

NFPA 850

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

2005 Edition



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

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NFPA 850

Recommended Practice for

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

2005 Edition

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 and acted on by NFPA at its November Association Technical Meeting held November 13–17, 2004, in Miami Beach, FL. It was issued by the Standards Council on January 14, 2005, with an effective date of February 7, 2005, and supersedes all previous editions.

This edition of NFPA 850 was approved as an American National Standard on February 7, 2005.

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 fire suppression systems, and additional requirements were added for water mist fire suppression systems.

The 2005 edition of NFPA 850 has undergone 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 have been renumbered.

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

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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.

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. 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 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 electric generating plants and high voltage direct current converter stations, except as follows: nuclear power plants are addressed in NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*; and hydroelectric plants are addressed in NFPA 851, *Recommended Practice for Fire Protection for Hydroelectric Generating Plants*.

1.2 Purpose.

1.2.1 This document is prepared for the guidance of those charged with the design, construction, operation, and protection of fossil fueled (i.e., coal, gas, or oil) or alternative fueled (i.e., municipal solid waste, refuse derived fuel, biomass, rubber tires, and other combustibles) steam electric generating plants, combustion turbine and internal combustion engine electric generating plants, and high voltage direct current converter stations.

1.2.2 This document provides fire prevention and fire protection recommendations for the safety of construction and operating personnel, the physical integrity of plant components, and the continuity of plant operations.

1.2.3 Nothing in this document is intended to restrict new technologies or alternative arrangements.

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 on the nature of the installation. Many of the specific recommendations herein might require modification after due consideration of all local factors involved.

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

1.4.1 Unless otherwise specified, the provisions of this recommended practice should not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the recommended practice. Where specified, the provisions of this recommended practice should 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 should be permitted to apply retroactively any portions of this recommended practice deemed appropriate.

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*, 2002 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2005 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2005 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2004 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2002 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2003 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2001 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2003 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2002 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2003 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2003 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2002 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2002 edition.

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

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2003 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2001 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2002 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2003 edition.

NFPA 54, *National Fuel Gas Code*, 2002 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 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2002 edition.

NFPA 68, *Guide for Venting of Deflagrations*, 2002 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

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

NFPA 72[®], *National Fire Alarm Code*[®], 2002 edition.

NFPA 75, *Standard for the Protection of Information Technology Equipment*, 2003 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2000 edition.

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

NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, 2001 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2004 edition.

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

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, 2002 edition.

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

NFPA 92A, *Recommended Practice for Smoke-Control Systems*, 2000 edition.

NFPA 101[®], *Life Safety Code*[®], 2003 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2005 edition.

NFPA 204, *Standard for Smoke and Heat Venting*, 2002 edition.

NFPA 214, *Standard on Water-Cooling Towers*, 2005 edition.

NFPA 220, *Standard on Types of Building Construction*, 1999 edition.

NFPA 230, *Standard for the Fire Protection of Storage*, 2003 edition.

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

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

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, 2003 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, 2000 edition.

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

NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*, 2003 edition.

NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*, 2000 edition.

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

NFPA 600, *Standard on Industrial Fire Brigades*, 2005 edition.

NFPA 601, *Standard for Security Services in Fire Loss Prevention*, 2005 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2002 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2004 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2001 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2003 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2004 edition.

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*, 2001 edition.

NFPA 851, *Recommended Practice for Fire Protection for Hydroelectric Generating Plants*, 2005 edition.

NFPA 1143, *Standard for Wildland Fire Management*, 2003 edition.

NFPA 1144, *Standard for Protection of Life and Property from Wildfire*, 2002 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2002 edition.

NFPA 1962, *Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose*, 2003 edition.

NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, 2000 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2004 edition.

2.3 Other Publications.

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

ANSI C2, *National Electrical Safety Code*, 1981.

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

ASME B31.1, *Power Piping*, 1998.

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

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

ASTM D 448, *Standard Classification for Sizes of Aggregate for Road and Bridge Construction*, 2003.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 1994.

ASTM E 814, *Fire Tests of Through-Penetration Fire Stops*, 1994.

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

2.3.4 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*, 1974.

IEEE 484, *Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations*, 1987.

IEEE 634, *Testing of Fire Rated Penetration Seals*, 1978.

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

UL 900, *Standard for Safety Test Performance of Air Filters*, 1995.

UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, 2003.

2.3.6 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1910.156, "Fire Brigades," 1986.

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 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.

3.3.4 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, 2003]

3.3.5 Fire Loading. The amount of combustibles present in a given area, expressed in Btu/ft² (kJ/m²). [851, 2005]

3.3.6 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*. [30, 2003]

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

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

3.3.9 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. [851, 2005]

3.3.10 Fluid.

3.3.10.1 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.

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

3.3.11 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.

3.3.12 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.

