NFPA 853

Standard for the Installation of Stationary Fuel Cell Power Plants

2000 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

IMPORTANT NOTICE ABOUT THIS DOCUMENT

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

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

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

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

See inside back cover for additional important notices and information.

NOTICES

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

Users of this document should be aware that this document may be amended from time to time through the issuance of Tentative Interim Amendments, and that an official NFPA document at any point in time consists of the current edition of the document together with any Tentative Interim Amendments then in effect. In order to determine whether this document is the current edition and whether it has been amended through the issuance of Tentative Interim Amendments, consult appropriate NFPA publications such as the *National Fire Codes*® Subscription Service, visit the NFPA website at www.nfpa.org, or contact the NFPA at the address listed above.

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

The NFPA does not take any position with respect to the validity of any patent rights asserted in connection with any items which are mentioned in or are the subject of this document, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on this document. Users of this document are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Users of this document should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action that is not in compliance with applicable laws, and this document may not be construed as doing so.

8/00

Licensing Policy

NFPA 853

Standard for the

Installation of Stationary Fuel Cell Power Plants

2000 Edition

This edition of NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Plants*, was prepared by the Technical Committee on Electric Generating Plants and acted on by the National Fire Protection Association, Inc., at its World Fire Safety Congress and Exposition™ held May 14–17, 2000, in Denver, CO. It was issued by the Standards Council on July 20, 2000, with an effective date of August 18, 2000.

This edition of NFPA 853 was approved as an American National Standard on August 18, 2000.

Origin and Development of NFPA 853

In 1997, the Technical Committee on Electric Generating Plants appointed a Task Group on Fuel Cells to begin work on this document. The Standards Council officially approved this project in January 1998. The council recognized that fuel cells were becoming a popular means of producing electricity and that there were no installation standards for this technology. NFPA 853 addresses fire protection for siting, fuel supplies and storage, ventilation, and fire protection.

Technical Committee on Electric Generating Plants

Kenneth W. Dungan, *Chair*
Risk Technologies, LLC, TN [SE]

William D. Snell, *Secretary*
TXU Services Inc., TX [U]

Donald C. Birchler, FP&C Consultants Inc., MO [SE]
Bernhard G. Bischoff, Chemetron Fire Systems/Williams Plc, IL [M]
Rep. Fire Suppression Systems Assn.
John K. Bouchard, Palmer & Cay, Inc., MA [I]
Harold D. Brandes, Jr., Duke Power Co., NC [U]
Stanley J. Chingo, ComEd, IL [U]
Rep. Edison Electric Inst.
Thomas C. Clayton, Black & Veatch, MO [SE]
Harry M. Corson, IV, Siemens Cerberus Division, NJ [M]
Rep. Nat'l Electrical Mfrs. Assn.
Phillip A. Davis, Kemper Insurance Cos., IL [I]
Paul H. Dobson, FM Global, MA [I]
Don Drewry, Hartford Steam Boiler Inspection & Insurance Co., NJ [I]
Ismail M. Gosla, Fluor Daniel, CA [SE]
Richard M. Hansen, Richard M. Hansen & Assoc., Inc., IL [SE]
Leonard R. Hathaway, Alpharetta, GA [I]
Dwight S. Hull, II, Tennessee Valley Authority, TN [U]
Everett C. Hume, HSB Industrial Risk Insurers, CT [I]
Rickey L. Johnson, ACE USA, CT [I]
Rep. American Insurance Services Group
Robert Malanga, Fire and Risk Engr/Union Camp Corp., NJ [U]
Amjad M. Mian, Manitoba Hydro, MB, Canada [U]
James F. Mulvoy, Alison Control Inc., IL [M]
Gregory W. Powell, Constellation Energy Group, MD [U]
John G. Puder, F. E. Moran Inc., IL [IM]
Omer Semen, Raytheon Engr & Constructors, NJ [SE]
Steven F. Vieira, Tyco Int'l, Ltd, RI [M]
Rep. Nat'l Fire Sprinkler Assn.

