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NFPA 50B Standard for Liquefied Hydrogen Systems at Consumer Sites 1994 Edition

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 50B

Standard for

Liquefied Hydrogen Systems at Consumer Sites

1994 Edition

This edition of NFPA 50B, *Standard for Liquefied 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 15-18, 1993, in Phoenix, AZ. It was issued by the Standards Council on January 14, 1994, with an effective date of February 11, 1994, and supersedes all previous editions.

The 1994 edition of this document has been approved by the American National Standards Institute.

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.

Origin and Development of NFPA 50B

Preparation of this standard was initiated and materially assisted by a committee of the Compressed Gas Association, Inc., which submitted a text to the NFPA Committee on Industrial and Medical Gases in 1966. The standard was tentatively adopted in 1967. The first edition was adopted in 1968. Subsequent editions were adopted in 1971, 1973, 1978, 1985, and 1989.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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.

Contents

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

Information on referenced publications can be found in Chapter 8 and Appendix B.

Foreword

Liquefied hydrogen is transparent, odorless, and not corrosive or significantly reactive. The boiling point at atmospheric pressure is -423.2°F (-252.9°C). It is only 1/14 as heavy as water. In converting liquefied hydrogen to gaseous hydrogen at standard conditions, it expands approximately 850 times.

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.

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.

Compliance with this standard will minimize the possibility of a consumer fire involving a liquefied hydrogen system, as well as the possibility of a liquefied hydrogen fire involving consumer premises.

Chapter 1 General

1-1 Scope.

1-1.1 Application. This standard covers the requirements for the installation of liquefied hydrogen systems on consumer premises where the liquid hydrogen supply to the consumer premises originates outside the consumer premises and is delivered by mobile equipment.

1-1.2 Nonapplication. This standard shall not apply to:

(a) Portable containers having a total liquefied hydrogen content of less than 150 L (39.7 gal).

(b) Liquefied hydrogen manufacturing plants or other establishments operated by the hydrogen supplier or his or her agent for the sole purpose of storing liquefied hydrogen and refilling portable containers, trailers, mobile supply trucks, or tank cars.

NOTE: For information on gaseous hydrogen systems, see NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*.

1-2 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.

1-3 Definitions.

Approved. Acceptable to the authority having jurisdiction.

NOTE: 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 concerned with product evaluations that is in a position to determine compliance with appropriate standards for the current production of listed items.

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

NOTE: 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.

CF. Cubic feet of gas at 14.7 psia (101 kPa) and 70°F (21°C).

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

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

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

(c) Class IIIB liquids shall include those having flash points 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). (Liquefied hydrogen is classed as a flammable compressed gas by the U.S. Department of Transportation.)

Gallon. Standard U.S. gallon.

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, which, 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 increase in combustibility or flame spread rating beyond the limits herein established through the effects of age, moisture, or other atmospheric condition shall be 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. (*See NFPA 259, Standard Test Method for Potential Heat of Building Materials.*)

Liquefied Hydrogen System. A system into which liquefied hydrogen is delivered and stored and from which it is discharged in the liquid or gaseous form to consumer piping. The system includes stationary or portable containers, including unconnected reserves, pressure regulators, pressure relief devices, manifolds, interconnecting piping, and controls as required. The system originates at the storage container fill connection and terminates at the point where hydrogen at service pressure first enters the supply line.

Listed. Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which 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.

Noncombustible Material (as defined in NFPA 220, *Standard on Types of Building Construction*). 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. Materials reported as noncombustible, when tested in accordance with ASTM E136, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750°C*, shall be considered noncombustible materials.

Outdoor Location. Outside of any building or structure and not enclosed by more than two walls. This includes locations under a roof, weather shelter, or canopy that are provided with vent space between the walls and vented roof, weather shelter, or canopy.

Portable Containers.* Liquefied hydrogen cylinders, portable tanks, tank cars, and tank trucks as defined by the U.S. Dept. of Transportation.

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

Shall. Indicates a mandatory requirement.

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

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

Chapter 2 Design of Liquefied Hydrogen Systems

2-1 Containers. Hydrogen containers shall comply with the following:

(a) Storage containers shall be designed, constructed, and tested in accordance with appropriate requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for the Construction of Pressure Vessels."

