NFPA 853

Standard for the Installation of Stationary Fuel Cell Power Systems

2007 Edition

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

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NFPA 853

Standard for the

Installation of Stationary Fuel Cell Power Systems

2007 Edition

This edition of NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems*, was prepared by the Technical Committee on Electric Generating Plants. It was issued by the Standards Council on July 28, 2006, with an effective date of August 17, 2006, and supersedes all previous editions.

This edition of NFPA 853 was approved as an American National Standard on August 17, 2006.

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 the 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 general fire protection requirements.

The scope of the 2003 edition was changed significantly from that of the 2000 edition. The 2000 edition did not cover fuel cells smaller than 50 kW; the 2003 edition covered stationary fuel cell power systems of any size.

The changes to the 2007 edition of NFPA 853 are clarifications of existing requirements. The use of the concept of lower flammable limit was changed to correctly distinguish it from lower explosive limit.

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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 using nuclear fuel.

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

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard shall apply to the design, construction, and installation of stationary fuel cell power systems.

1.1.2 The scope of this document shall include the following:

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

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 systems. This standard shall apply to stationary fuel cells of all sizes.

1.3 Application. This standard shall not apply to portable fuel cells nor to fuel cell power systems that are used on any movable structure or vehicle unless the structure or vehicle is made stationary.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6* Units and Formulas. Metric units in this document shall be in accordance with the International System of Units, which is officially abbreviated SI in all languages.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2007 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2007 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2003 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2006 edition.

NFPA 52, *Vehicular Fuel Systems Code,* 2006 edition.

NFPA 54, *National Fuel Gas Code,* 2006 edition.

NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks,* 2005 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2004 edition.

NFPA 70, *National Electrical Code®,* 2005 edition.

NFPA 72®, National Fire Alarm Code®, 2007 edition.

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NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2007 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2002 edition.

NFPA *101®, Life Safety Code®,* 2006 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations,* 2004 edition.

NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials,* 2006 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials,* 2003 edition.

2.3 Other Publications.

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

ANSI A13.1, *Scheme for Identification of Piping Systems*, 1996.

ANSI CSA FC.1, *American National Standard for Fuel Cell Power Systems*, 2004.

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

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

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2007 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2007 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2004 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2006 edition.

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials,* 2003 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

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

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 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 or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Air.

3.3.1.1 ***Exhaust Air.*** Air removed from a space or power system and not reused.

3.3.1.2 ***Ventilation Air.*** The portion of supply air whose source is the outside/outdoors plus any recirculated air that has been treated and is acceptable for use by the power system ventilation system.

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

3.3.3 Combustible. Capable of undergoing combustion.

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

3.3.5* Distributed Integrated Controls (DIC). Systems or integrated controls used to monitor and control the functions of equipment, systems, or plants.

3.3.6 Evaluation.

3.3.6.1 ***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.

3.3.6.2* ***Fire Risk Evaluation.*** A detailed engineering review of a plant's construction features and operating process conducted to ensure that applicable fire prevention and fire protection requirements for safeguarding life and physical property are met.

3.3.7 Fire Damper. A device, installed in an air distribution system, designed to close automatically upon detection of heat to interrupt migratory airflow and to restrict the passage of flame. [**221,** 2006]

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3.3.8 Fire Prevention. Measures directed toward avoiding the inception of fire. [**801,** 2003]

3.3.9 Fire Protection. Methods of providing for fire control or fire extinguishment. [**801,** 2003]

3.3.10 Flammable Liquid. A liquid that has a closed-cup flash point that is below 37.8°C (100°F) and a maximum absolute vapor pressure of 2068 mm Hg (40 psi) at 37.8°C (100°F).

3.3.11 Flash Point. The minimum temperature at which a liquid or a solid emits vapor sufficient to form an ignitable mixture with air near the surface of the liquid or the solid.

3.3.12* Fuel Cell Power System. A generator system that converts the chemical energy of reactants (a fuel and oxidant) by an electrochemical process to electric energy (direct current or alternating current electricity) and thermal energy.

3.3.12.1* ***Engineered and Field-Constructed Fuel Cell Power System.*** A fuel cell power system that is not preassembled or does not have factory-matched components.

