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BRANCH TECHNICAL POSITION APCSB 9.5-1

GUIDELINES FOR

FIRE PROTECTION FOR NUCLEAR POWER PLANTS

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APCSB (9.5-1)
Fire Protection for Nuclear
Power Plants

I. Definitions

ANSI - American National Standards Institute

Approved: signifies devices or assemblies having been tested and accepted for a specific purpose or application by a nationally recognized testing laboratory.

Automatic - means self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example; a change in current strength, pressure, temperature or mechanical configuration.

Combustible Sources - any material which will burn or sustain the combustion process whether or not it exhibits flame under exposure fire conditions that can exist at their point of application.

Concealed - if space containing combustible material is inaccessible to the extinguishing agent, the combustibles are considered to be concealed.

Design Bases Fires - are those that are considered to cause most damage, and are fires that may develop in local areas assuming no manual, automatic or other fire fighting action has been initiated and the fire has passed flash over (i.e., the temperature at which auto-ignition of other combustibles in the area will occur) and has reached its peak burning rate.

Electrical Conduit - rigid or flexible tubing usually either steel or aluminum in which electrical cables are run.

Enclosed - surrounded by a case which will prevent a person from accidentally contacting live electrical parts. Can also apply to flammable liquids which are contained or encased in fire resistive materials or buildings.

Fire Area - that portion of a building or plant that is separated from other areas by boundary fire barriers (walls, floors or roofs) with any openings or penetrations protected with seals or closures having a fire resistance rating equal to that of the barrier.

Fire Barrier - those components of construction (walls, floors and roofs) that are rated by approving laboratories in hours for resistance to fire to prevent the spread of fire.

Fire Break - A feature of construction which prevents fire propagation along the length of cable(s) or prevents spreading of fire to nearby combustibles within a given fire area or fire zone.

Fire Brigade - The team of plant personnel assigned to fire fighting and who are trained in the fighting of fires by an approved training program.

Fire Detectors - A fire detector is a device designed to automatically detect the presence of fire and initiate an alarm system.

Classification of Typical Fire Detectors

Heat Detector. A device which detects abnormally high temperature or rate-of-temperature rise.

Smoke Detector. A device which detects the visible or invisible particles of combustion.

Flame Detector. A device which detects the infrared, or ultraviolet, or visible radiation produced by a fire.

Products of Combustion Detector. A detector whose actuation mechanism depends upon pyrolysis or combustion products.

For further definitions, see NFPA 72E, "Automatic Fire Detectors."

Fire Protection Program - encompasses the components, procedures and personnel utilized in carrying out all activities of fire protection and includes such things as fire prevention, detection, annunciation, control, confinement, suppression, extinguishment, administrative procedures, fire brigade organization, inspection and maintenance, training, quality assurance, and testing.

Fire Rating - refers to the endurance period of a fire barrier or structure and defines the period of resistance to a standard fire exposure elapsing before the first critical point in behavior is observed. (Refer to NFPA 251).

Fire Suppression - refers to capability for control and extinguishing of fires (fire fighting). Manual fire suppression activities refer to use of hoses or portable extinguishers. Automatic fire suppression refers to fixed systems such as water sprinklers, halon, or carbon dioxide.

Fire Zones - subdivisions of fire areas in which the fire suppression systems are designed to combat particular types of fires. The concept of fire zone aids in defining to the fire-fighter the fire parameters and the actions which would be necessary.

Hydraulic Designed Sprinkler System - a system in which sprinkler spacing and pipe sizing is, within limits, determined by hydraulic calculations rather than a standard schedule of allowable pipe sizes.

IGL - International Guidelines for the Protection of Nuclear Power Plants published by the National Nuclear Risks Insurance Pools.

MAERP - Mutual Aromic Energy Reinsurance Pool

NELPIA - Nuclear Energy Liability and Property Insurance Association.
NFPA - National Fire Protection Association
Noncombustible - Materials no part of which will ignite and burn when subjected to fire.

Raceway - Any channel for holding wires, cables or bus-bars which is designed expressly for, and used solely for this purpose.

