

NFPA 50A

Standard for Gaseous Hydrogen Systems at Consumer Sites

1999 Edition



National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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NFPA 50A

Standard for

Gaseous Hydrogen Systems at Consumer Sites

1999 Edition

This edition of NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, was prepared by the Technical Committee on Industrial and Medical Gases and acted on by the National Fire Protection Association, Inc., at its Fall Meeting held November 16–18, 1998, in Atlanta, GA. It was issued by the Standards Council on January 15, 1999, with an effective date of February 4, 1999, and supersedes all previous editions.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

This edition of NFPA 50A was approved as an American National Standard on February 4, 1999.

Origin and Development of NFPA 50A

Development of NFPA 50A was initiated by the Compressed Gas Association, Inc., which submitted a complete text to the NFPA Committee on Gases in 1959. Working responsibility for the project was assigned to the Sectional Committee on Industrial Gases, and the standard was tentatively adopted at the Annual Meeting in 1961. Official adoption, as NFPA 567, followed at the 1963 Annual Meeting as recommended by the Committee on Gases.

In June 1966, responsibility for NFPA 567 was reassigned to the Committee on Industrial and Medical Gases. With the 1969 edition, which superseded the 1963 edition, the standard was redesignated as NFPA 50A. Subsequent editions were adopted in 1973, 1978, 1984, 1989, and 1994.

Technical Committee on Industrial and Medical Gases

Charles B. Henrici, *Chair*
River Forest Fire Dept., IL [E]
Rep. Int'l Assn. of Fire Chiefs

William H. Barlen, Airgas, CT [M]
Francis X. Bender, Hazards Research Corp., NJ [SE]
Carl A. Caves, U.S. Dept. of Energy, MD [U]
Rick Ginn, Wright Brothers, Inc., OH [M]
Rep. Nat'l Welding Supply Assn.
Douglas F. Nelson, HSB Industrial Risk Insurers, PA [I]
John T. Pavlovcak, Air Products & Chemicals, Inc., PA [IM]
Rep. Compressed Gas Assn., Inc.
William J. Satterfield, III, RODE & Assoc., LLC, CT [SE]
Samir Shibani, Intel Corp., AZ [U]

David N. Simon, Air Liquide America Corp., TX [IM]
Rep. Compressed Gas Assn., Inc.
Michael W. St. Clair, Ohio State University, OH [U]
Rep. NFPA Industrial Fire Protection Section
Gary F. Trojak, The Chlorine Inst., Inc., DC [M]
Randolph Viscomi, ARC Chemical, NY [IM]
Lionel Wolpert, BOC Gases, NJ [IM]
Rep. Compressed Gas Assn., Inc.
Robert A. Zeman, Underwriters Laboratories Inc., IL [RT]

Alternates

John Anicello, BOC Gases, CA [IM]
(Alt. to L. Wolpert)
Marshall Issen, Underwriters Laboratories Inc., IL [RT]
(Alt. to R. A. Zeman)
Michael E. Lyden, The Chlorine Inst., Inc., DC [M]
(Alt. to G. F. Trojak)

Anthony J. McErlean, Messer Group (MG Industries), PA [IM]
(Alt. to D. N. Simon)
Roger A. Smith, Compressed Gas Assn., Inc., VA [IM]
(Alt. to J. T. Pavlovcak)
William A. Thornberg, Industrial Risk Insurers, CT [I]
(Alt. to D. F. Nelson)

Nonvoting

Wendell Glasier, U.S. Dept. of Labor OSHA, DC [E]
(Alt. to J. E. Slattery)

Fred K. Kitson, F K Kitson Safety Assoc., VA [SE]
Joanne E. Slattery, U.S. Dept. of Labor OSHA, DC [E]

Carl Rivkin, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in membership may have occurred. A key to classifications is found at the back of this 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 the storage, transfer, and use of industrial gases. Included are the storage and handling of such gases in their gaseous or liquid phases; the installation of associated storage, piping, and distribution equipment; and operating practices. The Committee also has a technical responsibility for contributions in the same areas for medical gases and clean rooms.

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

Information on referenced publications can be found in Chapter 7 and Appendix C.