3.3.13 Interior Finish. The exposed surfaces of walls, ceilings, and floors within buildings. [5000, 2003]

3.3.13.1 Class A Interior Finish. Materials having flame spread index 0–25, smoke developed index 0–450 when tested in accordance with NFPA 255, *Standard Method of Test of 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.

3.3.13.2 Class B Interior Finish. Materials having flame spread index 26–75, smoke developed index 0–450 when tested in accordance with NFPA 255, *Standard Method of Test of 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.

3.3.14 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 3.2 mm (0.127 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.)

3.3.15 Liquid.

3.3.15.1 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 37.8°C (100°F). (See NFPA 30, *Flammable and Combustible Liquids Code*.)

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

3.3.15.3 High Fire Point Liquid. A combustible dielectric liquid listed as having a fire point of not less than 572°F (300°C).

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

3.3.16 Mass Burn. A process in which municipal solid waste is hauled directly to a tipping floor or storage pit and then is used as a boiler fuel without any special processing.

3.3.17 Municipal Solid Waste (MSW). Solid waste materials consisting of commonly occurring residential and light commercial waste.

3.3.18 Noncombustible. A material that, in the form in which it is used and under the conditions anticipated, will not aid combustion or add appreciable heat to an ambient fire. Materials when tested in accordance with ASTM E 136, *Standard Test*

Method for Behavior of Materials in a Vertical Tube Furnace at 750°C, and conforming to the criteria contained in Section 7 of the referenced standard are considered noncombustible.

3.3.19 Rating.

3.3.19.1 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.

3.3.19.2 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 Endurance of Building Construction and Materials*. [220, 1999]

3.3.20 Refuse Derived Fuel (RDF). A boiler fuel manufactured by means of a process that includes storing, shredding, classifying, and conveying of municipal solid waste.

Chapter 4 Fire Risk Control Program

4.1 General.

4.1.1 This chapter provides recommended criteria for the development of a fire risk control program that contains administrative procedures and controls necessary for the execution of the fire prevention and fire protection activities and practices for electric generating plants and high voltage direct current converter stations.

4.1.2 The fire risk control program recommended in this chapter should be reviewed and updated periodically.

4.1.3 The intent of this chapter can be met by incorporating the features of this chapter in the plant's operating procedures or otherwise as determined by plant management.

4.2 Management Policy and Direction.

4.2.1 Corporate management should establish a policy and institute a comprehensive fire risk control program to promote the conservation of property, continuity of operations, and protection of safety to life by adequate fire prevention and fire protection measures at each facility.

4.2.2 Proper preventative maintenance of operating equipment as well as adequate operator training are important aspects of a viable fire prevention program.

4.3 Fire Risk Control Program. A written plant fire prevention program should be established and as a minimum should include the following:

- (1) Fire safety information for all employees and contractors. This information should include, as a minimum, familiarization with fire prevention procedures, plant emergency alarms and procedures, and how to report a fire.
- (2) Documented regularly scheduled plant inspections including provisions for handling of remedial actions to correct conditions that increase fire hazards.
- (3) A description of the general housekeeping practices and the control of transient combustibles. Fire experience has shown that transient combustibles can be a significant factor during a fire situation, especially during outages.

- (4) Control of flammable and combustible liquids and gases in accordance with appropriate NFPA standards.
- (5) Control of ignition sources including smoking, grinding, welding, and cutting. (See NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.)
- (6) Fire prevention surveillance. (See NFPA 601, *Standard for Security Services in Fire Loss Prevention*.)
- (7) Fire report, including an investigation and a statement on the corrective action to be taken. (See Annex B.)
- (8) Fire hazards of materials located in the plant or storage areas identified in accordance with NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*.

4.4 Fire Protection Program.

4.4.1 Testing, Inspection, and Maintenance.

4.4.1.1 Upon installation, all fire protection systems should be preoperationally inspected and tested in accordance with applicable NFPA standards. Where appropriate standards do not exist, inspection and test procedures outlined in the purchase and design specifications should be followed.

4.4.1.2* All fire protection systems and equipment should be periodically inspected, tested, and maintained in accordance with applicable *National Fire Codes*. (See Table 4.4.1.2 for guidance.)

Table 4.4.1.2 Reference Guide for Fire Equipment Inspection, Testing, and Maintenance

Item	NFPA Document No.
Supervisory and fire alarm circuits	72
Fire detectors	72
Manual fire alarms	72
Sprinkler water flow alarms	25/72
Sprinkler and water spray systems	25/72
Foam systems	11/16/25
Halogenated agent, chemical and CO ₂ systems	12/12A/17/2001
Fire pumps and booster pumps	25/72
Water tanks and alarms	25/72
P.I.V.s and O.S. & Y. valves	25/72
Fire hydrants and associated valves	13/24
Fire hose and standpipes and hose nozzles	1962/25
Portable fire extinguishers	10
Fire brigade equipment	1971
Fire doors and dampers	80/90A
Smoke vents	204
Emergency lighting	110
Radio communication equipment	1221
Audible and visual signals	72
Water mist fire protection systems	750

4.4.1.3 Testing, inspection, and maintenance should be documented with written procedures, results, and follow-up corrective actions recorded and tracked for closure.

