

NFPA 804

Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants

2006 Edition



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

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Standard for

Fire Protection for Advanced Light Water Reactor Electric Generating Plants

2006 Edition

This edition of NFPA 804, *Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants*, was prepared by the Technical Committee on Fire Protection for Nuclear Facilities. It was issued by the Standards Council on January 27, 2006, with an effective date of February 16, 2006, and supersedes all previous editions.

This edition of NFPA 804 was approved as an American National Standard on February 16, 2006.

Origin and Development of NFPA 804

The need for fire protection in nuclear power facilities has been demonstrated in a number of incidents, including the Browns Ferry Fire in 1975 and other more recent incidents in the United States and abroad. Probabilistic risk assessments of existing plants have shown that fire represents one of the largest single contributors to the possibility of reactor damage. This document represents a comprehensive consensus of baseline fire protection requirements for all aspects of advanced light water reactor electric generating plants, including their design, construction, operation, and maintenance.

There were no technical changes made in the 2001 edition. All the changes were in the definitions section to comply with the *NFPA Glossary of Terms*.

The 2006 edition was reorganized to conform to the *Manual of Style for NFPA Technical Committee Documents*.

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Committee Scope: This Committee shall have primary responsibility for documents on the safeguarding of life and property from fires in which radiation or other effects of nuclear energy might be a factor.

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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 mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1* Scope. This standard applies only to advanced light water reactor electric generating plants and provides minimum fire protection requirements to ensure safe shutdown of the reactor, minimize the release of radioactive materials to the environment, provide safety to life of on-site personnel, limit property damage, and protect continuity of plant operation. The fire protection is based on the principle of defense in depth.

1.2 Purpose.

1.2.1 This standard is prepared for the use and guidance of those charged with the design, construction, operation, and regulation of advanced light water reactor electric generating plants.

1.2.2 This standard covers those requirements essential to ensure that the consequences of fire will have minimum impact on the safety of the public and on-site personnel, the physical integrity of plant components, and the continuity of plant operations.

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

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

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

1.4 Units and Formulas. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter unit, which is commonly used in international fire protection, is not part of but is recognized by SI. Conversion factors for these units are found in Table 1.4.

Table 1.4 Metric Units of Measure

Name of Unit	Unit Symbol	Conversion Factor
Bar	bar	1 psi = 0.0689 bar
Bar	bar	1 bar = 10^5 Pa
Cubic decimeter	dm ³	1 gal = 3.785 dm ³
Kilogram	kg	1 lb = 0.4536 kg
Kilopascal	kPa	1 psi = 6.895 kPa
Liter	L	1 gal = 3.785 L
Liter per minute per square meter	L/min·m ²	1 gpm/ft ² = 40.746 L/min·m ²
Meter	m	1 ft = 0.3048 m
Millimeter	mm	1 in. = 25.4 mm
Millimeters of mercury	mm Hg	1 psi = 51.72 mm Hg
Pascal	Pa	1 psi = 6894.757 Pa

Note: For additional conversions and information, see ANSI/IEEE 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 standard and shall be considered part of the requirements of this document.

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2006 edition.

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

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2005 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 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*, 2006 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2006 edition.

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

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

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

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

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

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

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

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1999 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 101[®], *Life Safety Code*[®], 2006 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, 2006 edition.

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

NFPA 220, *Standard on Types of Building Construction*, 2006 edition.

NFPA 232, *Standard for the Protection of Records*, 2000 edition.

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

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

NFPA 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*, 2006 edition.

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

NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*, 2003 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 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2004 edition.

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

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

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2002 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, 25 West 43rd Street, 4th Floor, New York, NY 10036.

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

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

ASME Boiler and Pressure Vessel Code, Section III, 2004.

ASME B31.1 *Power Piping*, 2004.

ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, 1994.

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*, 1990.

ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 1994.

ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 1988.

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.

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

ANSI/IEEE C2, *National Electrical Safety Code*[®], 2002.

IEEE 383, *Standard for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations*, 1974 (rev. 1992).

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

UL 586, *Standard for Test Performance of High-Efficiency Particulate Air Filter Units*, 1996 with revisions through April 2000.

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

2.3.6 Other Publication.

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

2.4 References for Extracts in Mandatory Sections.

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

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

NFPA 220, *Standard on Types of Building Construction*, 2006 edition.

