

NFPA® 52

Vehicular Gaseous Fuel Systems Code

2013 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® DOCUMENTS
NOTICE AND DISCLAIMER OF LIABILITY CONCERNING THE USE OF NFPA DOCUMENTS

NFPA® codes, standards, recommended practices, and guides (“NFPA Documents”), of which the document contained herein is one, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in NFPA Documents.

The NFPA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on NFPA Documents. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making NFPA Documents available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of NFPA Documents. Nor does the NFPA list, certify, test, or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

REMINDER: UPDATING OF NFPA DOCUMENTS

Users of NFPA codes, standards, recommended practices, and guides (“NFPA Documents”) should be aware that NFPA Documents may be amended from time to time through the issuance of Tentative Interim Amendments or corrected by Errata. An official NFPA Document at any point in time consists of the current edition of the document together with any Tentative Interim Amendment and any Errata then in effect.

In order to determine whether an NFPA Document has been amended through the issuance of Tentative Interim Amendments or corrected by Errata, visit the Document Information Pages on NFPA’s website. The Document Information Pages provide up-to-date, document specific information including any issued Tentative Interim Amendments and Errata.

To access the Document Information Page for a specific NFPA Document go to <http://www.nfpa.org/document> for a list of NFPA Documents, and click on the appropriate Document number (e.g., NFPA 101). In addition to posting all existing Tentative Interim Amendments and Errata, the Document Information Page also includes the option to sign-up for an “Alert” feature to receive an email notification when new updates and other information are posted regarding the document.

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® DOCUMENTS

ADDITIONAL NOTICES AND DISCLAIMERS

Updating of NFPA Documents

Users of NFPA codes, standards, recommended practices, and guides (“NFPA Documents”) should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of Tentative Interim Amendments. An official NFPA Document at any point in time consists of the current edition of the document together with any Tentative Interim Amendments and any Errata then in effect. In order to determine whether a given document is the current edition and whether it has been amended through the issuance of Tentative Interim Amendments or corrected through the issuance of Errata, consult appropriate NFPA publications such as the National Fire Codes® Subscription Service, visit the NFPA website at www.nfpa.org, or contact the NFPA at the address listed below.

Interpretations of NFPA Documents

A statement, written or oral, that is not processed in accordance with Section 6 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Patents

The NFPA does not take any position with respect to the validity of any patent rights referenced in, related to, or asserted in connection with an NFPA Document. The users of NFPA Documents bear the sole responsibility for determining the validity of any such patent rights, as well as the risk of infringement of such rights, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on NFPA Documents.

NFPA adheres to the policy of the American National Standards Institute (ANSI) regarding the inclusion of patents in American National Standards (“the ANSI Patent Policy”), and hereby gives the following notice pursuant to that policy:

NOTICE: The user’s attention is called to the possibility that compliance with an NFPA Document may require use of an invention covered by patent rights. NFPA takes no position as to the validity of any such patent rights or as to whether such patent rights constitute or include essential patent claims under the ANSI Patent Policy. If, in connection with the ANSI Patent Policy, a patent holder has filed a statement of willingness to grant licenses under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, copies of such filed statements can be obtained, on request, from NFPA. For further information, contact the NFPA at the address listed below.

Law and Regulations

Users of NFPA Documents should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of its codes, standards, recommended practices, and guides, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

NFPA Documents are copyrighted. They are made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of safe practices and methods. By making these documents available for use and adoption by public authorities and private users, the NFPA does not waive any rights in copyright to these documents.

Use of NFPA Documents for regulatory purposes should be accomplished through adoption by reference. The term “adoption by reference” means the citing of title, edition, and publishing information only. Any deletions, additions, and changes desired by the adopting authority should be noted separately in the adopting instrument. In order to assist NFPA in following the uses made of its documents, adopting authorities are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. For technical assistance and questions concerning adoption of NFPA Documents, contact NFPA at the address below.

For Further Information

All questions or other communications relating to NFPA Documents and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA documents during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101; email: stds_admin@nfpa.org

For more information about NFPA, visit the NFPA website at www.nfpa.org.

Copyright © 2013 National Fire Protection Association®. All Rights Reserved.

NFPA® 52

Vehicular Gaseous Fuel Systems Code

2013 Edition

This edition of NFPA 52, *Vehicular Gaseous Fuel Systems Code*, was prepared by the Technical Committee on Vehicular Alternative Fuel Systems. It was issued by the Standards Council on November 27, 2012, with an effective date of December 17, 2012, and supersedes all previous editions.

This edition of NFPA 52 was approved as an American National Standard on December 17, 2012.

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 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 *Manual of Style for NFPA 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 encase the modified terms.

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

Technical Committee on Vehicular Alternative Fuel Systems

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

Ronald C. Adcock, Marsh Risk Consulting, AZ [I]
Eugene Bushmelov, Hydrogen Safety LLC, MA [SE]
Steven Dallman, U.S. Department of Transportation,
OK [SE]
David J. Farese, Air Products and Chemicals, Inc., PA [M]
Larry L. Fluor, Fluor, Inc., CA [IM]
Rep. Compressed Gas Association
Thomas J. Forsythe, Hughes Associates, Inc., CA [SE]
Karen I. Hall, Fuel Cell & Hydrogen Energy Association,
United Kingdom [M]
Tara Henriksen, CASE Forensics Corporation, WA [SE]
Douglas B. Horne, DBHorne LLC, GA [M]
Rep. Clean Vehicle Education Foundation

Michael W. Mackey, GP Strategies, CA [SE]
Timothy E. Meyers, U.S. Coast Guard, DC [E]
Gregory A. Milewski, Shell Oil, TX [M]
Rep. American Petroleum Institute
Robert E. Petsinger, CNG Services International Inc.,
PA [IM]
Gary Pope, USA PRO & Associates LLC, CA [SE]
E. Michael Steele, Steele Consulting, CA [M]
Rep. Society of Automotive Engineers
Mihai Ursan, Westport Power Inc., Canada [M]
Steven E. Younis, Prospective Technology, Inc., MA [SE]

Alternates

Richard A. Craig, Compressed Gas Association, VA [IM]
(Alt. to L. L. Fluor)
John B. Dimmick, Clean Vehicle Education Foundation,
WI [M]
(Alt. to D. B. Horne)
Steven W. Hoffman, Air Products and Chemicals, Inc.,
CA [M]
(Alt. to D. J. Farese)

Thomas Joseph, Bethlehem Hydrogen Inc., PA [M]
(Alt. to K. I. Hall)
Nicholas A. Woessner, U.S. Coast Guard, DC [E]
(Alt. to T. E. Meyers)