(b) Portable containers shall be designed, constructed, and tested in accordance with U.S. Dept. of Transportation Specifications and Regulations.

2-2 Supports. Permanently installed containers shall be provided with substantial supports of noncombustible material securely anchored on firm foundations of noncombustible material. Steel supports in excess of 18 in. (46 cm) in height shall be protected with protective coating having a 2-hour fire resistance rating.

2-3 Marking. Each container shall be legibly marked to indicate "LIQUEFIED HYDROGEN — FLAMMABLE GAS."

2-4 Pressure Relief Devices.

2-4.1 Stationary liquefied hydrogen containers shall be equipped with pressure relief devices sized in accordance with CGA S-1.3, *Pressure Relief Device Standards — Part 3 — Compressed Gas Storage Containers.*

2-4.2 Portable liquefied hydrogen containers complying with the U.S. Dept. of Transportation Regulations shall be equipped with pressure relief devices as required in the U.S. Dept. of Transportation Specifications and Regulations. Pressure relief devices shall be sized in accordance with the requirements of CGA S-1.1, *Pressure Relief Device Standards, — Part 1 — Cylinders for Compressed Gases*, and, CGA S-1.2, *Pressure Relief Device Standards — Part 2 — Cargo and Portable Tanks for Compressed Gases.*

2-4.3 Pressure relief devices shall be arranged to discharge unobstructed to the outdoors and in such a manner as to prevent impingement of escaping liquid or gas upon the container, adjacent structures, or personnel. See 3-1.5 for venting of pressure relief devices in special locations.

2-4.4 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.

2-4.5 Pressure relief devices shall be provided in piping wherever liquefied hydrogen could be trapped between closures.

2-4.6 A sign shall be placed on the container near the pressure relief valve vent stack or on the vent stack that warns against spraying water on or in the vent opening.

2-5 Piping, Tubing, and Fittings.

2-5.1* Piping, tubing, and fittings, and gasket and thread sealants, shall be suitable for hydrogen service at the pressures and temperatures involved. Consideration shall be given to the thermal expansion and contraction of piping systems when exposed to temperature fluctuations of ambient to liquefied hydrogen temperatures.

2-5.2 Material specifications and thickness requirements for piping and tubing shall conform to ANSI B31.3, *Chemical Plant and Petroleum Refinery Piping*. Piping or tubing for operating temperatures below –20°F (–30°C) shall be fabricated from materials meeting the impact test requirements of Chapter III of ANSI B31.3 when tested at the minimum operating temperature to which the piping may be subjected in service.

2-5.3 Joints in piping and tubing shall be made by welding or brazing. Brazing materials shall have a melting point above 1000°F (538°C).

Exception: Flanged, threaded, socket, slip, or suitable compression fittings shall be permitted to be used.

2-5.4 Means shall be provided to minimize exposure of personnel to piping operating at low temperatures and to prevent air condensate from contacting piping, structural members, and surfaces not suitable for cryogenic temperatures. Insulation shall be of noncombustible material and shall be designed to have a vapor-tight seal in the outer covering to prevent the condensation of air and subsequent oxygen enrichment within the insulation. The insulation material and outside shield also shall be of adequate design to prevent attrition of the insulation due to normal operating conditions.

2-5.5 Uninsulated piping and equipment that operate at liquefied hydrogen temperature shall not be installed above asphalt surfaces or other combustible materials in order to prevent contact of liquid air with such materials. Drip pans shall be permitted to be installed under uninsulated piping and equipment to retain and vaporize condensed liquid air.

2-6 Equipment Assembly.

2-6.1 Valves, gauges, regulators, and other accessories shall be suitable for liquefied hydrogen service and for the pressures and temperatures involved.

2-6.2 Installation of liquefied hydrogen systems shall be supervised by personnel familiar with proper practices and with reference to their construction and use.

2-6.3 Storage containers, piping, valves, regulating equipment, and other accessories shall be readily accessible and shall be protected against physical damage and against tampering. A shutoff valve shall be located in liquid product withdrawal lines as close to the container as practical. On containers of over 2000 gal (7,570 L) capacity, this shutoff valve shall be of the remote control-type with no connections, flanges, or other appurtenances (other than a welded manual shutoff valve) allowed in the piping between the shutoff valve and its connection to the inner container.

