

NFPA® 804

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

2015 Edition



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NFPA® 804

Standard for

Fire Protection for Advanced Light Water Reactor Electric Generating Plants

2015 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 November 11, 2014, with an effective date of December 1, 2014, and supersedes all previous editions.

This edition of NFPA 804 was approved as an American National Standard on December 1, 2014.

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, first released in 1995, 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.

For the 2010 edition, the document scope was revised in order to coordinate with the release of and option to use a new risk-informed option for atomic power plants under NFPA 806, *Performance-Based Standard for Fire Protection for Advanced Nuclear Reactor Electric Generating Plants Change Process*. The 2010 edition was also harmonized with other documents in the field, and a new Annex B was added for best practice guidance for defense against fires and explosions.

The 2015 edition of the document has been updated to remove references to NFPA 251, which has been withdrawn. Changes also have been made to include from NFPA 101 and NFPA 1144 the definition and requirements pertaining to combustible, noncombustible, and limited combustible materials.



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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 C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1* Scope. 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. For plants that have adopted a risk-informed, performance-based approach to fire protection, subsequent changes to the fire protection program shall be made in accordance with NFPA 806.

1.2 Purpose.

1.2.1 This standard is prepared for use by 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	L/min·m ²	1 gpm/ft ² = 40.746 L/min·m ²
per square meter		
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 IEEE/ASTM SI 10, *American National Standard for Metric Practice*.

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*, 2013 edition.

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

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2015 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2013 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2012 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2015 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2013 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2013 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2013 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2013 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2015 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2011 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2015 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.

NFPA 54, *National Fuel Gas Code*, 2015 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2013 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.

NFPA 70®, *National Electrical Code®*, 2014 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition.

NFPA 75, *Standard for the Protection of Information Technology Equipment*, 2013 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2013 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2015 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2015 edition.

NFPA 101®, *Life Safety Code®*, 2015 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, 2013 edition.

NFPA 214, *Standard on Water-Cooling Towers*, 2011 edition.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

NFPA 232, *Standard for the Protection of Records*, 2012 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2013 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, 2012 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, 2015 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2013 edition.

NFPA 600, *Standard on Facility Fire Brigades*, 2015 edition.

NFPA 601, *Standard for Security Services in Fire Loss Prevention*, 2015 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2015 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2014 edition.

NFPA 806, *Performance-Based Standard for Fire Protection for Advanced Nuclear Reactor Electric Generating Plants Change Process*, 2015 edition.

NFPA 1143, *Standard for Wildland Fire Management*, 2014 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2013 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2015 edition.

2.3 Other Publications.

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

ASME Boiler and Pressure Vessel Code, Section III, 2013.

ASME B31.1, *Power Piping*, 2012.

ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, 2012.

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

ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, 2012.

ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2013.

ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2012.

ASTM E 814, *Fire Tests of Through-Penetration Fire Stops*, 2013.

ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-Shaped Airflow Stabilizer*, at 750°C, 2012.

2.3.3 IEEE Publications. IEEE, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

ANSI/IEEE C2, *National Electrical Safety Code®*, 2012.

IEEE 383, *Standard for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations*, 1974 (rev. 2003).

IEEE 1202, *Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies*, 2006.

IEEE/ASTM SI 10, *American National Standard for Metric Practice*, 2010.

2.3.4 NEI Publications. Nuclear Energy Institute, 1776 I Street, NW, Suite 400, Washington, DC 20006-3708.

NEI 00-01, *Guidance for Post-Fire Safe Shutdown Circuit Analysis*, prepared by NEI Circuit Failure Issues Task Force, October 2002.

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

ANSI/UL 586, *Standard for Test Performance of High-Efficiency Particulate Air Filter Units*, 2009.

ANSI/UL 723, *Test for Surface Burning Characteristics of Building Materials*, 2008, revised 2010.

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

UL 2196, *Standard for Tests of Fire Resistive Cables*, 2002.

2.3.6 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 101®, *Life Safety Code®*, 2015 edition.

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, 2014 edition.

NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*, 2013 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2015 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. An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

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. A combustible material is any material that, in the form in which it is used and under the conditions anticipated, will ignite and burn or will add appreciable heat to an ambient fire. [1144, 2013]

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. The aggregate gross floor area contained within fire walls, fire barriers, or exterior walls of a building. [5000, 2015]

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, 2015]

3.3.12 Fire Door. A door assembly rated in accordance with NFPA 252 and installed in accordance with NFPA 80.

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, 2014]

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 tested in accordance with UL 2196, *Standard for Tests of Fire Resistive Cables*.

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 an approved test procedure

appropriate for the structure, building, or component under consideration. [801, 2014].

3.3.21 Fire-Safe Shutdown (FSSD). 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. 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 Index. A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Test for Surface Burning Characteristics of Building Materials*. [101, 2015]

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.

3.3.30 Limited-Combustible (Material). See 8.3.4.

3.3.31 Noncombustible (Material). See 8.3.4.

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*)
- (6) Fire prevention surveillance plan (*see NFPA 601*)
- (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 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.

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.

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.

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.

