

NFPA®

52

Vehicular Natural Gas Fuel Systems Code

2019



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NFPA® 52

Vehicular Natural Gas Fuel Systems Code

2019 Edition

This edition of NFPA 52, *Vehicular Natural Gas Fuel Systems Code*, was prepared by the Technical Committee on Vehicular Alternative Fuel Systems. It was issued by the Standards Council on November 5, 2018, with an effective date of November 25, 2018, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at www.nfpa.org for more information.

This edition of NFPA 52 was approved as an American National Standard on November 25, 2018.

Origin and Development of NFPA 52

While compressed natural gas (CNG) vehicles have been used extensively in other countries since the late 1940s, it was not until the late 1970s that their use in the United States became extensive enough to warrant preparation of a national standard.

Between 1980 and 1982, a committee of the American Gas Association (AGA) developed a draft of a fire safety standard for vehicular fuel systems. This was based on existing worldwide standards and current U.S. practice.

In late 1981, the AGA petitioned the NFPA to establish a technical committee project on the subject. The normal NFPA solicitation of comments revealed sufficient response from various interested parties, and the Committee on Compressed Natural Gas Vehicular Fuel Systems was established by the Standards Council in July 1982.

The first edition of NFPA 52, *Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems*, was issued in 1984, and it was revised in 1988, 1992, 1995, and 1998.

The 2002 edition of NFPA 52 contained minor revisions, most of these in the chapter on engine fuel systems. There also were some changes made to comply with the NFPA *Manual of Style* for technical committee documents. The most significant of these were reordering of chapters and numbering of definitions.

The 2006 edition of NFPA 52 was a complete revision. NFPA 57, *LNG Vehicular Fuel Systems Code*, was incorporated into NFPA 52. Additionally, the scope of the committee was expanded to include hydrogen, and new chapters were added that addressed general gaseous hydrogen requirements and equipment qualifications; service and maintenance of gaseous hydrogen engine fuel systems; gaseous hydrogen compression, gas processing, storage, and dispensing systems; and liquefied hydrogen fueling facilities.

The 2010 edition of NFPA 52 revised the committee scope so that it better coordinated with the responsibilities of NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, with regard to hydrogen storage systems. A large number of changes were also made to the chapters concerning hydrogen to update to current material in NFPA documents, the *Manual of Style for NFPA Technical Committee Documents*, and acceptable performance criteria.

Paragraphs extracted from NFPA 55 were shown with the extract reference in brackets [] at the end of the paragraph. In some cases, modifications were made to the extracted text to use terminology appropriate for this standard, such as the term *cryogenic fluid* instead of *compressed gas*. In those instances, brackets encased the modified terms.

The 2013 edition removed the requirements for hydrogen systems, the responsibility for which were transferred to NFPA 2, *Hydrogen Technologies Code*. A chapter on general fueling requirements was added, and changes were made to the onboard gas detection requirements for LNG-fueled vehicles. The installation requirements for ASME Tanks for LNG were updated to coordinate with NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*.

The 2016 edition was completely reorganized for easier access to requirements. The title of the document was changed from *Vehicular Gaseous Fuel Systems Code* to *Vehicular Natural Gas Fuel Systems Code* to coordinate with the removal of hydrogen systems from the scope of the document in 2013. New and revised definitions harmonized the code with the new CSA Group NGV 5.1 standard, *Residential Fueling Appliances*. Most notably, a new definition for *residential fueling appliances* was added and the definition for *vehicle fueling appliances* was revised.

For the 2019 edition, text reorganization and additions have been made to address vehicle fueling applications (VFAs). A new chapter was added for nonresidential CNG fueling applications. Several terms have been added and updated to align with current definitions and VFA updates to the document. Examples are changing the term *Qualified Engineer* to *Qualified Person* and adding the definition of the term *Contiguous Building Volume* to Chapter 3. Sections of the residential CNG Fueling chapter were removed because they were part of the certification of appliances covered in CSA Group NGV 5.1, *Residential Fueling Appliances*.

Technical Committee on Vehicular Alternative Fuel Systems

Stephen V. Abernathy, *Chair*
Consultant, SC [SE]

Jim Ames, Ameswest Technical Services, UT [IM]

Michael Battaglia, CNG-ONE, LLC, OH [IM]

Dan Bowerson, NGVAmerica, MI [M]

Julie Cairns, CSA Group, OH [RT]

Matt T. Creedon, Pacific Gas & Electric Company, CA [U]

Denis C. K. Ding, Clean Energy Fuels Corporation, CA [M]

Rob Early, Compressed Gas Association, NY [M]

Thomas J. Forsythe, JENSEN HUGHES, CA [SE]
Rep. JENSEN HUGHES

Mike Gust, Quantum Fuel Systems, CA [U]

Alan D. Hatfield, Braemar Engineering, TX [SE]

John Jordan, Agility Fuel Systems, MN [M]

Zach Klein, McNeilus Truck And Manufacturing, MN [M]

Quon Y. Kwan, U.S. Department of Transportation, DC [E]
Rep. U.S. Department of Transportation

Reid B. Larson, Chart Industries, MN [M]

Rick Long, Petroleum Equipment Institute, OK [IM]

Michael W. Mackey, GP Strategies Corporation, CA [SE]

Timothy E. Meyers, U.S. Coast Guard, DC [E]

Nancy C. Pehrson, CenterPoint Energy, Inc., MN [U]

April Dawn Richardson, Railroad Commission of Texas, TX [E]

Joel E. Sipe, Exponent, Inc., CA [SE]

Glen E. Smith, Union Pacific Railroad, NE [SE]
Rep. American Railway Engineering & Maintenance-of-Way Assn.

E. Michael Steele, Steele Consulting, CA [M]
Rep. Society of Automotive Engineers

Kent Whiting, BlackPak Inc., CA [M]

Ted Williams, American Gas Association, DC [U]
Rep. American Gas Association

Alternates

Richard A. Craig, Compressed Gas Association, VA [M]
(Alt. to Rob Early)

Andrew Gibbons, U.S. Coast Guard, DC [E]
(Alt. to Timothy E. Meyers)

Susan Bershad, NFPA Staff Liaison

James P. Lewis, Jim Lewis LNG Expertise, TX [SE]
(Alt. to Michael W. Mackey)

Timothy Lester Morse, Exponent, MA [SE]
(Alt. to Joel E. Sipe)

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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.

Committee Scope: This Committee shall have primary responsibility for documents on fire and explosion hazards associated with compressed natural gas (CNG), 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 the Liquefied Natural Gas Committee with respect to storage of LNG within its scope.

Contents

Chapter 1 Administration	52- 6	Chapter 11 CNG Fueling	52- 25
1.1 Scope.	52- 6	11.1 Application.	52- 25
1.2 Purpose.	52- 6	11.2 General.	52- 25
1.3 Retroactivity.	52- 6	11.3 CNG Dispensing.	52- 25
1.4 Alternate Provisions.	52- 6	Chapter 12 Residential CNG Fueling Appliances	52- 31
1.5 Training.	52- 7	12.1 Application.	52- 31
1.6 Units.	52- 7	12.2 System Component Qualifications.	52- 32
1.7 Enforcement.	52- 7	12.3 General Safety Requirements.	52- 32
Chapter 2 Referenced Publications	52- 7	12.4 Installation.	52- 32
2.1 General.	52- 7	12.5 Installation of PRVs.	52- 32
2.2 NFPA Publications.	52- 7	12.6 Installation of Pressure Gauges.	52- 32
2.3 Other Publications.	52- 7	12.7 Pressure Regulation.	52- 32
2.4 References for Extracts in Mandatory Sections. ...	52- 8	12.8 Piping and Hose.	52- 32
Chapter 3 Definitions	52- 8	12.9 Testing.	52- 32
3.1 General.	52- 8	12.10 Operation.	52- 32
3.2 NFPA Official Definitions.	52- 8	12.11 Maintenance and Inspection.	52- 32
3.3 General Definitions.	52- 9	Chapter 13 Nonresidential CNG Fueling Appliances	52- 33
Chapter 4 Facility Management	52- 12	13.1 General.	52- 33
4.1 General.	52- 12	13.2 Installation.	52- 34
4.2 Building Construction Materials.	52- 12	13.3 Operation.	52- 34
4.3 Qualifications.	52- 13	13.4 Maintenance and Inspection.	52- 34
4.4 Equipment Security.	52- 13	Chapter 14 LNG Fueling	52- 34
4.5 Operations and Maintenance.	52- 13	14.1 Application.	52- 34
4.6 CNG Training.	52- 15	14.2 General.	52- 34
4.7 LNG Training.	52- 15	14.3 LNG Dispensing.	52- 34
4.8 Special Hazard Requirements.	52- 15	14.4 LNG Storage.	52- 40
Chapter 5 Facility Fire Protection	52- 16	14.5 Piping Systems and Components.	52- 41
5.1 General.	52- 16	Chapter 15 Automotive Equipment (Onboard)	52- 41
5.2 CNG Supplemental Requirements.	52- 16	15.1 Scope.	52- 41
5.3 LNG Supplemental Requirements.	52- 17	15.2 Application.	52- 41
Chapter 6 Facility Gas Detection, Alarm, and Emergency Shutdown Systems	52- 18	15.3 General.	52- 41
6.1 General.	52- 18	15.4 CNG Supplemental Requirements.	52- 42
6.2 CNG Supplemental Requirements.	52- 18	15.5 LNG Supplemental Requirements.	52- 43
6.3 LNG Supplemental Requirements.	52- 18	Chapter 16 Automotive Fuel and Safety Systems (Onboard)	52- 45
Chapter 7 Fuel Quality	52- 18	16.1 Application.	52- 45
7.1 General.	52- 18	16.2 General.	52- 45
7.2 CNG.	52- 18	16.3 CNG Engine Fuel Systems.	52- 47
7.3 LNG. (Reserved)	52- 18	16.4 LNG Engine Fuel Systems.	52- 52
Chapter 8 Facility Equipment	52- 18	Chapter 17 Installation Requirements for ASME Tanks for LNG	52- 56
8.1 Scope.	52- 18	17.1 Application.	52- 56
8.2 Application.	52- 18	17.2 General.	52- 56
8.3 General.	52- 18	17.3 Containers.	52- 56
8.4 CNG Systems.	52- 19	17.4 Container Foundations and Supports.	52- 57
Chapter 9 Outdoor Storage	52- 22	17.5 Container Installation.	52- 57
9.1 Scope.	52- 22	17.6 Automatic Product Retention Valves.	52- 57
9.2 General. (Reserved)	52- 22	17.7 Inspection.	52- 58
9.3 CNG Supplemental Requirements.	52- 22	17.8 Testing and Purging of LNG Containers.	52- 58
9.4 LNG Supplemental Requirements.	52- 22	17.9 Piping.	52- 59
Chapter 10 Indoor Storage	52- 23	17.10 Container Instrumentation.	52- 59
10.1 Scope.	52- 23	17.11 Pressure Gauging and Control.	52- 59
10.2 General. (Reserved)	52- 23	Chapter 18 Reserved	52- 59
10.3 CNG Supplemental Requirements.	52- 23	Chapter 19 Reserved	52- 59
10.4 LNG Supplemental Requirements.	52- 25		