Information on the physical properties of gaseous hydrogen can be found in Appendix B.

Chapter 1 General Information

1-1 Scope. This standard covers the requirements for the installation of gaseous hydrogen systems on consumer premises where the hydrogen supply to the consumer premises originates outside the consumer premises and is delivered by mobile equipment.

1-2 Classification. Systems are classified according to the total volume of hydrogen, including unconnected reserves, as follows:

- (a) Less than 3500 scf (99 m³), except as covered in 1-3.1
- (b) From 3500 (99 m³) to 15,000 scf (425 m³)
- (c) In excess of 15,000 scf (425 m³)

1-3 Application.

1-3.1 The application of this standard at places of public assembly shall be subject to approval of the authority having jurisdiction.

1-3.2 This standard shall not apply to single systems using containers having a total hydrogen content of less than 400 scf (11 m³). Where individual systems, each having a total hydrogen content of less than 400 scf (11 m³), are located less than 5 ft (1.5 m) from each other, this standard shall apply.

1-3.3 This standard shall not apply to hydrogen manufacturing plants or other establishments operated by the hydrogen supplier or his or her agent for the purpose of storing hydrogen and refilling portable containers, trailers, mobile supply trucks, or tank cars.

1-4 Retroactivity. An existing system that is not in strict compliance with the provisions of this standard shall be permitted to be continued in use where such use does not constitute a distinct hazard to life or adjoining property.

1-5 Definitions.

Approved.* Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction.* The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

Combustible Liquid. A liquid having a closed-cup flash point at or above 100°F (37.8°C) and are subdivided as follows:

- (a) Class II liquids include those having a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

- (b) Class IIIA liquids include those having a flash point at or above 140°F (60°C) and below 200°F (93.4°C).
- (c) Class IIIB liquids include those having a flash point at or above 200°F (93.4°C).

Flammable Liquid (Class I).* Any liquid having a closed-cup flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia (276 kPa) at 100°F (37.8°C).

Gallon. A standard U.S. gallon.

Gaseous Hydrogen System.* A system in which the hydrogen is delivered, stored, and discharged in the gaseous form to consumer's piping. The system terminates at the point where hydrogen at service pressure first enters the consumer's distribution piping.

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.

Limited-Combustible Material. A material, as defined in NFPA 220, *Standard on Types of Building Construction*, not complying with the definition of noncombustible material that, in the form in which it is used, has a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg) and complies with one of the following paragraphs (a) or (b). Materials subject to an increase in combustibility or flame spread rating, beyond the limits herein established, through the effects of age, moisture, or other atmospheric condition are considered combustible.

- (a) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 1/8 in. (3.2 mm) that has a flame spread rating not greater than 50.
- (b)*Materials, in the form and thickness used, other than as described in (a), having neither a flame spread rating greater than 25 nor evidence of continued progressive combustion and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread rating greater than 25 nor evidence of continued progressive combustion.

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 identified standards or has been tested and found suitable for a specified purpose.

Noncombustible Material. A material, as defined in NFPA 220, *Standard on Types of Building Construction*, 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. Materials reported as noncombustible, when tested in accordance with ASTM E 136, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750°C*, are considered noncombustible materials.

Outdoors. Location outside of any building or structure or locations under a roof, weather shelter, or canopy provided this area is not enclosed on more than two sides.

Separate Building. A detached, noncommunicating building used exclusively to house a hydrogen system.

Shall. Indicates a mandatory requirement.

Special Room. A separate enclosed area that is part of or attached to another building and is used exclusively for a hydrogen system.

Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

Standard Cubic Foot (scf). One cubic foot of gas at 70°F (21°C) and 14.7 psia (an absolute pressure of 101 kPa).

Chapter 2 Design of Gaseous Hydrogen Systems

2-1 Containers.

2-1.1 Hydrogen containers shall comply with one of the following:

- (a) Designed, constructed, and tested in accordance with appropriate requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII, “Rules for the Construction of Pressure Vessels”
- (b) Designed, constructed, tested, and maintained in accordance with 49 *CFR* 171–190

2-1.2 Permanently installed containers shall be provided with substantial supports of noncombustible material on firm foundations of noncombustible material.