3.3.12.2* ***Pre-Engineered and Matched Modular Components Fuel Cell Power System.*** A fuel cell power system that has components that are assembled in a factory in separate modules, such as the fuel cell stack, reformer, and inverter.

3.3.12.3 ***Prepackaged, Self-Contained Fuel Cell Power System.*** A fuel cell power system that is designed as one unit, assembled in a factory, and shipped to site.

3.3.13 Gas.

3.3.13.1* ***Digester Gas.*** The biogas derived by fermentation of organic wastes, such as sewage, animal and food waste, and industrial organic waste.

3.3.13.2* ***Landfill Gas.*** The biogas derived from decomposition of municipal solid waste (landfill).

3.3.14 Hazardous Material (Chemical). A substance that, by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful, is likely to cause death or injury.

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

3.3.15.1* ***Indoor Installation.*** A fuel cell power system completely surrounded and enclosed by walls, a roof, and a floor.

3.3.15.2 ***Outside or Outdoor Installation.*** A power system installation that is not located inside a building or that has only partial weather protection (maximum coverage of a roof and up to 50 percent enclosing walls).

3.3.15.3 ***Portable Fuel Cell Installation.*** A fuel cell generator of electricity that is not fixed in place. A portable appliance utilizes a cord and plug connection to a grid-isolated load and has an integral fuel supply.

3.3.15.4 ***Rooftop Installation.*** A power system installation located on the roof of a building.

3.3.16* Limited Combustible. A building construction 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 (8141 kJ/kg), where tested in accordance with NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, and complies with (a) or (b): (a) materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of ⅛ in. (3.2 mm) that has a flame spread index not greater than 50; and (b) materials, in the form and thickness used, other than as described in (a), having neither a flame spread index 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 index greater than 25 nor evidence of continued progressive combustion. (Materials subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric condition shall be considered combustible.) [**33,** 2007]

3.3.17 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.

3.3.18 Lower Flammable Limit (LFL). The lowest concentration of a flammable gas/vapor in air in which flame is propagated.

3.3.19 Noncombustible. Not capable of igniting and burning when subjected to a fire. [**80,** 2007]

3.3.20 Stationary. Permanently connected and fixed in place.

3.3.21 System.

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

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

3.3.21.3 ***Biogas Fuel Cell System.*** A fuel cell 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 system.

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

3.3.21.5 ***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.

3.3.21.6 ***Exhaust System.*** An air-conveying system for moving materials from a source to a point of discharge. [**91,** 2004]

3.3.22 Ventilation.

3.3.22.1 ***Mechanical Ventilation.*** 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.

3.3.22.2 ***Natural Ventilation.*** 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.

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Chapter 4 General Equipment Configuration

4.1* General.

4.2 Prepackaged, Self-Contained Fuel Cell Power Systems.

4.2.1 Prepackaged, self-contained fuel cell power systems shall be designed, tested, and listed in accordance with ANSI CSA FC.1, *American National Standard for Fuel Cell Power Systems*.

4.2.2 Prepackaged, self-contained fuel cell power systems outside the scope of ANSI CSA FC.1, *American National Standard for Fuel Cell Power Systems*, shall meet the provisions of Section 4.3.

4.3 Pre-Engineered Fuel Cell Power Systems.

4.3.1 Pre-engineered fuel cell power systems and matched modular components shall be designed and tested to meet the intent of ANSI CSA FC.1, *American National Standard for Fuel Cell Power Systems*.

4.3.2 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.

4.4 Engineered and Field-Constructed Fuel Cell Power Systems.

4.4.1 Documentation for engineered and field-constructed fuel cell power systems shall be provided.

4.4.2 Documentation shall include a fire risk evaluation prepared by a registered engineer or third party acceptable to the authority having jurisdiction.

Chapter 5 Siting and Interconnections

5.1 General Siting.

5.1.1 A fuel cell power system(s) and associated equipment, components, and controls shall be sited and installed in accordance with the manufacturer's instructions and meet the following requirements:

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

5.1.2* Where demonstrated by an engineering analysis that the prescriptive requirements in this section are unnecessary to achieve an equivalent level of safety, approved alternatives shall be permitted.

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

5.2 Outdoor Installations.

5.2.1 For outdoor installations, a fuel cell power system and related components shall be designed and constructed for outdoor installation.