Susan Bershad, NFPA Staff Liaison

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

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

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- 5	6.10 Wiring Installation	52-17
1.1 Scope	52- 5	6.11 Labeling	52-17
1.2 Purpose	52- 5	6.12 System Testing	52-17
1.3 Retroactivity	52- 5	6.13 System Maintenance and Repair	52-17
1.4 Alternate Provisions	52- 5	6.14 Discharge from Vehicle Containers	52-18
1.5 Units	52- 6		
1.6 Enforcement	52- 6	Chapter 7 CNG Compression, Gas Processing,	
1.7 Training	52- 6	Storage, and Dispensing Systems	52-18
Chapter 2 Referenced Publications	52- 6	7.1 Application	52-18
2.1 General	52- 6	7.2 System Component Qualifications	52-18
2.2 NFPA Publications	52- 6	7.3 General System Requirements	52-18
2.3 Other Publications	52- 6	7.4 System Siting	52-19
2.4 References for Extracts in Mandatory		7.5 Installation of Containers and	
Sections	52- 7	Container Appurtenances (Other	
Chapter 3 Definitions	52- 7	than Pressure Relief Devices)	52-20
3.1 General	52- 7	7.6 Installation of Pressure Relief Devices	52-21
3.2 NFPA Official Definitions	52- 7	7.7 Installation of Pressure Regulators	52-21
3.3 General Definitions	52- 8	7.8 Installation of Pressure Gauges	52-21
Chapter 4 General Fueling Station		7.9 Installation of Piping and Hoses	52-21
Requirements	52-10	7.10 System Testing	52-21
4.1 Installer Qualifications	52-10	7.11 Installation of Emergency Shutdown	
4.2 Installation Supervision	52-11	Equipment	52-22
4.3 Alternate Design	52-11	7.12 Installation of Electrical Equipment	52-22
4.4 Installation Validation	52-11	7.13 Stray or Impressed Currents and	
4.5 Building Construction Materials	52-11	Bonding	52-22
Chapter 5 General CNG Requirements and		7.14 System Operation	52-22
Equipment Qualifications	52-11	7.15 Fire Protection	52-23
5.1 Application	52-11	7.16 System Maintenance	52-23
5.2 Composition	52-11	7.17 Vehicle Fueling Appliances in	
5.3 System Approvals	52-12	Nonresidential Occupancies	52-23
5.4 Design and Construction of			
Containers	52-12	Chapter 8 CNG Residential Fueling Facilities	
5.5 Pressure Relief Devices (PRDs)	52-12	(RFF-CNGs)	52-24
5.6 Pressure Gauges	52-13	8.1 Application	52-24
5.7 Pressure Regulators	52-13	8.2 System Component Qualifications	52-24
5.8 Fuel Lines	52-13	8.3 General Safety Requirements	52-24
5.9 Valves	52-13	8.4 Installation	52-24
5.10 Hose and Hose Connections	52-13	8.5 Installation of PRVs	52-24
5.11 Vehicle Fueling Connection	52-14	8.6 Installation of Pressure Gauges	52-24
Chapter 6 CNG Engine Fuel Systems	52-14	8.7 Pressure Regulation	52-25
6.1 Application	52-14	8.8 Piping and Hose	52-25
6.2 System Component Qualifications	52-14	8.9 Testing	52-25
6.3 Installation of Fuel Supply Containers	52-14	8.10 Installation of Emergency Shutdown	
6.4 Installation of Venting Systems	52-15	Equipment	52-25
6.5 Installation of Piping	52-15	8.11 Operation	52-25
6.6 Installation of Valves	52-16	8.12 Maintenance and Inspection	52-25
6.7 Installation of Pressure Gauges	52-16		
6.8 Installation of Pressure Regulators	52-16	Chapter 9 LNG Engine Fuel Systems	52-25
6.9 Installation of Fueling Connection	52-16	9.1 Application	52-25
		9.2 Materials	52-25
		9.3 Vehicular Fuel Containers	52-26
		9.4 Pressure Relief Devices	52-26
		9.5 Pressure Gauges	52-27
		9.6 Pressure Regulators	52-27

9.7	Piping, Tubing, and Fittings	52-27	13.7	Inspection	52-40
9.8	Valves	52-27	13.8	Testing and Purging of LNG Containers	52-40
9.9	Pumps and Compressors	52-27	13.9	Piping	52-40
9.10	Vaporizers	52-27	13.10	Container Instrumentation	52-41
9.11	Component Qualification	52-27	13.11	Pressure Gauging and Control	52-41
9.12	Installation	52-28			
9.13	System Testing	52-30			
Chapter 10	LNG Fueling Facilities	52-30	Chapter 14	LNG and CNG on Commercial Marine Vessels and Pleasure Craft	52-41
10.1	Application	52-30	14.1	Application	52-41
10.2	Facility Design	52-31	14.2	Installation of Fuel Supply Containers	52-41
10.3	Cargo Transport Unloading	52-33	14.3	Installation of Pressure Gauges	52-42
10.4	Vehicle Fuel Dispensing Systems	52-33	14.4	Labeling	52-42
10.5	Piping Systems and Components	52-34	14.5	Operation	52-42
10.6	Safety and Relief Valves	52-34	14.6	Fire Protection for Vessels	52-42
10.7	Corrosion Control	52-34	14.7	Installation of Powered Ventilation	52-42
10.8	Stationary Pumps and Compressors	52-34	14.8	Fueling Systems	52-43
10.9	Vaporizers	52-35	14.9	Storage and Handling of Fuels	52-43
10.10	LNG-to-CNG (L/CNG) Systems	52-35	14.10	Marine Service Stations	52-43
10.11	Instrumentation	52-35	14.11	Engine Rooms or Compartments	52-43
10.12	Electrical Equipment	52-35	14.12	Tank Rooms or Compartments	52-45
10.13	Maintenance	52-36	14.13	Vent Masts	52-45
Chapter 11	Reserved	52-36	14.14	Deluge Systems	52-46
Chapter 12	LNG Fire Protection	52-36	14.15	Alarm Systems	52-46
12.1	Application	52-36	14.16	Safety Equipment	52-46
12.2	Fire Protection, Safety, and Security	52-36	14.17	Safety Training	52-46
12.3	Ignition Source Control	52-37	Chapter 15	Reserved	52-46
12.4	Personnel Safety and Training	52-37	Chapter 16	Reserved	52-46
12.5	Security	52-37	Chapter 17	Reserved	52-46
12.6	Hazard Detection	52-37	Chapter 18	Reserved	52-46
12.7	Parking of LNG Vehicles	52-37	Annex A	Explanatory Material	52-47
12.8	Warning Signs	52-37	Annex B	Sample Ordinance Adopting NFPA 52	52-52
Chapter 13	Installation Requirements for ASME Tanks for LNG	52-37	Annex C	Pressure Relief Devices (PRDs)	52-53
13.1	Application	52-37	Annex D	Informational References	52-53
13.2	General	52-37	Index		52-55
13.3	Containers	52-37			
13.4	Container Foundations and Supports	52-38			
13.5	Container Installation	52-39			
13.6	Automatic Product Retention Valves	52-39			

NFPA 52

Vehicular Gaseous Fuel Systems Code

2013 Edition

IMPORTANT NOTE: This NFPA document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notices and Disclaimers Concerning NFPA Documents." They can also be obtained on request from NFPA or viewed at www.nfpa.org/disclaimers.

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

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

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, 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 associated storage, including the following:

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

1.1.2 This code shall apply to the design, installation, operation, and maintenance of liquefied natural gas (LNG) engine fuel systems on vehicles of all types, to their associated fueling (dispensing) facilities, and to LNG to CNG facilities with LNG storage in ASME containers of 70,000 gal (265 m³) or less.

