ..... 7.4, 8.14, 8.15, A.7.4, A.8.14.1; *see also* Protective clothing and equipment
Training ..... 7.2.1(6), 7.4.1, 7.4.3, 8.15, A.7.4.3
Enforcement of code 1.7
Engine compartments 8.3.2, 8.9
Components in 4.11.2
Definition 3.3.10
Engine exhaust gases, use of 4.10.5
Engine rooms 8.3.2, 8.9, 8.13.6
Definition 3.3.11
Safety equipment ..... 8.14.1, 8.14.2, A.8.14.1(7)
Engines
Marine vessels 8.9.5
Vaporizers 5.9.7
Equivalency to code 1.4
ESD (emergency shutdown device) ..... 7.2.1(3), 7.2.1(4)
Definition 3.3.12
Fueling facilities 5.4.2, 5.11.3
LNG-to-CNG systems 5.10.3
Pump and compressor shutdown 5.8.3
Exposure, protection from ..... 7.2.1(2)

-F-

Fail-safe 5.11.3, 6.6, 6.10.1
Definition 3.3.13
Fire detection systems 7.6
Fire protection
Fueling facilities 5.13.6, 5.13.7, 7.2, A.7.2.3
Marine vessels 8.6, 8.9.8, 8.10.10
Fired equipment, location of 5.2.2.3
Fittings 4.7, 4.12.3, 5.2.3.6, 8.12.3
Fixed liquid level device 6.10.2
Definition 3.3.14
Flame spread rating (definition) 3.3.15
Flammable liquid storage tanks, location of 5.2.3.4
Fuel dispenser systems 5.4
Definition 3.3.16
Inside or attached to buildings 5.2.4.7
Fueling connectors 5.4.8, 5.4.9
Definition 3.3.17
Fueling facilities ..... Chap. 5
Cargo transport unloading 5.3
Corrosion control 5.7
Definition 3.3.18
Design 5.2, A.5.2
Electrical equipment and wiring 5.12, A.5.12.4
Emergency controls 5.2.1.3
Fire protection 7.2.1
Fuel dispensing systems 5.4
Indoor 5.2.4, A.5.2.4.2, A.5.2.4.4
Instrumentation 5.11
Lighting 5.2.1.4
LNG-to-CNG systems 5.10, A.5.10.2
Maintenance 5.13, A.5.13
Piping systems and components 5.5
Safety and relief valves 5.6
Siting 5.2.2
Stationary pumps and compressors 5.8
Unattended 5.2.1.1, 5.2.1.2
Vaporizers 5.9
Fueling facility containers ..... *see* Containers
Fueling receptacles
Definition 3.3.19
Installation 4.12.2.2, 4.12.9
Fusible links 4.2.1

-G-

G (definition) 3.3.20
Gas-dangerous spaces 8.3.2, 8.13.6
Definition 3.3.31.3
Gas detection systems 4.12.2.4, 5.2.4.6, 7.6, 8.9.6, 8.9.7, 8.10.7, 8.13.1
Gas detectors, portable ..... 8.14.1(7), A.8.14.1(7)
Gas-safe spaces 8.13.6
Definition 3.3.31.4

-H-

Heating systems, indirect 4.10.5

-I-

Ignition sources 5.2.2.4
Cargo transport unloading 5.3.6
Control of 7.3
Definition 3.3.21
Impounding areas ..... 5.2.2.3, 5.2.3.3 to 5.2.3.6, A.5.2.3.3
Definition 3.3.22
LNG-to-CNG systems 5.10.4
Separation distances 6.5.1
Indoors ..... *see* Buildings
Inspection ..... *see* Testing and inspection
Installation
Electrical equipment and wiring 5.12, A.5.12.4
Engines, vaporizer 5.9.7
Fueling receptacle 4.12.2.2
Marine vessel fuel containers 8.2
Vehicle fuel system 4.12
Instrumentation, fueling facility 5.11
Isolation valves 5.3.3, 5.8.1, 6.5.4, 8.12.1

-L-

Labeled (definition) ..... 3.2.4; *see also* Markings/warning signs
Leak testing, of containers 6.8.1
Lighting
Fueling facility 5.2.1.4
Marine vessel tank rooms 8.10.11
Limited combustible material (definition) 3.3.23, A.3.3.23
Liquefied natural gas (LNG) (definition) 3.3.24, A.3.3.24
Liquefied natural gas (LNG)-to-compressed natural gas (CNG) systems 5.10, A.5.10.2
Listed (definition) 3.2.5, A.3.2.5