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

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*, 2006 edition.

NFPA 5000[®], *Building Construction and Safety Code*[®], 2006 edition.

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

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

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

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1* Advanced Light Water Reactors (ALWRs). ALWRs are next generation light water reactors.

3.3.2 Alternative Shutdown Capability. The ability to safely shut down the reactor and maintain shutdown using equipment and processes outside the normal reactor shutdown process.

3.3.3* Associated Circuits of Concern. Safety-related and non-safety-related circuits that are not directly required to perform a safe shutdown function and that do not have a required physical separation.

3.3.4 Cable Tray Fire Break. A noncombustible or limited-combustible material installed in vertical or horizontal cable trays to limit fire spread.

3.3.5 Cold Shutdown. A stable nuclear power plant condition in which the affected reactor is subcritical and the average reactor coolant system temperature is less than or equal to 200°F (93°C).

3.3.6* Combustible. Capable of undergoing combustion.

3.3.7 Combustible Liquid. A liquid that has a closed-cup flash point at or above 100°F (37.8°C).

3.3.8* Defense in Depth. A principle aimed at providing a high degree of fire protection by achieving a balance of preventing fires from starting; detecting fires quickly and suppressing those fires that occur, thereby limiting damage; and designing a nuclear power plant to limit the loss of life, property, and environment to fire and to ensure continuity of nuclear power plant operation and safe shutdown capability.

3.3.9* 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. [5000, 2006]

3.3.10* Fire Area Subdivision. A portion of a fire area that is separated from the remainder of the fire area by substantive barriers, which are not necessarily fire rated; by physical features, such as pipe tunnels; by spatial separation.

3.3.11 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, 2006]

3.3.12 Fire Door. A door assembly rated in accordance with NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, and installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*.

3.3.13 Fire Hazards Analysis (FHA). An analysis to evaluate potential fire hazards and appropriate fire protection systems and features to mitigate the effects of fire in any plant location.

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

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

3.3.16 Fire Protection Manager. The person directly responsible for the fire prevention and fire protection program at the plant.

3.3.17* Fire-Rated Cables. Cables with an hourly fire resistance rating based on maintaining functionality when exposed to fire tests in NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials*.

3.3.18 Fire-Rated Internal Conduit Seal. A conduit seal that is a tested and approved hourly rated fire seal in accordance with ASTM E 814, *Fire Tests of Through-Penetration Fire Stops*.

3.3.19 Fire-Rated Penetration Seal. An assembly provided in a fire barrier opening for the passage of pipes, cable trays, and so forth, to maintain the fire resistance rating of the fire barrier.

3.3.20 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, 2006]

3.3.21 Fire-Safe Shutdown. Actions, components, capabilities, and design features necessary to achieve and maintain safe shutdown of the reactor after a fire in a specific fire area.

3.3.22* Fire-Safe Shutdown Component (FSSD). Component (nuclear safety related and non-safety related), equipment, instrument-sensing line, or cable, including associated circuits of concern, that is required to safely shut down a nuclear plant in the event of fire.

3.3.23* First Break. The first place in a conduit run where the interior of the conduit is accessible to install a seal.

3.3.24 Flame Spread Rating. A relative measurement of the surface burning characteristics of building materials when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

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

3.3.26 Free of Fire Damage. The structure, system, or component under consideration that is capable of performing its intended function during and after the postulated fire, as needed.

3.3.27 High Impedance Faults. Fire-induced faults on circuits routed through a common fire area that are assumed to occur simultaneously and have a current magnitude below the trip point for the individual circuits and the sum of the currents generated by the simultaneous occurrence of such faults could trip the main circuit breaker and cause the loss of a safe shutdown power supply.

3.3.28* High-Low Pressure Interface. A valve or set of valves that separates a high-pressure primary coolant system from a low-pressure system.

3.3.29* Industrial Fire Brigade. An organized group of employees within an industrial occupancy who are knowledgeable, trained, and skilled in at least basic fire-fighting operations, and whose full-time occupation might or might not be the provision of fire suppression and related activities for their employer. [600, 2005]

3.3.30 Limited-Combustible Material. Refers to a building construction material not complying with the definition of noncombustible 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, and includes either (1) materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 3.2 mm (1/8 in.) that has a flame spread index not greater than 50, or (2) materials, in the form and thickness used 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, when tested in accordance with NFPA 255, or ASTM E 84. [220, 2006]

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

3.3.32 Normal Operations. All modes of nonemergency nuclear power plant operation, ranging from 0 percent to 100 percent power, which include refueling outages but do not include extended outages when fuel is removed from the reactor.