1.1.3 Vehicles and fuel supply containers complying with federal motor vehicle safety standards (FMVSSs) covering the installation of CNG fuel systems on vehicles and certified by the respective manufacturer as meeting these standards shall not be required to comply with Sections 5.4, 5.8, 5.9, and 5.10 and Chapter 6 (except Sections 6.9, 6.11, 6.12, 6.13, and 6.14).

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

1.1.5 Vehicles that are required to comply with applicable federal motor vehicle safety standards covering the installation of LNG fuel systems on vehicles and that are certified by the manufacturer as meeting these standards shall not be required to comply with Chapter 9, except 9.12.8.

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

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

1.1.7.1 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.

1.4.1 Advancements in technology and improvements in system design and equipment shall be permitted to result in equipment fabrication methods, component design requirements, and installation and operating practices that differ from those specified in this code.

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

1.4.1.2 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.

1.4.2 Designers, fabricators, and constructors of LNG fueling facilities shall be competent and have expertise in the design, fabrication, and construction of LNG containers, cryogenic

equipment, loading and unloading systems, fire protection equipment, detection, siting, containment, piping systems, and other components of the facility.

1.4.3 The installation of LNG and CNG systems shall be supervised by personnel familiar with proper practices with reference to their construction and use.

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

1.4.4.1 The validation shall at a minimum include 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 qualified engineer(s) with proven expertise in these fields

1.4.5 Vehicles compliant with FMVSS for on-road use are compliant with this code at the point in time of original manufacture.

1.5 Units.

1.5.1 Metric units in this code are based on ANSI SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*.

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

1.6 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.*)

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

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 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2012 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2010 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2009 edition.

NFPA 54, *National Fuel Gas Code*, 2012 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2013 edition.

- NFPA 70®, *National Electrical Code*®, 2011 edition.
- NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2013 edition.
- NFPA 101®, *Life Safety Code*®, 2012 edition.
- NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2013 edition.
- NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, 2010 edition.
- NFPA 303, *Fire Protection Standard for Marinas and Boatyards*, 2011 edition.
- NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2013 edition.
- NFPA 5000®, *Building Construction and Safety Code*®, 2012 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

- ANSI SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 1997.

ANSI Z87.1, *Practice for Occupational and Educational Eye and Face Protection*, 1979.

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

2.3.2 API Publication. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

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

2.3.3 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*, 2010.

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

ANSI/ASME B31.3, *Process Piping*, 2004.

ASME Boiler and Pressure Vessel Code, Section VIII, X, 2004.

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

ASTM A 47/A 47M, *Standard Specification for Ferritic Malleable Iron Castings*, 1999 (2009).

ASTM A 395/A 395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, (1999) 2009.

ASTM A 536, *Standard Specification for Ductile Iron Castings*, 1984 (2009).

ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2012.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube at 750°C*, 2011.

ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*, 2009a.



2.3.6 CGA Publications. Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923.

CGA S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, 2007.

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

CGA 341, *Standard for Insulated Cargo Tank Specification for Nonflammable Cryogenic Liquids*, 2006 (reaffirmed 2011).

2.3.7 CSA Publications. Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON, L4W 5N6, Canada.

CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code*, 2009.

CSA 12.54, *Breakaway Devices for Dispensing Systems*, 1999.

2.3.8 FMCSA Publication. Federal Motor Carrier Safety Administration, United States Department of Transportation, 1200 New Jersey Avenue, SE, Washington, DC 20590.

Commercial driver's license standards; requirements and penalties; 383.5 definitions, 2012.

2.3.9 IAS-CSA Publications. Canadian Standards Association, 8503 East Pleasant Valley Road, Cleveland, OH 44131.

ANSI NGV1/CSA NGV1, *Standard for Compressed Natural Gas Vehicle (NGV) Fueling Connection Devices*, 2006.

ANSI NGV2, *Compressed Natural Gas Vehicle (NGV) Fuel Containers*, 2007.

ANSI/IAS NGV 4.4/CSA 12.54, *Breakaway Devices for Natural Gas Dispensing Hoses and Systems*, 1999.

ANSI/IAS PRD 1, *Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers*, 1998 (Reaffirmed 2006).

ANSI/IAS PRD 1a, *Addenda to ANSI/IAS PRD 1-1998, Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers*, 1999 (Reaffirmed 2006).

ANSI/CSA PRD 1b, *Addenda to ANSI/IAS PRD 1-1998, Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers*, 2007.

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

NACE RP0169, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems*, 2007.

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

NB-23, *National Board Inspection Code*, 2004.

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

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

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

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

2.3.13 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.

2.3.14 U.S. Department of Transportation Publications 1200 New Jersey Avenue, SE, Washington, DC 20590.

DOT Specification 4L.

2.3.15 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1910.

Title 49, Code of Federal Regulations, Part 571.304.

2.3.16 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*, 2012 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2013 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2013 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2011 edition.

NFPA 101®, *Life Safety Code®*, 2012 edition.

NFPA 1925, *Standard on Marine Fire-Fighting Vessels*, 2013 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2012 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 materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or

service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.6 Shall. Indicates a mandatory requirement.

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

3.3 General Definitions.

3.3.1 ANSI. American National Standards Institute.

3.3.2 Area.

3.3.2.1 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.

3.3.2.2 Indoor Area. An area that is within a building or structure having overhead cover, other than a structure qualifying as “weather protection.” (See also 3.3.2.3, *Outdoor Area.*) [55, 2013]

3.3.2.3 Outdoor Area. An area that is not an indoor area. [55, 2013]

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

3.3.4 Buildings. Structures, usually enclosed by walls and a roof, constructed to provide support or shelter for an intended occupancy. [5000, 2012]

3.3.4.1* Important Building. A building that is considered nonexpendable in an exposure fire. [30, 2012]

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

3.3.6* Cathodic Protection. A technique to resist the corrosion of a metal surface by making the surface the cathode of an electrochemical cell. [55, 2013]

3.3.7 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, 2013]

3.3.8 Certified. A formally stated recognition and approval of an acceptable level of competency, acceptable to the AHJ. [96, 2011]

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

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

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

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

3.3.9.4 Fueling Facility Container. Primary storage for vehicular fueling.

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

3.3.11 Container Valve. See 3.3.58.1.

3.3.12 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, 2013]

3.3.13 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, 2013]

3.3.14 Cylinder. A container constructed, inspected, and maintained in accordance with DOT and Transport Canada regulations or ANSI NGV2, *Compressed Natural Gas Vehicle (NGV) Fuel Containers*.

3.3.15 Device.

3.3.15.1 Emergency Shutdown Device (ESD). A device that closes all operations within the fueling facility from either local or remote locations.

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

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

3.3.16* 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.

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

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

3.3.19 DOT. U.S. Department of Transportation.

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

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

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

3.3.22 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.

3.3.23 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 E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or with ANSI/UL 723, *Tests for Surface Burning Characteristics of Building Materials*.

3.3.24 Fuel Line. The pipe, tubing, or hose on a vehicle, including all related fittings, through which natural gas passes.