Annex A	Explanatory Material	52– 60	Annex D	Informational References	52– 67
Annex B	Sample Ordinance Adopting NFPA 52	52– 66	Index		52– 69
Annex C	Pressure Relief Devices (PRDs)	52– 67			

NFPA 52

Vehicular Natural Gas Fuel Systems Code

2019 Edition

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

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, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex D. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1* Scope.

1.1.1 This code shall apply to the design, installation, operation, and maintenance of compressed natural gas (CNG) and liquefied natural gas (LNG) engine fuel systems on vehicles of all types and for fueling vehicle (dispensing) systems and facilities, and associated storage, including the following:

- (1) Original equipment manufacturers (OEMs)
- (2) Final-stage vehicle integrator/manufacture (FSVIM)
- (3) Vehicle fueling (dispensing) systems

1.1.2 This code shall apply to the design, installation, operation, and maintenance of 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 100,000 gal (379 m³) or less.

1.1.3 This code shall not apply to those aspects of vehicles and fuel supply containers that are covered by federal motor vehicle safety standards (FMVSSs).

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

1.1.5 Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

1.1.6 Where, in any specific case, different sections of this code specify different materials, methods, or other requirements, the most restrictive shall govern.

1.1.7 Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable.

1.1.8 Manufacturer specifications shall equal or surpass the applicable requirements of this code.

1.2 Purpose. The purpose of this code shall be to provide fundamental safeguards against 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.

1.3 Retroactivity. The provisions of this code reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this code at the time the code was issued.

1.3.1 Unless otherwise specified, the provisions of this code are not intended to require upgrading facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the code. Where specified, the provisions of this code shall be retroactive.

1.3.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this code deemed appropriate.

1.3.3 The retroactive requirements of this code shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where a reasonable degree of safety is provided and is clearly evident.

1.4 Alternate Provisions. Site conditions, advancements in technology, and improvements in system design and equipment shall be permitted to allow for equipment fabrication methods, component design requirements, and installation and operating practices that differ from those specified in this code.

1.4.1 Such deviations or improvements shall be permitted to provide equivalent safety and compatible operation that meet the intent of this code.

1.4.2 Such deviations shall be permitted where the authority having jurisdiction has seen evidence that a special investigation of all factors has been made and, based on sound experience and engineering judgment, has concluded that the proposed deviations meet the intent of this code.

1.5 Training. Persons engaged in the handling and storage of LNG, CNG, and LCNG shall be trained in the hazards and properties of these materials.

1.6 Units.

1.6.1 Metric units in this code are based on IEEE/ASTM SI 10, *American National Standard for Metric Practice*.

1.6.2 All pressures in this document are gauge pressures, unless otherwise indicated.

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, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.
NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2016 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2018 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2017 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2019 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2017 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2019 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2018 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2019 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2017 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2018 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2019 edition.

NFPA 54, *National Fuel Gas Code*, 2018 edition.

NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*, 2017 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2016 edition.

NFPA 70®, *National Electrical Code®*, 2017 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®*, 2019 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2019 edition.

NFPA 101®, *Life Safety Code®*, 2018 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2018 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2017 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2019 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2018 edition.

2.3 Other Publications.

2.3.1 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 2013.

2.3.2 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, 2016.

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

ANSI/ASME B31.3, *Process Piping*, 2016.

ASME Boiler and Pressure Vessel Code, 2017.

2.3.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings*, 2014.

ASTM A395/A395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, 2014.

ASTM A536, *Standard Specification for Ductile Iron Castings*, 2014.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2016.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2016.

ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, 2016.

ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, 2017.

2.3.5 CGA Publications. Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-2923.

CGA 341, *Standard for Insulated Cargo Tank Specification for Nonflammable Cryogenic Liquids*, 2017.

CGA C-6.4, *Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Vehicle (HGV) Fuel Containers and Their Installations*, 2012.

CGA S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, 2011.

CGA S-1.2 *Pressure Relief Device Standards — Part 2 — Portable Containers for Compressed Gases*, 2009.

CGA S-1.3, *Pressure Relief Device Standards — Part 3 — Stationary Storage Containers for Compressed Gases*, 2008.

▲ **2.3.6 CSA Group Publications.** CSA Group, 8501 East Pleasant Valley Road, Cleveland, OH 44131.

CSA B51, *Boiler, pressure vessel, and pressure piping code*, Part 3, 2013.

CSA/ANSI NGV 1, *Compressed natural gas vehicle (NGV) fueling connection devices*, 2006 (reaffirmed 2012).

CSA/ANSI NGV 2, *Compressed natural gas vehicle fuel containers*, 2016.

ANSI NGV 3.1/CSA 12.3, *Fuel system components for compressed natural gas powered vehicles*, 2014.

ANSI/IAS NGV 4.4/CSA 12.54, *Breakaway devices for natural gas dispensing hoses and systems*, 1999 (reaffirmed 2014).

CSA/ANSI NGV 5.1, *Residential fueling appliances*, 2016.

CSA/ANSI NGV 5.2, *Vehicle fueling appliances (VFA)*, 2017.

CSA/ANSI NGV 6.1, *Compressed natural gas (CNG) fuel storage and delivery systems for road vehicles*, 2018.

CSA/ANSI PRD 1, *Pressure relief devices for natural gas vehicle (NGV) fuel containers*, 2013.

2.3.7 IEEE Publications. IEEE, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE/ASTM SI 10, *American National Standard for Metric Practice*, 2017.

2.3.8 NACE Publications. NACE International, 15835 Park Ten Place, Houston, TX 77084-4906.

NACE SP0169, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*, 2013.

2.3.9 NB Publications. National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, OH 43229-1183.

NB-23, *National Board Inspection Code*, 2013.

NB-514, *Accreditation of "VR" Repair Organizations*, 2016.

2.3.10 SSPC Publications. Society for Protective Coatings, 800 Trumbull Drive, Pittsburgh, PA 15205.

SSPC-PA 1, *Shop, Field and Maintenance Painting*, 2004.

SSPC-PA 2, *Procedure for Determining Conformance to Dry Coatings Thickness*, 2012.

SSPC-SP 6, *Commercial Blast Cleaning*, 2007.

2.3.11 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, 2010.

ANSI/UL 969, *Standard for Marking and Labeling Systems*, 2014.

2.3.12 U.S. Government Publications. U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 29, Code of Federal Regulations, Part 1910.

Title 49, Code of Federal Regulations, Part 178.57, "Specification 4L Welded Insulated Cylinders."

Title 49, Code of Federal Regulations, Part 390.5.

Title 49, Code of Federal Regulations, Part 390.21.

Title 49, Code of Federal Regulations, Part 571.304.

49 U.S.C. 5103, "General Regulatory Authority."

2.3.13 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2016 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2017 edition.

NFPA 101®, *Life Safety Code®*, 2018 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2016 edition.

NFPA 1925, *Standard on Marine Fire-Fighting Vessels*, 2018 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2018 edition.

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 defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or 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 materi-

als, 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 Alterer. A person or business making changes to a certified vehicle. These changes do not include the addition, substitution, or removal of readily attachable components, such as mirrors or tire and rim assemblies. They also do not include minor finishing operations such as painting. The term *alterer* also means a person or business who alters a certified vehicle in such a manner that its stated weight ratings are no longer valid. All of these changes are made before the first purchase of the vehicle in good faith for purposes other than resale.

3.3.2 ANSI. American National Standards Institute.

3.3.3 Area.

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

3.3.3.2 Indoor Area. An area that is within a building or structure having overhead cover, other than a structure qualifying as "weather protection." (See also 3.3.3.3, *Outdoor Area*.) [55, 2016]

3.3.3.3 Outdoor Area. An area that is not an indoor area. [55, 2016]

3.3.4 ASME Code. The American Society of Mechanical Engineers *Boiler and Pressure Vessel Code*.

3.3.5 Buildings. Structures, usually enclosed by walls and a roof, constructed to provide support or shelter for an intended occupancy. [5000, 2018]

3.3.5.1* Important Building. A building that is considered nonexpendable in an exposure fire. [30, 2018]

3.3.6 Capacity. The water volume of a container in liters (gallons).

3.3.7* Cathodic Protection. A technique to resist the corrosion of a metal surface by making the surface the cathode of an electrochemical cell. [55, 2016]

3.3.8 Cathodic Protection Tester. A person who demonstrates an understanding of the principles and measurements of all common types of cathodic protection systems applicable to metal piping and container systems who has education and experience in soil resistivity, stray current, structure-to-soil

potential, and component electrical isolation measurements of metal piping and container systems. [55, 2016]

3.3.9 Certified. A formally stated recognition and approval of an acceptable level of competency, acceptable to the AHJ. [96, 2017]

3.3.10 Container. A pressure vessel, cylinder, or cylinder(s) permanently manifolded together used to store CNG or LNG.

3.3.10.1 Cargo Transport Container. A mobile unit designed to transport LNG or CNG.

3.3.10.2 Composite Container. A container consisting of an inner metal or plastic gas-containing component, reinforced with a filament and resin outer layer.

