

NFPA® 851

Recommended Practice for Fire Protection for Hydroelectric Generating Plants

2010 Edition



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

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ISBN: 978-087765944-0 (Print)
ISBN: 978-087765992-1 (PDF)

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NFPA® 851

Recommended Practice for

Fire Protection for Hydroelectric Generating Plants

2010 Edition

This edition of NFPA 851, *Recommended Practice for Fire Protection for Hydroelectric Generating Plants*, was prepared by the Technical Committee on Electric Generating Plants. It was issued by the Standards Council on October 27, 2009, with an effective date of December 5, 2009, and supersedes all previous editions.

This edition of NFPA 851 was approved as an American National Standard on December 5, 2009.

Origin and Development of NFPA 851

The Committee on Non-Nuclear Power Generating Plants was organized in 1979 to have primary responsibility for documents on fire protection for non-nuclear electric generating plants. The Hydroelectric Subcommittee was formed in 1982 to write this document. The first edition of NFPA 851 was issued in 1987 and revised in 1992. The 1996 edition contained minor changes to clarify the life safety recommendations and generator windings protection. The 2000 edition editorially revised Chapter 2 to be consistent with NFPA 850, *Recommended Practice for Fire Protection of Electric Generating Plants and High Voltage Direct Current Converter Stations*. In addition, the document was revised to clarify the requirements for fire suppression systems for generator windings of different composition.

The 2005 edition of NFPA 851 was restructured to conform to the requirements of the *Manual of Style for NFPA Technical Committee Documents*. There were changes made to clarify existing recommendations under 5.2.2.3 and 5.2.2.4 using new artwork. Other changes included coordination of similar recommendations from NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*.

The 2010 edition of NFPA 851 now includes a chapter containing recommendations for a fire protection design process and a fire protection design basis document (new Chapter 4). An annex has been added showing an example of a Fire Protection Design Basis document. The chapter on Fire Risk Control Program has been moved to a new Chapter 9.

The use of compressed air foam systems and fast-depressurization systems has been recognized, and recommendations for the use of these systems are now included.

10/27/09 10:00 AM



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

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 the recommendations sections of this document are given in Chapter 2 and those for extracts in the informational sections are given in Annex E. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope. This document provides recommendations (not requirements) for fire prevention and fire protection for hydroelectric generating plants. The term "hydroelectric generating plant" also can be referred to as "station," "project," "unit(s)," "facility," or "site."

1.2 Purpose.

1.2.1 This document provides guidance for those charged with the design, construction, and operation of hydroelectric generating plants.

1.2.2 This document provides fire hazard control recommendations for the safety of construction and operating personnel, the physical integrity of plant components, and the continuity of plant operations. Specific concerns are generalized and categorized in 1.2.2.1 through 1.2.2.4.

1.2.2.1 Protection of Plant Personnel. Risk of injury and loss of life should be controlled in the event of fire. Specific criteria should be established for means of egress. When for plant safety and emergency response reasons personnel are not able to evacuate immediately, specific criteria for assuring their

safety until they can evacuate and safe passage to egress routes should be established.

1.2.2.2 Assets Protection. The large capital costs of the structures, systems, and components for the facilities addressed in this recommended practice create financial risks for the owners, investors, and financiers. Specific criteria should be established for the mitigation of the risks from fires exposing these assets.

1.2.2.3 Business Interruption. The ability of these facilities to generate and transmit electricity is important not only to the owners of the facilities but also to the consumers of that energy, including the public. Specific criteria for managing the effects of fire on the ability to generate and transmit its power should be developed, based on economic and societal considerations.

1.2.2.4 Environmental Protection. Fires in these facilities have the potential of creating environmental impact, by damaging pollution control systems and components and by creating unwanted releases to the environment from the fire and fire-fighting activities. Specific criteria should be established to control the impact of fire and fire-fighting activities on the environment.

1.3 Application.

1.3.1 This document is intended for use by persons knowledgeable in the application of fire protection for electric generating plants and high voltage direct current converter stations.

1.3.2 The recommendations contained in this document are intended for new installations, as the application to existing installations might not be practicable. However, the recommendations contained in this document represent good industry practice and should be considered for existing installations.