3.3.25 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 liquid or vapor.

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

3.3.27 Gaseous Fuels. All combinations of gaseous natural gas, propane, ethane, and butane commonly used as automotive fuels as they pertain to refueling sites, onboard fuel systems, safety, dispensing, and vehicle onboard use regardless of the fuel combinations.

3.3.28 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.

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

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

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

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

3.3.32 Material.

3.3.32.1 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 non-combustible nor limited-combustible.

3.3.32.2* Limited-Combustible Material. See Section 5.5.

3.3.32.3 Noncombustible Material. See Section 5.5.

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

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

3.3.35 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.

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

3.3.36.1 Compressed Natural Gas (CNG). Mixtures of hydrocarbon gases and vapors consisting principally of methane in gaseous form that has been compressed for use as a vehicular fuel.

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

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

3.3.39* 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.

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

3.3.41 Overpressure. The pressure in a blast wave above atmospheric pressure, or a pressure within a containment structure that exceeds the maximum allowable working pressure of the containment structure.

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

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

3.3.44 Pressure.

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

3.3.44.2 Maximum Allowable Working Pressure (MAWP). The maximum pressure to which any component or portion of the pressure system can be subjected over the entire range of design temperatures. This value is $1.1 \times 1.25 \times$ the service pressure.

3.3.44.3 Operating Pressure. The varying pressure in a fuel supply container during normal container use.

3.3.44.3.1* Maximum Operating Pressure. The steady-state gauge pressure at which a part or system normally operates. This value is $1.25 \times$ the pressure.

3.3.44.4 Service Pressure. The settled gas pressure at a uniform gas temperature of 70°F (21°C) in CNG systems when the equipment is fully charged with gas.

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

3.3.44.6 Settled Pressure. The pressure in a container after the temperature of the gas reaches equilibrium.

3.3.44.7 Storage Pressure. The varying pressure in the storage containers.

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

3.3.46 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.

3.3.47 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code* or CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code*.

3.3.48 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.

3.3.49 Residential CNG Fueling Facility (RFF-CNG). An assembly with a capacity not exceeding 5 scf/min (0.14 SCM/min) of natural gas, that can be used for fueling a vehicle at a home or residence.

3.3.50 Room.

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

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

3.3.51 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, 2013]

3.3.52 Space.

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

3.3.52.2 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.

3.3.52.3 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.

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

3.3.52.5 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.

3.3.53 System.

3.3.53.1 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.

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

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

3.3.53.4 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, 2013]

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

3.3.55 TC. Transport Canada.

3.3.56 Temperature Compensation. A process that allows the gauge 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 settled pressure at a specified temperature.

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

3.3.58 Valve.

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

3.3.59 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.

3.3.59.1 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.

3.3.59.2 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.

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

3.3.59.2.2 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.

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

3.3.60.1 Commercial Motor Vehicle. A motor vehicle or combination of motor vehicles used in commerce to transport passengers or property if the motor vehicle has a gross combination weight rating of 11,794 kilograms or more (26,001 pounds or more) inclusive of a towed unit(s) with a gross vehicle weight rating of more than 4,536 kilograms (10,000 pounds), or has a gross vehicle weight rating of 11,794 or more kilograms (26,001 pounds or more), or is designed to transport 16 or more passengers, including the driver, or is of any size and is used in the transportation of hazardous materials as defined in this section. [FMCSA 383.5]

3.3.61 Vehicle Fueling Appliance (VEA). A listed, self-contained system that compresses natural gas and dispenses the natural gas to a vehicle's engine fueling system.

3.3.62 Vehicular Fuel. Fuel stored on board a vehicle.

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

3.3.64 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, 2013]

Chapter 4 General Fueling Station Requirements

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



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

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

4.4 Installation Validation. The refueling station and associated storage equipment shall be validated per the specifics of 4.4.1 when a change is made to the fundamental design, or not less than every 4 years.

4.4.1 The validation shall at a minimum include 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 qualified engineer(s) with proven expertise in these fields

4.4.1.1 Validation shall be kept on site and provided to the AHJ upon request.

4.5* Building Construction Materials.

4.5.1* Noncombustible Material. A material that complies with any of the following shall be considered a noncombustible material: [101:4.6.13.1]

- (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. [101:4.6.13.1(1)]
- (2) A material that is reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750° C*. [101:4.6.13.1(2)]
- (3) A material that is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*. [101:4.6.13.1 (3)]

4.5.2* Limited-Combustible Material. A material shall be considered a limited-combustible material where all the conditions of 4.5.2.1 and 4.5.2.2, and the conditions of either 4.5.2.3 or 4.5.2.4, are met. [101:4.6.14.2]

4.5.2.1 The material shall not comply with the requirements for noncombustible material, in accordance with 4.5.1. [101:4.6.14.2.1]

4.5.2.2 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, *Standard Test Method for Potential Heat of Building Materials*. [101:4.6.14.2]

4.5.2.3 The material shall have the structural base of a noncombustible material with a surfacing not exceeding a thickness of 1/8 in.

(3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E 84, *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]

4.5.2.4 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 E 84 or ANSI/UL 723, 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 E 84 or ANSI/UL 723. [101:4.6.14.4]

4.5.2.5 Where the term *limited-combustible* is used in this code, it shall also include the term *noncombustible*. [101:4.6.14.5]

Chapter 5 General CNG Requirements and Equipment Qualifications

5.1* Application. This chapter applies only to pressurized system components handling CNG.

5.2* Composition. Natural gas composition in the container shall comply with 5.2.1.

5.2.1 The contained natural gas shall be composed of the following:

- (1) Hydrogen sulfide and soluble sulfides, 1 gr/100 scf (23 mg/m³), maximum
- (2) Water (GH₂O), 7.0 lb/MMScf (110 mg/m³), maximum
- (3) Carbon dioxide, 3.0 volume percent, maximum
- (4) Oxygen, 0.5 volume percent, maximum
- (5) Where the dew point of the natural gas entering the cylinder is below the lowest anticipated container temperature at the maximum anticipated container pressure, none of the above limits in 5.2.1(1) through 5.2.1(4) shall apply.

5.2.1.1 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.

5.2.1.1.1 Natural gas or blends not meeting this definition shall have site and onboard methane detection systems installed and certified by a qualified engineer with expertise in methane detection or fire protection.

5.2.1.2 Methanol and/or glycol shall not be deliberately added to the natural gas at the fueling station.

5.2.1.3 When natural gas is not supplied to the vehicle in accordance with 5.2.1, containers shall be designed to tolerate being filled with natural gas meeting both of the following conditions:

- (1) Dry gas in which water vapor is limited to less than 2 lb/MMScf (32 mg/m³) and having a pressure dew point of 7°F (−14°C) at 3000 psi (20,700 kPa), with no maximum constituent limits for dry gas, except for the following:
 - (a) GH₂S, 1 gr/100 scf (23 mg/m³)
 - (b) O₂, 1 percent by volume

- (2) Wet gas in which gas that contains 2 lb/MMScf (32 mg/m³) of water or more, meeting the maximum constituent limits, as follows:
- (a) GH₂S and other soluble sulfides, 1 gr/100 scf (23 mg/m³)
 - (b) Total sulfur, 5 gr/100 scf (115 mg/m³)
 - (c) O₂, 1 percent by volume
 - (d) CO₂, 3 percent by volume
 - (e) Hydrogen, 0.1 percent by volume

5.2.1.4 Under wet gas conditions, a minimum of 0.007 grains of compressor oil per pound of gas (1 mg of compressor oil per kilogram of gas) shall be considered necessary to protect metallic containers, liners, and bosses.