-M-

Maintenance
Fire protection equipment 5.2.4
Fueling facilities 5.13, A.5.13
Marine service stations 8.8
Marine vessels, pleasure craft and commercial ..... Chap. 8
Alarm systems ..... *see* Alarm systems
Deluge systems ..... *see* Deluge systems
Engine compartments or rooms ..... *see* Engine compartments; Engine rooms
Engines 8.9.5
Fire protection 8.6, 8.9.8, 8.10.10
Fueling systems and operations 8.5, 8.7
Fuel supply containers, installation of 8.2
Labeling 8.4, 8.5.2
Natural gas monitoring 8.9.6, 8.9.7, 8.10.7
Pressure gauges, installation of 8.3
Safety equipment ..... 8.14, A.8.14.1(7)
Safety training for crew 8.15
Tank compartments or rooms ..... *see* Tank compartments; Tank rooms
Ventilation ..... 8.10.2 to 8.10.6, 8.10.7.4, 8.10.7.5, 8.10.7.7, 8.10.10.4, 8.13.6
Vent masts 8.11
Markings/warning signs 7.8
ASME tanks 6.3.8, 6.3.9

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Equipment being serviced 5.13.4
Fuel dispensing systems 5.4.2
Indoor fueling facilities 5.2.4.8
Marine vessels 8.4, 8.5.2
Shutoff valves 4.12.1.12
Vaporizers 4.10.2
Vehicles 4.12.8
Vehicular fuel containers 4.3.8, 4.12.1.4
Maximum allowable liquid level 4.3.2
Maximum allowable working pressure ..... 4.3.1.2, 4.3.5, 4.6, 4.9.1, 4.10.2, 4.10.3, 4.12.8.1(2), 5.4.3
Definition 3.3.25
Maximum filling volume 4.3.5
Definition 3.3.26
Maximum vehicle fuel flow rate 4.10.1
Metallic materials 4.2
Metric practice 1.6
Multiple fuel systems
Marine vessels 8.9.5.2
Shutoff valves for 4.12.4.4

-N-

Noncombustible material (definition) 3.3.27

-P-

Parking, of LNG vehicles 7.7
Personnel ..... *see* Employees
Piping
ASME tanks 6.3.1, 6.3.2, 6.9
Fueling facilities 5.5
Impoundment areas 5.2.3.6
Indoor 5.2.4.9
Underground, corrosion control for 5.7.1
Marine service stations 8.8
Marine vessel deluge systems 8.12.3
Transfer
LNG cargo transport unloading 5.3.3
LNG-to-CNG systems 5.10.5
Vaporizers 4.10.4
Vehicle fuel systems 4.7, 4.12.3
Pleasure craft ..... *see* Marine vessels, pleasure craft and commercial
Points of transfer 5.2.2.4, 5.3.5
Definition 3.3.28
Pressure control, ASME tanks 6.11
Pressure gauges
ASME tanks 6.10.3
Fueling facility 5.11.1
Vehicle fuel systems 4.5, 4.12.6, 8.3
Pressure regulators, vehicle fuel system 4.6, 4.12.5, 8.9.3
Pressure relief devices/valves
ASME tanks 6.11
Definition 3.3.29
LNG fueling facilities 5.6
Marine vessel vent masts 8.11.2, 8.11.4
Pumps and compressors, fueling facilities 5.8.4
Vaporizers 4.10.4, 5.9.4
Vehicle fuel systems 4.4, 4.9.1, 4.9.2, 4.12.3.6, 8.2.10
Pressure test 4.13.1
Pressure vessel (definition) 3.3.30
Product retention valves 6.6
Protective clothing and equipment ..... 7.2.1(6), 7.4.2, 8.14, A.7.2.3, A.8.14.1(7)
Pumps
LNG-to-CNG systems 5.10.5
Stationary (fueling facilities) 5.8
Sump 5.2.3.6
Vehicle fuel systems 4.9, 4.10.3
Purging, LNG containers 6.8.3, A.6.8.3
Purpose of code 1.2

-R-

References ..... Chap. 2, Annex B
Relief valves ..... *see* Pressure relief devices/valves
Repair, of containers 4.3.7
Retroactivity of code 1.3
Reuse, of containers 4.3.6

-S-

Safety, employee ..... *see* Employees
Safety equipment, marine vessels ..... 8.14, A.8.14.1(7)
Safety valves ..... *see* Pressure relief devices/valves
Scope of code 1.1, A.1.1
Security 7.5
Seismic design, ASME tank 6.3.5, 6.3.7
Self-contained breathing apparatus (SCBA) ..... 8.14.1(1), 8.14.4
Separation distances
Fired equipment 5.2.2.3
Impoundment areas 6.5.1
Points of transfer 5.2.2.4
Service spaces ..... *see* Spaces
Shall (definition) 3.2.6
Should (definition) 3.2.7
Shutoff valves ..... *see also* Stop valves
Fuel dispensing systems 5.4.2, 5.4.4
Indoor fueling facilities piping 5.2.4.9
Vehicle fuel systems
Fuel containers 4.3.4, 4.8.2, 4.12.1.12, A.4.3.4
Fuel supply line 4.12.4.3
Multiple fuel systems 4.12.4.4
Piping/tubing 4.12.3.6
Smoking 7.3.1
Spaces
Accommodation 8.2.1, 8.3.1, 8.10.10.2
Definition 3.3.31.1
Control (definition) 3.3.31.2
Gas-dangerous 8.3.2, 8.13.6
Definition 3.3.31.3
Gas-safe 8.13.6
Definition 3.3.31.4
Service 8.2.1, 8.3.1, 8.10.10.2
Definition 3.3.31.5
Spill containment ..... 5.2.2.3, 5.2.3, 7.2.1(1), A.5.2.3.3
Stainless steel 4.2.4, 5.7.2
Stop valves ..... 6.11.2, 6.11.3; *see also* Shutoff valves
Submerged piping, corrosion control for 5.7.1

