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NFPA 50B Liquefied Hydrogen Systems at Consumer Sites 1989 Edition

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 3, 1982

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.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

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NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 50B

Standard for

Liquefied Hydrogen Systems at Consumer Sites

1989 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 14-17, 1988 in Nashville, Tennessee. It was issued by the Standards Council on January 13, 1989, with an effective date of February 6, 1989, and supersedes all previous editions.

The 1989 edition of this standard 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, and 1985.

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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.

Contents

NFPA 50B

Standard for

Liquefied Hydrogen Systems at Consumer Sites

1989 Edition

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 10.

Chapter 1 Introduction

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

1-2 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 upon 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.

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.

1-4 Compliance with this standard will minimize the possibility of a consumer fire involving the liquefied hydrogen system, as well as the possibility of a liquefied hydrogen fire involving the consumer premises.

Chapter 2 Application of Standard

2-1 This standard covers the general principles recommended 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.

2-2 The system shall be classified according to the maximum total quantity of liquefied hydrogen including unconnected liquefied hydrogen reserves, as follows:

— Less than 3,501 gallons, except as covered in Section 2-4.

— From 3,501 to 15,000 gallons.

— From 15,001 to 75,000 gallons.

— (For SI Units, 1 gal = 3.785 L.)

2-3 An existing system which is not in strict compliance with the provisions of the this standard may be continued in use when such use does not constitute a distinct hazard to life or adjoining property.

2-4 This standard does not apply to portable containers having a total liquefied hydrogen content of less than 150 liters (39.63 gallons).

2-5 This standard does not apply to liquefied hydrogen manufacturing plants or other establishments operated by the hydrogen supplier or his agent for the sole purpose of storing liquefied hydrogen and refilling portable containers, trailers, mobile supply trucks or tank cars.

2-6 This standard does not apply to gaseous hydrogen systems. NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, provides information on this subject.

Chapter 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 or 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 which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is 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, 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 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:

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

Class IIIA liquids shall include those having a flash point at or above 140 °F (60 °C) and below 200 °F (93.4 °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 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 per 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 ⅛ in. (3.2 mm) which 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. One 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 may include stationary or portable containers, 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 which, 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 Verticle 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 which 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 which is part of or attached to another building and is used exclusively for a liquefied hydrogen system.

Chapter 4 Design of Liquefied Hydrogen Systems

4-1 Containers.

4-1.1 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 (1986).

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

4-2 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 inches in height shall be protected with protective coating having a 2-hour fire-resistance rating.

4-3 Marking. Each container shall be legibly marked to indicate "LIQUEFIED HYDROGEN — FLAMMABLE GAS."

4-4 Pressure Relief Devices.

4-4.1 Stationary liquefied hydrogen containers shall be equipped with pressure relief devices sized in accordance with CGA Pamphlet S-1, Part 3, Pressure Relief Device Standards for Compressed Gas Storage Containers.

4-4.2 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 Pamphlet S-1, Pressure Relief Device Standards, Part 1, Compressed Gas Cylinders and Part 2, Cargo and Portable Tank Containers.

4-4.3 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 5-1.5 for venting of pressure relief devices in special locations.

4-4.4 Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner which would interfere with proper operation of the device.

4-4.5 Pressure relief devices shall be provided in piping wherever liquefied hydrogen could be trapped between closures.

4-5 Piping, Tubing, and Fittings.

4-5.1* 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.

4-5.2 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 (– 29.9 °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.

4-5.3 Joints in piping and tubing shall preferably be made by welding or brazing; flanged, threaded, socket, slip, or suitable compression fittings may be used. Brazing materials shall have a melting point above 1000 °F (538 °C).

4-5.4 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 shall also be of adequate design to prevent attrition of the insulation due to normal operating conditions.

4-5.5 Uninsulated piping and equipment which 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 may be installed under uninsulated piping and equipment to retain and vaporize condensed liquid air.

4-6 Equipment Assembly.

4-6.1 Valves, gages, regulators, and other accessories shall be suitable for liquefied hydrogen service and for the pressures and temperatures involved.

4-6.2 Installation of liquefied hydrogen systems shall be supervised by personnel familiar with proper practices and with reference to their construction and use.

4-6.3 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 2,000 gallons (7570 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.

4-6.4 Cabinets or housings containing hydrogen control equipment shall be ventilated to prevent any accumulation of hydrogen gas.

4-7 Testing.

4-7.1 After installation, all field erected piping shall be tested and proved hydrogen gastight at operating pressure and temperature.

4-7.2 Containers if out of service in excess of one year shall be inspected and tested as outlined in 4-7.1. The safety pressure devices shall be checked to determine if they are operable and properly set.