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

5.2.3 The exhaust outlet(s) from process areas or areas that contain fuel-bearing components of a fuel cell power system shall be located at least 4.6 m (15 ft) from heating, ventilating, and air-conditioning (HVAC) air intakes, windows, doors, and other openings into buildings.

5.2.3.1 The exhaust outlet(s) shall not be directed onto walkways or other paths of travel for pedestrians.

5.2.3.2 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*.

5.2.4 Security barriers, fences, landscaping, and other enclosures shall not affect the required air flow into or exhaust out of the fuel cell power system and its components.

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

5.3 Indoor Installations. A fuel cell power system and its associated components that are not located in areas designed for industrial uses shall be located in a room that meets the conditions of 5.3.1 through 5.3.6.

5.3.1 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 Resistance of Building Construction and Materials*.

5.3.2 Electrical and piping penetrations and joints associated with the room shall be sealed with approved materials that have a 1-hour fire resistance rating.

5.3.3 Openings between the room and other occupied spaces shall be protected by fire doors and dampers.

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5.3.4 Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, and shall have a minimum fire resistance rating equivalent to that of the barrier.

5.3.5 Fire dampers shall be installed in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

5.3.6 Each room shall be provided with egress in accordance with NFPA *101*, *Life Safety Code*.

5.4 Rooftop Installation.

5.4.1 Fuel cell power systems and components located on rooftops shall be installed in accordance with Section 5.2.

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

5.5 Interconnections with Other Building Systems.

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

5.5.2 Fuel gas connections to the power system(s) or components of a matched modular or field-engineered fuel cell power system shall be in accordance with Chapter 6.

Chapter 6 Fuel Supplies and Storage Arrangements

6.1 General.

6.1.1 The installation and location of fuel cell power system fuel supplies, associated fuel piping, and components and their connection to a stationary fuel cell power system shall be in accordance with this chapter.

6.1.2 All gaseous fuel piping outside the fuel cell power system shall be marked or identified in accordance with ANSI A13.1, *Scheme for Identification of Piping Gases*.

6.2 Natural Gas Fuel Supplies.

6.2.1 Natural Gas.

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

6.2.1.2* Where deodorized gas is stored, piping shall be configured to prohibit reverse flow of natural gas into other buildings or source piping.

6.2.2 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, *Vehicular Fuel Systems Code*.

6.3 Liquefied Petroleum Gas (LP-Gas) Systems and Storage.

6.3.1 The design, location, and installation of liquefied petroleum gas (LP-Gas) storage and piping systems shall comply with NFPA 58, *Liquefied Petroleum Gas Code*.

6.3.2 In the determination of separation distances from the fuel cell power system to LP-Gas containers required by NFPA 58, *Liquefied Petroleum Gas Code*, the power system shall be considered a building.

6.4* Hydrogen Fuel Systems and Storage.

6.4.1 Gaseous Hydrogen Storage. The design, location, and installation of gaseous hydrogen storage shall comply with NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*.

6.4.2 Liquid Hydrogen Storage. The design, location, and installation of liquid hydrogen storage shall comply with NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*.

6.4.3 Hydrogen Piping. Hydrogen piping, valves, and fittings from the hydrogen storage system to the fuel cell power system shall conform to ASME/ANSI B31.3, *Process Piping*, and 6.4.3.1 through 6.4.3.7.

6.4.3.1* An accessible shutoff valve shall be located in the hydrogen piping to the fuel cell power system within 1.8 m (6 ft) of the storage container.

6.4.3.2* The hydrogen supply piping to the fuel cell power system shall be provided with a second accessible shutoff valve that is located within 1.8 m (6 ft) of the power system, unless the power system is enclosed by a room with a 1-hour fire resistance rating as described in Section 5.3.

6.4.3.3 If the power system is enclosed by a room with a 1-hour fire resistance rating, the valve shall be located outside the room.

6.4.3.4 For indoor installation of a power system, where the fuel supply is stored outdoors, an automatic shutoff valve interlocked with gas detection shall be located outside the building that houses the power system in accordance with 8.1.5.

6.4.3.5 Piping, valves, regulators, or other equipment shall be located so that they are not subject to physical damage or otherwise be protected against physical damage.

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

6.4.3.7 Hydrogen containers and associated piping shall be electrically grounded and bonded.

6.5* Biogas Fuel Systems.