3.3.10.3 Fuel Supply Container. A container mounted on a vehicle to store LNG or CNG as the fuel supply to the vehicle.

3.3.10.4 Fueling Facility Container. Primary storage for vehicular fueling.

3.3.11 Container Appurtenances. Devices connected to container openings for safety, control, or operating purposes.

3.3.12 Container Valve. See 3.3.64.1.

3.3.13 Contiguous Building Volume. The freely communicating volume of a building into which a release of flammable gas or vapor might accumulate from a single leak source and represent a flammability hazard.

3.3.14 Converter. An individual or organization that installs a natural gas fuel system on a vehicle after first sale and who is not required to certify compliance with federal motor vehicle safety standards.

3.3.15 Corrosion Expert. A person who, by reason of knowledge of the physical sciences and the principles of engineering acquired through professional education and related practical experience is qualified to engage in the practice of corrosion control of container systems. [55, 2016]

3.3.16 Corrosion Protection. Protecting a container, piping, or system to resist degradation of the metal through oxidation or reactivity with the environment in which it is installed. [55, 2016]

3.3.17 Cylinder. A container constructed, inspected, and maintained in accordance with DOT regulations, the ASME *Boiler and Pressure Vessel Code*, or CSA/ANSI NGV 2, *Compressed natural gas vehicle fuel containers*.

3.3.18 Device.

3.3.18.1 Emergency Shutdown Device (ESD). A device that brings all operations to a fail-safe condition within the fueling facility from either local or remote locations.

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

3.3.18.3 Pressure Relief Device (PRD). A device that, when activated under specified performance conditions, is used to vent the container contents.

3.3.18.4 Pressure Relief Valve (PRV) A reclosing device that opens to relieve pressure at the set pressure.

3.3.19* Dew Point (at Container Pressure). The dew point value of the gas at the maximum anticipated container pressure of the CNG or vehicular fuel system usually measured in the container prior to pressure reduction.

3.3.20 Dike. A structure used to establish an impounding area or containment.

3.3.21 Dispensing Station. A natural gas installation that dispenses CNG or LNG from storage containers or a distribution pipeline into vehicular fuel supply containers, portable cylinders, or transportation vehicles by means of a compressor, vaporizer, or pressure booster.

3.3.22 DOT. U.S. Department of Transportation.

3.3.23 DOT Number. A number assigned by the U.S. Department of Transportation (DOT) to a motor carrier that is required to be marked on all power units of the motor carrier in accordance with 49 CFR 390.21.

3.3.24 Enclosure. A structure that protects equipment from the environment or provides noise attenuation.

3.3.24.1 Dispenser Enclosure. A cabinet that contains process piping and equipment for dispensing fuel.

3.3.25 Engine Compartment (on a marine vessel). An engine space on a marine vessel that is too small for an individual to enter.

3.3.26 Fail-Safe. A design feature that provides for the maintenance of safe operating conditions in the event of a malfunction of control devices or an interruption of an energy source.

▲ 3.3.27 Flame Spread Index. A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame vs. time for a material tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or with ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*.

3.3.28 Fuel Line. The pipe, tubing, or hose on a vehicle, including all related fittings, through which natural gas passes during normal vehicle fueling or operation.

3.3.29 Fueling Nozzle. A mating device at the refueling station, including shutoff valves, that connects the fueling dispenser hose to the vehicle fuel filling system receptacle for the transfer of gas, liquid, or vapor.

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

3.3.31 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 or onboard the vehicle.

3.3.32* Installation. A system that includes natural gas containers, pressure booster, compressors, vaporizers, and all attached valves, piping, and appurtenances.

3.3.33* LCNG. CNG formed by the vaporization of LNG followed by compression of the vapors.

3.3.34 Liquefied Natural Gas (LNG). A fluid in the cryogenic liquid state that is composed predominantly of methane.

3.3.34.1* Saturated LNG Gas. Preheated LNG held under pressure and released to atmosphere as a gas.

3.3.35 Lower Flammability Limit (LFL). That concentration of a combustible material in air below which ignition will not occur.

3.3.36 Material.

3.3.36.1 Combustible Material. A building material that, in the form in which it is used and under the design conditions, will ignite and burn; a material that is neither noncombustible nor limited-combustible.

3.3.36.2* Limited-Combustible Material. See Section 4.2.

3.3.36.3 Noncombustible Material. See Section 4.2.

3.3.37 Maximum Filling Volume. The maximum volume to which a liquid-containing vessel could be filled.

3.3.38 Metallic Hose. A hose whose strength depends primarily on the strength of its metallic parts; it can have metallic liners or covers, or both.

3.3.39 Mobile Refueling. The use of a DOT-approved vehicle or mobile equipment on site with tank(s) and/or pump(s) that dispenses engine fuel directly to vehicles, storage vessels/cylinders, or secondary refueling equipment.

3.3.40 Natural Gas. Mixtures of hydrocarbon gases and vapors consisting principally of methane in gaseous form.

▲ 3.3.40.1 Compressed Natural Gas (CNG). Mixtures of hydrocarbon gases and vapors consisting principally of methane in gaseous form and meeting the composition requirements of Section 5.2 that have been compressed for use as a vehicular fuel.

3.3.41 Operating Company. The individual, partnership, corporation, public agency, or other entity that owns or operates a plant or site.

3.3.42 Original Component Manufacturer (OCM). One who provides components, performance data, and engineering specifications for individual components within a system.

3.3.43* Original Equipment Manufacturer (OEM). Any vehicle manufacturer that is subject to DOT regulations and first introduces a vehicle for sale, including any manufacturer that performs final stage manufacturer processes for the assembly and/or sale of natural gas vehicles.

3.3.44 Overhead (Marine). The unfinished area in the top of a room or compartment but not a ceiling.

3.3.45 Overpressure. The pressure in a blast wave above atmospheric pressure, a pressure within a containment structure that exceeds the maximum allowable working pressure of the containment structure, or 1.25 times the service pressure of the CNG vehicle component upstream of the first stage of pressure regulation.

3.3.46 Piping. A means of transporting natural gas. This term applies to refueling facilities.

3.3.47* Point of Transfer. The location where connections and disconnections are made.

3.3.48* Power Unit. A vehicle that contains a propulsion system.

3.3.49 Pressure.

3.3.49.1 Compression Discharge Pressure. The varying pressure at the point of discharge from the compressor.

3.3.49.2 Maximum Allowable Working Pressure (MAWP). The maximum pressure to which a component is designed to be subjected when handling fluid or gas over the range of design temperature.

3.3.49.3 Operating Pressure. The varying pressure in a fuel system component during normal use.

3.3.49.4 Service Pressure. The settled pressure of the CNG fuel container at a uniform gas temperature of 21°C (70°F) and full gas content and for which the container, under normal conditions, has been constructed.

3.3.49.5 Set Pressure. The start-to-discharge pressure for which a relief valve is set and marked.

▲ **3.3.49.6* Working Pressure.** The maximum pressure that a vehicle component can be expected to experience in actual service.

3.3.50 Pressure Regulator. A device, either adjustable or nonadjustable, for controlling and maintaining, within acceptable limits, a uniform outlet pressure.

3.3.51 Pressure Relief Device Channels. The passage or passages beyond the operating parts of the pressure relief device through which fluid passes to reach the atmosphere.

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

3.3.53 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by virtue of education, training, experience, or other special attributes, possesses expertise regarding a particular subject matter, work, or project. [1901, 2016]

3.3.54 Remotely Located, Manually Activated Shutdown Control. A control system that is designed to initiate shutdown of the flow of gases or liquids and that is manually activated from a point located some distance from the delivery system.

▲ **3.3.55 Residential Fueling Appliance (RFA).** A self-contained CNG fueling appliance designed, listed, or approved, and intended to be installed as one system for fueling vehicles at residential (i.e., home) locations.

3.3.56 Room.

3.3.56.1 Engine Room (on a marine vessel). An engine space on a marine vessel that is large enough for an individual to enter.

3.3.56.2 Tank Room. A space on a marine vessel dedicated for fuel tanks that is large enough for an individual to enter.

3.3.57 Space.

3.3.57.1 Accommodation Space. Space designed for human occupancy as living space for persons aboard a vessel.

3.3.57.2 Control Space. Space on a marine vessel in which the vessel's radio, the 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.

3.3.57.3 Gas-Dangerous Space. An enclosed or semi-enclosed space on a marine vessel in which piping contains compressed natural gas or where fuel containers or the engine room or compartment is located.

3.3.57.4 Gas-Safe Space. Any space on a marine vessel that is not a gas-dangerous space.

3.3.57.5 Service Space. Space on a marine vessel outside the cargo area that is used for a galley; a pantry containing cooking appliances, lockers, or storerooms; workshops (except those workshops located in machinery spaces); and other similar spaces and access trunk to those spaces.

3.3.58 Standard Cubic Foot (scf) of Gas. An amount of gas that occupies one cubic foot when measured at an absolute pressure of 14.7 psi (101 kPa) and a temperature of 70°F (21°C). [55, 2016]

3.3.59 System.

3.3.59.1 Cascade Storage System. Storage in multiple pressure vessels, cylinders, or containers, which can be at different pressures, such that fueling is normally done initially from lower pressure containers and completed from higher pressure containers.

3.3.59.2 Fuel Dispenser System. The complete system, including controls used for the delivery of CNG or LNG fuel, and the removal of vapor from a vehicle.

3.3.59.3 Gas Detection System. One or more sensors capable of detecting natural gas at specified concentrations and activating alarms and safety systems.

