NFPA® 850

Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations

2015 Edition

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An International Codes and Standards Organization

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This edition of NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, was prepared by the Technical Committee on Electric Generating Plants. It was issued by the Standards Council on November 11, 2014, with an effective date of December 1, 2014, and supersedes all previous editions.

This edition of NFPA 850 was approved as an American National Standard on December 1, 2014.

Origin and Development of NFPA 850

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. Begun early in 1980, the first edition of NFPA 850 was officially released in 1986 as the *Recommended Practice for Fire Protection for Fossil Fueled Steam Electric Generating Plants.*

The second edition of NFPA 850 was issued in 1990 under the revised title of *Recommended Practice for Fire Protection for Fossil Fueled Steam and Combustion Turbine Electric Generating Plants.* This second edition incorporated a new Chapter 6 on the identification and protection of hazards for combustion turbines.

In 1991 the committee changed its name to the Technical Committee on Electric Generating Plants. This simplified name was made to reflect the committee's scope to cover all types of electric generating plants except nuclear.

The 1992 edition of NFPA 850 incorporated a new Chapter 7 on alternative fuel electric generating plants. As part of these changes, the document title was revised to the *Recommended Practice for Fire Protection for Electric Generating Plants.* Various other technical and editorial changes were also made.

The 1996 edition of the standard added a new Chapter 8 on fire protection for high voltage direct current (HVDC) converter stations. In addition, the title was changed to *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations* to incorporate the new chapter.

The 2000 edition revised the application of the document to apply to existing facilities, as it is a good industry practice. Chapter 2 was reorganized to be specific to a fire risk control program. The document also clarified that a single water tank is not a reliable water supply, the spacing of hydrants, and lock-out of five suppression systems, and additional requirements were added for water mist fire suppression systems.

The 2005 edition of NFPA 850 underwent a complete revision to comply with the *Manual of Style for NFPA Technical Committee Documents.* Chapter 2 now contains mandatory references and Chapter 3 now contains definitions, and the subsequent chapters were renumbered.

Additional changes included revised figures in Chapter 5 that are intended to further clarify existing requirements and the addition of new annex material on fire protection requirements.

The 2010 edition of NFPA 850 included a chapter containing recommendations for a fire protection design process and fire protection design basis documentation (the new Chapter 4). The chapter on fire risk control program was moved to Chapter 16. New chapters on wind turbine generating facilities, solar thermal power generation, geothermal power plants, and integrated gasification combined cycle (IGCC) generating facilities (Chapters 10–13) were added.

The use of compressed air-foam systems and fast-depressurization systems were recognized, and recommendations for the use of these systems included.

The 2015 edition has undergone a significant revision with the merger of NFPA 851. The recommendations contained in NFPA 850 and 851 were aligned, and a new chapter (Chapter 14) was created to provide recommendations specific to hydroelectric generating plants. Recommendations for aerosol extinguishing systems have been added. Recommendations for active carbon injection systems have been added to Chapter 7, and Chapter 11 has been expanded to provide recommendations for fire and life safety involving photoelectric solar power plants.

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 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 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 Alternative Fuels. Solid fuels such as municipal solid waste (MSW), refuse derived fuel (RDF), biomass, rubber tires, and other combustibles that are used instead of fossil fuels (gas, oil, or coal) in a boiler to produce steam for the generation of electrical energy.

3.3.2 Biomass. A boiler fuel manufactured by means of a process that includes storing, shredding, classifying, and conveying of forest and agricultural byproducts (e.g., wood chips, rice hulls, sugar cane).

3.3.3 Combustible. Capable of undergoing combustion.

3.3.4 Combustible Material. A 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.

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

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

3.3.7 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.

3.3.8 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*, 2015]

3.3.9 Fire Loading. The amount of combustibles present in a given area, expressed in Btu/ft^2 (kJ/m^2).

3.3.10 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 D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*. [**30**, 2015]

3.3.11 Fire Prevention. Measures directed toward avoiding the inception of fire. [**801**, 2014]

3.3.12 Fire Protection. Methods of providing for fire control or fire extinguishment. [**801**, 2014]

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

3.3.14 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.

3.3.15 Fluid.

3.3.15.1 ***Fire-Resistant Fluid.*** A listed hydraulic fluid or lubricant that is difficult to ignite due to its high fire point and autoignition temperature and that does not sustain combustion due to its low heat of combustion.

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

3.3.16 Fossil Fueled. Fuel containing chemical energy, which has been formed from animal and plant matter over many years (i.e., oil, coal, and natural gas) that are used in a boiler to produce steam for the generation of electrical energy.