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 or NFPA 37 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 and NFPA 241 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* 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* (connectors and solid fuel); *NFPA 54* (fuel gas appliances); and *NFPA 31* (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 non-fire 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 or NFPA 1500 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 the plant features necessary to realize those 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 worse case.

7.3.1.3* A fire shall not impair safe shutdown capability inside primary containment or annulus areas.

7.3.1.4 The plant shall be assumed to be operating at 100 percent power, with all components in their normal configuration, when a postulated fire occurs; however, the analysis also shall consider changes in plant configurations during all normal modes of operation.

7.3.1.5 A concurrent single active component failure independent of the postulated fire shall not be assumed to occur.

7.3.1.6 Plant accidents or severe natural phenomena shall not be assumed to occur concurrently with a postulated fire, except as specified in 7.3.2.

7.3.1.7 A loss of off-site power shall be assumed concurrent with the postulated fire only where the safe shutdown analysis (including alternative shutdown) indicates the fire could initiate the loss of off-site power.

7.3.1.8* Fire-safe shutdown components shall be capable of performing all the following functions in the event of the postulated fire:

- (1) Achieving and maintaining subcritical reactivity conditions in the reactor
- (2) Maintaining the reactor coolant inventory such that plant safety limits are not violated
- (3) Establishing reactor decay heat removal to prevent fuel damage and to achieve and maintain cold shutdown conditions
- (4) Providing support functions such as process cooling and lubrication necessary to allow operation of the FSSD components
- (5) Providing direct readings of the process variables necessary to perform and control the FSSD functions

7.3.1.9 Limiting Safety Conditions. During a postfire shutdown, the fission product boundary integrity shall be maintained within acceptable limits (e.g., fuel clad damage, rupture of any primary coolant boundary, or rupture of the primary containment boundary).

7.3.1.10 Spurious Signals.

7.3.1.10.1 An evaluation of spurious signals shall be performed based on the following:

- (1) All components shall be assumed to be in their normal operating positions for the particular mode of operation being considered by the spurious signal evaluation.
- (2) The evaluation shall consider the following cable failure modes:
 - (a) A hot short in which individual conductors within a cable are shorted to individual conductors of a different cable such that a de-energized circuit might become energized by shorting to an external source of electrical power
 - (b) An open circuit in which the cable failure results in the loss of electrical continuity
 - (c) A short to ground in which a cable conductor shorts to grounded structures
 - (d) A short circuit in which individual conductors within multiconductor cable short to each other

7.3.1.10.2 Functional failure or damage modes of equipment and components that can spuriously operate shall be considered.

7.3.1.11 Fire-Induced Spurious Actuation. The postulates specified in 7.3.1.11.1 through 7.3.1.11.5 shall be used in the analysis of fire-induced spurious actuation of equipment.

7.3.1.11.1 FSSD capability shall not be adversely affected by simultaneous spurious actuation of all valves in a single high-to-low pressure interface line where the power or control circuits for the valves can be damaged by a postulated fire.

7.3.1.11.2 For other than high-to-low pressure boundaries, FSSD capability shall not be adversely affected by spurious actuation or signal.

7.3.1.11.3 Separate conditions shall be analyzed concurrent with the spurious actuation(s) or signal addressed in 7.3.1.11.1 and 7.3.1.11.2.

7.3.1.11.4 All automatic functions (signal, logic, etc.) from the circuits that can be damaged by the postulated fire shall be assumed lost or assumed to function as intended, whichever is the worse case.

7.3.1.11.5 Potential spurious signals shall be analyzed in accordance with NEI 00-01, *Guidance for Post-Fire Safe Shutdown Circuit Analysis*.

7.3.1.12* For the purpose of analysis for cases involving high-to-low pressure interface, hot shorts involving three-phase ac circuits shall be postulated.

7.3.1.13 For ungrounded dc circuits, if it can be shown that only two hot shorts of the proper polarity without grounding could cause spurious operation, no further evaluation shall be necessary, except for cases involving high-to-low pressure interfaces.

7.3.1.14* Circuits Associated by Common Power Supply. All common power supply-associated circuits of concern shall be isolated from FSSD circuits by coordinated circuit breakers or fuses.

7.3.1.15* Circuits Associated by Common Enclosure.

7.3.1.15.1 Protection for circuits associated by common enclosure shall meet the following criteria:

- (1) Protection shall be demonstrated by ensuring that suitable electrical overcurrent protection devices are provided for all cables.
- (2) Appropriate measures to prevent the propagation of fire, such as rated fire stops and seals in the raceway or enclosure, shall be provided.

7.3.1.15.2 The overcurrent protection devices specified in 7.3.1.15.1(1) shall be located outside the fire area containing the common enclosure.

7.3.1.16 High-Impedance Faults.

7.3.1.16.1 A high-impedance fault shall be assumed to occur as a result of a fire.

7.3.1.16.2 Evaluation of the impact of high-impedance faults on the ability to achieve and maintain safe shutdown shall be performed to demonstrate that sufficient capacity exists in the electrical protective system to preclude a trip of the main source breaker to the supply.