3.3.59.4 Piping System. Interconnected piping consisting of mechanical components suitable for joining or assembly into pressure-tight fluid-containing system. Components include pipe, tubing, fittings, flanges, bolting, valves, and devices such as expansion joints, flexible joints, pressure hoses, in-line portions of instruments, and wetted components other than individual pieces or stages of equipment. [55, 2016]

3.3.60 Tank Compartment. A space on a marine vessel that is dedicated for fuel tanks and is too small for an individual to enter.

3.3.61 TC. Transport Canada.

3.3.62 Temperature Compensation. A process that allows the pressure in a container at the actual present gas temperature to be calculated so that the quantity of gas contained is the same as will be in the container at a specified service pressure at 21°C (70°F).

3.3.63 Validation. Verification by responsible individuals as indicated in the code text where the requirement appears.

3.3.64 Valve.

3.3.64.1 Container Valve. A valve connected directly to a container outlet.

3.3.65 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 for the purpose of saturating LNG.

3.3.65.1 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.

3.3.65.2 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.

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

3.3.65.2.2 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.

3.3.66 Vehicle. A device or structure for transporting persons or things; a conveyance (e.g., automobiles, trucks, marine vessels, railroad trains).

3.3.66.1 Commercial Motor Vehicle. Any self-propelled or towed motor vehicle used on a highway in interstate commerce to transport passengers or property when the vehicle (1) has a gross vehicle weight rating or gross combination weight rating, or gross vehicle weight or gross combination weight, of 10,001 lb (4536 kg) or more, whichever is greater; or (2) is designed or used to transport more than eight passengers (including the driver) for compensation; or (3) is designed or used to transport more than 15 passengers, including the driver, and is not used to transport passengers for compensation; or (4) is used in transporting material found by the Secretary of Transportation to be hazardous under 49 U.S.C. 5103, "General Regulatory Authority," and transported in a quantity requiring placarding under regulations prescribed by the Secretary under 49 CFR 390.5, "Federal Motor Carrier Safety Regulations; General."

Δ 3.3.67 Vehicle Fueling Appliance (VFA). A listed appliance manufactured and certified for refueling CNG vehicles at fleet and public dispensing operations and that compresses and dispenses natural gas to a vehicle's engine fueling system.

3.3.68 Vehicular Fuel. Fuel stored on board a vehicle for powering vehicle systems.

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

3.3.70 Weather Deck. Any deck that is exposed to the weather and normally accessible to personnel and that permits walking or moving around outboard of the superstructure. [1925, 2018]

Chapter 4 Facility Management

4.1 General.

4.1.1 Application. This chapter shall apply to facilities containing CNG, LCNG, and LNG fuel supply systems that store and dispense fuel.

4.1.2 Buildings or Structures. Compression, dispensing equipment, and storage containers connected for use shall be permitted to be located inside of buildings reserved exclusively for these purposes or in rooms within or attached to buildings used for other purposes in accordance with this section.

4.1.2.1 Rooms Within Buildings.

4.1.2.1.1 Rooms within or attached to other buildings shall be constructed of noncombustible or limited-combustible materials.

4.1.2.1.2 Window glazing shall be permitted to be plastic.

4.1.2.1.3 Interior walls or partitions shall be continuous from floor to ceiling, be anchored in accordance with the requirements of the building code, and have a fire resistance rating of at least 2 hours.

4.1.2.1.4 At least one wall shall be an exterior wall.

4.1.2.1.5 Explosion venting shall be provided in accordance with 11.3.6.2.2.

4.1.2.1.6 Access to the room shall be from outside the primary structure.

4.1.2.1.7 If access to the room from outside the primary structure is not possible, 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 rated for the location where installed.

4.1.2.2 Building Construction.

4.1.2.2.1 Buildings reserved exclusively for an LNG fueling facility shall be of Type I or Type II construction in accordance with *NFPA 5000*.

Δ 4.1.2.2.2 Windows and doors shall be located to permit ready egress in case of emergency.

4.2* Building Construction Materials.

Δ 4.2.1* Noncombustible Material. A material that complies with any of the following shall be considered a noncombustible material:

- (1)* A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat.
- (2) A material that is reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*.
- (3) A material that is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*. [101:4.6.13.1]

Δ 4.2.2* Limited-Combustible Material. A material shall be considered a limited-combustible material where one of the following is met:

- (1) The conditions of 4.2.2.1 and 4.2.2.2, and the conditions of either 4.2.2.3 or 4.2.2.4, shall be met.
 - (2) The conditions of 4.2.2.5 shall be met.
- [101:4.6.14]

4.2.2.1 The material shall not comply with the requirements for noncombustible material, in accordance with 4.2.1. [101:4.6.14.1]

Δ 4.2.2.2 The material, in the form in which it is used, shall exhibit a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg), where tested in accordance with NFPA 259. [101:4.6.14.2]

4.2.2.3 The material shall have the structural base of a noncombustible material with a surfacing not exceeding a thickness of $\frac{1}{8}$ in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. [101:4.6.14.3]

4.2.2.4 The material shall be composed of materials that, in the form and thickness used, exhibit neither a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, and shall be of such composition that all surfaces that would be exposed by cutting through the material on any plane would exhibit neither a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E84 or ANSI/UL 723. [101:4.6.14.4]

N 4.2.2.5 Materials shall be considered limited-combustible materials where tested in accordance with ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, at an incident heat flux of 75 kW/m² for a 20-minute exposure and both of the following conditions are met:

- (1) The peak heat release rate shall not exceed 150 kW/m² for longer than 10 seconds.
- (2) The total heat released shall not exceed 8 MJ/m². [101:4.6.14.5]

4.2.2.6 Where the term *limited-combustible* is used in this code, it shall also include the term *noncombustible*. [101:4.6.14.6]

4.3 Qualifications.

4.3.1 Designers, fabricators, and constructors of LNG, LCNG, and CNG fueling facilities shall be competent and have expertise in the design, fabrication, and construction of LNG, LCNG, and CNG containers; cryogenic equipment; loading and unloading systems; fire protection equipment; detection systems; facility siting; containment; piping systems; and other components of the facility.

4.3.2 The installation of LNG and CNG systems shall be supervised by qualified personnel with reference to their construction and use.

4.4 Equipment Security.

4.4.1 Equipment related to a compression, storage, or dispensing installation shall be protected to prevent damage from vehicles and minimize the possibilities of physical damage and vandalism.

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

4.4.3 The fueling facility shall provide protection to minimize unauthorized access and damage to the facility.

4.4.4 Security procedures shall be posted in readily visible areas near the fueling facility.

4.5 Operations and Maintenance.

4.5.1 Programs and Activities.

4.5.1.1* CNG Facility Maintenance

4.5.1.1.1 The system maintenance requirements of 4.5.1.1 shall be retroactive and shall be applied to existing stations.

4.5.1.1.2 Containers and their appurtenances, piping systems, compression equipment, controls, and detection devices shall be maintained in safe operating condition and according to manufacturers' instructions.

4.5.1.2* LNG Facility Maintenance.

Δ 4.5.1.2.1 Each facility shall have written maintenance procedures based on experience, knowledge of similar facilities, and conditions under which the facilities will be maintained. [59A:13.18.4]

4.5.1.2.2 The maintenance program shall be carried out by a qualified representative of the equipment owner.

4.5.1.2.3 Maintenance Manual.

(A) Each facility operator shall prepare a written manual that sets out an inspection and maintenance program for identified components that are used in the facility. [59A:13.8.4.2(A)]

(B) The maintenance manual for facility components shall include the following:

- (1) The manner of carrying out and the frequency of the inspections and tests referred to in 4.5.1.3
- (2) A description of any other action in addition to those referred to in 4.5.1.2.3(B)(1) that is necessary to maintain the facility in accordance with this standard
- (3) All procedures to be followed during repairs on a component that is operating while it is being repaired, to ensure the safety of persons and property at the facility [59A:13.8.4.2(B)]

(C) Each facility operator shall conduct the facility's maintenance program in accordance with the written manual for facility components. [59A:13.8.4.2(C)]

4.5.1.2.4 Maintenance shall be performed based on the component manufacturers' recommendations and not less than every six months.

4.5.1.2.5 Relief valves shall be inspected and set-point tested at least once every 2 calendar years, with intervals not exceeding 30 months, to ensure that each valve relieves at the proper setting. [59A:13.18.4.5(D)]

4.5.1.2.6 The refueling site shall have a maintenance program or process safety analysis program in place.

4.5.1.2.7 Each facility operator shall maintain a record of the date and the type of each maintenance activity performed. [59A:13.18.4.6(A)]

4.5.1.2.8 Maintenance records shall be kept for the duration of the fueling operation.

4.5.1.3 Each LNG facility operator shall carry out periodic inspection, tests, or both on a schedule that is included in the maintenance plan on identified components and its support system in service in the LNG facility, to verify that the components are maintained in accordance with the equipment manufacturer's recommendations and the following:

- (1) The support system or foundation of each component shall be inspected at least annually to ensure that the support system or foundation is sound.
- (2) Each emergency power source at the LNG plant shall be tested monthly to ensure that it is operational and tested annually to ensure that it is capable of performing at its intended operating capacity.
- (3) When a safety device serving a single component is taken out of service for maintenance or repair, the component shall also be taken out of service, except where the safety function is provided by an alternative means.
- (4) Where the operation of a component that is taken out of service could cause a hazardous condition, a tag bearing the words "Do Not Operate," or equivalent, shall be attached to the controls of the component, or the component shall be locked out.
- (5) Stop valves for isolating pressure or vacuum-relief valves shall be locked or sealed open and shall be operated only by an authorized person.
- (6) No more than one pressure or vacuum relief valve stop valve shall be closed at one time on an LNG container.

[59A:13.18.4.1]

4.5.1.3.1 All maintenance and servicing shall be done in accordance with 29 CFR 1910 for energy control.

4.5.1.4 All LNG facilities shall be free of rubbish, debris, and other material that will present a fire hazard to the distance of at least 25 ft (7.6 m).