6.5.1 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 system.

6.5.2 Additional fuel gas cleanup equipment shall be considered part of the associated equipment.

6.5.3 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*.

6.6* Liquid Fuels. 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*.

6.7 Solid Fuels. Solid fuels acceptable to the authority having jurisdiction shall be permitted to be used as fuel for fuel cell power systems.

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Chapter 7 Ventilation and Exhaust

7.1 General.

7.1.1 All fuel cell power systems shall be provided with a source of ventilation, exhaust, and makeup air in accordance with this chapter, with the exception of the following:

(1) Fuel cell power systems installed outdoors
(2) Listed prepackaged or pre-engineered and matched modular fuel cell power systems 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

7.1.2* The ventilation and exhaust system shall be designed to provide a negative or neutral pressure in the room, with respect to the building.

7.1.3 The air intake and exhaust system shall meet the requirements specified in Sections 5.1, 7.2, and 7.3.

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

7.2 Ventilation Air.

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

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

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

7.3 Exhaust Systems.

7.3.1 An exhaust system shall be provided for the area where a fuel cell power system is located.

7.3.2 The exhaust system shall be designed such that all emissions are exhausted to a safe location.

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

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

7.3.5 The exhaust outlet shall be located as specified in 5.2.3.

7.4 Process Purging and Venting.

7.4.1 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.

7.4.2 The vent shall be designed to prevent entry of water or foreign objects.

Chapter 8 Fire Protection

8.1 Fire Protection and Detection.

8.1.1 Site Fire Protection.

8.1.1.1 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*.

8.1.1.2 The hydrants specified in 8.1.1.1 shall have a water supply of at least 946 L/min (250 gpm) for 2 hours.

8.1.1.3 Fuel cell power systems 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 required site protection.

8.1.1.4 If fuel cell power systems are sited at locations that do not have hydrant protection, power systems shall be protected in accordance with a fire risk evaluation.

8.1.1.5 Fuel cell power systems located inside buildings shall be protected in accordance with 8.1.5.

8.1.2* Fuel Cell Fire Protection and Detection. Fuel cell systems designed and constructed in accordance with Section 4.4 shall be provided with an automatic fire detection and alarm system in accordance with *NFPA 72, National Fire Alarm Code*.

8.1.3 Electrical Equipment and Components.

8.1.3.1 Transformers installed in compartments, in modules, or in rooms that contain fuel cell power systems shall be the dry type.

8.1.3.2 All transformers shall be installed in accordance with NFPA 70, *National Electrical Code*.

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

(1) A minimum spatial separation of 7.6 m (25 ft) between each transformer containment area and other structures
(2) A 2-hour-rated fire barrier between adjacent noncombustible or limited combustible structures, transformers, or switchgear that extend 30.5 cm (1 ft) above the transformer or structure and 61 cm (2 ft) 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 10.2 $L/min \cdot m^2$ (0.25 gpm/ft^2) over all surfaces of the transformer

8.1.4 Control Rooms and Distributed Integrated Controls Equipment. If a separate room or building is provided for a fuel cell power system'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*.

8.1.5 Indoor Installation.

8.1.5.1 Indoor liquid fuel pumps shall be protected by an automatic fire suppression system.

8.1.5.2* Liquid fuel systems shall be provided with curbing, diking, or drainage in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

8.1.5.3 When an automatic fire suppression system is provided, it shall be interconnected to shut off the fuel supply when the suppression system is activated.

8.1.5.4 Combustible gas detector(s) shall be installed in the fuel cell power system enclosure, the exhaust system, or the room that encloses the fuel cell power system installation.

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8.1.5.5 A combustible gas detector that meets the requirements of 8.1.5.4 shall be provided for all indoor or separately enclosed gas compressors.

8.1.5.6 When gaseous or liquefied hydrogen is piped into the room or area from outside, hydrogen detector(s) shall be installed in accordance with 8.1.5.7.

8.1.5.7 The following criteria for combustible gas detection systems, including detection specific to hydrogen, shall be met:

(1) The location of the detection device(s) shall be based on leakage sources and fuel type.
(2) The combustible gas detection system shall be arranged to alarm at 25 percent of the lower flammable limit (LFL) and be interlocked to shut down the power system fuel supply at 60 percent LFL.
(3) The LFL used shall be the lowest flammability limit of the gas or gas mixture.