Alternates

Patrick T. Borns, McDaniel Fire Systems Inc., IN [M]
(Alt. to B. G. Bischoff)
Philip L. Conrad, Jr., Tennessee Valley Authority, TN [U]
(Alt. to D. S. Hull)
Randy P. Edwards, Fire Control Instruments, Inc., MA [M]
(Alt. to H. M. Corson)
John W. Koester, Marsh USA, Inc., MD [I]
(Alt. to L. R. Hathaway)
Roland Lafontaine, The Viking Corp., MI [M]
(Alt. to S. F. Vieira)
Jane I. Lataille, HSB Industrial Risk Insurers, CT [I]
(Alt. to E. C. Hume)
Allan P. Rhodes, Duke Engr & Services (DE&S), CA [SE]
(Alt. to H. D. Brandes)
Samuel L. Rogers, Kemper Nat'l Insurance Cos., CO [I]
(Alt. to P. A. Davis)
Richard Wickman, Constellation Energy Group, MD [U]
(Alt. to G. W. Powell)

Richard P. Bielen, NFPA Staff Liaison

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

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

Committee Scope: This Committee shall have primary responsibility for documents on fire protection for electric generating plants and high-voltage direct-current (HVDC) converter stations, except for electric generating plants that use nuclear fuel.

Contents

NFPA 853

Standard for the

Installation of Stationary Fuel Cell Power Plants

2000 Edition

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.

Chapter 1 Introduction

1.1 Scope.

1.1.1 This standard shall apply to the design, construction, and installation of stationary fuel cell power plants with a gross electrical generation that exceeds 50 kW. The scope of this document shall include the following:

(1) A singular prepackaged, self-contained power plant unit
(2) Any combination of prepackaged, self-contained power plant units
(3) Power plant units comprised of two or more factory matched modular components intended to be assembled in the field
(4) Engineered and field-constructed power plants that employ fuel cells

1.1.2 This standard shall not apply to fuel cell power plants that are used on any movable structure or vehicle except to the degree that the structure or vehicle is made stationary.

1.2 Purpose. This document shall provide fire prevention and fire protection requirements for safeguarding life and physical property associated with buildings or facilities that employ stationary fuel cell power plants.

1.3 Alternative Materials and Methods. Nothing in this document shall prevent the use of systems, methods, or devices of quality, strength, fire resistance, effectiveness, durability, and safety equivalent or superior to those prescribed by this document, provided that technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

1.4 Definitions.

1.4.1* **Approved.** Acceptable to the authority having jurisdiction.

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

1.4.3 Automatic Fire Detection System. A system that senses the presence of fire, smoke, or heat and activates a sprinkler system or an automatic alarm system.

1.4.4 Automatic Sprinkler System. A system of pipes with water under pressure that allows water to be discharged immediately when a sprinkler head operates.

1.4.5 Base Flood Evaluation. A reference point based on the depth or peak elevation of flooding, including wave height, which has a 1 percent (100-year) or greater chance of occurring in any given year.

1.4.6 Biogas Fuel Cell System. A system comprised of a conventional biogas source, such as a landfill gas site or municipal sewage digester site, a fuel cell specific gas cleanup unit, and a prepackaged or matched modular fuel cell power plant.

1.4.7 Booster. An electrically driven, sealed gas, in-line, pressure-boosting device that supplies fuel that is consumed by a continuous process without intermediate storage.

1.4.8 Combustible. Any material that, in the form in which it is used and under the conditions anticipated, will ignite and burn. A material that does not meet the definition of noncombustible or limited-combustible.

1.4.9 Compressor. A device used for increasing the pressure and density of a gas.

1.4.10 Damper. A valve or plate for controlling draft or the flow of gases, including air.

1.4.11 Digester Gas. The biogas derived by fermentation of organic wastes, such as sewage, animal and food waste, and industrial organic waste. This gas can contain approximately 50 percent methane, the rest being approximately 50 percent carbon dioxide (CO_2). Trace contaminants can include sulfur (S) and chlorine (Cl) compounds.

1.4.12 Direct Vented System. A system by which all air for combustion is obtained from the outside atmosphere, and all exhaust air/gases are discharged to the outside atmosphere.

1.4.13 Distributed Integrated Controls (DIC). Systems, or integrated controls, used to monitor and control the functions of equipment, systems, or plants. The DIC is made up of a collection of modules, each with its own function, interconnected to process data for a specific operation or function. DIC is also referred to as *Distributed Control System (DCS).*

1.4.14 Duct System. A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, fans, and accessory air-managing equipment and appliances.