3.3.17 High Voltage Direct Current (HVDC) Converter Station. A facility that functions as an electrical rectifier (ac-dc) or an inverter (dc-ac) to control and transmit power in a high voltage network. There are two types of HVDC valves — the mercury arc valve and the present-day technology solid state thyristor valve. Both types of valves present a fire risk due to high voltage equipment that consists of oil-filled converter transformers, wall bushings, and capacitors in addition to various polymeric components.

3.3.18 Interior Finish. The exposed surfaces of walls, ceilings, and floors within buildings. [**5000**, 2015]

3.3.18.1 ***Class A Interior Finish.*** Materials having a flame spread index of 0–25, and a smoke developed index of

4.5.2 During the various stages of the design development and the development of the DBD, assumptions will be made when inadequate or insufficient information is available. These assumptions should be clearly identified and documented in accordance with Section 4.5. As additional information becomes available, the assumptions should be updated or replaced with actual design information and the DBD should be amended as necessary to reflect the more definitive information.

4.5.3 The process identified in 4.5.1 and 4.5.2 should be documented. The format of the document is a statement on general fire protection philosophy for the facility and a comparison of the facility fire protection features to the guidelines in the design chapters; for example, protection of oil hazards and also addressing containment and drainage. A sample table of contents for the DBD is contained in Annex E.

Chapter 5 General Plant Design

5.1 Plant Arrangement.

5.1.1 Fire Area Determination.

5.1.1.1 The electric generating plant and the high voltage direct current converter station should be subdivided into separate fire areas as determined by the Fire Protection Design Basis Document for the purpose of limiting the spread of fire, protecting personnel, and limiting the resultant consequential damage to the plant. Fire areas should be separated from each other by fire barriers, spatial separation, or other approved means.

5.1.1.2 Determination of fire area boundaries should be based on consideration of the following:

(1) Types, quantity, density, and locations of combustible material
(2) Location and configuration of plant equipment
(3) Consequence of losing plant equipment
(4) Location of fire detection and suppression systems

5.1.1.3* Unless consideration of the factors of 5.1.1.2 indicates otherwise or if adequate spatial separation is provided as permitted in 5.1.1.5, it is recommended that fire area boundaries be provided to separate the following:

(1) Cable spreading room(s), and cable tunnel(s) and high voltage lead shafts from adjacent areas
(2) Control room, computer room, or combined control/computer room from adjacent areas
(3) Rooms with major concentrations of electrical equipment, such as a switchgear room or relay room, from adjacent areas
(4) Battery rooms from associated battery chargers, equipment, and adjacent areas
(5) Maintenance shop(s) from adjacent areas
(6) Main fire pump(s) from reserve fire pump(s) where these pumps provide the only source of fire protection water
(7) Fire pumps from adjacent areas
(8) Warehouses from adjacent areas
(9) Emergency generators from each other and from adjacent areas
(10) Fossil fuel–fired auxiliary boiler(s) from adjacent areas
(11) Fuel oil pumping, fuel oil heating facilities, or both, used for continuous firing of the boiler from adjacent areas
(12) Storage areas for flammable and combustible liquid tanks and containers from adjacent areas
(13) Office buildings from adjacent areas
(14) Telecommunication rooms, supervisory control and data acquisition (SCADA) rooms, and remote terminal unit (RTU) rooms from adjacent areas
(15) Adjacent turbine generators beneath the underside of the operating floor
(16) Between the boiler house and the areas of the coal handling system above the bin, bunker, or silo
(17) Fan rooms and plenum chambers from adjacent areas [fire dampers might not be advisable in emergency ventilation ducts *(see Section 5.4)*]
(18) Switchgear area and sulfur hexafluoride (SF_6) switchyard area from adjacent areas

5.1.1.4 Fire barriers separating fire areas should be a minimum of 2-hour fire resistance rating.

5.1.1.5 If a fire area is defined as a detached structure, it should be separated from other structures by an appropriate distance as determined by NFPA 80A evaluation.

5.1.2 Openings in Fire Barriers.

5.1.2.1* All openings in fire barriers should be provided with fire door assemblies, fire dampers, through penetration seals (fire stops), or other approved means having a fire protection rating consistent with the designated fire resistance rating of the barrier. Windows in fire barriers (e.g., control rooms or computer rooms) should be provided with a fire shutter or automatic water curtain. Through penetration fire stops for electrical and piping openings should be listed or should meet the requirements for an "F" rating when tested in accordance with ASTM E814, *Standard Test Method for Fire Tests of Penetration Firestop Systems.* Other test methods for qualifications of penetration seals, such as IEEE 634, *Testing of Fire Rated Penetration Seals,* or ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops,* are permitted to be considered for this application.