4.5.1.5 Grass areas on the LNG fueling facility grounds shall be maintained in a manner that does not present a fire hazard.

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

4.5.1.7 Control systems that are used as part of the fire protection system at the LNG plant shall be inspected and tested in accordance with the applicable fire codes and standards and conform to the following criteria:

- (1) Monitoring equipment shall be maintained in accordance with NFPA 72 and NFPA 1221.
- (2) Fire protection water systems, if required, shall be maintained in accordance with NFPA 13, NFPA 14, NFPA 15, NFPA 20, NFPA 22, NFPA 24, and NFPA 25.
- (3) Portable or wheeled fire extinguishers suitable for gas fires, preferably of the dry-chemical type, shall be available at strategic locations, as determined in accordance with Chapter 14, within an LNG facility and on tank vehicles, and shall be maintained in accordance with NFPA 10.
- (4) Fixed fire extinguishers and other fire-control systems that are installed shall be maintained in accordance with NFPA 11, NFPA 12, NFPA 12A, NFPA 16, and NFPA 17.

[59A:13.18.4.5(C)]

4.5.1.8 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 comprised.

4.5.1.9 The external surfaces of LNG storage tanks shall be inspected and tested as set out in the maintenance manual for the following:

- (1) Inner tank leakage
- (2) Soundness of insulation
- (3) Tank foundation heating to ensure that the structural integrity or safety of the tanks is not affected

[59A:13.18.4.5(E)]

4.5.1.10 LNG storage facilities and, in particular, the storage container and its foundation shall be externally inspected after each major meteorological disturbance to ensure that the structural integrity of the LNG facility is intact. [59A:13.18.4.5(F)]

4.5.1.11 Access routes for movement of fire control equipment to an LNG fueling facility shall be maintained at all times.

4.5.1.12 Operations and Maintenance.

4.5.1.12.1 Each facility shall have written operating, maintenance, and training procedures based on experience, knowledge of similar facilities, and conditions under which the facility will be operated. [59A:13.18]

4.5.1.12.1.1 Basic Operations Requirement. Each LNG facility shall meet the following requirements:

- (1) Have written procedures covering operation, maintenance, and training
- (2) Keep up-to-date drawings of LNG facility equipment showing all revisions made after installation
- (3) Revise the plans and procedures as operating conditions or facility equipment require
- (4) Establish a written emergency plan
- (5) Establish liaison with appropriate local authorities such as police, fire department, or municipal works and inform them of the emergency plans and their role in emergency situations
- (6) Analyze and document all safety-related malfunctions and incidents for the purpose of determining their causes and preventing the possibility of recurrence

[59A:13.18.1]

4.5.1.12.1.2 Operating Procedures Manual.

(A) Each facility shall have a written manual of operating procedures, including the following:

- (1) Conducting a proper startup and shutdown of all components of the facility, including those for an initial startup of the LNG facility that will ensure that all components will operate satisfactorily
- (2) Purging and inerting components
- (3) Cooling down components
- (4) Ensuring that each control system is properly adjusted to operate within its design limits
- (5) Maintaining the vaporization rate, temperature, and pressure so that the resultant gas is within the design tolerance of the vaporizer and the downstream piping
- (6) Determining the existence of any abnormal conditions and indicating the response to those conditions
- (7) Ensuring the safety of personnel and property while repairs are carried out, whether or not equipment is in operation
- (8) Ensuring the safe transfer of hazardous fluids
- (9) Ensuring security at the LNG plant

- (10) Monitoring operation by watching or listening for warning alarms from an attended control center and by conducting inspections on a planned, periodic basis
- (11) Monitoring the foundation heating system weekly [59A:13.18.2.1]

(B) The manual shall be accessible to operating and maintenance personnel. [59A:13.18.2.2]

(C) The manual shall be updated when changes in equipment or procedures are made. [59A:13.18.2.3]

Δ (D) The operations manual shall contain procedures to ensure the following:

- (1) That the cool down of each system of components under its control and subjected to cryogenic temperatures is limited to a rate and a distribution pattern that maintain the thermal stresses within the design limits of the system during the cool down period, having regard for the performance of expansion and contraction devices. [59A:13.18.2.4(1)]

(E) Each operations manual shall include purging procedures [in accordance with NFPA 56] that, when implemented, minimize the presence of a combustible mixture in LNG facility piping or equipment when a system is being placed into or taken out of operation. [59A:13.18.2.5]

(F) The operations manual shall contain procedures for loading or unloading operations applicable to all transfers, including the following:

- (1) Written procedures shall cover all transfer operations and shall cover emergency as well as normal operating procedures.
- (2) Written procedures shall be kept up-to-date and available to all personnel engaged in transfer operations.
- (3) Prior to transfer, gauge readings shall be obtained or inventory established to ensure that the receiving vessel cannot be overfilled.
- (4) Levels of the receiving vessel shall be checked during transfer operations.
- (5) The transfer system shall be checked prior to use to ensure that valves are in the correct position.
- (6) Pressure and temperature conditions shall be observed during the transfer operation. [59A:13.18.2.6]

(G) Each operations manual for a facility that transfers LNG from or to a cargo tank vehicle or a tank car shall contain procedures for loading or unloading tank cars or tank vehicles, including the following:

- (1) While tank car or tank vehicle loading or unloading operations are in progress, rail and vehicle traffic shall be prohibited within 25 ft (7.6 m) of LNG facilities or within 50 ft (15 m) of refrigerants whose vapors are heavier than air.
- (2) Prior to connecting a tank car, the car shall be checked and the brakes set, the derailler or switch properly positioned, and warning signs or lights placed as required.
- (3) The warning signs or lights shall not be removed or reset until the transfer is completed and the car disconnected.
- (4) Unless required for transfer operations, truck vehicle engines shall be shut off.
- (5) Brakes shall be set and wheels checked prior to connecting for unloading or loading.

- (6) The engine shall not be started until the truck vehicle has been disconnected and any released vapors have dissipated.

[59A:13.18.2.7]

4.5.2 Manuals. (Reserved)

4.5.3 Record Requirements. A written record of maintenance shall be provided.

4.6 CNG Training. CNG maintenance personnel shall be trained in leak detection procedures and equipment in accordance with manufacturers' recommendations.

4.7* LNG Training.

4.7.1 All persons employed in handling and dispensing LNG shall be trained in handling and operating duties and procedures.

4.7.2 Protective clothing, face shield/goggles, and gloves shall be provided for all operators dispensing and handling LNG, except as provided in 4.7.3.

4.7.3 The requirements specified in 4.7.2 shall be permitted to be excluded where equipment is demonstrated to operate without exposing operators to the release of LNG or cold gases.

4.7.4* Training shall be conducted upon employment and every 2 years thereafter.

4.7.5 Training.

4.7.5.1 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) 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) Emergency response plan as required in 5.3.2.4
- (9) Evacuation and fire drills

4.7.5.2 Each operator shall provide and implement a written plan of initial training to instruct all designated operating and supervisory personnel in the characteristics and hazards of LNG used or handled at the site, including low LNG temperature, flammability of mixtures with air, odorless vapor, boil-off characteristics, and reaction to water and water spray; the potential hazards involved in operating activities; and how to carry out the emergency procedures that relate to personnel functions and to provide detailed instructions on mobile LNG operations.

4.8 Special Hazard Requirements.

4.8.1 A hazard analysis of the proposed modification and the startup plan shall be required and prepared prior to the modification and operation of the facility.

4.8.2 CNG shall not be used to operate any device or equipment that has not been designed or modified for CNG service.

Chapter 5 Facility Fire Protection

5.1 General.

5.1.1 Siting. LNG, LCNG, CNG, and other gaseous/cryogenic installations shall be permitted to use alternate site distances, operating requirements, and equipment locations with validation by a qualified person(s) with proven expertise in mechanical systems, electrical systems, gaseous storage systems, cryogenic storage systems, fire protection, and gas detection.

5.1.1.1 Validation.

5.1.1.1.1 The validation shall address the following:

- (1) Process safety analysis and hazard and operability studies (HAZOPS)
- (2) Mitigating fire protection measures such as suppression systems
- (3) Aboveground or belowground systems or vaults for the containers
- (4) Fire and gas detection systems designed to interface with an emergency shutdown device (ESD)
- (5) Ventilation and other facility features
- (6) Drainage and impounding for the individual site as administered by a qualified person(s) with proven expertise in these fields

5.1.1.1.2 The refueling station and associated storage equipment shall be validated per the specifics of 5.1.1.1.1 upon initial installation and revalidated per 5.1.1.1.1 when a change is made to the last validated design, including, but not limited to, changes in the service pressure. The installation validation shall also be reviewed at least every 4 years to detect any undocumented changes.

5.1.1.1.3 The validation shall be conducted by a qualified person(s) with proven expertise in the specific fueling and supporting equipment being installed.

5.1.1.1.4 Validation shall be kept on site and provided to the AHJ.

5.1.1.2 Fire Extinguishers. A portable fire extinguisher having a rating of not less than 20-B:C shall be provided at the dispensing area.

5.1.2 Ignition Source Control.

5.1.2.1 Smoking. Smoking and ignition sources shall be prohibited, except in accordance with 5.1.2.2.

5.1.2.2 Welding, Oxygen-Acetylene Cutting, and Similar Operations. 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.

5.1.2.3 Vehicles.

5.1.2.3.1 Vehicles shall not be considered a source of ignition with respect to the provisions of this chapter, except as provided in 5.1.2.3.2.

5.1.2.3.2 Vehicles containing fuel-fired equipment (e.g., recreational vehicles and catering trucks) shall be considered a source of ignition unless this equipment is shut off completely before entering an area in which ignition sources are not permitted.