4.4.2 Impairments.

4.4.2.1 A written procedure should be established to address impairments to fire protection systems and other plant systems that impact the level of fire hazard (e.g., dust collection

systems, HVAC systems). As a minimum this procedure should address the following:

- (1) Identify equipment not available for service
- (2) Identify personnel to be notified (e.g., plant fire brigade leader, public fire department, plant fire protection coordinator, control room operator)
- (3) Increase fire surveillance as needed [see Section 4.3(6)]
- (4) Provide additional protected measures as necessary (e.g., temporary water supplies, additional hose)

4.4.2.2 Impairment to fire protection systems should be as short in duration as practical. If the impairment is planned, all necessary parts and manpower should be assembled prior to removing the protection system(s) from service. When an impairment is not planned, or when a system has discharged, the repair work or system restoration should be expedited.

4.4.2.3 Proper reinstallation after maintenance or repair should be performed to ensure proper systems operation. Once repairs are complete, tests that will ensure proper operation and restoration of full fire protection equipment capabilities should be made. Following restoration to service, the parties previously notified of the impairment should be advised. The latest revision of the design documents reflecting as-built conditions should be available to ensure that the system is properly reinstalled (e.g., drawings showing angles of nozzles).

4.4.3 Management of Change. A system should be implemented that would ensure that the appropriate individual(s) with fire protection responsibility are made aware of new constructions, modifications to existing structures, changes to operating conditions, or other action that could impact the fire protection of the plant. The fire risk evaluation and the appropriate procedures and programs discussed in this chapter might need to be revised to reflect the impact of this action.

4.4.4* Fire Emergency Plan. A written fire emergency plan should be developed, and, as a minimum, this plan should include the following:

- (1) Response to fire alarms and fire systems supervisory alarms
- (2) Notification of personnel identified in the plan
- (3) Evacuation of employees not directly involved in fire-fighting activities from the fire area
- (4) Coordination with security forces or other designated personnel to admit public fire department and control traffic and personnel
- (5) Fire preplanning that defines fire extinguishment activities
- (6) Periodic drills to verify viability of the plan
- (7) Control room operator(s) and auxiliary operator(s) activities during fire emergencies

4.4.5 Fire Brigade.

4.4.5.1 The size of the plant and its staff, the complexity of fire fighting problems, and the availability of a public fire department should determine the requirements for a fire brigade. NFPA 600, *Standard on Industrial Fire Brigades* and OSHA standard 29 CFR 1910.156, "Fire Brigades," should be consulted for determining operation limitations.

4.4.5.2* If a fire brigade is provided, its organization and training should be identified in written procedures.

4.4.6 Turbine Lubricating Oil Fires.

4.4.6.1 A critical aspect of responding to turbine lubricating oil fires is minimizing the size and duration of the oil spill. The need for lubrication to protect the turbine-generator bearings

and shaft should be balanced against the fire damage from allowing the oil leak to continue. The following steps can be useful in minimizing fire damage and should be considered during preplanning and training for emergency conditions:

- (1) Tripping the turbine
- (2) Breaking condenser vacuum
- (3) Emergency purging of the generator
- (4) Shut down oil pumps

4.4.6.2 Shutting down oil pumps can cause additional mechanical damage to the turbine depending on rotating speed. However, it can be effective in mitigating the overall damage due to fire. (See Annex D.)

4.4.7 Special Fire-Fighting Conditions. Subsection 4.4.7 discusses special fire-fighting conditions unique to fossil fueled steam electric generating plants. This information might be useful in fire preplanning. It could also be utilized in the education and training of both on-site and off-site fire-fighting personnel who would respond in the event of a fire emergency.

4.4.7.1 Regenerative Air Heaters. Since laboratory tests and reported incidents indicated a rapid increase in temperature to the 2800°F–3000°F (1537°C–1648°C) range in an air preheater fire, great care should be given to manual fire fighting. Large amounts of water will be needed to cool and extinguish a preheater fire. Fire preplanning should be accomplished to ensure use of an adequate number of access doors and safe access to the doors.

4.4.7.2 Electrostatic Precipitators. Once a fire is detected, the unit should go into emergency shutdown immediately. It should be recognized that during operation the atmosphere in the precipitator is oxygen-deficient and opening doors or running system fans following a fuel trip could cause conditions to worsen (increased potential for backdraft explosion). Once the flow of air and fuel to the fire has been stopped and the electrostatic precipitator has been shut down and de-energized, the precipitator doors can be permitted to be opened and water hoses employed if necessary.