3.3.33* Nuclear Safety Function. Any function that is necessary to ensure the integrity of the reactor coolant pressure boundary; the capability to shut down the reactor and maintain it in a safe shutdown condition; or the capability to prevent or mitigate the consequences of nuclear power plant conditions that could result in the potential for a significant fraction of allowable off-site releases.

3.3.34* Nuclear Safety Related. Structures, systems, or components that are required to remain functional to ensure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents that could result in potential off-site exposures comparable to regulatory guideline exposures.

3.3.35 Postulated Fire. A fire that is assumed to occur in a specific area of a nuclear plant.

3.3.36* Power Block. Structures that have equipment required for nuclear plant operations.

3.3.37 Redundant Component, System, or Subsystem. A component, system, or subsystem that independently duplicates the essential function of another component, system, or subsystem.

3.3.38 Safe Shutdown. A shutdown with the reactivity of the reactor kept subcritical as specified by the technical specifications for the unit.

3.3.39* Safety Division. The designation applied to a given system or set of nuclear safety-related components that enable the establishment and maintenance of physical, electrical, and functional independence from other redundant systems or sets of components.

3.3.40* Spurious Operation. An unwanted change in state of equipment due to fire-induced faults (e.g., hot shorts, open circuits, or shorts to ground) on its power or control circuitry.

3.3.41 Spurious Signal. A fire-induced signal that could cause the spurious operation of components or equipment that would adversely affect the safe shutdown capability.

Chapter 4 Fire Protection Program

4.1* General.

4.1.1 All elements of the site fire protection program shall be reviewed every 2 years and updated as necessary.

4.1.2 Other review frequencies shall be permitted where specified in site administrative procedures and approved by the authority having jurisdiction.

4.2 Management Policy Direction and Responsibility.

4.2.1 A policy document shall be prepared that defines management authorities and responsibilities and establishes the general policy for the site fire protection program.

4.2.2 The policy document shall designate the senior management person with immediate authority and responsibility for the fire protection program.

4.2.3 The policy document shall define the fire protection interfaces with other organizations and assign responsibilities for the coordination activities.

4.2.4 The policy document shall include the authority for conflict resolution.

4.3 Fire Prevention Program. A fire prevention program shall be established and documented to include all of the following:

- (1) Fire safety information for all employees and contractors, including as a minimum familiarization with plant fire prevention procedures, fire reporting, and plant emergency alarms, including evacuation
- (2) Documented plant inspections, including provisions for handling of remedial actions to correct conditions that increase fire hazards
- (3) Procedures for the control of general housekeeping practices and the control of transient combustibles
- (4) Procedures for the control of flammable and combustible gases in accordance with NFPA standards
- (5) Procedures for the control of ignition sources, such as smoking, welding, cutting, and grinding (*see NFPA 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*)

- (6) Fire prevention surveillance plan (*see* NFPA 601, *Standard for Security Services in Fire Loss Prevention*)
- (7) Fire-reporting procedure, including investigation requirements and corrective action requirements

4.4* Fire Hazards Analysis.

4.4.1 A documented fire hazards analysis shall be made for each site.

4.4.2 The analysis shall document all of the following:

- (1) Physical construction and layout of the buildings and equipment, including fire areas and the fire ratings of area boundaries
- (2)*Inventory of the principal combustibles within each fire subdivision
- (3) Description of the fire protection equipment, including alarm systems and manual and automatic extinguishing systems
- (4) Description and location of any equipment necessary to ensure a safe shutdown, including cabling and piping between equipment
- (5) Analysis of the postulated fire in each fire area, including its effect on safe shutdown equipment, assuming automatic and manual fire protection equipment do not function
- (6) Analysis of the potential effects of a fire on life safety, release of contamination, impairment of operations, and property loss, assuming the operation of installed fire-extinguishing equipment
- (7) Analysis of the potential effects of other hazards, such as earthquakes, storms, and floods, on fire protection
- (8) Analysis of the potential effects of an uncontained fire in causing other problems not related to safe shutdown, such as a release of contamination and impairment of operations
- (9) Analysis of the postfire recovery potential
- (10) Analysis for the protection of nuclear safety-related systems and components from the inadvertent actuation or breaks in a fire protection system
- (11) Analysis of the smoke control system and the impact smoke can have on nuclear safety and operation for each fire area
- (12) Analysis of the emergency planning and coordination requirements necessary for effective loss control, including any necessary compensatory measures to compensate for the failure or inoperability of any active or passive fire protection system or feature