2-1.3 Each portable container shall be legibly marked with the name HYDROGEN in accordance with ANSI/CGA C-4, *Method of Marking Portable Compressed Gas Containers to Identify the Material Contained*. Each manifold hydrogen supply unit shall be legibly marked with the name HYDROGEN or a legend such as “This unit contains hydrogen.”

2-2 Pressure Relief Devices.

2-2.1 Hydrogen containers shall be equipped with pressure relief devices as required by the ASME *Code* or the DOT *Specifications and Regulations* under which the container is fabricated.

2-2.2 Pressure relief devices shall be arranged to discharge upward and unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures, or personnel. This requirement shall not apply to DOT specification containers having an internal volume of 2.0 ft³ (0.057 m³) or less.

2-2.3 Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner that would interfere with proper operation of the device.

2-3 Piping, Tubing, and Fittings.

2-3.1 Piping, tubing, and fittings shall be suitable for hydrogen service and for the pressures and temperatures involved. Cast-iron pipe and fittings shall not be used.

2-3.2 Material specifications and thickness requirements for piping and tubing shall conform to ASME B31.3, *Code for Chemical Plant and Petroleum Refinery Piping*.

2-3.3 Joints in piping and tubing shall be made by welding or brazing or by use of flanged, threaded, socket, slip, or compression fittings. Gaskets and thread sealants shall be suitable for hydrogen service. Brazing materials shall have a melting point above 1000°F (538°C).

2-4 Equipment Assembly.

2-4.1 Valves, gauges, regulators, and other accessories shall be recommended for hydrogen service by the manufacturer or the hydrogen supplier.

2-4.2 Installation of hydrogen systems shall be supervised by personnel familiar with proper practices with reference to their construction and use.

2-4.3 Storage containers, piping, valves, regulating equipment, and other accessories shall be accessible and shall be protected against physical damage and against tampering by the general public.

2-4.4 Cabinets or housings containing hydrogen control or operating equipment shall be ventilated to minimize accumulation of hydrogen.

2-4.5 Each mobile hydrogen supply unit used as part of a hydrogen system shall be secured to prevent movement.

2-4.6 Mobile hydrogen supply units shall be electrically bonded to the system before discharging hydrogen.

2-5 Marking. The hydrogen storage location shall be permanently placarded either as follows or with equivalent wording:

HYDROGEN — FLAMMABLE GAS
NO SMOKING — NO OPEN FLAMES

2-6 Testing. After installation, all piping, tubing, and fittings shall be tested and proved hydrogen gas-tight at maximum operating pressure.

Chapter 3 Location of Gaseous Hydrogen Systems

3-1 General Requirements.

3-1.1 The system shall be located so that it is accessible to delivery equipment and to authorized personnel. Roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

3-1.2 Systems shall be located above ground either at grade or above grade.

3-1.3 Systems shall not be located beneath or where exposed to failure of the following:

- (a) Electric power lines
- (b) Piping containing all classes of flammable or combustible liquids (*see definition in Section I-5*)
- (c) Piping containing other flammable gases, or piping containing oxidizing materials

3-1.4 Systems within 50 ft (15 m) of aboveground storage of all classes of flammable and combustible liquids shall be located on ground higher than such storage, except where dikes, diversion curbs, grading, or separating solid walls are used to prevent accumulation of these liquids under the system.

Table 3-2.1 Preferred Locations of Gaseous Hydrogen Systems

Nature of Location	Size of Hydrogen System		
	Less than 3500 scf (99 m ³)	3500 scf to 15,000 scf (99 m ³ to 425 m ³)	In Excess of 15,000 scf (425 m ³)
Outdoors	I	I	I
In a separate building	II	II	II
In a special room	III	III	Not permitted
Inside buildings not in a special room or exposed to other occupancies	IV	Not permitted	Not permitted

3-2. Specific Requirements.

3-2.1 The location of a system, as determined by the maximum total contained volume of hydrogen, shall be in the order of preference as indicated by Roman numerals in Table 3-2.1.