1.3.3 It should be recognized that rigid uniformity of generating station design and operating procedures does not exist and that each facility will have its own special conditions that impact the nature of the installation. Many of the specific recommendations herein might require modification after due consideration of all applicable factors involved. This modification should be made only after the methodology described in Chapter 4 and provided in the fire protection design basis document has been followed.

1.4 Equivalency. Nothing in this recommended practice 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 recommended practice.

1.4.1 Equivalency should be demonstrated following the methodology described in Chapter 4 and provided in the fire protection design basis document.

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

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this recommended practice and should be considered part of the recommendations of this document.



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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2010 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2010 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2008 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2009 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2010 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2010 edition.

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

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2007 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2009 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2010 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2008 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2010 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2008 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2008 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2008 edition.

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

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2010 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2009 edition.

NFPA 54, *National Fuel Gas Code*, 2009 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2008 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2010 edition.

NFPA 75, *Standard for the Protection of Information Technology Equipment*, 2009 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2010 edition.

NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, 2007 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2007 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2009 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, 2009 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2008 edition.

NFPA 101®, *Life Safety Code*®, 2009 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2010 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2010 edition.

NFPA 204, *Standard for Smoke and Heat Venting*, 2007 edition.

NFPA 220, *Standard on Types of Building Construction*, 2009 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2009 edition.

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

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, 2008 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, 2006 edition.

NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*, 2007 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2008 edition.

NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*, 2009 edition.

NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2010 edition.

NFPA 600, *Standard on Industrial Fire Brigades*, 2010 edition.

NFPA 601, *Standard for Security Services in Fire Loss Prevention*, 2010 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2010 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2010 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2008 edition.

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*, 2010 edition.

NFPA 1143, *Standard for Wildland Fire Management*, 2009 edition.

NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*, 2008 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2010 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2009 edition.

NFPA 1962, *Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose*, 2008 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2007 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2008 edition.

NFPA Fire Protection Handbook, 20th edition.

2.3 Other Publications.

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

ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*, 2003.

ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2009.

ASTM E 108, *Standard Test Method for Fire Tests of Roof Coverings*, 2007.

ASTM E 814, *Fire Tests of Through-Penetration Fire Stops*, Rev B-94.

ASTM SI 10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 1997.

2.3.2 IEEE Publications. Institute of Electrical and Electronics Engineers, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE 383, *Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations*, 2003.

IEEE 484, *Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations*, 2002.

2.3.3 SFPE Publications. Society of Fire Protection Engineers, 7315 Wisconsin Avenue, Suite 1225 W, Bethesda, MD 20814.

SFPE Engineering Guide to Fire Risk Assessment, 2006.

SFPE Handbook of Fire Protection Engineering, 4th edition.

2.3.4 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 723, *Test for Surface Burning Characteristics of Building Materials*, 2008.

UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2004.

2.3.5 Other Publications.

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

2.4 References for Extracts in Recommendations Sections.

NFPA 30, *Flammable and Combustible Liquids Code*, 2008 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 2007 edition.

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

NFPA 101®, *Life Safety Code®*, 2009 edition.

NFPA 220, *Standard on Types of Building Construction*, 2009 edition.

NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, 2009 edition.

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, 2008 edition.

NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2010 edition.

Chapter 3 Definitions

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

odic 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 Recommended Practice. A document that is similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word "should" to indicate recommendations in the body of the text.

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

3.3 General Definitions.

3.3.1 Combustible. Capable of undergoing combustion.

3.3.2 Compressed Air Foam (CAF). A homogenous foam produced by the combination of water, foam concentrate, and air or nitrogen under pressure.

3.3.3 Fast Depressurization System. A passive mechanical system designed to depressurize the transformer a few milliseconds after the occurrence of an electrical fault.

3.3.4 Fire Area. An area that is physically separated from other areas by space, barriers, walls, or other means in order to contain fire within that area.

3.3.5 Fire Barrier. A continuous membrane or a membrane with discontinuities created by protected openings with a specified fire protection rating, where such membrane is designed and constructed with a specified fire resistance rating to limit the spread of fire, that also restricts the movement of smoke. [101, 2009]

3.3.6 Fire Loading. The amount of combustibles present in a given area, expressed in Btu/ft² (kJ/m²).

3.3.7 Fire Point. The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame in accordance with ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*. [30, 2008]

3.3.8 Fire Prevention. Measures directed toward avoiding the inception of fire. [801, 2008]

3.3.9 Fire Protection. Methods of providing for fire control or fire extinguishment. [801, 2008]

3.3.10 Fire Protection Rating. The time, in minutes or hours, that materials and assemblies used as opening protection have withstood a fire exposure as established in accordance with test procedures of NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, and NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*, as applicable. [850, 2010]

3.3.11 Fire Rated Penetration Seal. An opening in a fire barrier for the passage of pipe, cable, duct, and so forth, that has been sealed so as to maintain a barrier rating.