4.5 Procedures. A formal procedure system for all actions pertaining to the fire protection program shall be established, including all of the following:

- (1) Inspection, testing, maintenance, and operation of fire protection systems and equipment, both manual and automatic, such as detection and suppression systems
- (2) Inspection, testing, and maintenance of passive fire protection features, such as fire barriers and penetration seals
- (3) Trend analysis requirements
- (4) Provisions for entering areas with access restrictions
- (5) Training requirements

4.6 Quality Assurance.

4.6.1 A quality assurance program shall be established in accordance with ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, for all of the following aspects of the fire protection program related to nuclear safety:

- (1) Design and procurement document control

- (2)*Instructions, procedures, and drawings
- (3)*Control of purchased material, equipment, and services
- (4)*Inspection
- (5)*Test and test control
- (6)*Inspection, test, and operating status
- (7)*Nonconforming items
- (8)*Corrective action
- (9)*Records
- (10)*Audits

4.6.2 The quality assurance program shall be documented in detail to verify its scope and adequacy.

4.7 Fire Emergency Plan.

4.7.1 A written fire emergency plan shall be established.

4.7.2 As a minimum, this plan shall include the following:

- (1) Response to fire and supervisory alarms
- (2) Notification of plant and public emergency forces
- (3) Evacuation of personnel
- (4) Coordination with security, maintenance, operations, and public information personnel
- (5) Fire extinguishment activities
- (6) Postfire recovery and contamination control activities
- (7) Control room operations during an emergency
- (8) Prefire plan
- (9) Description of interfaces with emergency response organizations, security, safety, and others having a role in the fire protection program, including agreements with outside assistance agencies, such as fire departments and rescue services

4.8 Fire Brigade. A plant fire brigade shall be established as indicated in Chapter 6.

Chapter 5 Fire Prevention and Administrative Controls

5.1* General.

5.2 Plant Inspections.

5.2.1 The owner or a designated manager shall develop, implement, and update as necessary a fire prevention surveillance plan integrated with recorded rounds to all accessible sections of the plant.

5.2.2 Inspections of the plant shall be conducted in accordance with NFPA 601, *Standard for Security Services in Fire Loss Prevention*.

5.2.3 A prepared checklist shall be used for the inspection.

5.2.4 Areas of primary containment and high-radiation areas normally inaccessible during plant operation shall be inspected as plant conditions permit but at least during each refueling outage.

5.2.5 The results of each inspection shall be documented and retained for 2 years.

5.2.5.1 For those plant areas inaccessible for periods greater than 2 years, the most recent inspection shall be retained.

5.3 Control of Combustible Materials.

5.3.1* Plant administrative procedures shall specify appropriate requirements governing the storage, use, and handling of flammable and combustible liquids and flammable gases.

5.3.1.1* An inventory of all temporary flammable and combustible materials shall be made for each fire area, identifying the location, type, quantity, and form of the materials.

5.3.1.2* Temporary but predictable and repetitive concentrations of flammable and combustible materials shall be considered.

5.3.1.3 Combustibles, other than those that are an inherent part of the operation, shall be restricted to designated storage compartments or spaces.

5.3.1.4 Consideration shall be given to reducing the fire hazard by limiting the amount of combustible materials.

5.3.1.5 The storage and use of hydrogen shall be in accordance with NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*.

5.3.1.6 The temporary use of wood shall be minimized.

5.3.1.7 Plant administrative procedures shall specify that if wood must be used in the power block, it shall be listed pressure-impregnated fire-retardant lumber.

5.3.2 Housekeeping.

5.3.2.1 Housekeeping shall be performed in such a manner as to minimize the probability of fire.

5.3.2.2 Accumulations of combustible waste material, dust, and debris shall be removed from the plant and its immediate vicinity at the end of each work shift or more frequently as necessary for safe operations.