4.4.7.3 Cable Trays. Cable tray fires should be handled like any fire involving energized electrical equipment. It might not be practical or desirable to de-energize the cables involved in the fire. Water is the most effective extinguishing agent for cable insulation fires but should be applied with an electrically safe nozzle. Some cables [polyvinyl chloride (PVC), neoprene, or Hypalon] can produce dense smoke in a very short time. In addition, PVC liberates hydrogen chloride (HCl) gas. Self-contained breathing apparatus should be used by personnel attempting to extinguish cable tray fires.

4.4.7.4 Hydrogen System. Due to the wide explosive limits of hydrogen (4 percent to 75 percent volume of gas in air), under most conditions it is safer to allow a hydrogen fire to burn in a controlled manner until the gas can be shut off rather than to risk an explosion. It might be necessary to extinguish the fire in order to gain access to the shutoff valves.

4.4.7.5 Coal Storage and Handling.

4.4.7.5.1 Once the location and extent of a fire in a coal storage pile has 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.

4.4.7.5.2 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.

4.4.7.6 Coal Pulverizers. (See NFPA 85, *Boiler and Combustion Systems Hazards Code*.)

4.5 Identification of Fire Hazards of Materials. Materials located in the plant or storage areas should be identified in accordance with NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*.

Chapter 5 General Plant Design

5.1 Fire Risk Evaluation. A fire risk evaluation should be initiated as early in the 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 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. The fire risk evaluation should be approved by the owner prior to final drawings and installation.

5.2 Plant Arrangement.

5.2.1 Fire Area Determination.

5.2.1.1 The electric generating plant and high voltage direct current converter station should be subdivided into separate fire areas as determined by the fire risk evaluation 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.

5.2.1.2 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

5.2.1.3* Unless consideration of the factors of 5.2.1.2 indicates otherwise or if adequate spatial separation is provided as permitted in 5.2.1.5, it is recommended that fire area boundaries be provided to separate the following:

- (1) Cable spreading room(s) and cable tunnel(s) 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 switchgear room and relay room, from adjacent areas
- (4) Battery rooms from 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 internal combustion 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 from adjacent areas
- (15) Adjacent turbine generators beneath the underside of the operating floor

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

5.2.1.5 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, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, evaluation.

5.2.2 Openings in Fire Barriers.

5.2.2.1* 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 E 814, *Fire Tests of Through-Penetration Fire Stops*. 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.

5.2.2.2 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, *Standard for Fire Doors and Fire Windows*.)

5.2.3 Hydrogen Storage. Hydrogen storage facilities should be separated from adjacent areas. (See NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*.)

5.2.4 Outdoor Oil-Insulated Transformers.

5.2.4.1 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.

5.2.4.2 Determination of the type of physical separation to be used should be based on consideration 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) Power rating of the transformer
- (5) Fire suppression systems provided
- (6) Type of electrical protective relaying provided

5.2.4.3* Unless consideration of the factors in 5.2.4.2 indicates otherwise, it is recommended that any oil-insulated transformer containing 500 gal (1890 L) or more of oil be separated from adjacent noncombustible or limited combustible structures by a 2-hour-rated firewall or by spatial separation in accordance with Table 5.2.4.3. Where a firewall is provided between structures and a transformer, it should extend vertically and horizontally as indicated in Figure 5.2.4.3.

Table 5.2.4.3 Outdoor Oil-Insulated Transformer Separation Criteria

Transformer Oil Capacity		Minimum (Line-of-Sight) Separation Without Firewall	
		ft	m
gal	L		
<500	<1,890	See 5.2.4.2	
500–5000	1,890–18,925	25	7.6
>5000	>18,925	50	15

5.2.4.4 Unless consideration of the factors in 5.2.4.2 indicates otherwise, it is recommended that adjacent oil-insulated transformers containing 500 gal (1890 L) or more of oil be separated from each other by a 2-hour-rated firewall or by spatial separation in accordance with Table 5.2.4.3. 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. (See Figure 5.2.4.4 for an illustration of the recommended dimensions for a firewall.)