4-8 Liquefied Hydrogen Vaporizers.

4-8.1 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.

4-8.2 The vaporizer and its piping shall be adequately protected on the hydrogen and heating media sections with pressure relief devices.

4-8.3 Heat used in a liquefied hydrogen vaporizer shall be indirectly supplied utilizing media such as air, steam, water, or water solutions.

4-8.4 A low temperature shutoff switch shall be provided in the vaporizer discharge piping to prevent flow of liquefied hydrogen in the event of the loss of the heat source.

4-9 Electrical Systems.

4-9.1 Electrical wiring and equipment located within 3 ft (0.9 m) of a point where connections are regularly made and disconnected, shall be in accordance with Article 501 of NFPA 70, *National Electrical Code®*, for Class I, Group B, Division 1 locations.

4-9.2 Except as provided in 4-9.1, electrical wiring and equipment located within 25 feet (7.6 m) of a point where connections are regularly made and disconnected or within 25 feet (7.6 m) of a liquid hydrogen storage container, shall be in accordance with Article 501 of NFPA 70, *National Electrical Code*, for Class I, Group B, Division 2 locations. When equipment approved for Class I, Group B atmospheres is not commercially available, the equipment may 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. This requirement does not apply to electrical equipment which is installed on mobile supply trucks or tank cars from which the storage container is filled.

4-10 Bonding and Grounding. The liquefied hydrogen container and associated piping shall be electrically bonded and grounded.

Chapter 5 Location of Liquefied Hydrogen Storage

5-1 General Requirements.

5-1.1 The storage containers shall be located so that they are readily accessible to mobile supply equipment at ground level and to authorized personnel. Suitable roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

5-1.2* 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.

5-1.3 Where it is necessary to locate the liquefied hydrogen container 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.

5-1.4 Storage sites shall be fenced and posted to prevent entrance by unauthorized personnel. Sites shall also be placarded as follows: "LIQUEFIED HYDROGEN — FLAMMABLE GAS — NO SMOKING — NO OPEN FLAMES."

5-1.5 If liquefied hydrogen is located (as specified in Table 1) in a separate building, in a special room, or inside buildings when 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 4-4.3.

5-2 Specific Requirements.

5-2.1 The location of liquefied hydrogen storage, as determined by the maximum total quantity of liquefied hydrogen, shall be in the order of preference as indicated by Roman numerals in Table 1.

5-2.2 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 2.

(a) Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 2 than the distances given for the storage system.

Table 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 does 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 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 5-1.3) Exception: Distances may be reduced to 15 ft 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 5-1.3)	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 2

NOTE 1. Portions of wall less than 10 ft (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 distance in Nos. 1 and 13 facilitates maintenance and enhances ventilation.

NOTE 4 The distances in Nos. 1, 4, 6, 7, 8 and 11 may be reduced where protective structures have a minimum fire resistance rating of two hours interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure. (*See definition of Outdoor Location*.)

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

5-3 Handling of Liquefied Hydrogen Inside Buildings other than Separate Buildings and Special Rooms.

5-3.1 Portable liquefied hydrogen containers of 50 gallons (189 L) or less capacity as permitted in Table 1 and in compliance with 5-1.5 when housed inside buildings not located in a special room and exposed to other occupancies shall comply with the following minimum requirements:

(a) 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) Be located 25 ft (7.6 m) from ordinary electrical equipment, and other sources of ignition including process or analytical equipment (*see 4-9.1*).

(c) Be located 50 ft (15.2 m) from intakes of ventilation and air-conditioning equipment or intakes of compressors.

(d) Be located 50 ft (15.2 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) The area shall be adequately ventilated. Pressure relief devices on the containers shall be vented directly outdoors or to a suitable hood. See 4-4.3 and 5-1.5.

Chapter 6 Design Considerations at Specific Locations

6-1 Outdoor Locations.

6-1.1 Roadways and yard surfaces located below liquefied hydrogen piping, from which liquid air may drip, shall be constructed of noncombustible materials.

6-1.2 If walls, roofs, weather shelters, or canopies are provided, they shall be constructed of noncombustible or limited-combustible materials.

6-1.3 Electrical wiring and equipment shall comply with 4-9.1 and 4-9.2.

6-1.4 Adequate lighting shall be provided for nighttime transfer operation.

6-2 Separate Buildings.

6-2.1 Separate buildings containing more than 300 gal (1136 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 per sq ft (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 may be of plastic.

6-2.1.1 Separate buildings containing 300 gal (1136 L) or less of liquefied hydrogen shall be constructed in accordance with 6-2.1 except that explosion venting may be in accordance with 6-3.3.