1.4.15 Exhaust Air. Air removed from a space or power plant and not reused.

1.4.16 Exhaust System. A system of pipes or ducts that conveys used exhausted air from a room area or space to the outside atmosphere either mechanically or naturally.

1.4.17 Fire Damper. A device arranged to interrupt airflow automatically when excessive high temperatures are sensed through a duct system, so as to restrict the passage of heat and fire.

1.4.18 Fire Prevention. Measures directed toward avoiding the inception of fire.

1.4.19 Fire Protection. Methods of providing for fire control or fire extinguishment.

1.4.20 Fire Risk Evaluation. A detailed engineering review of the plant's construction features and operating process conducted to ensure that applicable fire prevention and fire protection requirements for safeguarding life and physical property. The evaluation results in a list of required fire protection elements to be provided based on acceptable means for separation or control of common or special hazards (i.e., temperature, pressure), the control or elimination of ignition sources, the detection and suppression of fires, and the safety of life.

1.4.21 Flammable Liquid. Any liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia (absolute pressure of 276 kPa) at 100°F (37.8°C).

1.4.22 Flash Point. The minimum temperature to which a material must be heated in an open test vessel in order to sustain combustion for a specified period after ignition by an external source.

1.4.23 Fuel Cell Power Plant, Engineered and Field Constructed. Fuel cell power plants that are not preassembled or have factory matched components. The power plant is engineered and designed for the assembly of various components from various sources and installed on site. *(See Appendix B, Figure B.1, for a schematic of a typical fuel cell power plant.)*

1.4.24 Fuel Cell Power Plant, Pre-Engineered and Matched Modular Components. Fuel cell power plant that has components that are assembled in a factory in separate modules, such as the fuel cell stack, reformer, and inverter. The modules are matched to be installed in the field.

1.4.25 Fuel Cell Power Plant, Prepackaged, Self-Contained. Fuel cell power plant that is designed as one unit, consisting of the fuel cell stack, reformer, inverter, and electric components. The unit is assembled in a factory and shipped to site.

1.4.26 Hazardous Materials (Chemicals). Any substance, which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful, is likely to cause death or injury.

1.4.27 Installation. The location where a fuel cell power plant is sited as a unit or built as an assembly.

1.4.27.1 Indoor Installation. A power plant completely surrounded and enclosed by walls, roof, and floor. This can be a separate building or a room within a building.

1.4.27.2 Outside or Outdoor Installation. A unit not installed inside a building or which has only partial weather protection (maximum coverage of a roof and up to 50 percent enclosing walls).

1.4.27.3 Roof Top Installation. A unit installed on the roof of a building.

1.4.28 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.

1.4.29 Landfill Gas. The biogas derived from decomposition of municipal solid waste (landfill). This gas is approximately 50 percent methane, the remainder being approximately 50 percent CO_2. Trace contaminants can include S, Cl, H_2O, and O_2 introduced by air leakage into the collection system.

1.4.30* Limited Combustible. As applied to a building construction material, a material, 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 (8.14×10^6 J/kg) (see NFPA 259, *Standard Test Method for Potential Heat of Building Materials*) and (a) materials that have a structural base of noncombustible material with a surfacing not exceeding a thickness of $^1/_8$ in. (3.175 mm) that has a flame spread rating not greater than 50 and (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 the 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. 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 are considered combustible.

1.4.31* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

1.4.32 Listing Agency. 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 that the equipment or material either meets appropriate standards or has been tested and found suitable for use in a specified manner.

1.4.33 Lower Explosive Limit (LEL). The lowest concentration of a flammable gas/vapor in air in which flame is propagated.

1.4.34 Noncombustible. A material that, in the form in which it is used and under the conditions anticipated, will not aid combustion or add appreciable heat to an ambient fire. Materials when tested in accordance with ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°*, and conforming to the criteria contained in Section 7 of the referenced standard shall be considered noncombustible.

1.4.35 Shall. Indicates a mandatory requirement.

1.4.36 Smoke Damper. A device to restrict the passage of smoke through a duct that operates automatically and is controlled by a smoke detector.