3.3.12 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials*. [220, 2009]

3.3.13 Fire Risk Evaluation. An evaluation of the plant-specific considerations regarding design, layout, and anticipated operating requirements. The evaluation should result in a list of recommended fire prevention features to be provided based on acceptable means for separation or control of common and special hazards, the control or elimination of ignition sources, and the suppression of fires.

3.3.14 Interior Finish. The exposed interior surfaces of buildings including, but not limited to, fixed or movable walls and partitions, columns, and ceilings. Interior finish materials are grouped as Class A Interior Finish and Class B Interior Finish.

3.3.14.1 Class A Interior Finish. Materials having a flame spread index of 0–25 and a smoke developed index of 0–450 when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Test for Surface Burning Characteristics of Building Materials*. Includes any material with a flame spread index of 25 or less and with a smoke developed index of 450 or less when any element thereof, when tested, does not continue to propagate fire.

3.3.14.2 Class B Interior Finish. Materials having a flame spread index of 26–75 and a smoke developed index of 0–450 when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Test for Surface Burning Characteristics of Building Materials*. Includes any material with a flame spread index of 26 or more but not more than 75 and with a smoke developed index of 450 or less.

3.3.15 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 8141 kJ/kg (3500 Btu/lb), 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 3 mm (1/8 in.) 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]

3.3.16 Liquid.

3.3.16.1 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 37.8°C (100°F). [306, 2009]

3.3.16.2 Flammable Liquid. A liquid that has a closed-cup flash point below 37.8°C (100°F) and a maximum vapor pressure of 2068 mm Hg (40 psia) at 37.8°C (100°F). [30B, 2007]

3.3.16.3 High Fire Point Liquid. A combustible dielectric liquid listed as having a fire point of not less than 572°F (300°C). [850, 2010]

3.3.16.4 Less Flammable Liquid. A combustible dielectric liquid listed as having a fire point of not less than 572°F (300°C).

3.3.17 Noncombustible. Not capable of igniting and burning when subjected to a fire.

3.3.18 Nonflammable Fluid. A nonflammable dielectric fluid that does not have a flash point and is not flammable in air.

3.3.19 Stakeholder. An individual, group of individuals, or an organization that is perceived to affect or be affected by the fire hazards associated with the facility being evaluated. Stakeholders include all those who have a financial, personnel safety, public safety, or regulatory interest in the fire risk, such as the public (e.g., neighbors, community groups, first responders), employees, owner/investor(s), operator, insurer, regulator(s), and design team.

Chapter 4 Fire Protection Design Process

4.1 General.

4.1.1 The fire protection design process should be initiated under the direction of someone experienced in the area of fire protection engineering and having extensive knowledge and experience in power plant operation of the type of plant under consideration.

4.1.2 The creation of the fire protection design basis should be initiated as early in the plant design process as practical to ensure that the fire prevention and fire protection recommendations as described in this document have been evaluated in view of the plant-specific consideration regarding design, layout, and anticipated operating requirements.

4.1.3 Applicable process safety management (PSM) techniques should be considered.

4.1.4 The purpose of the fire protection design basis document (DBD) is to provide a record of the decision-making process in determining the fire prevention and fire protection for specific hazards.

4.1.5 The DBD should be a living document that evolves as the plant design is refined and that will be maintained and revised for the life of the plant.

4.2 Stakeholders.

4.2.1 The stakeholders with an interest in the scope and applicability of the fire protection design should be identified early in the process.

4.2.2 The stakeholders establish goals and objectives and evaluate whether or not the recommendations of NFPA 851 are adequate to meet those goals and objectives. The criteria for acceptability of the level of fire protection should consider the perspective of the various stakeholders.

4.3 Inputs to the Design Process.

4.3.1 General Inputs. In addition to the guidelines in this document, the following list should be reviewed for applicability:

- (1) Codes
 - (a) Building codes — state and local
 - (b) Fire codes — state and local