3-2.2 The minimum distance in feet from a hydrogen system of indicated capacity located either outdoors, in separate buildings, or in special rooms to any specified outdoor exposure shall be in accordance with Table 3-2.2. The distances in numbers 1, 3 through 10, and 14 inclusive in Table 3-2.2 shall not apply where protective structures having a minimum fire resistance rating of 2 hours are located between the system and the exposure.

Table 3-2.2 Minimum Distance from Outdoor Gaseous Hydrogen Systems to Exposures

Type of Outdoor Exposure	Total Gaseous Hydrogen Storage					
	Less than 3500 scf (99 m ³)		3500 scf to 15,000 scf (99 m ³ to 425 m ³)		In Excess of 15,000 scf (425 m ³)	
	ft	m	ft	m	ft	m
1. Building or structure						
(a) Wall(s) adjacent to system constructed of noncombustible or limited-combustible materials						
(1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents	0 ^a	0	5 ^a	1.5	5 ^a	1.5
(2) Unsprinklered building or structure with combustible contents						
Adjacent wall(s) with fire resistance rating less than 2 hours ^b	0 ^c	0	10	3.1	25 ^d	7.6
Adjacent wall(s) with fire resistance rating of 2 hours or greater ^b	0	0	5	1.5	5	1.5
(b) Wall(s) adjacent to system constructed of other than noncombustible or limited-combustible materials	10	3.1	25	7.6	50 ^d	15.2
2. Wall openings						
(a) Not above any part of a system	10	3.1	10	3.1	10	3.1
(b) Above any part of a system	25	7.6	25	7.6	25	7.6
3. All classes of flammable and combustible liquids above ground						
(a) 0–1000 gal (3785 L)	10	3.1	25	7.6	25	7.6
(b) In excess of 1000 gal (3785 L)	25	7.6	50	15.2	50	15.2
4. All classes of flammable and combustible liquids below ground — 0–1000 gal (3785 L) ^e						
(a) Tank	10	3.1	10	3.1	10	3.1
(b) Vent or fill opening of tank	25	7.6	25	7.6	25	7.6
5. All classes of flammable and combustible liquids below ground — in excess of 1000 gal (3785 L) ^e						
(a) Tank	20	6.1	20	6.1	20	6.1
(b) Vent or fill opening of tank	25	7.6	25	7.6	25	7.6

(continues)

Table 3-2.2 Minimum Distance from Outdoor Gaseous Hydrogen Systems to Exposures (continued)

Type of Outdoor Exposure	Total Gaseous Hydrogen Storage					
	Less than 3500 scf (99 m ³)		3500 scf to 15,000 scf (99 m ³ to 425 m ³)		In Excess of 15,000 scf (425 m ³)	
	ft	m	ft	m	ft	m
6. Flammable gas storage (other than hydrogen), either high pressure or low pressure						
(a) 0–15,000 scf (255 m ³) capacity	10	3.1	25	7.6	25	7.6
(b) In excess of 15,000 scf (255 m ³) capacity	25	7.6	50	15.2	50	15.2
7. Oxygen storage						
(a) 20,000 scf (566 m ³) or less	Refer to NFPA 51, <i>Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes</i>					
(b) More than 20,000 scf (566 m ³)						
8. Fast-burning solids such as ordinary lumber, excelsior, or paper	50	15.2	50	15.2	50	15.2
9. Slow-burning solids such as heavy timber or coal	25	7.6	25	7.6	25	7.6
10. Open flames and welding	25	7.6	25	7.6	25	7.6
11. Air compressor intakes or inlets to ventilating or air-conditioning equipment	50	15.2	50	15.2	50	15.2
12. Places of public assembly	25	7.6	50	15.2	50	15.2
13. Public sidewalks and parked vehicles	15	4.6	15	4.6	15	4.6
14. Line of adjoining property that can be built upon	5	1.5	5	1.5	5	1.5

^aPortions of wall less than 10 ft (3 m) (measured horizontally) from any part of a system shall have a fire resistance rating of at least 1/2 hour.

^bExclusive of windows and doors (see number 2 of Table 3-2.2).

^cPortions of walls less than 10 ft (3 m) (measured horizontally) from any part of a system shall have a fire resistance rating of at least 1 hour.