-T-

Tank compartments 8.2.10, 8.2.11, 8.3.2, 8.10, 8.13.6
Definition 3.3.32
Tank rooms 8.2.10, 8.2.11, 8.3.2, 8.10
Definition 3.3.33
Safety equipment ..... 8.14.1, 8.14.2, A.8.14.1(7)
Tanks ..... *see also* Containers
ASME ..... *see* ASME tanks
Flammable liquid storage 5.2.3.4
Marine fuel storage ..... 8.7(2)
Temperature instruments, fueling facility 5.11.2
Testing and inspection
ASME tanks 6.7, 6.8, A.6.8.3
Fueling facilities 5.2.1.5, 5.13.1, 5.13.6
Safety and fire protection equipment 5.13.6
Vehicle fuel systems 4.13
Tractors and trailers, fuel connection between 4.12.3.5
Training, of employees 7.4.1, 7.4.3, 8.15, A.7.4.3
Transfer points ..... *see* Points of transfer
Tubing ..... *see* Piping
Turbines, vaporizer 5.9.7

-U-

Unattended fueling facilities 5.2.1.1, 5.2.1.2

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Underground containers 6.5.2, 6.5.3, A.6.5.3
Underground piping, corrosion control for 5.7.1

-V-

Vacuum insulation ..... 4.3.1.3, 6.3.6(B)
Valves
Backflow check valves 4.12.4.5
Discharge 4.10.4
Extended bonnet 4.8.3
Isolation ..... *see* Isolation valves
Marine vessel deluge systems 8.12.3
Pressure relief ..... *see* Pressure relief devices/valves
Product retention 6.6
Shutoff ..... *see* Shutoff valves
Spill containment 5.2.3.6
Stop 6.11.2, 6.11.3
Vehicle fuel systems 4.8, 4.12.4
Vaporizers 4.10
Ambient ..... 5.10.4 Ex., 5.11.2.1 Ex.
Definition 3.3.34.1
Definition 3.3.34
Fueling facilities 5.9
Heated 5.9.4
Definition 3.3.34.2
Integral heated 5.9.5
Definition 3.3.34.2.1
LNG-to-CNG systems 5.10.4
Remote heated ..... 5.9.2, 5.10.4 Ex.
Definition 3.3.34.2.2
Temperature instruments 5.11.2.1
Vehicle (definition) 3.3.35
Vehicle fuel dispensing systems 5.4
Vehicle fuel systems ..... Chap. 4
Component qualification 4.11
Containers ..... *see* Containers
Installation 4.12
Materials 4.2
Pressure gauges 4.5, 4.12.6
Pressure regulators ..... *see* Pressure regulators, vehicle fuel system
Pressure relief devices ..... *see* Pressure relief devices/valves
Pumps and compressors 4.9
Testing 4.13
Valves 4.8
Vaporizers 4.10
Vehicular fuel (definition) 3.3.36
Vehicular fuel containers ..... *see* Containers
Vent connections 5.3.7, 5.4.7
Ventilation 5.2.4.3, 5.2.4.4, A.5.2.4.4
Dispensing rooms ..... 5.2.4.7(D)
Marine vessels 8.9.4, 8.9.6.7, 8.10.10.4, 8.13.6
Tank rooms/compartments ..... 8.10.2 to 8.10.6, 8.10.7.4, 8.10.7.5, 8.10.7.7
Venting, deflagration 5.2.4.2, A.5.2.4.2
Vent masts 8.11
Vents
Interior of vehicle 4.12.2.1, 4.12.2.3
Marine vessels fuel containers 8.2.1, 8.2.10
Pumps and compressors, fueling facilities 5.8.4, 5.8.5

-W-

Warning signs ..... *see* Markings/warning signs
Water capacity (definition) 3.3.37
Weather deck (definition) 3.3.38
Welding 7.3.2
ASME tanks
Field welding of 6.8.2
Piping 6.9.2
Furnace butt-welded steel ..... 4.2.7, 6.9.2(A)
Oxygen-fuel gas ..... 4.2.6, 6.9.2(C), 7.3.2
Wiring, electrical
Fueling facilities 5.12, A.5.12.4
Vehicle fuel systems 4.12.7

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