Restricted Area - Any area to which access is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials.

Safety Related Systems and Components - Systems and components required to shut down the reactor and mitigate the consequences of postulated accidents and maintain it in a safe shutdown condition.

Sprinkler System - A system of overhead piping and components from the first supply valve to the point where water discharges from the system to the fire area. The system is usually activated by heat or smoke from a fire. The system sometimes includes a controlling and/or a sectionalizing valve which is activated by a fire detection system and a device for actuating an alarm when the system is in operation.

Sprinkler Systems Classification

Wet-Pipe - A system employing automatic closed head (fusible link operated) sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by a fire.

Dry-Pipe - A system employing automatic closed head sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which, as from the opening of a sprinkler, permits the water pressure to open a valve known as a dry-pipe valve. The water then flows into the piping system and out the opened sprinklers.

Pre-Action System - A system employing automatic closed head sprinklers attached to a piping system containing air that may or may not be under pressure, with a fire detection system installed in the same areas as the sprinklers. Actuation of the fire detection system, as from a fire, opens a valve which permits water to flow into the sprinkler piping system and to be discharged from any sprinklers which may have been opened by the fire.

Deluge System - A system employing open head sprinklers and/or nozzles attached to a piping system connected to a water supply through a valve which is opened by the operation of a fire detection system installed in the same areas as the sprinklers and/or nozzles. When this valve opens water flows into the piping system and discharges from all sprinklers and/or nozzles attached thereto.

Standpipe and Hose Systems - A fixed piping system connected to a water supply to provide effective fire hose streams in the shortest possible time to specific areas inside the building.

II. Introduction

General Design Criterion 3, "Fire Protection" of Appendix A to 10 CFR Part 50, "General Design Criterion for Nuclear Power Plants," requires that "structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat resistant materials should be used wherever practical throughout the unit, particularly in locations such as the containment and control room. Fire detection and suppression systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effect of fires on structures, systems, and components important to safety. Fire fighting systems shall be designed to assure that their failure, rupture, or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components."

The purpose of this document is to describe guidelines acceptable for implementing this criterion for nuclear reactor power plants.[1] The purpose of the Fire Protection Program for nuclear power plants is to maintain the ability to perform safe reactor plant shutdown functions and to minimize radioactive releases to the environment in the event of a fire.

This Branch Technical Position addresses only fire protection for safety related systems and equipment in nuclear power plants. Economic property loss considerations will probably dictate additional fire protection program requirements. It does not give guidance for redundant cable separation distance. Such criteria are presented in Regulatory Guide 1.75, "Physical Independence of Electrical Systems."

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[1] Designs or methods different from the guidelines set out in this document may be acceptable if they provide fire protection comparable to that recommended in the guidelines. Suitable bases and justification must be provided for alternate approaches to establish acceptable implementation of General Design Criterion 3.

The Fire Protection Program for a nuclear power plant consists of design features, personnel, and equipment. Management participation in the program should begin with early design concepts and plant layout work and continue through plant operation. This requires a qualified staff which should be responsible for engineering and design of fire protection systems for nuclear power plants. This staff should also be responsible for fire prevention activities, maintenance of fire protection systems, training, and manual fire fighting activities. The equipment portion of the fire protection program comprises that equipment which provides fire detection, annunciation, control, containment, suppression, and extinguishment. It is the combination of all these that provides the needed defense-in-depth protection of the public health and safety.

The Browns Ferry fire and subsequent events have shown potential inadequacies in fire protection. To date there have been 32 fires in operating U.S. nuclear power plants. Of these, the fire on March 22, 1975, at Browns Ferry Nuclear Plant was the most severe. With approximately 250 operating reactor years of experience, one may infer a frequency on the order of one fire per ten reactor years. Thus, on the average, a nuclear power plant may experience one or more fires of varying severity during its operating life.

WASH-1400, "Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," dated October 1975, concluded that the Browns Ferry fire did not affect the validity of the overall risk assessment. In any event, cost-effective fire protection measures should be instituted to significantly decrease the frequency and severity of fires.