2-6.4 Cabinets or housings containing hydrogen control equipment shall be ventilated to prevent any accumulation of hydrogen gas.

2-7 Testing.

2-7.1 After installation, all field-erected piping shall be tested and proved hydrogen gastight at operating pressure and temperature.

2-7.2 Containers, if out of service in excess of 1 year, shall be inspected and tested as outlined in 2-7.1. The safety pressure devices shall be checked to determine if they are operable and properly set.

2-8 Liquefied Hydrogen Vaporizers.

2-8.1 The vaporizer shall be anchored, and its connecting piping shall be sufficiently flexible to provide for the effect of expansion and contraction due to temperature changes.

2-8.2 The vaporizer and its piping shall be protected on the hydrogen and heating media sections with pressure relief devices.

2-8.3 Heat used in a liquefied hydrogen vaporizer shall be indirectly supplied utilizing media such as air, steam, water, or water solutions.

2-8.4 A low-temperature shutoff switch or valve shall be provided in the vaporizer discharge piping to prevent flow of liquefied hydrogen in the event of the loss of the heat source.

2-9 Electrical Systems. Electrical wiring and equipment shall be in accordance with Table 2-9 and Article 501 of NFPA 70, *National Electrical Code®*.

Exception No. 1: Where equipment approved for Class I, Group B atmospheres is not commercially available, the equipment shall be permitted to be:

1. Purged or ventilated in accordance with NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment; or

2. Intrinsically safe; or

3. Approved for Class I, Group C atmospheres.

Exception No. 2: Electrical equipment installed on mobile supply trucks or tank cars from which the storage container is filled.

Table 2-9 Electrical Area Classification

Location	Division	Extent of Classified Area
Points where connections are regularly made and disconnected	1	Within 3 ft (1 m) of connection
	2	Between 3 ft (1 m) and 25 ft (7.6 m) of connection

2-10 Bonding and Grounding. The liquefied hydrogen container and associated piping shall be electrically bonded and grounded.

Chapter 3 Location of Liquefied Hydrogen Storage

3-1 General Requirements.

3-1.1 The storage containers shall be located so that they are readily accessible to mobile supply equipment at ground level 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 not be located beneath or where exposed by failure of electric power lines, piping containing all classes of flammable and combustible liquids (see definition), piping containing other flammable gases, or piping containing oxidizing materials.

3-1.3 Where a liquefied hydrogen container is installed on ground that is level with, or lower than adjacent, all classes of flammable and combustible liquid storage or liquid oxygen storage, suitable protective means shall be taken such as by diking, diversion curbs, or grading of the flammable and combustible liquid storage or liquid oxygen storage) to prevent accumulation of liquids within 50 ft (15.2 m) of the liquefied hydrogen container.

3-1.4 Storage sites shall be fenced and posted to prevent entrance by unauthorized personnel. Sites also shall be placarded as follows: "LIQUEFIED HYDROGEN — FLAMMABLE GAS — NO SMOKING — NO OPEN FLAMES."

3-1.5 If liquefied hydrogen is located (as specified in Table 3-2.1) in a separate building, in a special room, or inside buildings where not in a special room and exposed to other occupancies, containers shall have the pressure relief devices vented unobstructed to the outdoors at a minimum elevation of 25 ft (7.6 m) above grade to a safe location as required in 2-4.3.

3-2 Specific Requirements.

3-2.1 The location of liquefied hydrogen storage, as determined by the maximum total quantity of liquefied hydrogen, shall be in the order of preference indicated by the Roman numerals in Table 3-2.1.

3-2.2 The minimum distance in feet from liquefied hydrogen systems of indicated storage capacity located outdoors, in a separate building, or in a special room to any specified exposure shall be in accordance with Table 3-2.2.

(a) 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.

3-2.3 Container fill connections shall be not less than 25 ft (7.6 m) from parked vehicles.

3-3 Handling of Liquefied Hydrogen inside Buildings other than Separate Buildings and Special Rooms. Portable liquefied hydrogen containers of 50-gal (189-L) or less capacity as permitted in Table 3-2.1 and in compliance with 3-1.5 where housed inside buildings not located in a special room and exposed to other occupancies shall comply with the following minimum requirements:

(a) They shall be located 20 ft (6.1 m) from all classes of flammable and combustible liquids and readily combustible materials such as excelsior or paper.