6-2.2 Adequate 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 one square foot per 1,000 cu ft (1 m^2/300 m^3) of room volume. Discharge from outlet openings shall be directed or conducted to a safe location.

6-2.3 There shall be no sources of ignition.

6-2.4 Electrical wiring and equipment shall comply with 4-9.1 and 4-9.2 except that the provisions of 4-9.2 shall apply to all electrical wiring and equipment in the separate building.

6-2.5 Heating, if provided, shall be by steam, hot water, or other indirect means, except that electrical heating may be used if in compliance with 6-2.4.

6-3 Special Rooms.

6-3.1 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 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 doors shall be located in such a manner that they will be accessible in an emergency.

Exception: Window glazing may be of plastic.

6-3.2 Ventilation shall be as provided in 6-2.2.

6-3.3 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.

6-3.3.1 Where applicable, snow loads shall be considered.

6-3.3.2 The venting area shall be equal to not less than 1 sq ft per 30 cu ft (1 m^2/9 m^3) of non-volume.

6-3.4 There shall be no sources of ignition.

6-3.5 Electrical wiring and equipment shall comply with 4-9.1 and 4-9.2 except that the provisions of 4-9.2 shall apply to all electrical wiring and equipment in the special room.

6-3.6 Heating, if provided, shall be by steam, hot water, or other indirect means except that electrical heating may be used if in compliance with 6-3.5.

Chapter 7 Operating Instructions

7-1 For installations which require any operation of equipment by the user, legible instructions shall be maintained at operating locations.

7-2 A qualified person shall be in attendance at all times while the mobile hydrogen supply unit is being unloaded.

7-3 Each mobile liquefied hydrogen supply unit used as part of a hydrogen system shall be adequately secured to prevent movement.

7-4 The mobile liquefied hydrogen supply unit shall be grounded.

Chapter 8 Maintenance

8-1 Each liquefied hydrogen system installed on consumer premises shall be inspected annually and maintained by a qualified representative of the equipment owner.

8-2 Weeds or similar combustibles shall not be permitted within 25 ft (7.6 m) of any liquefied hydrogen equipment.

Chapter 9 Fire Protection

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.

9-1 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.

9-2 Personnel shall be cautioned that hydrogen flames are practically invisible.

Chapter 10 Referenced Publications

10-1 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.

10-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 70-1987, *National Electrical Code*

NFPA 220-1985, *Standard on Types of Building Construction*

10-1.2 ASME Publications. American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017.

ANSI/ASME B31.3 (1987), *Chemical Plant and Petroleum Refinery Piping.*

Boiler and Pressure Vessel Code (1986), Section VIII, Rules for the Construction of Pressure Vessels.

10-1.3 CGA Publications. Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

Pressure Relief Device Standards:

S-1.1, *Cylinders for Compressed Gases* (1979)

S-1.2, *Cargo and Portable Tanks for Compressed Gases* (1980)

S-1.3, *Compressed Gas Storage Containers* (1980).

10-1.4 ASTM Publication. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

E-136-1982, *Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750 °C*

10-1.5 U.S. Government Printing Office, Washington, DC.

DOT Specifications and Regulations. *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

A-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). Available from 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. Available from CTC, Union Station, Ottawa, Ontario.

A-4-5.1 Some materials suitable for liquefied hydrogen temperature are austenitic chromium-nickel alloys, certain copper alloys, and aluminum which retain ductility and do not become brittle at the temperature of liquefied hydrogen.

A-5-1.2 When locating liquefied hydrogen storage containers near aboveground all classes of 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.

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SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.

INSTRUCTIONS

Please use the forms which follow for submitting proposed amendments. Use a separate form for each proposal.

1. For each document on which you are proposing amendment indicate:
   (a) The number and title of the document
   (b) The specific section or paragraph.

2. Check the box indicating whether or not this proposal recommends new text, revised text, or to delete text.

3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

6. 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.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and

(b) identification of the document, paragraph of the document to which the proposal is directed, and

(c) a statement of the problem and substantiation for the proposal, and

(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.

FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269

Date 5/18/85 **Name** John B. Smith **Tel. No.** 617-555-1212

Address 9 Seattle St.. Seattle, WA 02255

Representing (Please indicate organization, company or self) Fire Marshals Assn. of North America

1. a) **Document Title:** Protective Signaling Systems **NFPA No. & Year** NFPA 72D

   b) **Section/Paragraph:** 2-7.1 (Exception)

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:**

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

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

I agree to give NFPA all and full rights, including rights of 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 or analogous form is used.

John B. Smith

Signature

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Address _____

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

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5. ☐ This Proposal is original material.
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