5.3.3 Transient Combustible Loading.

5.3.3.1* Plant administrative procedures shall require the following:

- (1) The total fire loads, including temporary and permanent combustible loading, shall not exceed those quantities established for extinguishment by permanently installed fire protection systems and equipment.
- (2) Where limits are temporarily exceeded, the plant fire protection manager shall ensure that appropriate fire protection measures are provided.

5.3.3.2 The fire protection manager or a designated representative shall conduct weekly walk-through inspections to ensure implementation of required controls.

5.3.3.2.1 During major maintenance operations, the frequency of these walk-throughs shall be increased to daily.

5.3.3.2.2 The results of these inspections shall be documented and the documentation retained for a minimum of 2 years.

5.3.3.3 When the work is completed, the plant fire protection manager shall have the area inspected to confirm that transient combustible loadings have been removed from the area.

5.3.3.3.1 Extra equipment shall then be returned to its proper location.

5.3.3.3.2 The results of this inspection shall be documented and retained for 2 years.

5.3.3.4* Only noncombustible panels or flame-retardant tarpaulins or approved materials of equivalent fire-retardant characteristics shall be used.

5.3.3.5 Any fabrics or plastic films used, other than those complying with 5.3.3.4, shall be certified to conform to the large-scale fire test described in NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.

5.3.4 Flammable and Combustible Liquids.

5.3.4.1 Flammable and combustible liquid storage and use shall be in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

5.3.4.2 Where oil-burning equipment, stationary combustion engines, or gas turbines are used, they shall be installed and used in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, or NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, as appropriate.

5.3.4.3 Flammable and combustible liquid and gas piping shall be in accordance with ASME B31.1, *Power Piping*, or ASME Boiler and Pressure Vessel Code, Section III, as applicable.

5.3.4.4 Hydraulic systems shall use only listed fire-resistant hydraulic fluids, except as specified by 5.3.4.5.

5.3.4.5 Where unlisted hydraulic fluids must be used, they shall be protected by a fire suppression system.

5.3.4.6 The ignition of leaked or spilled liquid shall be minimized by the following methods:

- (1)*Keeping the liquid from contact with hot parts of the steam system (wall temperature greater than or equal to ignition temperature), such as steam pipes and ducts, entry valve, turbine casing, reheater, and bypass valve
- (2) Using suitable electrical equipment
- (3) Sealing the insulation of hot plant components to prevent liquid saturation
- (4) Using concentric piping
- (5) Using liquid collection systems

5.4 Control of Ignition Sources.

5.4.1 Plant Administrative Procedures.

5.4.1.1 Plant administrative procedures shall require an in-plant review and prior approval of all work plans to assess potential fire hazard situations.

5.4.1.2 Where potential fire hazards are determined to exist, special precautions shall be taken to define appropriate conditions under which the work is authorized.

5.4.2 Hot Work.

5.4.2.1 The owner or a designated manager shall develop, implement, and update as necessary a welding and cutting safety procedure using NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, and NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, as a guide.

5.4.2.2 Written permission from the fire protection manager or a designated alternate shall be obtained before starting activities involving cutting, welding, grinding, or other potential ignition sources.

5.4.2.3* A permit shall not be issued until all of the following are accomplished:

- (1) An inspection has determined that hot work can be conducted at the desired location.
- (2) Combustibles have been moved away or covered.

- (3) The atmosphere is nonflammable.
- (4) A trained fire watch (with equipment) is posted for the duration of the work and for 30 minutes thereafter, to protect against sparks or hot metal starting fires.

5.4.2.4 All cracks or openings in floors shall be covered or closed.

5.4.3 Smoking.

5.4.3.1 Smoking shall be prohibited at or in the vicinity of hazardous operations or combustible and flammable materials.

5.4.3.2 "No Smoking" signs shall be posted in the areas specified in 5.4.3.1.