5.3 System Approvals.

5.3.1* The following systems and system components 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 (nozzle and receptacle)
- (7) Engine fuel systems
- (8) Electrical equipment related to CNG systems
- (9) Gas detection equipment and alarms
- (10) Fire protection and suppression equipment
- (11) Vehicle fueling appliances (VFAs)

5.3.1.1 Vehicles certified by the manufacturer to be in compliance with applicable federal motor vehicle safety standards shall not be subject to 5.3.1.

5.3.2 Devices not otherwise specifically provided for shall be constructed to provide safety equivalent to that required for other parts of a system.

5.4* Design and Construction of Containers.

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

5.4.2 The container shall be designed for CNG service.

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

5.4.3 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.

5.4.4* Cylinders shall be manufactured, inspected, marked, tested, retested, equipped, and used in accordance with the following:

- (1) U.S. Department of Transportation (DOT) or Transport Canada (TC) regulations, exemptions, or special permits
- (2) ANSI NGV2, *Compressed Natural Gas Vehicle (NGV) Fuel Containers*, specifically for CNG service
- (3) CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code*
- (4) U.S. Federal Motor Vehicle Safety Standard, 49 CFR 571.304, *Compressed Natural Gas Fuel Container Integrity*

5.4.4.1 Cylinders that have reached the labeled expiration date shall be removed from service.

5.4.4.2* Composite reinforced cylinders or other cylinders marked with exemption or special permit numbers shall be

removed from service at the end of the service life designated in the exemption or special permit.

5.4.5 ASME Compliance.

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

5.4.5.2 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*.

5.4.5.3* 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.

5.4.6 The + (plus) and * (star) markings on DOT and TC cylinders shall not apply in accordance with DOT and TC regulations for cylinders for flammable compressed gases.

5.4.6.1 The star marking shall be removed or obliterated.

5.4.6.2 The removal of the star marking shall be by peening and otherwise be in accordance with DOT or TC regulations.

5.4.6.3 Grinding shall be prohibited.

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

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

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

5.5 Pressure Relief Devices (PRDs). (See Annex C.)

5.5.1 Each cylinder complying with 5.4.4 shall be fitted with one or more pressure relief devices (PRDs) with the number, location, and part number as specified by the cylinder manufacturer and OEM for CNG service for a new vehicle, in accordance with the following:

- (1) For a retrofitted vehicle, each cylinder complying with 5.4.4 shall be of the number, location, and part number as specified by the cylinder manufacturer.
- (2) A PRD shall be in accordance with one of the following standards:
 - (a) CGA S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*
 - (b) ANSI/IAS PRD 1, *Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers*
 - (c) ANSI/IAS PRD 1a, *Addenda to ANSI/IAS PRD 1, Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers*
 - (d) ANSI/CSA PRD 1b, *Addenda to ANSI/IAS PRD 1, Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers*
- (3) The PRD shall be in direct communication with the fuel and vented to the atmosphere by a method that withstands the maximum pressure that results.

5.5.1.1 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.



5.5.1.2 PRDs shall be located so that the temperature to which they are subjected is representative of the temperature to which the fuel supply container is subjected.

5.5.1.3 Where parts of the vehicular fuel container are exposed to higher temperatures than the PRD during a localized fire, the fuel container shall be protected by any of the following:

- (1) Noncombustible heat-insulating shielding to retard localized heating of the container
- (2) Installation of a thermally sensitive “fusing” system to trigger the PRD in a fire situation
- (3) Other design for venting of the fuel container in a fire situation

5.5.2 Pressure vessels complying with 5.4.5 or cylinders used for stationary storage without temperature compensation of the storage pressure shall be protected with one or more spring-loaded pressure relief valves in accordance with the ASME *Boiler and Pressure Vessel Code*.

5.5.2.1 The minimum rate of discharge of PRDs on containers shall be in accordance with CGA S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, or the ASME *Boiler and Pressure Vessel Code*, whichever is applicable.

5.5.2.2 Pressure relief valves (PRVs) for CNG service shall not be fitted with lifting devices.

5.5.2.2.1 The adjustment, if external, shall be provided with a means for sealing the adjustment to prevent tampering.

5.5.2.2.2 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.

5.5.2.2.3 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.

5.5.2.2.4 The organization making such adjustment shall attach a permanent tag with the setting, capacity, and date.

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

5.5.3 Containers and pressure vessels not constructed in accordance with 5.4.4 or 5.4.5 shall be provided with PRDs approved by the authority having jurisdiction.

5.6 Pressure Gauges. A pressure gauge, if provided, shall be capable of reading at least 1.2 times the system design pressure.

5.7 Pressure Regulators.

5.7.1 A pressure regulator inlet and each chamber shall be designed for its service pressure with a pressure safety factor of at least 4.

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

5.8 Fuel Lines.

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

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

5.8.3 Natural gas piping shall be fabricated and tested in accordance with ANSI/ASME B31.3, *Process Piping*.

5.8.4 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 A 47, *Standard Specification for Ferritic Malleable Iron Castings (Grade 35018)*; ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*; and ASTM A 536, *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 alloy with copper content exceeding 70 percent

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

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

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

5.9 Valves.

5.9.1 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.

5.9.1.1 Shutoff valves shall have a rated service pressure not less than the rated service pressure of the entire system and shall be capable of withstanding a hydrostatic test of at least four times the rated service pressure without rupture.

5.9.1.2 Leakage shall not occur at less than 1½ times the rated service pressure.

5.9.2 Valves of cast irons other than those complying with ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings (Grade 35018)*; ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*; and ASTM A 536, *Standard Specification for Ductile Iron Castings (Grade 60-40-18)*, shall not be used as primary stop valves.

5.9.3 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.

5.9.4 The manufacturer shall stamp or otherwise permanently mark the valve body to indicate the service ratings.

5.9.4.1 Container valves incorporating integral PRDs complying with 5.5.1 shall not require additional marking.

5.10 Hose and Hose Connections.

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

5.10.2 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 service pressure.

5.10.3 Prior to use, hose assemblies shall be tested by the OEM or its designated representative at a pressure at least twice the service pressure.

5.10.4 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.

5.11 Vehicle Fueling Connection.

5.11.1 CNG vehicle fueling connection devices shall be listed in accordance with ANSI/IAS NGV1, *Standard for Compressed Natural Gas Vehicle (NGV) Fueling Connection Devices*.

5.11.2 The use of adapters shall be prohibited.

Chapter 6 CNG Engine Fuel Systems

6.1* Application.

6.1.1 This chapter applies to the design, installation, inspection, and testing of CNG fuel supply systems for vehicular internal combustion engines.