5.1.2.4 Nonelectrical sources of ignition shall not be permitted.

5.1.3 Signage.

5.1.3.1 The location of signs shall be determined by local conditions.

5.1.3.2 The lettering on signs shall be large enough to be visible and legible from each point of transfer.

5.1.3.3 A warning sign with the words “NO SMOKING, FLAMMABLE GAS” shall be posted in every compressor and storage area.

5.1.3.4 Access doors shall have warning signs with the words “WARNING — NO SMOKING — FLAMMABLE GAS.”

5.1.3.5 The wording shall be in plainly legible, bright red letters not less than 1 in. (25 mm) high on a white background.

5.2 CNG Supplemental Requirements.

5.2.1 Siting.

5.2.1.1 Setbacks.

5.2.1.1.1 Compression, storage, and dispensing equipment located outdoors shall be a minimum of 10 ft (3 m) from the nearest important building or line of adjoining property that is able to be built upon or from any source of ignition.

5.2.1.1.2 Compression, storage, and dispensing equipment located outdoors shall be not less than 10 ft (3 m) from the nearest public street or sidewalk line and at least 50 ft (15 m) from the nearest rail of any railroad main track.

5.2.1.1.3 Combustible material shall not be permitted within 10 ft (3 m) of any stationary container.

5.2.1.1.4 The minimum separation between containers and aboveground tanks containing flammable or combustible liquids shall be 20 ft (6 m).

5.2.1.1.5 Point of Transfer.

5.2.1.1.5.1 During outdoor fueling operations, the point of transfer shall be located at least 10 ft (3 m) from any important building, mobile home, public sidewalk, highway, street, or road and at least 3 ft (1 m) from storage containers.

5.2.1.1.5.2 The point of transfer shall be permitted to be located at a lesser distance from buildings or walls constructed of concrete or masonry materials or of other material having a fire resistance rating of at least 2 hours, but at least 10 ft (3 m) from any building openings.

5.2.1.1.6 Sources of ignition shall not be permitted within 10 ft (3.0 m) of any filling connection during a transfer operation.

5.2.2 Signage.

5.2.2.1 A warning sign(s) shall be posted at each dispensing point with the following words:

FLAMMABLE GAS — STOP MOTOR, NO SMOKING.

NATURAL GAS VEHICLE FUEL CYLINDERS SHALL BE INSPECTED AT INTERVALS NOT EXCEEDING 3 YEARS TO ENSURE SAFE OPERATION OF THE VEHICLE.

NATURAL GAS FUEL CYLINDERS PAST THEIR END-OF-LIFE DATE SHALL NOT BE REFUELED AND SHALL BE REMOVED FROM SERVICE.

5.3 LNG Supplemental Requirements.

5.3.1 Application. This section applies to LNG fire protection, personnel safety, security, LNG fueling facilities and training for LNG vehicles, and warning signs.

5.3.2 Fire Protection, Safety, and Security.

5.3.2.1 Fire protection shall be provided for all LNG fueling facilities.

5.3.2.1.1 The extent of such protection shall be determined by an evaluation based on sound fire protection and methane detection 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.

5.3.2.1.2 Guidance factors for making such an evaluation shall include the following:

- (1) 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) Methods necessary for the protection of vehicles, equipment, and structures from the effects of fire exposure
- (3) Equipment and processes to be incorporated within the ESD system
- (4) Type, quantity, and location of sensors necessary to initiate automatic operation of the ESD system
- (5) Availability and duties of individual facility personnel and the availability of external response personnel during an emergency
- (6) Protective equipment and special training required by personnel for emergency duties

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

5.3.2.3 All-weather accessibility to the site for emergency services equipment shall be provided.

5.3.2.4* An emergency response plan shall be prepared to cover foreseeable emergency conditions.

5.3.2.5 The fire protection and methane detection equipment shall be maintained in accordance with the manufacturer's instructions and the AHJ.

5.3.2.6 An operating, portable, flammable-gas detector shall be readily available.

5.3.3 Siting.

5.3.3.1 LNG tanks and their associated equipment shall not be located where exposed to failure of overhead electric power lines operating over 600 volts **unless approved protection is provided.**

5.3.3.2 Vaulted or underground installations shall be deemed to provide engineered protection from overhead power lines.

5.3.3.3 If other combustible or hazardous liquids are able to encroach on the LNG fueling facility, means shall be provided to protect the LNG facility.

5.3.3.4 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 is able to be built upon, or from fixed sources of ignition.

5.3.3.5 Flammable liquid storage tanks shall not be located within an LNG container impounding area.

5.3.4 Ignition Source Control.

5.3.4.1 LNG fueling facilities shall be free from rubbish, debris, and other material that present a fire hazard to a distance of at least 25 ft (7.6 m).

5.3.4.2 Grass areas on the LNG fueling facility grounds shall be maintained in a manner that does not present a fire hazard.

5.3.4.3 Gas leak detection and fire detection shall be **installed** based on the evaluation required in 5.3.2.1.1.

5.3.4.4 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.

5.3.5 Vehicles.

5.3.5.1 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.

5.3.5.2 Vehicles delivering LNG to the facility or vehicles being fueled from the facility shall not be considered sources of ignition.

5.3.5.3 Vehicles containing fuel-fired equipment (e.g., 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.

5.3.6 Electrical Classifications.

5.3.6.1 Fired equipment shall be located in accordance with Table **14.3.2.25.1** from any impounding area or container drainage system.

5.3.6.2 Buildings and rooms used for storage or dispensing shall be classified in accordance with Table **14.3.2.25.1** for installations of electrical equipment.

5.3.7 Signage. 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 Liquid or Cold Gas"
- (5) "Flammable Gas"
- (6) "Unodorized Gas"

5.3.8 Emergency Response Measures.

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

5.3.8.2 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.

5.3.8.3 Access routes for movement of fire control equipment to an LNG fueling facility shall be maintained at all times.

Chapter 6 Facility Gas Detection, Alarm, and Emergency Shutdown Systems

6.1 General.

Δ 6.1.1 Gas Detection. Gas detection equipment and alarms for dispensing station systems and dispensing station system components shall be listed or approved

6.1.2 Flame Detection. (Reserved)

6.2 CNG Supplemental Requirements.

6.2.1 Gas Detection.

6.2.1.1 Where installed, a gas detection system shall be equipped to sound a latched alarm and visually indicate when a maximum of one-fifth of the lower flammable limit is reached.

6.2.1.2 Where attended fast-fill fueling is performed indoors, the following shall be installed:

- (1) An emergency manual shutdown device shall be installed as required by 11.3.2.16.5.
- (2) A gas detection system equipped to sound a latched alarm and visually indicate when a maximum of one-fifth of the lower flammable limit is reached shall be installed.

6.2.1.3 The actuation of the gas detection system shall shut down the compressor and stop the flow of gas into the structure.

6.2.1.4 Odorized CNG. (Reserved)

6.2.1.5 Nonodorized CNG. (Reserved)

6.2.1.6 Flame Detection. (Reserved)

6.3 LNG Supplemental Requirements.

6.3.1 Gas Detection.

6.3.1.1 A gas detection system shall be provided in all buildings containing LNG.

6.3.1.2 The gas detection system shall activate a latched alarm when a maximum of 20 percent of the LFL is reached.

Chapter 7 Fuel Quality

7.1 General.

7.2* CNG. Natural gas composition dispensed to vehicles shall comply with 7.2.1 and 7.2.2.

7.2.1 Natural gas introduced into any system covered by this code shall have a distinctive odor potent enough for its presence to be detected down to a concentration in air of not over one-fifth of the lower limit of flammability.

• N 7.2.2 Methanol or glycol shall not be deliberately added to the natural gas at the fueling station.

7.3 LNG. (Reserved)

Chapter 8 Facility Equipment

8.1 Scope. This chapter shall apply to equipment used for storage and dispensing of CNG and LNG as an engine fuel in fleet and public dispensing operations.

8.2 Application. CNG and LNG equipment used shall be in accordance with Section 8.3 and the fuel-specific paragraphs of Section 8.4, as applicable. Where there is a conflict between general requirements and fuel-specific requirements, the fuel-specific requirements shall apply.

8.3 General.

8.3.1 System Component Qualifications. (Reserved)

8.3.2* System Approvals. The following subsystems or components associated with storage and dispensing of CNG and LNG as an engine fuel in fleet and public dispensing operations shall be listed or approved:

- (1) Pressure relief devices, including pressure relief valves
- (2) Pressure gauges
- (3) Pressure regulators
- (4) Valves
- (5) Hose and hose connections
- (6) Vehicle fueling connections (e.g., nozzle and receptacle)
- (7) Engine fuel systems
- (8) Electrical equipment related to storage or dispensing systems
- (9) Gas detection equipment and alarms
- (10) Fire protection and suppression equipment
- (11) Vehicle fueling appliances (VFAs)
- (12) Residential fueling appliances (RFAs)

• N 8.3.3 Safety Equivalent. Devices not otherwise specifically provided for shall be constructed to provide safety equivalent to that required for other parts of a system.

8.3.4 Equipment.

8.3.4.1 Pressure Regulators.

8.3.4.1.1 Regulators shall be designed, installed, or protected so that their operation is not affected by freezing rain, sleet, snow, ice, mud, insects, or debris.

8.3.4.1.2 Regulator protection of 8.3.4.1.1 shall be permitted to be integral with the regulator.

8.3.4.2 Pressure Relief Devices (PRVs).

• N 8.3.4.2.1 PRVs shall not be fitted with lifting devices.

• N 8.3.4.2.1.1 The adjustment to PRVs, if external, shall be provided with a means for sealing the adjustment to prevent tampering.

• N 8.3.4.2.1.2 If at any time it is necessary to break such a seal as provided in 8.3.4.2.1.1, the valve shall be removed from service until it has been reset and sealed.

• N 8.3.4.2.1.3 PRV adjustments shall be made only by the manufacturer or other companies having competent personnel and facilities for the repair, adjustment, and testing of such valves.

N 8.3.4.2.1.4 The organization making such PRV adjustments shall attach a permanent tag with the setting, capacity, and date.