5.4.3.3 Smoking shall be permitted only in designated and supervised safe areas of the plant.

5.4.3.4 Where smoking is permitted, safe receptacles shall be provided for smoking materials.

5.4.4 Temporary Electrical Wiring. All temporary electrical wiring shall comply with the following to minimize the ignition of flammable materials:

- (1) Be kept to a minimum
- (2) Be suitable for the location
- (3) Be installed and maintained in accordance with NFPA 70, *National Electrical Code*, or ANSI/IEEE C2, *National Electrical Safety Code*, as appropriate
- (4) Be arranged so that energy shall be isolated by a single switch
- (5) Be arranged so that energy shall be isolated when not needed

5.4.5 Temporary Heating Appliances.

5.4.5.1 Only safely installed, approved heating devices shall be used in all locations.

5.4.5.2 Ample clearance shall be provided around stoves, heaters, and all chimney and vent connectors to prevent ignition of adjacent combustible materials in accordance with NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances* (connectors and solid fuel); NFPA 54, *National Fuel Gas Code* (fuel gas appliances); and NFPA 31, *Standard for the Installation of Oil-Burning Equipment* (liquid fuel appliances).

5.4.5.3 Refueling operations of heating equipment shall be conducted in an approved manner.

5.4.5.4 Heating devices shall be situated so that they are not likely to overturn.

5.4.5.5 Temporary heating equipment, when utilized, shall be monitored and maintained by properly trained personnel.

5.4.6 Open-flame or combustion-generated smoke shall not be used for leak testing.

5.4.7 Plant administrative procedures shall specify appropriate requirements governing the control of electrical appliances in all plant areas.

5.5 Temporary Structures.

5.5.1 Exterior Buildings.

5.5.1.1* Temporary buildings, trailers, and sheds, whether individual or grouped, shall be constructed of noncombustible material and shall be separated from other structures.

5.5.1.2 Temporary buildings, trailers, and sheds and other structures constructed of combustible or limited-combustible material shall be separated from other structures by a minimum distance of 30 ft (9.1 m), unless otherwise permitted by 5.5.1.3.

5.5.1.3 Where all portions of the exposed building (walls, roof) within 30 ft (9.1 m) of the exposure constitute a rated fire barrier, the minimum separation distance shall be permitted to be reduced in accordance with Table 5.5.1.3.

Table 5.5.1.3 Minimum Separation Distances

Exposed Building Fire Barrier Rating (hr)	Exposing Building Without Sprinkler Protection		Exposing Building with Automatic Sprinklers	
	ft	m	ft	m
3	5	1.5	0	0
2	10	3.0	5	1.5
1	20	6.1	10	3.0
<1	30	9.1	15	4.6

5.5.1.4 All exterior buildings, trailers, sheds, and other structures shall have the appropriate type and size of portable fire extinguishers.

5.5.2 Exterior Temporary Coverings. Where coverings are utilized for protection of the outdoor storage of materials or equipment, the following shall apply:

- (1) Only approved fire-retardant tarpaulins or other acceptable materials shall be used.
- (2) All framing material used to support such coverings shall be either noncombustible or fire-retardant pressure-impregnated wood.
- (3) Covered storage shall not be located within 30 ft (9.1 m) of any building.

5.5.3 Interior Temporary Facilities.

5.5.3.1 All interior temporary structures shall be constructed of noncombustible, limited-combustible, or fire-retardant pressure-impregnated wood.

5.5.3.1.1 Structures constructed of noncombustible or limited-combustible materials shall be protected by an automatic fire suppression system unless the fire hazard analysis determines that automatic suppression is not required.

5.5.3.1.2 The structure shall be protected by an automatic fire suppression system if the structure is constructed of fire-retardant pressure-impregnated wood.

5.5.3.2 The use of interior temporary coverings shall comply with the following criteria:

- (1) Be limited to special conditions where interior temporary coverings are necessary
- (2) Be constructed of approved fire-retardant tarpaulins

5.5.3.3 Where framing is required, it shall be constructed of noncombustible, limited-combustible, or fire-retardant pressure-impregnated wood.

5.5.3.4 All interior temporary facilities shall have the appropriate type and size of portable fire extinguisher.

5.6 Impairments.

5.6.1* A written procedure shall be established to address impairments to fire protection systems and features and other plant systems that directly affect the level of fire risk (e.g., ventilation systems, plant emergency communication systems).

5.6.2* Impairments to fire protection systems shall be as short in duration as practical.

5.6.3* Appropriate postmaintenance testing shall be performed on equipment that was impaired to ensure that the system will function properly.

5.6.4 Any change to the design or function of the system after the impairment shall be considered in establishing the testing requirements and shall be reflected in the appropriate design documents and plant procedures.