1.4.37 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.

1.4.38 Stationary. Permanently connected and fixed in place.

1.4.39 Ventilation Air. That portion of supply air that comes from the outside/outdoors plus any recirculated air that has been treated and is acceptable for use by the power plant ventilation system.

1.4.40 Ventilation, Mechanical. The flow of air or gas created by a fan, blower, or other mechanical means that will push or induce the gas stream through a ventilation system.

1.4.41 Ventilation, Natural. The flow of air or gases created by the difference in the pressures or gas densities between the outside and inside of a vent, room, or space.

1.5 Units. Metric units in this document are in accordance with the International System of Units, which is officially abbreviated SI in all languages. For a full explanation, see ASTM E 380/ANSI Z210.1, *Metric Practice Guide.*

Chapter 2* General Equipment Configuration

2.1 Prepackaged, Self-Contained Fuel Cell Power Plants. Prepackaged, self-contained fuel cell power plants for use with natural gas or liquefied petroleum gas and less than or equal to 600 volts ac output and less than or equal to 1 MW power output shall be designed, tested, and listed in accordance with ANSI Z21.83, *American National Standard for Fuel Cell Power Plants*. All other prepackaged, self-contained fuel cell power plants shall meet the provisions of Section 2.2.

2.2 Pre-Engineered Fuel Cell Power Plants. Pre-engineered fuel cell power plants and matched modular components shall be designed and tested to meet the intent of ANSI Z21.83, *American National Standard for Fuel Cell Power Plants*. Proprietary equipment or materials for which no generally recognized codes or standards exist shall be evaluated based on data from operational experience in the same or comparable service or test records covering the performance of the equipment or materials.

2.3 Engineered and Field-Constructed Fuel Cell Power Plants. Documentation for engineered and field-constructed fuel cell power plants shall be provided. Documentation shall include a fire-risk evaluation prepared by a registered engineer or third party acceptable to the authority having jurisdiction.

Chapter 3 Siting and Interconnections

3.1 General Siting.

3.1.1 A fuel cell power plant(s) and its associated equipment, components, and controls shall be sited in accordance with the following:

(1) Placed on a firm foundation that is capable of supporting the equipment or components
(2) Anchored, located, and protected so that the plant and equipment will not be adversely affected by rain, snow, ice, freezing temperatures, wind, seismic events, and lightning
(3) Located so the foundation of, and access to, associated components and the fuel cell power plant are above the base flood elevation
(4) Protected against access by unauthorized persons commensurate with the location and installation environment (Fire department access shall be provided.)
(5) Located outside of potentially hazardous atmospheres as defined by NFPA 70, *National Electrical Code®*, and NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, unless listed and approved for the specific installation
(6) Sited so the power plant and equipment do not affect required building exits during normal operations or fire emergencies
(7) Located so the power plant(s) and components of a matched modular or field-engineered fuel cell power plant and their respective vent or exhaust terminations are separated from doors, windows, outdoor air intakes, and other openings into a building
(8) Located in a manner that permits service, maintenance, and emergency access
(9) Located away from combustible materials, hazardous chemicals, high-piled stock, and other exposures to fire hazards
(10) Located or protected to prevent physical damage
(11) Siting of multiple power plants shall be located such that a fire or failure of one of the plants does not present an exposure hazard to adjacent power plants.

3.1.2 Fire protection for plants and areas under construction shall comply with NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

3.2 Outdoor Locations.

3.2.1 A fuel cell power plant and its related components shall be designed and constructed for outdoor installation.

3.2.2 Air intakes to a fuel cell power plant shall be located so the plant is not adversely affected by other exhausts, gases, or contaminants.

3.2.3 The exhaust outlet(s) from process areas or areas that contain fuel-bearing components of a fuel cell power plant shall be located at least 15 ft (4.6 m) from heating, ventilating, and air-conditioning (HVAC) air intakes, windows, doors, and other openings into buildings. The exhaust outlet(s) shall not be directed onto walkways or other paths of travel for pedestrians.

The area classification around outlets from processes or compartments that contain fuel-bearing components shall be in accordance with Article 500 of NFPA 70, *National Electrical Code*.