7.3.2* Seismic/Fire Interaction.

7.3.2.1 A risk assessment that demonstrates the potential risk from a seismically induced fire in relationship to the plant's core damage frequency shall be prepared and used as follows:



- (1) The assessment shall be used to evaluate the level of safety of the plant.
- (2) The assessment shall not be used to reduce the overall plant fire protection design basis.

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

7.4 Separation Criteria.

7.4.1 One safety division of systems that is necessary to achieve and maintain safe shutdown from either the control room or emergency control station(s) shall be maintained free of fire damage by a single fire, including an exposure fire.

7.4.2 One safety division of systems that is necessary to prevent the initiation of a design basis accident shall be maintained free of fire damage from a single fire that occurs outside the main control room.

7.4.3 Redundant cables, equipment, components, and associated circuits of nuclear safety-related or safe shutdown systems shall be located in separate fire areas, unless otherwise permitted by 7.4.3.1.

7.4.3.1 Where redundant system separation inside containment cannot be achieved, other measures shall be permitted in accordance with Section 7.6 to prevent a fire from causing the loss of function of nuclear safety-related or safe shutdown systems.

7.4.3.2 The fire barrier forming the separate fire areas specified in 7.4.3 shall have a 3-hour fire rating, and automatic area-wide detection shall be installed throughout the fire areas, unless all the following criteria are met:

- (1) The fire barriers forming the fire areas shall have a minimum fire-resistive rating of 1 hour.
- (2) Automatic area-wide detection and suppression shall be installed throughout the fire areas.
- (3) Structural steel forming a part of or supporting the fire barriers shall be protected to provide fire resistance equivalent to that of the barrier.

7.4.3.3 Structural steel forming a part of or supporting the fire barriers shall be protected to provide fire resistance equivalent to that of the 3-hour fire-rated barrier specified in 7.4.3.2.

7.4.4 Fire areas separated by minimum 3-hour fire-rated barriers shall be established to separate redundant safety divisions and safe shutdown functions from fire hazards in nonsafety or safe shutdown-related areas of the plant.

7.4.5 In fire areas containing components of either a nuclear safety-related or safe shutdown system, special attention shall be given to detecting and suppressing fire that can adversely affect the system.

7.4.6 Measures that shall be taken to reduce the effects of a postulated fire in a given fire area include the following:

- (1) Limiting the amount of combustible materials (*see Section 5.3*)
- (2) Providing fire-rated barriers between major components and equipment to limit fire spread within a fire area (*see Section 8.1*)
- (3) Installing fire detection (*see Section 9.8*) and fixed suppression systems (*see Section 9.6*)

7.5 Manual Actions.

7.5.1 Shutdown Procedures. Procedures shall be developed for actions necessary to achieve FSSD.

7.5.2 Operator Actions.

7.5.2.1 Operator actions necessary to achieve FSSD of the reactor shall meet criteria acceptable to the AHJ.

7.5.2.2* No credit shall be taken for operator actions required to effect repairs to equipment to achieve FSSD of the reactor.

7.5.2.3 Personnel necessary to achieve and maintain the plant in FSSD following a fire shall be provided from the normal on-site staff, exclusive of the fire brigade.

7.5.2.4 The operator training program shall include performance-based simulator training on FSSD procedures.

7.5.2.5 Walk-through of operator actions necessary to achieve FSSD of the reactor shall be performed to verify that the actions are feasible and shall be integrated into the operator training program.

7.5.2.6 Postfire shutdown and recovery plans shall be included in the station emergency preparedness plan.

7.5.2.7 Drills and operator requalification training shall ensure that operations personnel are familiar with and can accomplish the necessary actions.

7.5.3 Operator Access and Equipment Operation.

7.5.3.1 Operator Access.

7.5.3.1.1* Access routes to areas containing equipment necessary for safe shutdown of the reactor shall be protected from the effects of smoke and fire.

7.5.3.1.2 Two separate access routes shall be provided from the main control room to the remote shutdown location.

7.5.3.1.3 Emergency lighting shall be provided for the access routes and the remote shutdown location (*see Section 8.6*).

7.5.3.2 Equipment Operation.

7.5.3.2.1* Operator safety shall not be threatened by fire conditions while FSSD of the reactor is being implemented.

7.5.3.2.2* Operation of equipment required to effect FSSD of the reactor shall not require any extraordinary actions by the operator.

7.5.3.2.3 Operators (e.g., handwheels of valves that require manual manipulation for FSSD) shall be readily accessible.

7.5.3.2.3.1 If the handwheel is located more than 5 ft (1.5 m) above the floor, it shall be provided with either a chain operator or a permanent platform.

7.5.3.2.3.2 The platform shall be of sufficient size to allow the operator to safely perform the manual action.

7.6 Alternative Shutdown Capability.

7.6.1 Alternative shutdown capability provided for a specific fire area shall include the following:

- (1) Achieving and maintaining subcritical reactivity conditions in the reactor
- (2) Maintaining the reactor coolant inventory
- (3) Achieving safe shutdown
- (4) Maintaining safe shutdown following the fire event