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

5.2.4.6 For transformers with less than 500 gal (1890 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.

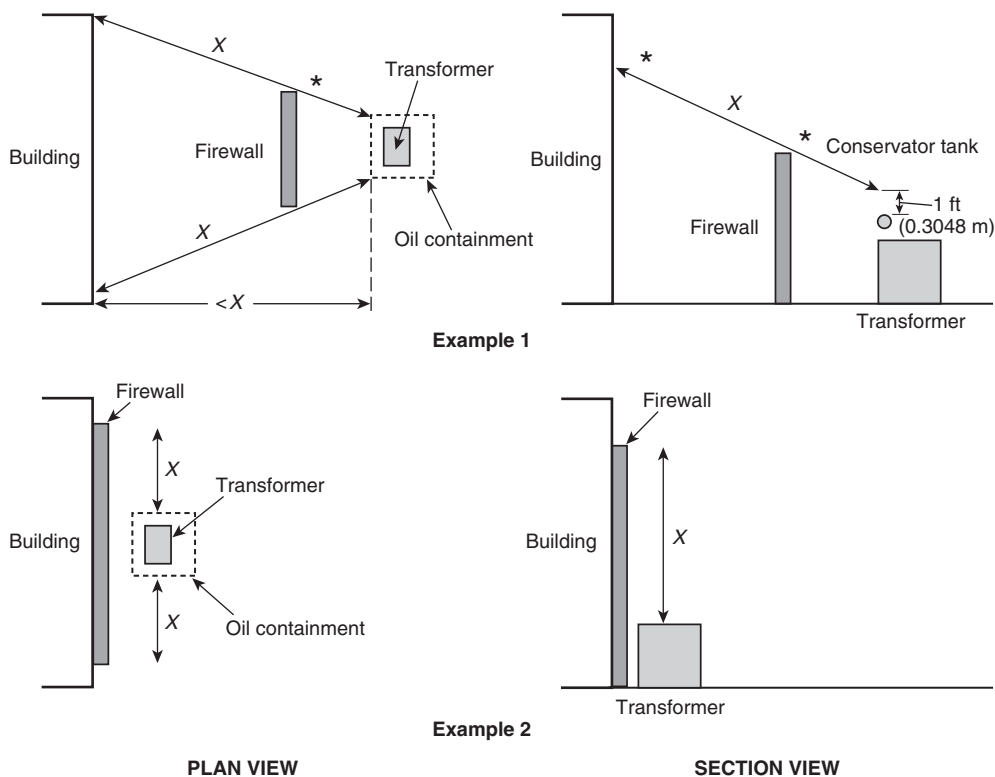
5.2.4.7 Outdoor transformers insulated with a less flammable liquid should be separated from each other and from adjacent structures that are critical to power generation by firewalls or spatial separation based on consideration of the factors in 5.2.4.2 and 5.2.4.5.

5.2.5 Indoor Transformers.

5.2.5.1 Dry-type transformers are preferred for indoor installations.

5.2.5.2* Oil-insulated transformers of greater than 100 gal (379 L) oil capacity installed indoors should be separated from adjacent areas by fire barriers of 3-hour fire resistance rating.

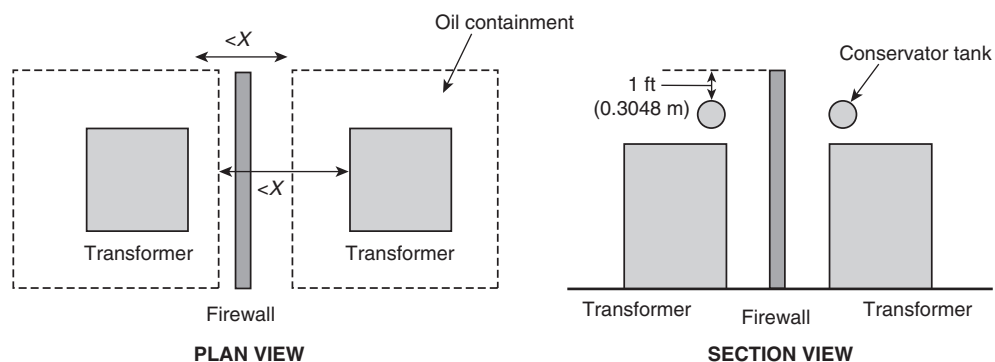
5.2.5.3 Transformers having a rating greater than 35 kV, insulated with a less flammable liquid or nonflammable fluid, and installed indoors should be separated from adjacent areas by fire barriers of 3-hour fire resistance rating.



X: Minimum separation distance from Table 5.2.4.3.

★: See A.5.2.4.3.

FIGURE 5.2.4.3 Illustration of Oil-Insulated Transformer Separation Recommendations.



X: Minimum separation distance from Table 5.2.4.3.

FIGURE 5.2.4.4 Outdoor Oil-Insulated Transformer Separation Criteria.

5.2.5.4 Where transformers are protected by an automatic fire suppression system, the fire barrier fire resistance rating is permitted to be reduced to 1 hour.

5.3 Life Safety.

5.3.1 For life safety for electric generating plants included in the scope of this document, see NFPA 101, *Life Safety Code*.

5.3.2* Structures should be classified as follows, as defined in NFPA 101, *Life Safety Code*.

- (1) General areas should be considered as special purpose industrial occupancies.
- (2) Open structures and underground structures (e.g., tunnels) should be considered as occupancies in special structures.
- (3) General office structures should be considered as business occupancies.
- (4) Warehouses should be considered as storage occupancies.

- (5) Coal preparation and handling facilities (e.g., enclosed crusher houses, transfer houses, and conveyors) should be considered special purpose industrial occupancies.
- (6) Scrubber buildings should be considered as special purpose industrial occupancies.