3.2.4 Security barriers, fences, landscaping, and other enclosures shall not affect the required airflow into or exhaust out of the fuel cell power plant and its components.

3.2.5 Fuel cell power plants shall not be located in areas that are used or are likely to be used for combustible, flammable, or hazardous materials storage.

3.3 Indoor Locations.

3.3.1 A fuel cell power plant and its associated components not located in areas designed for industrial uses shall be located in a room that meets the following conditions.

(a) The room shall be separated from the remainder of the building by floor, wall, and ceiling construction that has at least a 1-hour fire resistance rating in accordance with NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*.

(b) Electrical and piping penetrations and joints associated with the room shall be sealed with approved materials that have a fire resistance rating of 1 hour. Openings between the room and other occupied spaces shall be protected by fire doors and dampers. Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*, and shall have a minimum fire resistance rating equivalent to the barrier. Fire dampers shall be installed in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

(c) Each room shall be provided with egress in accordance with NFPA *101®*, *Life Safety Code®*.

3.4 Rooftop Locations.

3.4.1 Fuel cell power plants and their components located on rooftops shall be installed in accordance with Section 3.2.

3.4.2 The roofing material under and within 12 in. (30.5 cm) horizontally of a fuel cell power plant or component shall be noncombustible or shall have a Class A rating.

3.5 Interconnections with Other Building Systems.

3.5.1 All electrical connections and wiring to the power plant(s) or components of matched modular or field-engineered fuel cell power plants shall be in accordance with NFPA 70, *National Electrical Code*.

3.5.2 Fuel gas connections to the power plant(s) or components of a matched modular or field-engineered fuel cell power plant shall be in accordance with Chapter 4.

Chapter 4 Fuel Supplies and Storage Arrangements

4.1 General. The installation and location of fuel cell power plant fuel supplies and associated fuel piping and components and their connection to a stationary fuel cell power plant shall be in accordance with this chapter. All fuel piping outside the fuel cell power plant shall be marked or identified in accordance with ANSI A13.1, *Scheme for Identification of Piping Gases*.

4.2 Natural Gas Fuel Supplies.

4.2.1 Natural Gas.

4.2.1.1 Piping, valves, and fittings from the outlet of the supplier's piping to the outlet of the fuel cell power plant's shutoff valve shall be in accordance with NFPA 54, *National Fuel Gas Code*.

4.2.1.2 Where deodorized gas is stored, piping shall be configured to prohibit reverse flow of natural gas into other buildings or source piping (e.g., use of check valves).

4.2.2 Compressed Natural Gas (CNG). The design, location, and installation of piping valves and fittings from the outlet of the point of delivery from the supplier to the inlets of the equipment shutoff valves shall be in accordance with NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code*.

4.3 Liquefied Petroleum Gas (LP-Gas) Systems and Storage. The design, location, and installation of liquefied petroleum gas (LP-Gas) storage and piping systems shall comply with NFPA 58, *Liquefied Petroleum Gas Code*. When determining separation distances from the fuel cell power plant to LP-Gas containers required by NFPA 58, *Liquefied Petroleum Gas Code*, the power plant shall be considered a building.

4.4* Hydrogen Fuel Systems and Storage.

4.4.1 Gaseous Hydrogen Storage. The design, location, and installation of gaseous hydrogen storage shall comply with NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*.

4.4.2 Liquid Hydrogen Storage. The design, location, and installation of liquid hydrogen storage shall comply with NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites*.

4.4.3 Hydrogen Piping. Hydrogen piping, valves, and fittings from the hydrogen storage system to the fuel cell power plant shall conform to ASME/ANSI B31.3, *Process Piping*, and the following.

(a) A shutoff valve shall be located in the hydrogen piping to the power plant as close to the storage container as practical.

(b) The hydrogen supply piping to the fuel cell power plant shall be provided with a second accessible shutoff valve that is located within 6 ft (1.8 m) of the power plant, unless the power plant is enclosed by a room with a 1-hour fire resistance rating as described in Section 3.3. If the power plant is enclosed by a room with a 1-hour fire resistance rating, the valve shall be located outside the room.