N 8.3.4.2.2 PRVs protecting ASME pressure vessels shall be repaired, adjusted, and tested in accordance with NB-23, *National Board Inspection Code*.

N 8.3.4.2.3 PRVs shall be maintained in safe operating condition.

N 8.3.4.2.4 PRVs shall have vent lines to convey escaping gas upward to prevent impinging on buildings, other equipment, or areas open to the public (e.g., sidewalks).

N 8.3.4.2.5 The PRV shall not have a setting greater than the maximum allowable working pressure of the line it protects.

8.3.4.3 Piping. (Reserved)

8.3.4.4 Piping Connections. (Reserved)

8.3.4.5 Hoses and Breakaway Devices. (Reserved)

8.3.4.6 Valves. (Reserved)

8.3.4.7 Electrical Equipment. (Reserved)

8.4 CNG Systems.

8.4.1 Compressor Systems.

8.4.1.1 Design Temperature and Pressure.

8.4.1.1.1 Compression equipment shall be designed for use with CNG and for the pressures and temperatures to which it is subjected under operating conditions.

8.4.1.1.2* Compression equipment shall incorporate a means to minimize liquid carryover to the storage system.

8.4.1.2 Installation of Pressure Gauges. Gauges or other read-out devices shall be installed to indicate compression discharge pressure, storage pressure, and dispenser discharge pressure.

8.4.1.3 Pressure Relief Devices. Compression equipment shall have pressure relief valves that limit each stage pressure to the maximum allowable working pressure for the compression cylinder and piping associated with that stage of compression.

8.4.1.4 Shutdown Control.

8.4.1.4.1 CNG compression equipment shall be equipped with a high discharge and a low suction pressure automatic shutdown control.

8.4.1.4.2 Control circuits that shut down shall remain down until manually activated or reset after a safe **condition is restored**.

8.4.1.5 Engine Drives. Engine-driven compressor installations shall conform, where applicable, to NFPA 37.

8.4.2 Dispensing Systems and Dispensers.

8.4.2.1 Operation.

8.4.2.1.1 Static protection shall not be required where CNG is transferred by conductive hose, flexible metallic tubing, or pipe connections where both halves of the metallic couplings are in continuous contact.

Δ 8.4.2.1.2 A fuel **supply** container shall not be charged in excess of the quantity of fuel that would result in a gas pressure

equal to service pressure at a uniform temperature of 70°F (21°C).

N 8.4.2.1.3 Under no circumstances shall the fuel supply container be subjected to pressure in excess of 1.25 times the service pressure.

8.4.2.1.4 DOT, TC, and **CSA/ANSI NGV 2** cylinders shall be charged in accordance with DOT, TC, and **CSA/ANSI NGV 2** regulations.

8.4.2.2 Vehicle Fill Pressure Control.

8.4.2.2.1 CNG dispensing systems shall be equipped to stop fuel flow automatically when a vehicle fuel supply container reaches the maximum fill conditions of 8.4.2.1.2.

8.4.2.2.2 Malfunctions.

N 8.4.2.2.2.1 The dispenser shall be designed to detect any malfunction that fills the vehicle fuel container in excess of the limits specified, or causes the relief valve required in 11.3.2.3 to open.

N 8.4.2.2.2.2 If a malfunction is detected, the following shall occur:

- (A) The dispenser shall disable itself and provide clear visual annunciation until it is repaired, calibrated, or serviced.
- (B) The dispenser shall notify the vehicle operator or fueling technician shall be notified that the vehicle has been overfilled.
- (C) After any such malfunction, the dispenser shall be repaired and calibrated in accordance with 4.5.1.1 before continued operation.

8.4.2.3 Overpressure Protection.

8.4.2.3.1 Transfer systems shall be capable of depressurizing to facilitate disconnection.

8.4.2.3.2 The pressure relief valve shall be redundant to and independent from any operating control system used to control the supplied fuel pressure during dispenser operation.

8.4.2.3.3 The set pressure of the overpressure protection device shall not exceed 125 percent of the service pressure of the fueling nozzle it supplies.

8.4.2.4 Breakaway Protection.

8.4.2.4.1 Breakaway protection shall be provided in a manner that, in the event of a pullaway, natural gas ceases to flow at any separation.

(A) A breakaway device shall be arranged to separate using a force not greater than 150 lb (68 kg) when applied in any direction that the vehicle would move.

(B) Breakaway devices shall comply with ANSI/IAS NGV 4.4/CSA 12.54, *Breakaway devices for natural gas dispensing hoses and systems*.

8.4.2.5 Malfunction Control.

8.4.2.5.1 An emergency manual shutdown device shall be provided within 10 ft (3.0 m) of the dispensing area and also greater than 25 ft (7.6 m) from the dispensing area.

8.4.2.5.1.1 This device, when activated, shall shut off the power supply and gas supply to the compressor and the dispenser.

8.4.2.5.1.2 Control circuits shall be arranged so that, when an emergency shutdown device is activated, the systems that shut down shall remain off until manually activated or reset after a safe condition is confirmed.

N 8.4.2.5.1.3 When the electric power is cut off (i.e., blackout condition), the systems that shut down shall remain off until manually activated or reset after a safe condition is confirmed.

N 8.4.2.5.1.4 When the electric power is interrupted (i.e., brownout condition) or the station is equipped with backup power, the system that shut down should be allowed to reset after power is restored.

8.4.2.6 Electrical Classification. Electrical classification areas inside dispenser enclosures are determined by the requirements in Table 11.3.2.14.1.

8.4.2.7 System Testing.

8.4.2.7.1 Leak Testing.

(A) Piping, tubing and hose, and hose assemblies shall be leak tested after assembly to prove them free from leaks at a pressure equal to at least the maximum operating pressure of that portion of the system. Compression equipment that has, by design, interstage air movement and ventilation through the crankcase shall not be subjected to leak testing as this design will give an erroneous test reading.

(B) Compression equipment that has, by design, interstage air movement and ventilation through the crankcase shall not be subjected to this system testing, as its inclusion will give an erroneous reading to the system test.

N 8.4.2.8 Hose Assemblies.

N 8.4.2.8.1 Dispensing station hose, metallic hose, flexible metal hose, tubing, and their connections shall be designed or selected for the most severe pressures and temperatures under normal operating conditions with a burst pressure of at least four times the maximum allowable working pressure.

N 8.4.2.8.2 Prior to use, hose assemblies shall be tested by the OEM or its designated representative at a pressure of at least twice the maximum allowable working pressure (MAWP).

N 8.4.3 Shutoff Valves.

N 8.4.3.1 Shutoff valves for dispensing stations shall have a rated maximum allowable working pressure not less than the rated operating pressure of the system.

N 8.4.3.2 Shutoff valves shall be capable of withstanding a hydrostatic test of at least four times the rated operating pressure without rupture.

N 8.4.4* Design and Construction of Containers.

N 8.4.4.1 Containers shall be fabricated of steel, aluminum, or composite materials.

N 8.4.4.2 The container shall be designed for CNG service.

N 8.4.4.3 The container shall be permanently marked "CNG" by the manufacturer.

N 8.4.4.4 Containers manufactured prior to the effective date of this code shall be permitted to be used in CNG service if recommended for CNG service by the container manufacturer or if approved by the authority having jurisdiction.

N 8.4.4.5 ASME Compliance.

N 8.4.4.5.1 Pressure vessels shall be manufactured, inspected, marked, and tested in accordance with ASME *Boiler and Pressure Vessel Code*, Section VIII or Section X.

N 8.4.4.5.2 Adherence to applicable ASME *Boiler and Pressure Vessel Code* case interpretations and addenda shall be considered as compliant with the ASME *Boiler and Pressure Vessel Code*.

N 8.4.4.5.3* Pressure vessels manufactured to the requirements of the ASME *Boiler and Pressure Vessel Code* shall be registered with the National Board of Boiler and Pressure Vessel Inspectors.

N 8.4.4.5.4 The repair or alteration of an ASME pressure vessel shall comply with the requirements of NB-23, *National Board Inspection Code*.

N 8.4.4.5.5 Other welding or brazing shall be permitted only on saddle plates, lugs, or brackets attached to the pressure vessel by the pressure vessel manufacturer.

N 8.4.4.5.6 The exchange or interchange of pressure vessel appurtenances intended for the same purpose shall not be considered a repair or alteration.

N 8.4.5 Pressure Relief Devices (PRDs). See Annex C.

N 8.4.5.1 Container Protections. Each cylinder complying with 8.4.4.5 shall be fitted with one or more thermally activated PRDs with the number, location, and part number as specified by the cylinder manufacturer and shall be marked and certified in accordance with CSA/ANSI PRD 1, *Pressure relief devices for natural gas vehicle (NGV) fuel containers*.

N 8.4.5.1.1 Containers shall be permitted to be protected using a combination of fire-resistant barriers and PRDs.

N 8.4.5.1.2 Pressure vessels complying with 8.4.4.5 used in stationary storage without temperature compensation of the storage operating pressure shall be protected with one or more spring-loaded PRVs in accordance with the ASME *Boiler and Pressure Vessel Code*.

N 8.4.5.1.3 The minimum rate of discharge of PRDs on containers shall be in accordance with CGA S-1.3, *Pressure Relief Device Standards — Part 3 — Stationary Storage Containers for Compressed Gases*, or the ASME *Boiler and Pressure Vessel Code*, whichever is applicable.

N 8.4.5.1.4 PRVs for CNG service shall not be fitted with lifting devices.

N (A) The adjustment, if external, shall be provided with a means for sealing the adjustment to prevent tampering.

N (B) If at any time it is necessary to break such a seal, the valve shall be removed from service until it has been reset and sealed.

N (C) Adjustments shall be made only by the manufacturer or other companies having competent personnel and facilities for the repair, adjustment, and testing of such valves.

N (D) The organization making such adjustments shall attach a permanent tag with the setting, capacity, and date.