5.3.3 In the event of a plant fire, egress of occupants in control facilities can be delayed due to emergency shutdown procedures. (See NFPA 101, *Life Safety Code*, 40.2.5.1.2, *Ancillary Facilities with Delayed Evacuation*.) Control facilities should have a means of egress that is separated from other plant areas to facilitate a delayed egress.

5.4 Building Construction Materials.

5.4.1 Construction materials being considered for electric generating plants and high voltage direct current converter stations should be selected based on the fire risk evaluation and on consideration of the following NFPA standards:

- (1) NFPA 220, *Standard on Types of Building Construction*
- (2) NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*
- (3) NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*
- (4) NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*
- (5) NFPA 259, *Standard Test Method for Potential Heat of Building Materials*

5.4.2 Construction materials used in the boiler, engine, or turbine-generator buildings or other buildings critical to power generation or conversion should meet the definition of *noncombustible* or *limited combustible*, except roof coverings, which should be as outlined in 5.4.3, and except for limited use of translucent reinforced plastic panels as allowed by the fire risk evaluation.

5.4.3 The use of material that does not meet the definition of *noncombustible* or *limited combustible*, such as translucent reinforced plastic panels, are permitted in limited applications if the fire risk evaluation demonstrates they are acceptable.

5.4.4 Roof covering should be Class A in accordance with NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*. Metal roof deck construction, where used, should be "Class I" or "fire classified."

5.4.5 Interior Finish.

5.4.5.1 Cellular or foamed plastic materials (as defined in Annex A of NFPA 101, *Life Safety Code*) should not be used as interior finish.

5.4.5.2 Interior finish in buildings critical to power generation or conversion should be Class A.

5.4.5.3 Interior finish in buildings not critical to power generation or conversion should be Class A or Class B.

5.5 Smoke and Heat Venting, Heating, Ventilating, and Air Conditioning.

5.5.1 Smoke and Heat Venting.

5.5.1.1 General. Smoke and heat vents are not substitutes for normal ventilation systems unless designed for dual usage and should not be used to assist such systems for comfort ventilation. Smoke and heat vents should not be left open where they can sustain damage from high wind conditions. Smoke and heat vents should be included in preventative maintenance or surveillance programs to ensure availability in emergency situations.

5.5.1.2 Heat Vents.

5.5.1.2.1 Heat vents should be provided for areas identified by the fire risk evaluation. Where heat vents are provided, heat generated under fire conditions should be vented from its place of origin directly to the outdoors.

5.5.1.2.2 Heat vents in the boiler and turbine building are permitted to be provided through the use of automatic heat vents or windows at the roof eave line. Heat venting in areas of high combustible loading can reduce damage to structural components. (See NFPA 204, *Standard for Smoke and Heat Venting*.)

5.5.1.3 Smoke Vents.

5.5.1.3.1 Smoke venting should be provided for areas identified by the fire risk evaluation. Where smoke venting is provided, smoke should be vented from its place of origin in a manner that does not interfere with the operation of the plant.

5.5.1.3.2 Separate smoke ventilation systems are preferred; however, smoke venting can be integrated into normal ventilation systems using automatic or manually positioned dampers and motor speed control. (See NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*; NFPA 92A, *Recommended Practice for Smoke-Control Systems*; and NFPA 204, *Standard for Smoke and Heat Venting*.) Smoke venting also is permitted to be accomplished through the use of portable smoke ejectors.

5.5.1.3.3 Consideration should be given to smoke venting for the following areas: control room, cable spreading room(s), and switchgear room.

5.5.1.3.4 In the areas with gaseous fire extinguishing systems, the smoke ventilation system should be properly interlocked to ensure the effective operation of the gaseous fire extinguishing system.

5.5.1.3.5 Smoke removal system dampers, where installed, normally are operable only from an area immediately outside of, or immediately within, the fire area served since it is desired to have entry into, and inspection of, the fire area by fire-fighting personnel prior to restoring mechanical ventilation to the fire area. Smoke removal system dampers are permitted to be operable from the control room if provisions are made to prevent premature operation, which can be accomplished using thermal interlocks or administrative controls.

5.5.1.3.6 The fan power supply wiring and controls for smoke exhaust should be located external to the fire area served by the fan or be installed in accordance with the fire risk evaluation.

5.5.2 Normal Heating, Ventilating, and Air-Conditioning Systems.

5.5.2.1 For normal heating, ventilating, and air-conditioning systems, see NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, or NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, as appropriate.

5.5.2.2 Air conditioning for the control room should provide a pressurized environment to preclude the entry of smoke in the event of a fire outside the control room.

5.5.2.3 Plastic ducts, including listed fire-retardant types, should not be used for ventilating systems. Listed plastic fire-retardant ducts with appropriate fire protection are permitted to be used in areas with corrosive atmospheres.

5.5.2.4 Fire dampers (doors) compatible with the rating of the barrier should be provided at the duct penetrations in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, to the fire area unless the duct is protected throughout its length by a fire barrier equal to the rating required of fire barrier(s) penetrated (see Section 5.2).