(b) They shall be located 25 ft (7.6 m) from ordinary electrical equipment, and other sources of ignition including process or analytical equipment. (*See Section 2-9.*)

(c) They shall be located 50 ft (15 m) from intakes of ventilation and air-conditioning equipment or intakes of compressors.

(d) They shall be located 50 ft (15 m) from storage of other flammable gases or storage of oxidizing gases.

(e) Containers shall be protected against damage or injury due to falling objects or work activity in the area.

(f) Containers shall be firmly secured and stored in an upright position.

(g) Welding or cutting operations and smoking shall be prohibited while hydrogen is in the room.

(h) Ventilation to the outdoors shall be provided. Pressure relief devices on the containers shall be vented directly outdoors or to a suitable hood. (*See 2-4.3 and 3-1.5.*)

Table 3-2.1 Maximum Total Quantity of Liquefied Hydrogen Storage Permitted

Nature of Location	Size of Hydrogen Storage (Capacity in Gallons)			
	39.63 to 50	51 to 300	301 to 600	In excess of 600
Outdoors	I	I	I	I
In a separate building	II	II	II	Not Permitted
In a special room	III	III	Not Permitted	Not Permitted
Inside buildings not in a special room and exposed to other occupancies	IV	Not Permitted	Not Permitted	Not Permitted

NOTE: This table shall not apply to the storage in dewars of the type generally used in laboratories for experimental purposes.
For SI units: 1 gal = 3.785 L

Table 3-2.2 Minimum Distance (ft) from Liquefied Hydrogen Systems to Exposures[4]

Type of Exposure	Total Liquefied Hydrogen Storage (Capacity in Gallons)		
	39.63 to 3500	3501 to 15,000	15,001 to 75,000
1. Building/structure			
(a) Wall(s) adjacent to system constructed of noncombustible or limited-combustible materials			
(1) Sprinklered building/structure or unsprinklered building/structure having noncombustible contents	5[1,3]	5[1,3]	5[1,3]
(2) Unsprinklered building/structure with combustible contents Adjacent wall(s) with fire resistance rating less than 3 hours[2]	25	50	75
Adjacent wall(s) with fire resistance rating of 3 hours or greater[2]	5	5	5
(b) Wall(s) adjacent to system constructed of combustible materials			
(1) Sprinklered building/structure	50	50	50
(2) Unsprinklered building/structure	50	75	100
2. Wall Openings			
(a) Openable	75	75	75
(b) Unopenable	25	50	50
3. Air Compressor Intakes, Inlets for Air-Conditioning or Ventilating Equipment	75	75	75
4. All classes of flammable and combustible liquids (aboveground and vent or fill openings if below ground) *(see 3-1.3)*			
Exception: Distances may be reduced to 15 ft (4.6 m) for Class IIIB combustible liquids	50	75	100
5. Between stationary liquefied hydrogen containers	5	5	5
6. Flammable gas storage (other than hydrogen)	50	75	75
7. Liquid oxygen storage and other oxidizers *(see 3-1.3)*	75	75	75
8. Combustible solids	50	75	100
9. Open flames and welding	50	50	50
10. Places of public assembly	75	75	75
11. Public ways, railroads, and property lines	25	50	75
12. Inlet to underground sewers	5	5	5
13. Protective structures	5[3]	5[3]	5[3]

Notes to Table 3-2.2

NOTE 1: Portions of wall less than 10 ft (3.0 m) (measured horizontally) from any part of a system shall have a fire-resistance rating of at least ½ hour.

NOTE 2: Exclusive of windows and doors.

NOTE 3: Where protective structures are provided, ventilation and confinement of product shall be considered. The 5-ft (1.5-m) distance in Nos. 1 and 13 facilitates maintenance and enhances ventilation.

NOTE 4: The distances in Nos. 1, 4, 6, 7, 8, and 11 shall be permitted to be reduced by two-thirds, but to not less than 5 ft (1.5 m), for insulated portions of the system; and, for uninsulated portions of the system, by the use of protective structures having a minimum fire resistance rating of 2 hours, which interrupts the line of sight between the uninsulated portions of the liquefied hydrogen system and the exposure. The protective structure, or the insulated liquefied hydrogen tank, shall interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure.