8.1.5.8* Where leak detection is provided, fuel cell power systems that do not use gaseous fuels and do not generate flammable gas mixtures in any part of their systems shall not be required to have combustible gas detection to be installed.

8.1.5.9 Systems employing liquid fuels shall require leak detection.

8.2 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 system:

(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) 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 affect the level of fire hazards associated with the installation and that also addresses at least identification of equipment not available for service, personnel to be notified, and required enhancement of fire surveillance
(7) Requirements needed to complete a fire report, including an investigation and notification of corrective action to be taken
(8) Listing of frequency and requirements for periodic inspection, testing, and maintenance of the fuel cell power system emergency systems
(9) Signage prohibiting smoking and nonprocess ignition services within protective enclosures and signage that designates areas where smoking is permitted
(10) 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 system installations
(12) Signage providing instructions on the types of fire-suppressing materials that are prohibited and where they are prohibited
(13) Standard color or distinctive marking on all fuel piping and components, with marking in accordance with ANSI A13.1, *Scheme for Identification of Piping Systems*
(14) 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 9 Fuel Cell Power Systems 50 kW or Less

9.1 Chapter Scope. This chapter identifies additional requirements or modifications to Chapters 1 through 8 as they relate directly to fuel cell power systems 50 kW or less.

9.2 Outdoor Installations.

9.2.1 The exhaust outlets of the system shall be located at least 3 m (10 ft) from HVAC air intakes, windows, doors, and other openings into buildings.

9.2.2 The exhaust outlet(s) shall not be directed onto walkways or other paths of travel for pedestrians.

9.3 Indoor Installations.

9.3.1 Fuel cell systems that are supplied by natural gas, propane, or fuel oil and that are located in residences shall not be required to have fire-rated separations.

9.3.2 Fuel cells that are supplied by methanol, ethanol, or other alcohol fuels and that are located in residences shall not be required to have fire-rated separations if the fuel cell power system meets requirements 9.3.6.1 through 9.3.6.4.

9.3.3 Clearances from combustible construction and other combustible materials shall be in accordance with manufacturer's instructions; NFPA 31, *Standard for the Installation of Oil-Burning Equipment*; NFPA 54, *National Fuel Gas Code*; or NFPA 58, *Liquefied Petroleum Gas Code*.

9.3.4 Indoor use of fuel cell power systems that operate without ventilation air from the outside shall be provided with limit controls that will not permit room ambient oxygen levels to drop below 18 percent unless it can be demonstrated by other means that the oxygen level will not drop below 18 percent.

9.3.5 The exhaust system materials shall be compatible with the exhaust gas and any resulting condensate.

9.3.6 Fuel cell power systems using a flammable liquid as a fuel shall be located outside unless they meet the requirements for indoor installations in Chapters 1 through 8 or meet all the requirements in 9.3.6.1 through 9.3.6.4.

9.3.6.1 The fuel cell power system enclosure plus the connected indoor liquid fuel piping shall contain less than 0.019 m^3 (5 gal) of liquid fuel during all modes of operation, standby, and shutdown.

9.3.6.2 The bulk fuel storage shall be located outside.

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9.3.6.3 The indoor fuel piping shall be of solid pipe or tube or all-welded, soldered, or brazed construction up through the fuel cell power system enclosure.

9.3.6.4 The fuel cell power system shall be equipped with leakage detection and automatic isolation of the indoor fuel piping from the outdoor bulk fuel supply upon detection of fuel leakage using pump stoppage, valve closure, or other appropriate means as determined by the manufacturer. Outdoor bulk fuel storage located at an elevation above the fuel cell power system shall be equipped with an automatic isolation valve at the tank.

9.3.7 Fuel cell power systems that use hydrogen shall be installed in accordance with the manufacturer's instructions and NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks.*

9.3.7.1 Fuel cell systems supplied with a hydrogen fuel supply not exceeding a total of 11.33 m^3 (400 scf) shall not be required to have fire-rated separation.

9.4 Ventilation and Exhaust.

9.4.1 A direct-vented fuel cell power system operating at negative pressure with respect to the room shall not require additional mechanical exhaust from the room or area.