6.1.2* Final-Stage Vehicle Integrator/Manufacturer.

6.1.2.1* The FSVIM shall have the responsibility for integration of the engine, fuel system, and gaseous detection system, where required, onto the vehicle chassis and for the operation of the vehicle.

6.1.2.2 The FSVIM shall obtain, when available, documented approval of the chassis original equipment and component manufacturers of the onboard fuel and detection systems components, proper installation, and application from each of the following:

- (1) Vehicle
- (2) Chassis
- (3) Engine
- (4) Gas detection
- (5) Fuel system

6.1.2.3 Modifications of a vehicle gaseous fuel system shall conform with, when available, the engineering recommendations of the original specifications of the original chassis vehicle manufacturer.

6.2 System Component Qualifications.

6.2.1 System components shall comply with the applicable provisions of Chapter 5 and this section.

6.2.2 Temperature Range.

6.2.2.1 Components in the engine compartment shall be designed or selected for a minimum temperature range of -40°F to 250°F (-40°C to 121°C).

6.2.2.2 All other components shall be designed or selected for service per the OEM's engineering requirements.

6.2.3 Aluminum or copper pipe, tubing, or fittings shall not be used between the fuel container and the first-stage pressure regulator.

6.2.4 Fuel-carrying components, with the exception of container valves, tubing, and fittings, shall be labeled or stamped with the following:

- (1) Manufacturer's name or symbol
- (2) Model designation
- (3) Design service pressure
- (4) Direction of fuel flow where necessary for correct installation
- (5) Capacity or electrical rating, as applicable

6.3 Installation of Fuel Supply Containers.

6.3.1 Fuel supply containers shall be installed in accordance with the instructions of the container manufacturer and the requirements in 6.3.2 through 6.3.10.

6.3.2 Fuel supply containers on vehicles shall be permitted to be located within, below, or above the driver or passenger compartment, provided all connections to the container(s) are external to, or sealed and vented from, these compartments.

6.3.2.1 Fuel supply containers shall be protected with a means to prevent damage that occurs due to road hazards, loading, unloading, direct sunlight, exhaust heat, and vehicle use, including accidental cargo leakage.

6.3.2.2 Shields, if present, shall be installed in a manner that prevents damage to the shield or coating in the following occurrences:

- (1) Direct contact between the shield and the fuel supply container
- (2) Trapping of solid materials or liquids between the shield and fuel supply container

6.3.2.3 The fuel supply container shall be positioned to prevent contact with vehicle components such as, but not limited to, frame members, body panels, or brake lines that leads to container fretting or abrasion over time.

6.3.3 Vehicle fuel supply containers shall be mounted in a location to minimize damage from collision.

6.3.3.1 Containers shall be protected by covers from accidental contact with overhead electrical wiring.

6.3.3.2* The fuel system, including containers, shall be installed with as much road clearance as practical.

6.3.3.3 This minimum clearance shall be measured from the road to the container, its housing, or its fittings, whichever is lowest, and shall not, with the vehicle loaded to its gross weight rating, allow any component to touch the road surface in the event of a flat tire or the removal of any tire.

6.3.3.4 No portion of a fuel supply container or container appurtenance mounted on the undercarriage of the vehicle shall be located ahead of the front axle or behind the point of attachment of the rear bumper to the vehicle.

6.3.3.4.1 Container valves shall be protected from physical damage using the vehicle structure, valve protectors, or a metal shield.

6.3.3.5 No part of the fuel supply container or its appurtenances shall protrude beyond the sides or top of any vehicle to prevent the container from being struck or punctured.

6.3.4 Each fuel supply container rack shall be secured to the vehicle body, bed, or frame to prevent damage from road hazards, slippage, loosening, or rotation using a method capable



of withstanding a static force in the six principal directions shown in Figure 6.3.4 of eight times the weight of a fully pressurized container(s).

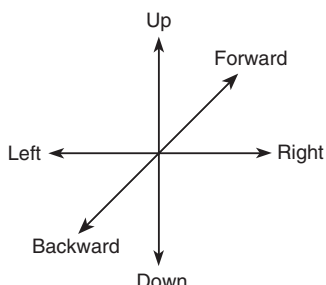


FIGURE 6.3.4 The Six Principal Directions.

6.3.5 Each fuel supply container in the rack shall be secured to its cradle in a manner that it is capable of withstanding a static force, applied in the six principal directions (*see Figure 6.3.4*), of eight times the weight of the fully pressurized container with a maximum displacement of 0.50 in. (13 mm).

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

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

6.3.8 The mounting system shall minimize fretting corrosion between the fuel supply container and the mounting system.

6.3.9 Fuel supply containers shall not be installed so as to adversely affect the driving characteristics of the vehicle.

6.3.10 Metal clamping bands and their supports shall not be in direct contact with a fuel supply container.

6.3.10.1 A resilient gasket that does not retain water shall be installed between the clamping bands and their supports and a container.

6.3.10.2 The resilient gasket shall provide insulation to protect clamping bands from galvanic corrosion in contact with the containers.

6.4* Installation of Venting Systems.

6.4.1* All pressure relief devices and connections between pressure-carrying components installed within driver, passenger, or a closed compartment (*see 6.4.7*) shall be vented to the outside of the vehicle.

6.4.1.1 This requirement shall not include plugs in the ends of containers with openings in each end.

6.4.2 The venting system shall be secured at intervals in such a manner as to minimize the possibility of damage, corrosion, breakage, or dislocation due to gas flow forces during venting, expansion, contraction, vibration, strains, or wear and to preclude any loosening while in operation.

6.4.3 The vent or vents for the venting system shall not exit into a wheel well.

6.4.4 A vent shall not restrict the operation of a container pressure relief device or pressure relief device channel.

6.4.5 Means shall be provided to prevent water, dirt, insects, and any foreign objects from collecting in the vent lines or pressure relief devices.

6.4.6 Protective devices in 6.4.5 shall not restrict the flow of gas.

6.4.7 Gastight Enclosures.

6.4.7.1 The neck of the container and all CNG fittings within the compartment shall be enclosed in a gastight enclosure made of linear, low-density polyethylene having a minimum thickness of 8 mils (0.20 mm) or an equally gastight alternate enclosure that is vented directly to the outside of the vehicle.

6.4.7.2 The gastight enclosure shall not be constructed of fire-resistant material.

6.4.8 Where located in a vehicle compartment capable of accumulating natural gas, a container shall be installed so that the following conditions are met:

- (1) The pressure relief device (PRD) for the protection of the container is installed in the same vehicle compartment as the container.
- (2) The discharge from the PRD is vented to the outside through an electrically conductive tube or hose, which shall be in accordance with the following:
 - (a) The tube or hose is secured at intervals in such a manner as to minimize the possibility of damage, corrosion, or breakage of either the vent line or the pressure relief device due to expansion, contraction, vibration, strains, or wear and to preclude any loosening while in operation.
 - (b) The tube or hose has a burst pressure of at least 1½ times the pressure in the vent that results from activation of the PRD.
- (3) The vent opening is not blocked by debris thrown up from the road, such as snow, ice, mud, and so forth, or otherwise affected by the elements.