Presently, the regulatory NRC guidance beyond General Design Criterion 3 covering fire protection can be found in Standard Review Plan 9.5.1 issued in April 1975 and in Section 9.5.1 of Regulatory Guide 1.70, "Standard Format and Contents of Safety Analysis Reports for Nuclear Power Plants," Rev. 2, issued in Septemer 1975. These include the need for the identification, analysis, and evaluation of the fire potential (to be described in the applicant's SAR) and the effects of the hazards on safety related equipment located nearby.

Although many codes and standards are applicable to the nuclear industry, there is no nationally recognized nuclear industry standard or regulatory guide available to provide detailed guidance on how to meet the requirements of General Design Criterion 3. A proposed nuclear industry standard which is in draft form recommends detailed fire protection review of each plant, but the guidance given is so general that it is of limited use to the designer. The staff has, therefore, developed these fire protection guidelines for nuclear power plants.

"The International Guidelines for the Fire Protection of Nuclear Power Plants," 1974 Edition, 2nd Reprint, published on behalf of the National Nuclear Risks Insurance Pools and Association, provides a set-by-step approach to assessing the fire risk in a nuclear power plant and describes protective measures to be taken as a part of the fire protection of these plants. It provides useful guidance in this important area. NELPIA has prepared "Specifications for Fire Protection of New Plants" which gives general conditions and valuable criteria. A Special Review Group under Dr. Stephen H. Hanauer, Technical Advisor to Executive Director for Operations, was organized by NRC to study the Browns Ferry fire and issued a report, NUREG 0050, "Recommendations Related to Browns Ferry Fire," published February 1976, which contains recommendations applicable to all nuclear power plants. The guidelines of this Branch Technical Position utilize the applicable information contained in these documents.

III. Discussion

Certain major conclusions in fire protection emerged from the Browns Ferry fire investigations. These matters warrant emphasis and are discussed below.

A. Defense-in-Depth

Nuclear power plants use the concept of defense-in-depth to achieve the required high degree of safety by use of echelons of safety systems. This concept is also applicable to fire safety in nuclear power plants. With respect to the fire protection program the defense-in-depth principle is aimed at achieving an adequate balance in:

a. Preventing fires from starting

b. Detecting fires quickly, suppressing those fires that occur, putting them out quickly and limiting their damage.

c. Designing plant safety systems so that a fire that gets started, in spite of the fire prevention program, and burns for a considerable time, in spite of fire protection activities, will not prevent essential plant safety functions from being performed.

No one of these echelons can be perfect or complete by itself. Strengthening any one can compensate in some measure for weaknesses, known or unknown, in the others.

The primary objective of the fire protection program is to minimize both the probability and consequences of postulated fires. In spite of steps taken to reduce the probability of fire in the design of the plant, it is expected that fires will occur. Therefore, means should be provided to detect, control and extinguish fires.

This is done by providing fixed fire detection and suppression systems of appropriate capability and adequate capacity in areas where the potential fire damage can jeopardize safe plant shutdown. Also backup manual fire fighting capability should be provided throughout the plant to limit the extent of a fire, by providing portable equipment consisting of hoses, nozzles, portable extinguishers, and air breathing equipment for use by properly trained fire fighting personnel.

A nuclear power plant must maintain its capability to combat a fire under any operating condition with fuel onsite. A single failure in the fire protection system or direct support systems should not impair both primary and backup plant fire protection capability. For example, to avoid such a consequence, the pumping portion of fire protection water supply systems should be redundant and independent, including associated power supplies and controls. Also, failure or inadvertent operation of the fire suppression system should not result in failure of safety related systems or components.