For SI units: 1 ft = 0.305 m; 1 gal = 3.785 L

Chapter 4 Design Considerations at Specific Locations

4-1 Outdoor Locations.

4-1.1 Roadways and yard surfaces located below liquefied hydrogen piping, and areas under the fill connections and delivery vehicle's uninsulated hydrogen piping from which liquid air may drip, shall be constructed of noncombustible materials. For the purposes of this standard, asphaltic and bitumastic paving shall be considered combustible. If expansion joints are used, fillers also shall be of noncombustible materials.

4-1.2 If walls, roofs, weather shelters, or canopies are provided, they shall be constructed of noncombustible or limited-combustible materials.

4-1.3 Electrical wiring and equipment shall comply with Section 2-9.

4-1.4 Lighting shall be provided for nighttime transfer operation.

4-2 Separate Buildings.

4-2.1 Separate buildings containing more than 300 gal (1,136 L) of liquefied hydrogen shall be constructed of noncombustible or limited-combustible materials on a substantial frame. Walls and roofs shall be lightly fastened. All venting elements shall be designed to relieve at a maximum pressure of 25 lb/ft^2 (1.2 kPa). Doors shall be located in such a manner that they will be readily accessible to personnel in an emergency.

Exception: Window glazing shall be permitted to be of plastic.

4-2.1.1 Separate buildings containing 300 gal (1,136 L) or less of liquefied hydrogen shall be constructed in accordance with 4-2.1.

Exception: Explosion venting shall be permitted to be in accordance with 4-3.3.

4-2.2 Ventilation to the outdoors shall be provided. Inlet openings shall be located near the floor level in exterior walls only. Outlet openings shall be located at the high point of the room in exterior walls or roof. Both the inlet and outlet vent openings shall have a minimum total area of 1 ft^2/per 1,000 ft^3 (1 m^2/300 m^3) of room volume. Discharge from outlet openings shall be directed or conducted to a safe location.

4-2.3 There shall be no sources of ignition.

4-2.4 Electrical wiring and equipment shall comply with Section 2-9, except that all electrical wiring and equipment in the separate building shall be Class I, Division 2, Group B.

4-2.5 Heating, if provided, shall be by indirect means such as steam, hot water, etc.

Exception: Electrical heating shall be in accordance with 4-2.4.

4-3 Special Rooms.

4-3.1 Floors, walls, and ceilings shall be constructed of noncombustible or limited-combustible materials. Interior walls or partitions shall have a fire resistance rating of at least 2 hours, be continuous from floor to ceiling, and 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 doors shall be located in such a manner that they will be accessible in an emergency.

Exception: Window glazing shall be permitted to be of plastic.

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

4-3.3 Explosion venting shall be provided in exterior walls or roof only. Vents may consist of any one or any combination of the following, designed to relieve at a maximum internal pressure of 25 lb per sq ft (1.2 kPa).

(a) Walls of light material;

(b) Lightly fastened hatch covers;

(c) Lightly fastened, outward-opening, swinging doors in exterior walls;

(d) Lightly fastened walls or roofs.

4-3.3.1 Where applicable, snow loads shall be considered.

4-3.3.2 The venting area shall be equal to not less than 1 ft^2/30 ft^3 (1 m^2/9 m^3) of room volume.

4-3.4 There shall be no sources of ignition.

4-3.5 Electrical wiring and equipment shall comply with Section 2-9, except that all electrical wiring and equipment in the special room shall be Class I, Division 2, Group B.

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

Chapter 5 Operating Instructions

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

5-2 Qualification of Personnel. A qualified person shall be in attendance at all times while the mobile hydrogen supply unit is being unloaded.

5-3 Securing Equipment. Each mobile liquefied hydrogen supply unit used as part of a hydrogen system shall be secured to prevent movement.

5-4 Grounding. The mobile liquefied hydrogen supply unit shall be grounded.

Chapter 6 Maintenance

6-1 Inspection. Each liquefied hydrogen system installed on consumer premises shall be inspected annually and maintained by a qualified representative of the equipment owner.

6-2 Clearance to Combustibles. Weeds or similar combustibles shall not be permitted within 25 ft (7.6 m) of any liquefied hydrogen equipment.

Chapter 7 Fire Protection

7-1* Cautionary Information. Personnel shall be cautioned that hydrogen flames are practically invisible.