^dBut not less than one-half the height of adjacent wall of building or structure.

^eDistances can be reduced to 15 ft (4.5 m) for Class IIIB combustible liquids.

3-2.3 Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 3-2.2 than the distances given for the storage system.

3-2.4 Hydrogen systems of less than 3500 scf (99 m³), where located inside buildings and exposed to other occupancies, shall be situated in the building so that the system will be as follows:

- (a) In an adequately ventilated area as in 4-2.2
- (b) 20 ft (6 m) from all classes of flammable and combustible liquids, oxidizing gases, and readily combustible materials, such as excelsior and paper
- (c) 25 ft (7.6 m) from open flames, ordinary electrical equipment, or other sources of ignition
- (d) 50 ft (15 m) from intakes of ventilation or air-conditioning equipment and air compressors
- (e) 50 ft (15 m) from other flammable gas storage
- (f) Protected against damage or injury due to falling objects or working activity in the area

3-2.5 More than one system of 3500 scf (99 m³) or less shall be permitted to be installed in the same room, provided the systems are separated by at least 50 ft (15 m) or where a masonry structure having a minimum fire resistance rating of 2 hours is located between the systems. Each such system shall meet all of the requirements of this section.

Exception: The separation distance between multiple systems of 3500 scf (99 m³) or less shall be permitted to be reduced to 25 ft (7.6 m) in buildings where the occupancy between storage areas is free of combustible materials

and protected with a sprinkler system designed for Ordinary Hazard, Group 1 occupancies or Light Hazard occupancies in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Chapter 4 Design Considerations at Specific Locations

4-1 Outdoor Locations.

4-1.1 Where protective walls or roofs are provided, they shall be constructed of noncombustible or limited-combustible materials.

4-1.2 Electrical equipment within 15 ft (4.6 m) shall be in accordance with Article 501 of NFPA 70, *National Electrical Code*[®], for Class I, Division 2 locations.

4-2 Separate Buildings.

4-2.1 Separate buildings shall be constructed of noncombustible or limited-combustible materials. Windows and doors shall be located so as to be readily accessible in case of emergency.

Exception: Window glazing shall be permitted to be plastic.

4-2.2 Ventilation to the outdoors shall be provided. Inlet openings shall be located near the floor in exterior walls only. Outlet openings shall be located at the high point of the room in exterior walls or roof. Inlet and outlet openings shall each

have a minimum total area of 1 ft²/1000 ft³ (1 m²/305 m³) of room volume. Discharge from outlet openings shall be directed or conducted to the atmosphere.

4-2.3* Exterior walls of separate buildings shall be constructed of lightweight materials or panels designed to relieve at a maximum internal pressure of 25 lb/ft² (13.3 kPa/m²).

4-2.4 There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.

4-2.5 Electrical equipment shall be in accordance with Article 501 of NFPA 70, *National Electrical Code*, for Class I, Division 2 locations.

4-2.6 Heating, if provided, shall be by steam, hot water, or other indirect means except that electrical heating shall be permitted to be used if in compliance with 4-2.5.

4-3 Special Rooms.

4-3.1 Floor, walls, and ceiling shall be constructed of noncombustible or limited-combustible materials. Interior walls or partitions shall have a fire resistance rating of at least 2 hours, shall be continuous from floor to ceiling, and shall be securely anchored. At least one wall shall be an exterior wall. Openings to other parts of the building shall not be permitted. Windows and doors shall be in exterior walls and shall be located so as to be readily accessible in case of emergency.

Exception: Window glazing shall be permitted to be plastic.

4-3.2 Ventilation shall be as provided in 4-2.2.

4-3.3 Explosion venting shall be as provided in 4-2.3.

4-3.4 There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.

4-3.5 Electrical equipment shall be in accordance with Article 501 of NFPA 70, *National Electrical Code*, for Class I, Division 2 locations.

4-3.6 Heating, if provided, shall be by steam, hot water, or indirect means except that electrical heating shall be permitted to be used if in compliance with 4-3.5.

Chapter 5 Operation and Maintenance

5-1 Operating Instructions. For installations that require any operation of equipment by the user, instructions shall be maintained at operating locations.