9.4.2 Where the total abnormal gas emission or concentration from the fuel cell power system is nontoxic and cannot attain 25 percent of LFL under normal room or area ventilation, the fuel cell power system shall not be required to supply additional ventilation and exhaust.

9.5 Fire Protection. The requirements of Chapter 8 shall not apply to 50 kW or smaller systems except as modified in 9.5.1 and 9.5.2.

9.5.1 Combustible gas detection shall be installed in accordance with 8.1.5.4 through 8.1.5.6 except where the fuel gas system is listed for indoor use and the fuel is odorized natural gas or LP-Gas.

9.5.2 Fuel cell power systems that meet the requirements of Section 4.2 or Section 4.3 shall not require a written fire prevention and emergency plan.

Annex A Explanatory Material

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

A.1.6 For a full explanation, see IEEE/ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System.*

A.3.2.1 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.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, 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.3.2.4 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.3.3.5 Distributed Integrated Controls (DIC). 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. Also referred to as distributed control system (DCS).

A.3.3.6.2 Fire Risk Evaluation. 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 (e.g., temperature and pressure), the control or elimination of ignition sources, the detection and suppression of fires, and the safeguarding of life.

A.3.3.12 Fuel Cell Power System. The system is composed of all or some of the systems shown in Figure B.1.

A.3.3.12.1 Engineered and Field-Constructed Fuel Cell Power System. The power system is engineered and designed for the assembly of various components from various sources and is installed on site. *(See Figure B.1 for a schematic of a typical fuel cell power system.)*

A.3.3.12.2 Pre-Engineered and Matched Modular Components Fuel Cell Power System. The modules are matched to be installed in the field.

A.3.3.13.1 Digester Gas. Digester gas can contain approximately 50 percent methane and approximately 25 percent carbon dioxide (CO_2). Trace contaminants can include sulfur (S) and chlorine (Cl) compounds.

A.3.3.13.2 Landfill Gas. Landfill gas is approximately 50 percent methane and approximately 20 percent CO_2. Trace contaminants can include sulfur (S), chlorine (Cl), water (H_2O), and oxygen (O_2) introduced by air leakage into the collection system.

A.3.3.15.1 Indoor Installation. An indoor installation can be a separate building, room, or area within a building.

A.3.3.16 Limited Combustible. For more information, see NFPA 259, *Standard Test Method for Potential Heat of Building Materials.* Materials that have neither a flame spread index greater than 25 nor evidence of continued progressive combustion

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should be tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials.*

A.4.1 Fuel cell technology is evolving at a rapid rate, and codes and standards criteria are needed to help acceptance of the new technology. Currently, there is only one standard for testing fuel cell power systems, which is ANSI CSA FC.1, *American National Standard for Fuel Cell Power Systems.* ANSI CSA FC.1 applies to a specific size fuel cell power system that is prepackaged and assembled as one complete unit. The constraints of ANSI CSA FC.1 limit the ability to test and list larger power plants or power systems that use fuels other than natural gas or LP-Gas or that are not prepackaged and self-contained.

NFPA 853 provides additional guidance for acceptance of power system installations that are not within the scope of ANSI CSA FC.1, commensurate with the need to protect life safety and property and the need of the adoption agencies to be able to uniformly evaluate power system installations outside the scope of available equipment standards.

A.5.1.1(5) For additional information on hazardous atmospheres, see NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

A.5.1.2 The siting of a fuel cell power system depends on many variables relating to the unit size, fuel, and failure mode.

A.6.2.1.2 One method of doing so would be the use of check valves.

A.6.4 Hydrogen is a colorless, odorless, highly flammable gas or liquid. The flammable range in air at atmospheric pressure is 4.0 percent to 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. Hydrogen 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 20°C (68°F)].

A.6.4.3.1 A cylinder valve meets the intent of 6.4.3.1.

A.6.4.3.2 An inlet shut off valve on the fuel cell system meets the intent of 6.4.3.2.

A.6.5 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.6.6 Examples of such liquid fuels include diesel, JP-4, JP-5, ethanol, and naphtha methanol.

A.7.1.2 The ventilation and exhaust system design should consider the manufacturer's air requirements for the fuel cell power system(s) and any additional equipment that is located within the space.