6.5 Installation of Piping.

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

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

6.5.2 Manifolds connecting containers or container pressure relief devices shall be designed to vent gas from the individual container(s) exposed to a fire so that all containers meet the requirements of Section 5.5.

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

6.5.4 Piping and fittings shall be clear and free from cutting or threading burrs and scales.

6.5.4.1 The ends of all piping shall be reamed.

6.5.5 Where necessary to prevent abrasion, fuel lines passing through a panel shall be protected by grommets or other protective devices.

6.5.6 Fuel lines shall have clearance from the engine exhaust system to protect the fuel lines from excessive heat by durable and effective means.

6.5.7 Fuel lines shall be mounted, braced, and supported to minimize vibration.

6.5.7.1 Fuel lines shall be protected against damage, corrosion, or breakage due to strain or wear.

6.5.8 A bend in piping or tubing shall be prohibited where such a bend weakens the piping or tubing.

6.5.9 Joints or connections on piping systems shall be located in an accessible location.

6.5.10 Where a fuel supply container is located on a trailer, the fuel supply line shall contain an emergency breakaway device designed to retain CNG on both sides of the breakaway point.

6.6 Installation of Valves.

6.6.1 Every cylinder shall be equipped with either of the following:

- (1) A manual valve
- (2) A normally closed, remotely actuated shutoff valve connected directly to the cylinder and equipped to bleed the cylinder manually

6.6.1.1 Vehicles with more than one fuel supply container, where each container is equipped with a normally closed remotely actuated shutoff valve, shall have an automatic system to detect the failure of any one of the valves.

6.6.2 In addition to the valve required by 6.6.1, a manual shutoff valve or a normally closed, automatically actuated shutoff valve shall be installed that allows isolation of the container(s) from the remainder of the fuel system.

6.6.2.1 An additional manual shutoff valve shall not be required on vehicles that are not normally operated on public streets, that have a single fuel supply cylinder, and that are equipped with an accessible manual cylinder shutoff valve.

6.6.2.2 The valve shall be mounted and shielded or installed in a protected location to minimize damage from vibration and unsecured objects.

6.6.2.3 Where a manual shutoff valve is used, it shall be in an accessible location.

6.6.2.3.1 The manual shutoff valve shall have not more than 90 degrees rotation (quarter turn fuel delivery valve) from the open to the closed positions.

6.6.2.4 Access to the manual shutoff valves shall not require the use of any key or tool.

6.6.2.5 Where a manual valve is used, the valve location shall be indicated by means of a decal or label containing the words "MANUAL SHUTOFF VALVE."

6.6.2.6 A weather-resistant decal or label with red, blue, or black letters on a white or silver reflective background shall be used.

6.6.2.7 The valve required by 6.6.2 shall not be used to introduce high-pressure gas to downstream components of the fuel system that have previously been depressurized.

6.6.3 A valve that automatically prevents the flow of gaseous fuel to the engine when the engine is not running, even if the ignition is switched on, shall be provided in the system.

6.6.4* Where multiple fuel systems are installed on the vehicle, automatic valves shall be provided, as necessary, to shut off the fuel not being used.

6.6.5 The fueling system shall be equipped with a backflow check valve that prevents the return flow of gas from the container(s) to the filling connection.

6.6.5.1 The backflow check valve shall be mounted to withstand the breakaway force specified in 7.11.6.2.

6.6.5.2 A second check valve shall be located between the fueling receptacle and the fuel supply containers.

6.7 Installation of Pressure Gauges.

6.7.1 Pressure gauges located within a driver or passenger compartment shall be installed in such a manner that no gas flows into the passenger compartment in the event of failure.

6.7.2 Pressure gauges installed outside a driver or passenger compartment shall be equipped with a limiting orifice, a shatterproof lens, and a body relief.

6.7.3 Pressure gauges shall be mounted, shielded, and installed in a protected location to prevent damage from vibration and unsecured objects.

6.8 Installation of Pressure Regulators.

6.8.1 An automatic pressure-reducing regulator(s) shall be installed to reduce the fuel container pressure to a level consistent with the service pressure required by the gas-air mixer, throttle body, or fuel injectors.

6.8.2 Means shall be provided to prevent regulator malfunctions due to refrigeration effects.

6.8.3 Regulators shall be installed so that their weight is not placed on, or supported by, the attached gas lines.

6.9 Installation of Fueling Connection.

6.9.1 Fueling connections installed on vehicles less than 10,000 lb (4500 kg) gross vehicle weight rating (GVWR) shall be in accordance with Section 5.11.

6.9.1.1 Larger vehicles such as buses and trucks shall be permitted to use fueling connections that are designed to prevent the connection of a lower service pressure vehicle to a higher service pressure source.

6.9.2 The fueling connection receptacle shall be mounted to withstand the breakaway force specified in 7.11.6.2.

6.9.3 The receptacle shall be installed in accordance with the manufacturer's instructions.

6.9.4 The clearance around the fueling connection shall be free of interference that prevents the connection of the fueling nozzle.

6.9.5 Service Pressure.

6.9.5.1 The service pressure of the fueling connection receptacle shall not exceed the marked service pressure of the fuel supply cylinders.

6.9.5.2 The service pressure of the fueling receptacle shall not exceed 80 percent of the set pressure of any relief valves installed on fuel supply containers in the vehicle.



6.10 Wiring Installation.

6.10.1 Wiring shall be secured and protected from abrasion and corrosion to the same standard as the original wiring on the vehicle.

6.10.2 All wiring shall be sized according to the Society of Automotive Engineers (SAE) and fuse-protected.

6.11 Labeling.

6.11.1 A vehicle equipped with a CNG fuel system shall bear the following durable labels:

- (1) A label readily visible and located in the engine compartment shall include the following:
 - (a) Identification as a CNG-fueled vehicle
 - (b) System service pressure
 - (c) Installer's name or company
 - (d) Fuel container life expires (insert date for limited-life fuel containers. This label item not required for containers with unlimited life.)
 - (e) Total container water volume in gallons (liters)
 - (f) Date by which fuel containers are to be inspected (insert date) and every (insert number) months thereafter
- (2) A label located at the fueling connection receptacle shall include the following:
 - (a) Identification as a CNG-fueled vehicle
 - (b) System service pressure
 - (c) Fuel container life expires (insert date for limited-life fuel containers. This label item not required for containers with unlimited life.)
 - (d) Fuel containers are to be inspected by (insert date) and each (insert number) months thereafter.

6.11.1.1 The fuel container inspection dates shall be changed after each required container inspection to denote the next required inspection date and shall be permitted on a separate additional label.

6.11.2 If both labels are located in one of the above areas, the labels shall be permitted to be combined into a single label.

6.11.3 In addition to the label(s) required by 6.11.1, each vehicle shall be identified with a weather-resistant, diamond-shaped label located on the exterior vertical surface or near-vertical surface on the lower right rear of the vehicle other than on the bumper of the vehicle.

6.11.3.1 The labels for vehicles less than Class 6 shall be a minimum of 4.72 in. long × 3.27 in. high (120 mm × 83 mm).

6.11.3.2 The labels for Class 6 vehicles and greater shall be a minimum of 5.7 in. long × 4.2 in. high (145 mm × 107 mm).