5.1.2.2 Fire door assemblies, fire dampers, and fire shutters used in 2-hour–rated fire barriers should be listed and approved for a minimum 1½ hour fire rating. *(See NFPA 80.)*

5.1.3 Hydrogen Storage. Hydrogen storage facilities should be separated from adjacent areas. *(See NFPA 55.)*

5.1.4 Outdoor Oil-Insulated Transformers.

5.1.4.1 Outdoor oil-insulated transformers should be separated from adjacent structures and from each other by firewalls, spatial separation, or other approved means for the purpose of limiting the damage and potential spread of fire from a transformer failure.

5.1.4.2 Determination of the type of physical separation to be used between transformers, control equipment, and building structures should be based on a detailed analysis of the following:

(1) Type and quantity of oil in the transformer
(2) Size of a postulated oil spill (surface area and depth)
(3) Type of construction of adjacent structures
(4) Type and amount of exposed equipment, including high line structures, motor control center (MCC) equipment, breakers, other transformers, and so forth.
(5) Power rating of the transformer
(6) Fire suppression systems provided
(7) Type of electrical protective relaying provided

(8) Availability of replacement transformers (long lead times)
(9)*The existence of fast depressurization systems

Once this analysis has been completed, any decisions made as a result should be included as part of the Fire Protection Design Basis Document.

5.1.4.3* Unless consideration of the factors in 5.1.4.2 indicates otherwise, it is recommended that any oil-insulated transformer containing 500 gal (1893 L) or more of oil be separated from adjacent structures by a 2-hour–rated firewall or by spatial separation in accordance with Table 5.1.4.3. Where a firewall is provided between structures and a transformer, it should extend vertically and horizontally as indicated in Figure 5.1.4.3.

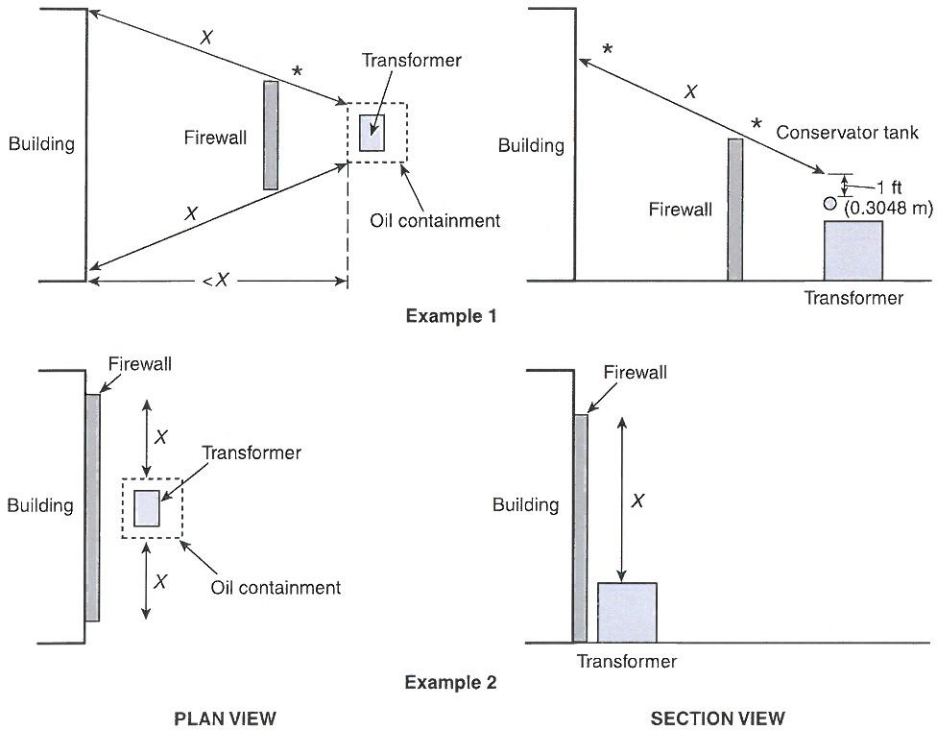
Table 5.1.4.3 Outdoor Oil-Insulated Transformer Separation Criteria

Transformer Oil Capacity		Minimum (Line-of-Sight) Separation Without Firewall	
gal	L	ft	m
<500	<1893	See 5.1.4.2	
500–5000	1893–18,925	25	7.6
>5000	>18,925	50	15