Chapter 8 Referenced Publications

8-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

8-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 220, *Standard on Types of Building Construction*, 1992 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 1993 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 1993 edition.

8-1.2 Publications. American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017.

ASME B31.3 (1993), *Chemical Plant and Petroleum Refinery Piping*.

ASME Boiler and Pressure Vessel Code (1992), Section VIII, "Rules for the Construction of Pressure Vessels."

8-1.3 CGA Publications. Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

S-1.1, *Pressure Relief Device Standards — Part 1 — Cylinders for Compressed Gases*, 1989.

S-1.2, *Pressure Relief Device Standards — Part 2 — Cargo and Portable Tanks for Compressed Gases*, 1980.

S-1.3, *Pressure Relief Device Standards — Part 3 — Compressed Gas Storage Containers*, 1980.

8-1.4 ASTM Publication. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM E136-1993, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750°C*.

8-1.5 U.S Government Publication. U.S. Government Printing Office, Washington, DC 20401.

Code of Federal Regulations, Title 49, Parts 171-190. (Also available from the Association of American Railroads, American Railroads Bldg., 1920 L St. NW, Washington, DC 20036 and American Trucking Assn., Inc. 1916 P. St. NW, Washington, DC 20036).

Appendix A Explanatory Material

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

A-1-3 Portable Containers. Regulations of the U.S. Dept. of Transportation outline specifications for transportation of explosives and dangerous articles (*Code of Federal Regulations*, Title 49, Parts 171-190). These are available from the U.S. Government Printing Office, Washington, DC, or from the Bureau of Explosives, 1920 L. St. N.W., Washington, DC, 20036. In Canada, the regulations of the Canadian Transport Commission for Canada apply. These are available from CTC, Union Station, Ottawa, Ontario.

A-2-5.1 Some materials suitable for liquefied hydrogen temperature include austenitic chromium-nickel alloys, certain copper alloys, and aluminum, which retain ductility and do not become brittle at the temperature of liquefied hydrogen.

A-3-1.2 When locating liquefied hydrogen storage containers near all classes of aboveground flammable and combustible liquid storage or liquid oxygen storage, it is advisable to locate the liquefied hydrogen container on ground higher than all classes of flammable and combustible liquid storage or liquid oxygen storage.

A-7-1 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 may occur if a metal surface adjacent to the flame is not cooled with water or other means.

The fire protection provided shall be determined by an analysis of local conditions of hazard within the plant, exposure to other properties, water supplies, the probable effectiveness of plant fire brigades, and the time of response and probable effectiveness of fire departments.

Appendix B Referenced Publications

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

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

NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, 1994 edition.

B-1.2 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20401.

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

Index

The NFPA Codes and Standards Development Process

Since 1896, one of the primary purposes of the NFPA has been to develop and update the standards covering all areas of fire safety.

Calls for Proposals
The code adoption process takes place twice each year and begins with a call for proposals from the public to amend existing codes and standards or to develop the content of new fire safety documents.

Report on Proposals
Upon receipt of public proposals, the technical committee members meet to review, consider, and act on the proposals. The public proposals – together with the committee action on each proposal and committee-generated proposals – are published in the NFPA's Report on Proposals (ROP). The ROP is then subject to public review and comment.

Report on Comments
These public comments are considered and acted upon by the appropriate technical committees. All public comments – together with the committee action on each comment – are published as the Committee's supplementary report in the NFPA's Report on Comments (ROC).

The committee's report and supplementary report are then presented for adoption and open debate at either of NFPA's semi-annual meetings held throughout the United States and Canada.

Association Action
The Association meeting may, subject to review and issuance by the NFPA Standards Council, (a) adopt a report as published, (b) adopt a report as amended, contingent upon subsequent approval by the committee, (c) return a report to committee for further study, and (d) return a portion of a report to committee.

Standards Council Action
The Standards Council will make a judgement on whether or not to issue an NFPA document based upon the entire record before the Council, including the vote taken at the Association meeting on the technical committee's report.

Voting Procedures
Voting at an NFPA Annual or Fall Meeting is restricted to members of record for 180 days prior to the opening of the first general session of the meeting, except that individuals who join the Association at an Annual or Fall Meeting are entitled to vote at the next Fall or Annual Meeting.