N 8.4.5.1.5 The discharge flow rate of the PRD shall not be reduced below that required for the capacity of the container upon which the device is installed.

N 8.4.6 Pressure Gauges. A pressure gauge, if provided, shall be capable of reading at least 1.5 times the service pressure for the vehicle.

N 8.4.7 Pressure Regulators.

N 8.4.7.1 A pressure regulator inlet and each chamber shall be designed with a pressure safety factor of at least 4 times the service pressure of the vehicle.

N 8.4.7.2 Low-pressure chambers shall provide for overpressure relief or be able to withstand the service pressure of the upstream pressure chamber.

N 8.4.8 Piping, Tubing, and Fittings.

N 8.4.8.1 The following components shall not be used for CNG service:

- (1) Fittings, street els, and other piping components of cast irons other than those complying with ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings (Grade 35018)*; ASTM A395/A395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*; and ASTM A536, *Standard Specification for Ductile Iron Castings (Grade 60-40-18)*
- (2) Plastic pipe, tubing, and fittings for high-pressure service
- (3) Galvanized pipe and fittings
- (4) Aluminum pipe, tubing, and fittings
- (5) Pipe nipples for the initial connection to a container
- (6) Copper allowed with copper content exceeding 70 percent

N 8.4.8.2 Pipe, tubing, fittings, gaskets, and packing material shall be compatible with the fuel under the maximum service conditions.

N 8.4.8.3 Pipe, tubing, fittings, and other components shall be designed with a minimum safety factor of 3.

N 8.4.8.4 Natural gas piping shall be fabricated and tested in accordance with ANSI NGV 3.1/CSA 12.3, *Fuel system components for compressed natural gas powered vehicles*.

N 8.4.8.5 The refueling connection shall be permitted to be made of nonsparking wrought aluminum alloy designed for the pressure employed.

N 8.4.8.6 Aluminum pipe, tubing, and fittings shall be permitted to be used downstream of the first-stage pressure regulator in an engine fuel system.

N 8.4.8.7 Piping components such as strainers, snubbers, and expansion joints shall be permanently marked by the manufacturer to indicate the service rating.

N 8.4.9 Valves.

N 8.4.9.1 Valves, valve packing, and gaskets shall be designed or selected for the fuel over the full range of pressures and temperatures to which they are subjected under operating conditions.

N 8.4.9.1.1 Shutoff valves for dispensing station shall have a rated maximum allowable working pressure not less than the rated operating pressure of the systems and shall be capable of withstanding a hydrostatic test of at least 4 times the rated operating pressure.

N 8.4.9.1.2 Leakage shall not occur at less than 1.5 times the rated operating pressure.

N 8.4.9.2 Valves of a design that allows the valve stem to be removed without removal of the complete valve bonnet or without disassembly of the valve body shall not be used.

N 8.4.9.3 Marking.

N 8.4.9.3.1 The manufacturer shall stamp or otherwise permanently mark the valve body to indicate the service pressure rating.

N 8.4.9.3.2 Container valves incorporating integral PRDs complying with 8.4.5.1 shall not require additional marking.

N 8.4.9.4 Valves of cast irons other than those complying with ASTM A47/A47M, *Standard Specification for Ferritic Malleable Iron Castings (Grade 35018)*; ASTM A395/A395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*; and ASTM A536, *Standard Specification for Ductile Iron Castings (Grade 60-40-18)*, shall not be used as primary stop valves.

N 8.4.9.5 Hose and Hose Connections.

N 8.4.9.5.1 Hose and metallic hose shall be constructed of or lined with materials that are resistant to corrosion and exposure to natural gas.

N 8.4.9.5.2 Hose Assemblies.

N 8.4.9.5.2.1 Vehicle hose, metallic hose, flexible metal hose, tubing, and their connections shall be designed or selected for the most severe pressures and temperatures under normal operating conditions with a burst pressure of at least 4 times the operating pressure.

N 8.4.9.5.2.2 Prior to use, hose assemblies shall be tested by the OEM or its designated representative at a pressure of at least twice the operating pressure.

N 8.4.9.5.2.3 Hose and metallic hose shall be distinctly marked by the OEM or component manufacturer, either by the manufacturer's permanently attached tag or by distinct markings indicating the manufacturer's name or trademark, applicable service identifier, and design pressure.

N 8.4.9.5.2.4 Vehicle hoses, metallic hose, flexible metal hose, tubing, and their connections shall comply with the requirements in 15.4.3.8 or ANSI NGV 3.1/CSA 12.3, *Fuel system components for compressed natural gas powered vehicles*.

N 8.4.10 Vehicle Fueling Connection.

N 8.4.10.1 CNG vehicle fueling connection devices shall be listed in accordance with CSA/ANSI NGV 1, *Compressed natural gas vehicle (NGV) fueling connection devices*.

N 8.4.10.2 The fueling connection shall be permitted to be made of nonsparking wrought aluminum alloy designed for the pressure employed.

N 8.4.10.3 The fueling connection shall prevent the escape of gas when the connector is not engaged or becomes separated.

N 8.4.10.4 The use of adapters to defeat the pressure-specific nozzle and receptacle connections shall be prohibited.

Chapter 9 Outdoor Storage

9.1 Scope. This chapter shall apply to the outdoor storage of vehicular gas fuel systems in portable and stationary cylinders, containers, equipment, systems and tanks.

9.2 General. (Reserved)

9.3 CNG Supplemental Requirements.

9.3.1 Compression, Storage, and Dispensing Equipment Located Outdoors. A facility in which CNG compression, storage, and dispensing equipment are sheltered by weather protection constructed in accordance with the requirements of the building code and by a roof designed for ventilation and dispersal of escaped gas shall be considered to be located outdoors.

9.3.1.1 Compression, storage, and dispensing equipment located outdoors shall be above ground.

Δ 9.3.1.2 Compression, storage, and dispensing equipment shall not be located where exposed to failure of overhead electric power lines operating over 600 volts unless approved protection is provided.

9.3.1.3 Compression, storage, and dispensing equipment located outdoors shall be above ground.

9.3.1.4 Compression, storage, and dispensing equipment located outdoors shall be a minimum of 10 ft (3 m) from the nearest important building or line of adjoining property that is able to be built upon or from any source of ignition.

9.3.1.5 Compression, storage, and dispensing equipment located outdoors shall be not less than 10 ft (3 m) from the nearest public street or sidewalk line and at least 50 ft (15 m) from the nearest rail of any railroad main track.

9.3.2 Location. CNG storage containers charged with CNG not connected for use shall be located outdoors.

9.3.2.1* Installation of Containers and Container Appurtenances (Other than Pressure Relief Devices).

N 9.3.2.1.1 Storage containers shall be installed above ground on stable, noncombustible foundations or in vaults with ventilation and drainage. *(See Section 4.2 for noncombustible.)*

9.3.2.1.2 Horizontal containers shall have no more than two points of support longitudinally.

9.3.2.1.3 In areas subject to flooding, container(s) shall be anchored to prevent floating.

9.3.2.2 Containers shall be protected by painting or other equivalent means where necessary to inhibit corrosion.

9.3.2.2.1 Composite containers shall not be painted without prior permission from the container manufacturer.

9.3.2.2.2 Horizontally installed containers shall not be in direct contact with each other.

9.3.2.2.3 Composite containers shall be protected from UV radiation as required by the manufacturer.

9.3.2.3 Means shall be provided to prevent the flow or accumulation of flammable or combustible liquids under containers, such as by grading, pads, or diversion curbs.

9.3.3 Anchoring. This equipment shall be installed on foundations with anchoring systems designed to meet the requirements of the adopted building code for the applicable seismic and wind conditions.

Δ 9.3.4 Electrical Installations. Areas for compression, storage, and dispensing shall be classified in accordance with Table 11.3.2.14.1 for installations of electrical equipment.

9.3.5 Warning Signs. See 5.1.3.

9.3.6 Connections.

9.3.6.1 Piping Connections.

9.3.6.1.1 Manifolds connecting fuel containers shall be fabricated to minimize vibration.

9.3.6.1.1.1 Manifolds shall be installed in a protected location or shielded to prevent damage from unsecured objects.

9.3.6.1.2 A pipe thread jointing material impervious to the action of the natural gas used in system shall be applied to all male pipe threads prior to assembly.

9.3.6.1.3 Threaded piping and fittings shall be clear and free from cutting or threading burrs and scales.

9.3.6.1.3.1 The ends of all piping shall be reamed.

9.3.6.1.4 A bend in piping or tubing shall be prohibited where such a bend weakens the pipe or tubing beyond its designed operating condition.

9.3.6.1.5 A joint or connection shall be located in an accessible location.

9.3.6.1.6 The number of joints shall be minimized and placed in a location considering personnel safety.

9.3.7 Separation Distances.

9.3.7.1 Sidewalks (and Rail). Pressure relief valves on storage systems shall have a pressure relief valve vent system to convey escaping gas to the outdoors and then upward to a safe area to prevent impinging on buildings, other equipment, or areas open to the public (e.g., sidewalks).

Δ 9.3.7.1.1 Installation of PRVs. PRVs shall have vent lines to convey escaping gas to the outdoors and then upward to prevent impinging on buildings, other equipment, or areas open to the public (e.g., sidewalks).

9.4 LNG Supplemental Requirements.

9.4.1 Spill Containment. See 14.3.2.19.2.

9.4.2 See Chapter 17 for requirements of ASME tanks for LNG.

9.4.3 Separation Distances.

9.4.3.1 Adjacent Buildings. See Table 17.5.1.

9.4.3.2 Power Lines.

9.4.3.2.1 LNG tanks and their associated equipment shall not be located where exposed to failure of overhead electric power lines operating over 600 volts unless approved protection is provided.

9.4.3.2.2 Vaulted or underground installations shall be deemed to provide engineered protection from overhead power lines.

Δ 9.4.3.3 Stationary Containers. See Table 17.5.1.