A.8.1.2 Units meeting ANSI CSA FC.1, *American National Standard for Fuel Cell Power Systems,* requirements have internal devices to monitor for overheating, and smoke and combustible gas releases, interlocked to shut down the fuel cell by isolating the fuel supply. The fire detection and alarm for engineered and field-constructed fuel cell power systems should provide for these internal hazards as well as hazards outside the fuel cell. If a fire alarm system is provided for the site or facility where a prepackaged and pre-engineered fuel cell is installed, the process monitors interlocked to shut down the fuel cell should be monitored by the fire alarm system.

A.8.1.5.2 The combination of curbs and drains should be sized to handle the combined discharge from automatic sprinklers and a fuel spill for a minimum of 10 minutes.

A.8.1.5.8 An example of such a system is a direct methanol fuel cell power system.

Annex B Typical Fuel Cell Power System

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

B.1 Figure B.1 presents a generalized stationary fuel cell power system schematic. *(For more information, see the definitions of various types of fuel cell power systems in Section* 3.3.*)*

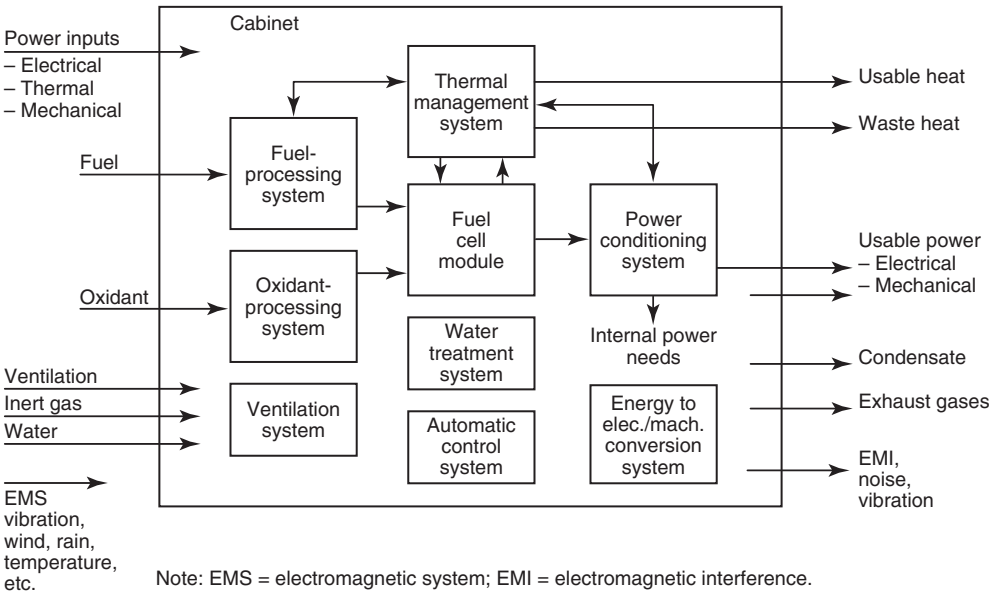


FIGURE B.1 Typical Fuel Cell Power System.

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Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, 2006 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2003 edition.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2004 edition.

C.1.2 Other Publications.

C.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 3rd Street, 4th Floor, New York, NY 10036.

ANSI CSA FC.1, *American National Standard for Fuel Cell Power Systems*, 2004.

C.1.2.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

IEEE/ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 2002.

C.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

C.2.1 CGA Publications. Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151–2923.

CGA G-5, *Hydrogen*, 1991.

CGA G-5.4, *Standard for Hydrogen Piping Systems at Consumer Locations*, 2001.

CGA G-5.5, *Hydrogen Vent Systems*, 1996.

C.3 References for Extracts in Informational Sections. (Reserved)

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- Committee meets to act on Proposals, to develop its own Proposals, and to prepare its Report.
- Committee votes by written ballot on Proposals. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Proposals (ROP) is published for public review and comment.

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- "*Notices of intent to make a motion"* are filed, are reviewed, and valid motions are certified for presentation at the Technical Report Session. ("Consent Documents" that have no certified motions bypass the Technical Report Session and proceed to the Standards Council for issuance.)
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Revise definition of effective ground-fault current path to read:

3.3.78 Effective Ground-Fault Current Path. An intentionally constructed, permanent, low impedance electrically conductive path designed and intended to carry ~~underground~~ electric fault current ~~conditions~~ from the point of a ground fault on a wiring system to the electrical supply source.

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