5.1.4.4 Unless consideration of the factors in 5.1.4.2 indicates otherwise, it is recommended that adjacent oil-insulated transformers containing 500 gal (1893 L) or more of oil be separated from each other by a 2 hour–rated firewall or by spatial separation in accordance with Table 5.1.4.3. When the oil containment, as shown in Figure 5.1.4.4, consists of a large, flat concrete containment area that holds several transformers and other equipment in it without the typical pit containment areas, specific containment features to keep the oil in one transformer from migrating to any other transformer or equipment should be provided. Subsection 5.5.7 can be used for guidance. Where a firewall is provided between transformers, it should extend at least 1 ft (0.31 m) above the top of the transformer casing and oil conservator tank and at least 2 ft (0.61 m) beyond the width of the transformer and cooling radiators, or to the edge of the containment area, whichever is greater. *(See Figure 5.1.4.4 for an illustration of the recommended dimensions for a firewall.)*

5.1.4.5* Where a firewall is provided, it should be designed to withstand the effects of projectiles from exploding transformer bushings or lightning arresters.

5.1.4.6 For transformers with less than 500 gal (1893 L) of oil and where a firewall is not provided, the edge of the postulated oil spill (i.e., containment basin, if provided) should be separated by a minimum of 5 ft (1.5 m) from the exposed structure to prevent direct flame impingement on the structure.



X: Minimum separation distance from Table 5.1.4.3.
*: See A.5.1.4.3.

FIGURE 5.1.4.3 Illustration of Oil-Insulated Transformer Separation Recommendations.

explosive range (for deflagrations and detonations) is narrower than the flammability range, but hydrogen explosions can occur inside turbine halls in the event of accidental release and delayed ignition. Under most conditions, it is safer to allow a hydrogen fire to burn in a controlled manner until such time as the gas source can be shut off. Extinguishing the fire while gas is still escaping could allow an explosive mixture to be generated. The Fire Protection Design Basis Document should include provisions so that hydrogen supplies can be shut off from a readily accessible location outside the fire area if called for in an emergency situation.

17.4.6.6 Coal Storage and Handling.

17.4.6.6.1 Once the location and extent of a fire in a coal storage pile have been determined, the coal should be dug out and the heated coal removed. Since moisture accelerates oxidation, water used for fire fighting can aggravate the situation if the seat of the fire is not reached. Water additives should be considered, to break the water tension and improve penetration.

17.4.6.6.2 Clearly marked access panels in equipment should be provided for manual fire fighting. Coal dust presents both a fire and explosion hazard. Combustible, finely divided material is easily ignited. However, there is a possibility that a deep-seated hard-to-extinguish fire can occur. Application of an extinguishing agent that disturbs coal dust deposits could result in a dust explosion.

17.4.6.7 Coal Pulverizers. *(See 9.5.4 of NFPA 85.)* Additional information can be obtained from published manufacturer's instructions.

17.5 Identification of Fire Hazards of Materials. Materials located in the plant or storage areas should be identified in accordance with NFPA 704 and the applicable MSDS.

Annex A Explanatory Material

Annex A is not a part of the recommendations 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.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.5.1.1.3 Where the control room and computer room are separated by a common wall, the wall need not have a fire resistance rating.

A.5.1.2.1 Listed penetration seals for large diameter piping might not be commercially available. In such instances the design should be similar to listed configurations.

Listed penetration seals for the internals of non-segregated phase bus ducts and isolated phase bus ducts can be excluded.

A.5.1.4.2(9) Oil-filled transformer explosions and fires can be prevented in some cases by the installation of a passive mechanical system designed to depressurize the transformer a few milliseconds after the occurrence of an electrical fault. This fast depressurization can be achieved by a quick oil evacuation triggered by the dynamic pressure peak generated by the short circuit. The protection technology activates within milliseconds before static pressure increases, therefore preventing transformer explosion and subsequent fire.

A.5.1.4.3 As a minimum, the firewall should extend at least 1 ft (0.31 m) above the top of the transformer casing and oil conservator tank and at least the width of the transformer oil containment. If columns supporting the turbine building roof at the exterior wall have a 2-hour fire-resistive rating above the operating floor, the firewall need not be higher than required to obtain line-of-sight protection to the height of the operating floor.

A.5.1.4.5 A higher noncombustible shield can be permitted to be provided to protect against the effects of an exploding transformer bushing.

A.5.1.5.2 Where multiple transformers of less than 100 gal (379 L) capacity each are located within close proximity, additional fire protection can be required based on the Fire Protection Design Basis Document.

A.5.2.2 It generally is recognized that boiler and turbine buildings, protected in accordance with this document, meet the intent of NFPA *101* for additional travel distances for fully sprinklered facilities.