6.11.3.3 The marking in the label required by 6.11.3.1 shall consist of a border and the letters "CNG" [1 in. (25 mm) minimum height centered in the diamond] of silver or white reflective luminous material on a blue background.

6.11.3.4 The marking in the label required by 6.11.3.2 shall consist of a border and the letters "CNG" [1.2 in. (30 mm) minimum height centered in the diamond] of silver or white reflective luminous material on a blue background.

6.11.4 Each assembly of CNG containers shall be permanently labeled near the container valve as follows:

DANGER. Venting of the pressure from this system requires the use of special instructions or tools that can be obtained from the manufacturer [Insert the name, telephone number, and email address of the vehicle manufacturer or system installer].

6.12 System Testing.

6.12.1* The completed fuel system assembly shall be leak tested using natural gas or inert gas.

6.12.2 Before use, every connection shall be verified leak free with a noncorrosive leak detector solution or a leak detector instrument after the equipment is connected and pressurized to its service pressure.

6.12.3 If the completed assembly is leak tested with natural gas, the testing shall be done under ventilated conditions.

6.12.4* Where a vehicle is involved in an accident or fire causing damage to the CNG container, or if the container is subjected to a pressure greater than 125 percent of service pressure, the CNG container shall be replaced or removed, inspected, and retested in accordance with the document under which it was originally manufactured before being returned to service.

6.12.5 Where a vehicle is involved in an accident or fire causing damage to any part of the CNG fuel system, the system shall be repaired and retested (*see Section 6.13*) before being returned to service.

6.12.6 Where a CNG container is removed from a vehicle in order to be installed within a different vehicle, it shall be inspected or retested in accordance with the inspection or requalification procedures of the standard under which it was originally manufactured before it is reinstalled.

6.13 System Maintenance and Repair.

6.13.1 Damaged fuel lines shall be replaced and not repaired.

6.13.2 All containers, container appurtenances, piping systems, venting systems, and other components shall be maintained in accordance with the manufacturer's requirements.

6.13.3 Vehicle fuel supply containers shall be inspected in accordance with the vehicle label required in 6.11.1 and one of the following:

- (1) Vehicle manufacturer's instructions
- (2) Container manufacturer's instructions

6.13.3.1 Fuel containers whose service life has expired shall be removed from service.

6.13.3.2 After periodic container inspection, a label showing the next required inspection date shall be affixed as required in 6.11.1.

6.13.4 Pressure relief devices on fuel containers shall be maintained in accordance with the following:

- (1) Pressure relief device channels or other parts that interfere with the functioning of the device shall not be plugged by paint or accumulation of dirt.
- (2) Only qualified personnel shall be permitted to service pressure relief devices.
- (3) Only assemblies or original manufacturer's parts shall be used in the repair of pressure relief devices unless the interchange of parts has been proved by tests.
- (4) No pressure relief device that has been in service shall be reinstalled on another fuel cylinder.

6.13.5 The following shall be done during vehicle maintenance:

- (1) Ensure the engine is isolated from the fuel supply unless engine operation is required. If a manual isolation valve is used, it shall comply with 6.6.2.
- (2) Prohibit torches, welding, or grinding equipment on or near high-pressure fuel lines and containers.
- (3) Prevent damage to containers, including actions such as dropping, dragging, or rolling of the container.
- (4) Prevent exposure of containers to strong chemicals such as battery acid or metal-cleaning solvents.
- (5) Store CNG containers in a manner to avoid damage.
- (6) Reinstall containers to their original configuration using approved gaskets, bolts, nuts, washers, and parts in accordance with the recommendations of the container manufacturer.
- (7) Prevent hoists or jacks from coming into direct contact with containers.
- (8) Prohibit personnel from walking on roof-mounted containers.

6.14 Discharge from Vehicle Containers.

6.14.1 The venting or depressurization of a CNG container shall be performed only by trained personnel using written procedures.

6.14.1.1 The gas to be removed from the container shall be discharged into a closed transfer system or vented by an approved method of atmospheric venting.

6.14.1.2 A valve shall be used to control the discharge of gas from high-pressure systems to a venting system.

6.14.2 Personnel performing container depressurization shall do the following:

- (1) Use grounding to prevent static electrical charge buildup.
- (2) Limit the rate of gas release from plastic-lined containers to a value not greater than that specified by the container manufacturer.
- (3) Restrain containers during depressurization to prevent container movement.

6.14.3 Direct gas venting shall be done through a vent tube that diverts the gas flow to atmosphere.

6.14.3.1 The vent tube shall have a gastight connection to the container prior to venting.

6.14.3.1.1 All components of the vent tube shall be grounded.

6.14.3.2 The vent tube shall be constructed of Schedule 80 pipe of at least 2 in. (51 mm) diameter.

6.14.3.3 The vent tube shall not be provided with any feature that limits or obstructs gas flow.

6.14.4* All vehicles shall be provided with a venting system to allow the high pressure portion of the CNG fuel system to be vented for service.

6.14.4.1 It shall not be required to break any connections while under pressure in order to vent the high pressure portion of the CNG fuel system.

6.14.4.1.1 A connection for an external vent system shall be provided.

6.14.4.2 The venting function shall be manually controlled.

6.14.4.3 All high pressure portions of the CNG fuel system shall be capable of being vented.

6.14.4.4 The vehicle manufacturer or system installer shall provide written venting instructions and specify any special tools needed for venting.

Chapter 7 CNG Compression, Gas Processing, Storage, and Dispensing Systems

7.1 Application.

7.1.1 This chapter applies to the design, construction, installation, and operation of containers, pressure vessels, compression equipment, buildings and structures, and associated equipment used for storage and dispensing of CNG as an engine fuel in fleet and public dispensing operations.

7.1.2 Mobile refueling vehicles, temporary trailers (with or without tractors), and other means of providing vehicle refueling or onsite storage shall be subject to the same requirements as a permanent refueling or storage installation, with the exception of vessel requirements.

7.1.3 Mobile refueling equipment shall meet the requirements of DOT or TC.

7.2 System Component Qualifications. System components shall comply with the applicable provisions of Chapter 5 and with Sections 7.5 through 7.13.

7.3 General System Requirements.

7.3.1 Where systems are served by a gas utility, the utility shall be notified of all CNG installations.

7.3.2 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.

7.3.3* Control devices shall be installed so that internal or external icing or hydrate formation does not cause vehicle or fueling station malfunction.

7.3.4 Vehicles shall not be considered a source of ignition with respect to the provisions of this chapter.

7.3.4.1 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.

7.3.5 The fueling connection shall prevent the escape of gas where the connector is not engaged or becomes separated.

7.3.6 Fueling nozzles installed on vehicles less than 10,000 lb (4500 kg) GVWR shall comply with Section 5.11.

7.3.6.1 Larger vehicles such as buses and trucks shall be permitted to use fueling nozzles that are designed to prevent the connection of a lower service pressure vehicle to a higher service pressure source.

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

7.3.8 Compression equipment shall have pressure relief devices that limit each stage pressure to the maximum allowable