5.5.2.5 Smoke dampers, where installed, should be installed in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

5.5.2.6 The fresh air supply intakes to all areas should either be located so as to minimize the possibility of drawing products of combustion into the plant, or be provided with automatic closure on detection of smoke. Separation from exhaust air outlets, smoke vents from other areas, and outdoor fire hazards should all be considered.

5.6 Drainage.

5.6.1 Provisions should be made in all fire areas of the plant for removal of liquids directly to safe areas or for containment in the fire area without flooding of equipment and without endangering other areas. (See Annex A of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*.) Drainage and prevention of equipment flooding should be accomplished by one or more of the following:

- (1) Floor drains
- (2) Floor trenches
- (3) Open doorways or other wall openings
- (4) Curbs for containing or directing drainage
- (5) Equipment pedestals
- (6) Pits, sumps, and sump pumps

5.6.2* The provisions for drainage and any associated drainage facilities should be sized to accommodate all of the following:

- (1) The spill of the largest single container of any flammable or combustible liquids in the area
- (2) The maximum expected number of fire hose operating for a minimum of 10 minutes
- (3) The maximum design discharge of fixed fire suppression systems operating for a minimum of 10 minutes

5.6.3 The drainage system for continuous fuel oil-fired boilers should consist of curbs and gutters arranged to confine the area of potential fuel oil discharge. Consideration also should be given to providing the same measures for coal-fired boilers using oil for ignition. Walking surfaces in the vicinity of burners should be made impervious to oil leakage by the use of checkered steel plate, sheet metal drip pans, or other means. Curbs in passageways should have ramps or steps or be otherwise constructed to present no obstacle to foot traffic. Gutter outlet pipes and all other drains should be trapped to prevent the passage of flames and permit the flow of oil. A clearance between the boiler front and the walk structure is required for the differential movement where the heated boiler elongates. This clearance space in the vicinity of the burners should be flashed and counter-flashed with sheet metal or otherwise arranged to allow movement and to redirect dripping oil, which can impinge on the boiler face.

5.6.4 Floor drainage from areas containing flammable or combustible liquids should be trapped to prevent the spread of burning liquids beyond the fire area.

5.6.5 Where gaseous fire suppression systems are installed, floor drains should be provided with adequate seals, or the fire suppression system should be sized to compensate for the loss of fire suppression agent through the drains.

5.6.6 Drainage facilities should be provided for outdoor oil-insulated transformers, or the ground should be sloped such that oil spills will flow away from buildings, structures, and adjacent transformers. Unless drainage from oil spills is accommodated by sloping the ground around transformers away from structures or adjacent equipment, consideration should be given to providing curbed areas or pits around transformers. The pit or drain system or both should be sized in accordance with 5.6.2. If a layer of uniformly graded stone is provided in the bottom of the curbed area or pit as a means of minimizing ground fires, the following should be addressed:

- (1) Sizing of the pit should allow for the volume of the stone.
- (2) The design should address the possible accumulation of sediment or fines in the stone.
- (3) Overflow of the containment pit and/or curbing should be considered in reviewing drainage pathways away from critical structures. Common containment pits for multiple transformers should be avoided.

5.6.6.1 Rock-Filled Pits. Where rock-filled pits are used, the rock should periodically be loosened and turned as necessary to prevent filling of void spaces by dirt, dust, or silt. The frequency is dependent on area of the country and location near manufacturing facilities that generate dust or fly ash.

5.6.6.2 Open Pits. Where an open pit is used, one of the following forms of protection should be provided:

- (1) Automatic sprinkler or water spray protection should be provided for the pit area designed to a discharge density of 0.15 gal/min·ft² (6 mm/min) over the area of the pit.
- (2) A 12 in. (30 cm) thick layer of rock located between steel grating should be provided at the top of the pit. The rock used should be 1.5 in. (3.8 cm) or larger washed and uniformly sized rock (size No. 2, ASTM D 448 *Standard Classification for Sizes of Aggregate for Road and Bridge Construction*).

5.6.7 For facilities consisting of more than one generating unit that are not separated by a fire barrier [see 5.2.1.3(15)], provisions such as a sloped floor, curb, or trench drain should be provided on solid floors where the potential exists for an oil spill, such that oil released from an incident in one unit will not expose an adjacent unit.

5.6.8 For environmental reasons, liquid discharges resulting from oil spills or operation of a fire suppression system might have to be treated (e.g., oil separation).