(c) For indoor installation of a power plant, an automatic shutoff valve interlocked with gas detection shall be located outside the building that houses the power plant, in accordance with Chapter 6.

(d) Piping, valves, regulators, or other equipment shall be located or otherwise be protected against physical damage.

(e) Areas classified as Class I, Division 2, due to hydrogen piping shall be provided with ventilation to the outdoors.

(f) Hydrogen containers and associated piping shall be electrically grounded and bonded.

4.5* Biogas Fuel Systems.

4.5.1 Biogas fuel systems, including landfill gases, anaerobic digester gases, and other gases derived from the decomposition of organic materials, shall be permitted to be used as a fuel supply for a fuel cell power plant. Additional fuel gas clean-up equipment shall be considered part of the associated equipment.

4.5.2 Biogas fuel system storage tanks and their associated equipment, piping valves, and regulators shall be designed and installed in accordance with NFPA 54, *National Fuel Gas Code*.

4.6 Liquid Fuels (Diesel, JP-4, JP-5 Ethanol, Naphtha Methanol). The design of liquid fuel piping systems and the location and storage of liquid fuels shall be in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

Chapter 5 Ventilation and Exhaust

5.1 General.

5.1.1 All fuel cell power plants shall be provided with a source of ventilation, exhaust, and makeup air in accordance with this chapter.

Exception No. 1: Fuel cell power plants installed outdoors.

Exception No. 2: Listed prepackaged or pre-engineered and matched modular fuel cell power plants that have a sealed, direct ventilation and exhaust system that is installed in accordance with the terms of the listing and manufacturer's installation instructions.

5.1.2* The ventilation and exhaust system shall be designed to provide a negative or neutral pressure in the room.

5.1.3 The air intake and exhaust system shall meet the requirements specified in Sections 3.1, 5.2, and 5.3.

5.1.4 If mechanical ventilation is required, a control interlock shall be provided to shut down the unit upon loss of ventilation.

5.2 Ventilation Air.

5.2.1 A separate mechanical ventilation system shall be provided for the area where a fuel cell power plant is located.

Exception: If it can be verified, natural ventilation shall be permitted to provide all required ventilation and makeup air.

5.2.2 The inlet air vent shall be designed to prevent foreign matter from entering.

5.3 Exhaust Systems.

5.3.1 An exhaust system shall be provided for the area where a fuel cell power plant is located. The exhaust system shall be designed such that all emissions are exhausted to a safe location.

5.3.2 The exhaust rate from the room shall not be less than 1 cfm/ft^2 (0.3 m^3/min·m^2) of floor area and not less than 150 cfm (45 m^3/min) of total floor area.

5.3.3 If mechanical exhaust is required, a control interlock shall be provided to shut down the unit upon loss of exhaust.

5.3.4* The exhaust outlet shall be located away from the HVAC air intakes for the building.

5.4 Process Purging and Venting. Pressure tanks and piping intended to be purged, pressure regulators, relief valves, and other potential sources of combustible gas shall be vented to the outside of the building. The vent shall be designed to prevent entry of water or foreign objects.

Chapter 6 Fire Protection

6.1 Fire Protection and Detection.

6.1.1 Site Fire Protection.

6.1.1.1 Sites that have flammable or combustible liquid fuel storage shall have fire hydrants provided in accordance with NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*. The hydrants shall have a water supply of at least 250 gpm (946 L/min) for 2 hours.

6.1.1.2 Fuel cell power plants that do not have flammable or combustible liquid fuel storage and are located outside buildings that have yard or city hydrant protection shall be considered to have adequate site protection. If fuel cell power plants are sited at locations that do not have hydrant protection, then power plants shall be protected in accordance with a Fire Risk Evaluation.

6.1.1.3 Fuel cell power plants located inside buildings shall be protected in accordance with 6.1.6.

6.1.2 Fuel Cell Fire Protection and Detection. Fuel cell power plant enclosures with flammable or combustible contents shall be provided with an automatic fire detection system that is connected to an annunciator at an attended location.

6.1.3 Fire Alarm System. Fire alarms provided for power plants installed in or at buildings with a constantly attended control room shall annunciate an alarm and trouble condition in the control room.