5.7 Testing and Maintenance.

5.7.1 Upon installation, all new fire protection systems and passive fire protection features shall be preoperationally inspected and tested in accordance with applicable NFPA standards.

5.7.2 Where appropriate test standards do not exist, inspections and test procedures described in the purchase and design specification shall be followed.

5.7.3* Fire protection systems and passive fire protection features shall be inspected, tested, and maintained in accordance with applicable NFPA standards, manufacturers' recommendations, and requirements established by those responsible for fire protection at the plant.

5.7.4 Inspection, testing, and maintenance shall be performed using established procedures with written documentation of results and a program of follow-up actions on discrepancies.

5.7.5* Consideration shall be given to the inspection, testing, and maintenance of nonfire protection systems and equipment that have a direct impact on the level of fire risk within the plant.

Chapter 6 Manual Fire Fighting

6.1 Prefire Plans.

6.1.1 Detailed prefire plans shall be developed for all site areas.

6.1.2* Prefire plans shall detail the fire area configurations and fire hazards to be encountered in the fire area along with any safety-related components and fire protection systems and features that are present.

6.1.3 Prefire plans shall be reviewed and, if necessary, updated at least every 2 years.

6.1.4* Prefire plans shall be available in the control room and made available to the plant fire brigade.

6.2* On-Site Fire-Fighting Capability.

6.2.1 General.

6.2.1.1 A minimum of five plant fire brigade members shall be available for response at all times.

6.2.1.2 Fire brigade members shall have no other assigned normal plant duties that would prevent immediate response to a fire or other emergency as required.

6.2.1.3 The brigade leader and at least two brigade members shall have training and knowledge of plant safety-related systems to understand the effects of fire and fire suppressants on safe shutdown capability.

6.2.1.4 The fire brigade shall be notified immediately upon verification of a fire or fire suppression system actuation.

6.2.2 Fire Fighter Qualifications and Requirements.

6.2.2.1 Plant fire brigade members shall be physically qualified to perform the duties assigned.

6.2.2.2 Each member shall pass an annual physical examination to determine that the fire brigade member can perform strenuous activity.

6.2.2.3 The physical examination shall determine each member's ability to use respiratory protection equipment.

6.2.3 Each fire brigade member shall meet training qualifications as specified in Section 6.3.

6.3 Training and Drills.

6.3.1 Plant Fire Brigade Training.

6.3.1.1 Plant fire brigade members shall receive training consistent with the requirements contained in NFPA 600, *Standard on Industrial Fire Brigades*, or NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, as appropriate.

6.3.1.2* Fire brigade members shall be given quarterly training and practice in fire fighting.

6.3.1.3 A written program shall detail the fire brigade training program.

6.3.1.4 Written records that include but are not limited to the following shall be maintained for each fire brigade member:

- (1) Initial fire brigade classroom and hands-on training
- (2) Refresher training
- (3) Special training schools attended
- (4) Drill attendance records
- (5) Leadership training for fire brigades

6.3.2 Drills.

6.3.2.1 Drills shall be conducted quarterly for each shift to test the response capability of the fire brigade.

6.3.2.2 Fire brigade drills shall be developed to test and challenge fire brigade response, including the following:

- (1) Brigade performance as a team
- (2) Proper use of equipment
- (3) Effective use of prefire plans
- (4) Coordination with other groups

6.3.2.3 Fire brigade drills shall be conducted in various plant areas, especially in those areas identified by the fire hazards analysis to be critical to plant operation and to contain significant fire hazards.

6.3.2.4 Drill records shall be maintained detailing the drill scenario, fire brigade member response, and ability of the fire brigade to perform the assigned duties.

6.3.2.5 A critique shall be held after each drill.

6.4 Fire-Fighting Equipment.

6.4.1* The plant fire brigade shall be provided with equipment that enables its members to adequately perform their assigned tasks.

6.4.2 Fire brigade equipment shall be tested and maintained.

6.4.3 Written records shall be retained for review.

6.5 Off-Site Fire Department Interface.

6.5.1 Mutual Aid Agreement.

6.5.1.1 A mutual aid agreement shall be offered to the local off-site fire department.

6.5.1.2 Where possible, the plant fire protection manager and the off-site fire authorities shall develop a plan for their interface.

6.5.1.3 The fire protection manager also shall consult with the off-site fire department to make plans for fire fighting and rescue, including assistance from other organizations, and to maintain these plans.