"Members" are defined by Article 3.2 of the Bylaws as individuals, firms, corporations, trade or professional associations, institutes, fire departments, fire brigades, and other public or private agencies desiring to advance the purposes of the Association. Each member shall have one vote in the affairs of the Association. Under Article 4.5 of the Bylaws, the vote of such a member shall be cast by that member individually or by an employee designated in writing by the member of record who has registered for the meeting. Such a designated person shall not be eligible to represent more than one voting privilege on each issue, nor cast more than one vote on each issue.

Any member who wishes to designate an employee to cast that member's vote at an Association meeting in place of that member must provide that employee with written authorization to represent the member at the meeting. The authorization must be on company letterhead signed by the member of record, with the membership number indicated, and the authorization must be recorded with the President of NFPA or his designee before the start of the opening general session of the Meeting. That employee, irrespective of his or her own personal membership status, shall be privileged to cast only one vote on each issue before the Association.

Sequence of Events Leading to Publication of an NFPA Committee Document

Call for proposals to amend existing document or for recommendations on new document.

▼

Committee meets to act on proposals, to develop its own proposals, and to prepare its report.

▼

Committee votes on proposals by letter ballot. If two-thirds approve, report goes forward. Lacking two-thirds approval, report returns to committee.

▼

Report is published for public review and comment. (Report on Proposals - ROP)

▼

Committee meets to act on each public comment received.

▼

Committee votes on comments by letter ballot. If two-thirds approve, supplementary report goes forward. Lacking two-thirds approval, supplementary report returns to committee.

▼

Supplementary report is published for public review. (Report on Comments - ROC).

▼

NFPA membership meets (Annual or Fall Meeting) and acts on committee report (ROP and ROC).

▼

Committee votes on any amendments to report approved at NFPA Annual or Fall Meeting.

▼

Complaints to Standards Council on Association action must be filed within 20 days of the NFPA Annual or Fall Meeting.

▼

Standards Council decides, based on all evidence, whether or not to issue standard or to take other action, including hearing any complaints.

▼

Appeals to Board of Directors on Standards Council action must be filed within 20 days of Council action.

FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269-9101
Fax No. 617-770-3500

Note: All proposals must be received by 5:00 p.m. EST/EDST on the published proposal-closing date.

If you need further information on the standards-making process, please contact the Standards Administration Department at 617-984-7249.

Date 9/18/93 **Name** John B. Smith **Tel. No.** 617-555-1212

Company _____

Street Address 9 Seattle St., Seattle, WA 02255

Please Indicate Organization Represented (if any) Fire Marshals Assn. of North America

1. a) NFPA Document Title National Fire Alarm Code **NFPA No. & Year** NFPA 72, 1993 ed.

b) Section/Paragraph 1-5.8.1 (Exception No.1)

FOR OFFICE USE ONLY
Log # _____
Date Rec'd _____

2. Proposal recommends: (Check one)
- ❑ **new text**
- ❑ **revised text**
- ☒ **deleted text**

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

Delete exception.

4. Statement of Problem and Substantiation for Proposal: (Note: State the problem that will be resolved by your recommendation; give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

5. ☒ This Proposal is original material. (Note: Original material is considered to be the submitter's own idea based on or as a result of his/her own experience, thought, or research and, to the best of his/her knowledge. is not copied from another source.)

❑ **This Proposal is not original material; its source (if known) is as follows:** _____

Note 1: Type or print legibly in black ink.
Note 2: If supplementary material (photographs. diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

I hereby grant NFPA the non-exclusive, royalty-free rights, including non-exclusive, royalty-free rights in copyright, in this proposal and I understand that I acquire no rights in any publication of NFPA in which this proposal in this or another similar analogous form is used.

John B. Smith
Signature (Required)

PLEASE USE SEPARATE FORM FOR EACH PROPOSAL

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Date _____ **Name** _____ **Tel. No.** _____

Company _____

Street Address _____

Please Indicate Organization Represented (if any) _____

1. a) NFPA Document Title _____ **NFPA No. & Year** _____

b) Section/Paragraph _____

2. Proposal Recommends: (Check one)
- ❑ **new text**
- ❑ **revised text**
- ❑ **deleted text**

FOR OFFICE USE ONLY

Log # _____

Date Rec'd _____

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

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Signature (Required)

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