6.1.4 Electrical Equipment and Components.

6.1.4.1 Transformers installed in compartments, in modules, or in rooms that contain fuel cell power plants shall be the dry type. All transformers shall be installed in accordance with NFPA 70, *National Electrical Code*.

6.1.4.2 Oil-filled transformers that have at least 500-gal (1892- L) capacity shall be protected by one of the following:

(1) A minimum spatial separation of 25 ft (7.6 m) between each transformer containment area and other structures
(2) A 2-hour rated fire barrier between adjacent transformers, structures, or switchgear [The barrier shall extend at least 1 ft (30.5 cm) above the transformer and 2 ft (61 cm) beyond the sides.]
(3) An automatic deluge water spray system designed in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, to provide a minimum density of 0.25 gpm/ft^2 (10.2 L/min·m^2) over all surfaces of the transformer

6.1.5 Control Rooms and Distributed Integrated Controls Equipment. If a separate room or building is provided for a fuel cell power plant's monitoring and control, the room or building shall be constructed in accordance with the appropriate building code and shall comply with NFPA *101*, *Life Safety Code*.

6.1.6 Indoor Locations.

6.1.6.1 The room in which the fuel cell power plant and its associated components are located shall be provided with an automatic fire suppression system that is in accordance with applicable NFPA standards.

6.1.6.2 Indoor liquid fuel pumping shall be protected by an automatic wet pipe sprinkler system. Curbing or diking shall be provided around all fuel-handling equipment. The fire suppression shall be designed for a density of 0.25 gpm/ft^2 (10.2 L/min·m^2). An automatic safety shutoff valve shall be interconnected to shut off the fuel supply when the sprinkler system is activated.

Dedicated floor drains shall be provided in accordance with the local plumbing code in all areas protected by sprinkler systems and subject to liquid fuel leaks. The drains shall be sized to handle water and liquid fuel flow for 10 minutes.

6.1.6.3 A combustible gas detection system shall be installed in the fuel cell power plant enclosure or exhaust system or in the room that encloses indoor or enclosed fuel cell power plant installations. The combustible gas detection system shall be arranged to alarm at 25 percent of the lower flammable limit (LEL) and be interlocked to shut down the power plant fuel supply at 60 percent LEL. The LEL used shall be the lowest flammability limits of the gas or gas mixtures.

6.1.6.4 A combustible gas detector that meets the requirements of 6.1.6.3 shall be provided for all indoor or separately enclosed gas compressors.

6.1.6.5 The room or area where the fuel cell power plant is installed shall have a hydrogen detector located where gaseous or liquefied hydrogen is piped into the room or area from outside. The gas detection system shall be arranged to alarm at 25 percent LEL and be interlocked to shut down the power plant fuel supply at 60 percent LEL.

6.2 Fire Prevention and Emergency Planning. A written fire prevention and emergency plan shall be provided and shall include the following, commensurate with the size and location of the fuel cell power plant:

(1) Written information on fire prevention procedures, plant emergency alarms, and egress procedures
(2) Requirements to conduct and document inspections and to identify and address needed remedial actions to correct conditions that increase fire hazards
(3) A written description of the general housekeeping practices and the control of transient combustibles
(4) Written procedures for the handling and storage of flammable and combustible liquids and gases

(5) Written procedures for the control of potential ignition sources
(6) A written procedure that addresses impairments to fire protection systems and other materials, systems, or equipment that impact the level of fire hazards associated with the installation (This procedure shall address at least identification of equipment that is not available for service, personnel to be notified, and required enhancement of fire surveillance.)
(7) The requirements needed to complete a fire report, including an investigation and notification of corrective action to be taken
(8) A listing of frequency and requirements for periodic inspection, testing, and maintenance of the fuel cell power plant emergency systems
(9) Signage prohibiting smoking and nonprocess ignition services within protective enclosures and signage that designates areas where smoking is allowed
(10) Conspicuous posting of the location of the operating instructions and the location of the emergency controls
(11) Requirements for the availability of portable flammable gas detectors at the service entrance to the fuel cell power plant installations
(12) Signage providing instructions on the type of fire-suppressing materials that are prohibited and where they are prohibited
(13) Standard color or distinctive marking on all fuel piping and components (The marking shall be in accordance with ANSI A13.1, *Scheme for the Identification of Piping Gases.*)
(14) A written fire emergency plan that includes the following:
    a. Response to fire alarms and fire system supervisory alarms and notification of personnel identified in the plan
    b. Evacuation of employees and visitors not directly involved in fire-fighting activities for the fire area
    c. Coordination with security forces or other designated personnel to admit public fire department and control traffic and personnel
    d. Fire extinguishment activities and identification of fire water application concerns on operating equipment
    e. Periodic drills to verify viability of the plan
    f. Operator activities during fire emergencies

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 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 1996 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1995 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2000 edition.

NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, 1999 edition.

NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites*, 1999 edition.

NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code*, 1998 edition.

NFPA 54, *National Fuel Gas Code*, 1999 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 1998 edition.

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

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1999 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 1999 edition.

NFPA *101®*, *Life Safety Code®*, 2000 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2000 edition.

NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*, 1999 edition.

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

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 1998 edition.

7.2 Other Publications.

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

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

7.2.2 ANSI Publications. American National Standards Institute, Inc., 11 West 42nd Street, 13th floor, New York, NY 10036.

ANSI A13.1, *Scheme for Identification of Piping Gases*, 1981.

ANSI Z21.83, *American National Standard for Fuel Cell Power Plants*, 1998.

7.2.3 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°*, 1996.

ASTM E 380/ANSI Z210.1, *Metric Practice Guide*, 1999.

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.1.4.1 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.1.4.2 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.1.4.30 Limited Combustible. For more information, see NFPA 259, *Standard Test Method for Potential Heat of Building Materials*. Materials that have neither a flame spread rating greater than 25 nor evidence of continued progressive combustion should be tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

A.1.4.31 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.2 Fuel cell technology is evolving at a rapid rate, and codes and standards criteria are needed to facilitate acceptance of the new technology. Presently, there is only one standard with which fuel cell power plants can be tested — ANSI Z21.83, *American National Standard for Fuel Cell Power Plants*. ANSI Z21.83 applies to a specific size [600 volts and (1 MW)] fuel cell power plant that is prepackaged and shipped as one complete unit. The constraints of ANSI Z21.83 limit the ability to test and list larger power plants or power plants that use fuels other than natural gas or LP-Gas or that are not prepackaged and self-contained. Although ANSI Z21.83 has an upper limit, it might not be totally applicable to smaller fuel cell power plants (e.g., those in the 5 to 10 kW range). In addition, this document does not apply to smaller residential-type appliances or units of less than 50 kW. NFPA 853 therefore provides additional guidance for acceptance of power plant installations that are not within the scope of ANSI Z21.83, commensurate with the need to protect life safety and property and the need of the adopting agencies to be able to uniformly evaluate power plant installations as outside the scope of available equipment standards.

A.4.4 Hydrogen is a colorless, odorless, highly flammable gas or liquid. The flammable range in air at atmospheric pressure is 4.0–75 percent by volume. It has a vapor density of 0.1. Being lighter than air, it can dissipate in open areas but be very explosive in confined spaces. It burns with an intensely hot nonluminous flame that makes it very difficult to judge the boundaries of a fire. Liquid hydrogen is similar to other cryogens that have a high liquid-to-gas volume expansion ratio [1 to 848 at 68°F (20°C)].

A.4.5 Biogas consists primarily of methane (about 50 percent), carbon dioxide (about 40 percent), hydrogen sulfide, water, and small amounts of organic compounds, including halogenated compounds.

A.5.1.2 The ventilation and exhaust system design must consider the manufacturer's air requirements for the fuel cell power plant(s) and any additional equipment that is located within the space.

A.5.3.4 See 3.2.3 for more information on where exhaust outlets must be located.

Appendix B Typical Fuel Cell Power Plant Schematic

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

B.1 Figure B.1 illustrates a typical fuel cell power plant schematic. *(For more information, see the definitions of various types of fuel cell power plants in Section 1.4.)*

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 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, 2000 edition.

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

C.1.2 ANSI Publication. American National Standards Institute, Inc., 11 West 42nd Street, 13th floor, New York, NY 10036.

ANSI Z21.83, *American National Standard for Fuel Cell Power Plants*, 1998.