6.5.1.4 The local off-site fire department shall be invited to participate in an annual drill.

6.5.2 Site-Specific Training.

6.5.2.1 Fire fighters from the off-site fire department who are expected to respond to a fire at the plant shall be familiar with the plant layout.

6.5.2.2 The access routes to fires in the controlled area (to which access doors are locked) shall be planned in advance.

6.5.2.3* The off-site fire department shall be offered instruction and training in radioactive materials, radiation, and hazardous materials that could be present.

6.5.3 Security and Health Physics.

6.5.3.1* Plant management shall designate a plant position to act as a liaison to the off-site fire department when it responds to a fire or other emergency at the plant.

6.5.3.2 Plant management shall ensure that the off-site fire department personnel are escorted at all times and emergency actions are not delayed.

6.6 Water Drainage. The fire brigade shall have at its disposal the necessary equipment to assist with routing water from the affected area.

6.7 Fire-Fighting Access.

6.7.1 All plant areas shall be accessible for fire-fighting purposes.

6.7.2 Prefire plans shall identify those areas of the plant that are locked and have limited access for either security or radiological control reasons.

6.7.2.1 Provisions shall be made to allow access to the locked areas, including having security and health physics personnel respond to the fire area along with the fire brigade, if necessary.

6.7.2.2 Health physics personnel shall confer with the fire brigade leader to determine the safest method of access to any radiologically controlled area.

6.8 Radiation Shielding.

6.8.1 Full advantage shall be taken of all fixed radiation shielding to protect personnel responding for fire suppression purposes.

6.8.2 Health physics personnel shall advise the fire brigade leader of the best method for affording radiological protection.

6.9* Smoke and Heat Removal. If fixed ventilation systems are not capable of removing smoke and heat, the fire brigade shall utilize portable ventilation equipment. (*See Section 8.4.*)

Chapter 7 Nuclear Reactor Safety Considerations

7.1* General.

7.2 Fire-Safe Shutdown Analysis (FSSA). A fire-safe shutdown analysis (FSSA) shall be prepared and maintained for the operating life of the reactor, and shall include, as a minimum, all of the following:

- (1) Fire hazards analysis (FHA)
- (2) Safe shutdown analysis (SSA)
- (3) Internal plant examination of external fire events for severe accident vulnerabilities

7.2.1 Fire Hazards Analysis. The fire hazards analysis shall include the criteria indicated in Section 4.4.

7.2.2 Safe Shutdown Analysis. A safe shutdown analysis of the effects of a fire on those essential structures, systems, and components required to safely shut down the plant and maintain it in a safe shutdown condition shall be performed, including, as a minimum, the requirements of this section.

7.2.2.1 A safe shutdown system available/unavailable calculation or table that provides the following shall be prepared and maintained for each fire area:

- (1) The document shall identify all safe shutdown equipment that is operable or inoperable due to the effects of a fire in that fire area.
- (2) The document shall demonstrate compliance with the requirements of Sections 7.3 and 7.4.

7.2.2.2* A shutdown logic diagram shall be available that identifies the conditions necessary to achieve and maintain safe shutdown capability in the event of a fire and those plant features necessary to realize these conditions, including auxiliary and support features.

7.2.3 Internal Plant Examination of External Fire Events for Severe Accident Vulnerabilities. A risk assessment that estimates the potential risk from a fire in relation to the plant's core damage frequency shall be prepared.

7.2.3.1* An industry-accepted examination process shall be used for the risk assessment.

7.2.3.2* An acceptable risk assessment shall demonstrate that the probability of core damage as a result of an internal fire is less than 1×10^{-6} per reactor year.

7.2.3.3 The internal plant examination of external fire events for severe accident vulnerabilities shall be used to evaluate the level of safety of the plant and shall not be used to reduce the overall plant fire protection design basis.

7.3 Design Basis Events and Requirements.

7.3.1 Fire.

7.3.1.1 Only one fire shall be assumed to occur at a given time, and for the purpose of a safe shutdown analysis, damage shall be assumed to occur immediately.

7.3.1.2* All components, including electrical cables, that are susceptible to fire damage in a single fire area (except primary containment and annulus areas) shall be assumed to be disabled or to be spuriously actuated, whichever is the worst case.