5.7 Emergency Lighting.

5.7.1 Emergency lighting should be provided for means of egress. (See NFPA 101, *Life Safety Code*.)

5.7.2 Emergency lighting should be provided for critical plant operations areas.

5.8 Lightning Protection. Lightning protection should be provided for those structures having a risk index (R) of 4 or greater when evaluated in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

Chapter 6 General Fire Protection Systems and Equipment

6.1 General. All fire protection systems, equipment, and installations should be dedicated to fire protection purposes.

6.2 Water Supply.

6.2.1 The water supply for the permanent fire protection installation should be based on providing a 2-hour supply for both 6.2.1(1) and 6.2.1(2) as follows:

- (1) Either of the following, whichever is larger:
 - (a) The largest fixed fire suppression system demand
 - (b) Any fixed fire suppression system demands that could reasonably be expected to operate simultaneously during a single event [e.g., turbine under floor protection in conjunction with other fire protection system(s) in the turbine area, coal conveyor protection in conjunction with protection for related coal handling structures during a conveyor fire, adjacent transformers not adequately separated according to 5.2.4]
- (2) The hose stream demand of not less than 500 gpm (1890 L/min)

6.2.2 A reliable water supply should be provided at this facility. The fire risk evaluation should evaluate the need for multiple sources. Factors to consider should include the following:

- (1) Reliability of source
- (2) Capacity of source
- (3) Reliance on water-based fire protection systems
- (4) Availability of alternate and backup sources
- (5) Consequences of loss

6.2.2.1 Potential sources to be considered can include tanks, ponds, rivers, municipal supplies, and cooling tower basins.

6.2.3 Each water supply should be connected to the yard main by separate connections arranged and valve controlled to minimize the possibility of multiple supplies being impaired simultaneously.

6.2.4 In some rivers and tributaries the existence of micro-organisms limits the use of raw water for fire protection without treatment. Consideration of water quality can prevent long-term problems relating to fire protection water supply. Demineralized water and ash water should not be considered for use as a fire protection water source due to excessive corrosion and erosion characteristics.

6.2.5 Fire Pumps.

6.2.5.1 Where multiple fire pumps are required by the fire risk evaluation, the pumps should not be subject to a common failure, electrical or mechanical, and should be of sufficient capacity to meet the fire flow requirements determined by 6.2.1 with the largest pump out of service.

6.2.5.2 Fire pumps should be automatic starting with manual shutdown, except as allowed in NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*. The manual shutdown should be at the pump controllers only. (See NFPA 20.)

6.2.6 Water Supply Tanks.

6.2.6.1 If tanks are of dual-purpose use, a standpipe or similar arrangement should be provided to dedicate the amount determined by 6.2.1 for fire protection use only. (See NFPA 22, *Standard for Water Tanks for Private Fire Protection*.)

6.2.6.2 Where tanks are used, they should be filled from a source capable of replenishing the 2-hour supply for the fire protection requirement in an 8-hour period. The 8-hour (time) requirement for refilling can be permitted to be extended if the initial supply exceeds the minimum storage requirement on a volume per time ratio basis. It normally is preferred for the refilling operation to be accomplished on an automatic basis.

6.3 Valve Supervision. All fire protection water supply and system control valves should be under a periodic inspection program (see Chapter 4) and should be supervised by one of the following methods:

- (1) Electrical supervision with audible and visual signals in the main control room or another constantly attended location.
- (2) Locking valves open. Keys should be made available only to authorized personnel.
- (3) Sealing valves open. This option should be followed only where valves are within fenced enclosures under the control of the property owners.

6.4 Yard Mains, Hydrants, and Building Standpipes.

6.4.1 Yard Mains and Hydrants.

6.4.1.1 Yard mains and outdoor fire hydrants should be installed on the plant site. (See NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.) Hydrant spacing in main plant areas should be a maximum of 300 ft (91.4 m). Hydrant spacing in remote areas such as long-term coal storage should be a maximum of 500 ft (152.4 m).

6.4.1.2 Remotely located plant-related facilities should be reviewed on an individual basis to determine the need for fire protection. If excessively long extensions of underground fire mains are necessary for fire protection at these locations, it can be permitted to supply this need from an available service main in the immediate area. Where common supply piping is provided for service water and fire protection water supply, it should be sized to accommodate both service water and fire protection demands.

6.4.1.3 The supply mains should be looped around the main power block and should be of sufficient size to supply the flow requirements determined by 6.2.1 to any point in the yard loop considering the most direct path to be out of service. Pipe sizes should be designed to encompass any anticipated expansion and future water demands.

6.4.1.4 Indicator control valves should be installed to provide adequate sectional control of the fire main loop to minimize plant protection impairments.

6.4.1.5 Each hydrant should be equipped with a separate shut-off valve located on the branch connection to the supply main.

6.4.1.6 Interior fire protection loops are considered an extension of the yard main and should be provided with at least two valved connections to the yard main with appropriate sectional control valves on the interior loop.

6.4.2 Standpipe and Hose Systems.

6.4.2.1 Standpipe and hose systems should be installed. (See NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.) The standpipe and hose system is an extension of the yard fire main and hydrant system. The hose stations should be capable of delivering the hose stream demand for the various hazards in buildings.