5-2 Maintenance. Each hydrogen system installed on consumer premises shall be inspected annually and maintained by a qualified representative of the equipment owner.

5-3 Clearance to Combustibles. The area within 15 ft (4.6 m) of any hydrogen container shall be kept free of dry vegetation and combustible material.

Chapter 6 Fire Protection

6-1* Caution. Personnel shall be cautioned that hydrogen flames are practically invisible.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix C.

7-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1996 edition.

NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites*, 1996 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 1997 edition.

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

NFPA 220, *Standard on Types of Building Construction*, 1995 edition.

7-1.2 Other Publications.

7-1.2.1 ASME Publications. American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

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

ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for the Construction of Pressure Vessels," 1995.

7-1.2.2 ASTM Publication. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 136-96a, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 1998.

7-1.2.3 CGA Publication. Compressed Gas Association, 1725 Jefferson Davis Highway, Arlington, VA 22202-4100.

ANSI/CGA C-4, *Method of Marking Portable Compressed Gas Containers to Identify the Material Contained*, 1990.

7-1.2.4 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 49, *Code of Federal Regulations*, Parts 171–190, U.S. Department of Transportation *Specifications and Regulations*.

Appendix A Explanatory Material

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

A-1-5 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is

thus in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-5 Authority Having Jurisdiction. The phrase “authority having jurisdiction” is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A-1-5 Flammable Liquid (Class I). Liquefied hydrogen is classed as a flammable compressed gas by the U.S. Department of Transportation.

A-1-5 Gaseous Hydrogen System. The system includes stationary or portable containers, pressure regulators, pressure relief devices, manifolds, interconnecting piping, and controls as required.

A-1-5(b) Limited-Combustible Material. See NFPA 259, *Standard Test Method for Potential Heat of Building Materials*.

A-1-5 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A-4-2.3 For guidance in these construction techniques, see NFPA 68, *Guide for Venting of Deflagrations*.

A-6-1 Hydrogen fires are not normally extinguished until the supply of hydrogen has been shut off because of the danger of reignition or explosion. In the event of fire, large quantities of water have been sprayed on adjacent equipment to cool the equipment and prevent involvement in the fire. Combination fog and solid stream nozzles have been preferred to permit widest adaptability in fire control. Small hydrogen fires have been extinguished by dry chemical extinguishers or with carbon dioxide, nitrogen, and steam. Reignition can occur if a metal surface adjacent to the flame is not cooled with water or other means.

The fire protection provided should be determined by an analysis of local conditions of hazard within the plant, exposure to other properties, water supplies, the probable effec-

tiveness of plant fire brigades, and the time of response and probable effectiveness of fire departments.

Appendix B Physical Properties of Gaseous Hydrogen

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

B-1 Physical Properties. Hydrogen is a flammable gas. It is colorless, odorless, tasteless, and nontoxic. It is the lightest gas known, having a specific gravity of 0.0695 (air = 1.0). Hydrogen diffuses rapidly in air and through porous materials.

B-1.1 Hydrogen burns in air with a pale blue, almost invisible flame. At atmospheric pressure the ignition temperature of hydrogen-air mixtures has been reported by the U.S. Bureau of Mines to be as low as 932°F (500°C). The flammable limits of hydrogen-air mixtures depend on pressure, temperature, and water vapor-content. At atmospheric pressure the flammable range is approximately 4 percent to 74 percent by volume of hydrogen in air.

B-1.2 Hydrogen remains as a gas at high pressures. It is liquefied when it is cooled to its boiling point of -423°F (-253°C).

B-1.3 Hydrogen is nontoxic, but can cause anoxia (asphyxiation) when it displaces the normal 21 percent oxygen in a confined area without adequate ventilation. Because hydrogen is colorless, odorless, and tasteless, its presence cannot be detected by the human senses.

B-2 Fire Prevention. Since the control of the hydrogen system can remain with the supplier, compliance with this standard will minimize the possibility of a consumer fire involving the hydrogen system, as well as the possibility of a hydrogen fire involving the consumer's premises.

Appendix C Referenced Publications

C-1 The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not considered part of the requirements of this standard unless also listed in Chapter 7. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this standard.

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

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

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

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