Postulated fires or fire protection system failures need not be considered concurrent with other plant accidents or the most severe natural phenomena; e.g., LOCA and fire. However, in the event of the most severe earthquake; namely, the safe shutdown earthquake (SSE), the fire protection system should be capable of delivering water from manual hose stations located within hose reach of areas containing equipment required for safe plant shutdown. The water supply for this condition may be obtained by manual operator actuation of valve(s) in a connection to the hose standpipe header from a normal seismic Category I water system such as the Essential Service Water system. Thus, at least manual hose and portable fire protection capability must be provided for all postulated design bases events requiring plant shutdown. The fire protection systems should, however, because of the higher probability of occurrence, retain their original design capability for (1) natural phenomena of less severity and greater

frequency (approximately once in 10 years) such as tornadoes, hurricanes, floods, ice storms or small intensity earthquakes which are characteristic of the site geographic region and (2) for potential man-created site related events such as oil barge collisions, aircraft crashes which have a reasonable probability of occurring at a specific plant site. The effects of lightning strikes should be included in the overall plant fire protection system.

Fire protection starts with design and must be carried through in all phases of construction and operation. Furthermore, quality assurance (QA) programs are needed to identify and rectify errors in design, construction, and operations, and are an essential part of defense-in-depth. The guidelines in this position are intended to implement the philosophy of defense-in-depth protection against the hazards of fire and its associated effects on safety-related equipment.

8. Use of Water on Electrical Fires

Experience with major electrical fires show that water should be used if initial attempts to put out a cable fire with other agents are not immediately successful. Since prompt extinguishing of the fire is paramount to reactor safety, damage would be reduced by discrete application of water from automatic sprinklers rather than manual application with fire hoses. The widespread opinion and practice which emphasizes the reasons for not using water as contrasted to those for its prompt and proper use is a concern. Firefighting procedures and fire training should, provide the techniques, equipment and skills for the use of water in fighting electrical fires in nuclear plants, particularly in areas containing a high concentration of electric cables with plastic insulation.

This is not to say that water systems should be installed everywhere. Equipment that may be damaged by water should be shielded or relocated away from the fire hazard and the water. Drains should be provided to remove any water used for fire suppression and extinguishment.

C. Establishment and Use of Fire Areas

The concept of separate fire areas for each division of safety equipment which requires redundancy will facilitate the installation of automatic water extinguishing systems since it will reduce the possibility of water damaging redundant safety-related equipment.

Fire areas should be established based upon the amount of combustible material present and considering suitably chosen design basis fires so that adequate protection can be provided for safety-related systems and equipment. Design basis fires are those fires that result in the most severe exposure to the area or systems being considered. For this condition, it is assumed that no manual or automatic fire suppression action has been started and the fire has reached its peak burning rate and involves all combustibles present.

Within each area special attention should be given to limiting the amount of combustible material and to providing effective barriers and fire resistive coatings to reduce the spreading of a fire in these areas. A design basis fire should be assumed and provisions should be made to limit the consequence of such a fire by providing fire barriers with suitable separation between redundant systems and components which are provided to carry out required safety functions. This separation is enhanced if the plant is divided into suitable fire areas since redundant safety equipment can then be placed in separate fire areas.

Particular design attention should be given to the use of separate isolated fire areas for redundant cables to avoid loss of redundant safety-related cables.

Provisions should also be made to limit the consequences of a fire by suitable design of the ventilation systems so that the spread of the products of combustion to other areas of the plant is prevented. Means should be provided to ventilate, exhaust, or isolate the area as required. The power supply and controls for the area ventilation system should be from outside the area, and the power and control cables should not pass through the area.

The fire detection systems should be designed using detectors of the right types at locations suitable to detect the particular type of fire expected in each area.

In the design, consideration should be given to provide personnel access to and escape routes from each fire area. The emergency plans for all plants should lay out access and escape routes to cover the event of a fire in critical areas of the plant.

IV. Positions

A. Overall Requirements of Nuclear Plant Fire Protection Program

1. Responsibility for the overall fire protection program should be assigned to a designated person in the upper level of management. This person should retain ultimate responsibility even though formulation and assurance of program implementation is delegated. Such delegation of authority should be to staff personnel prepared by training and experience in fire protection and nuclear plant safety to provide a balanced approach in directing a nuclear plant fire protection program. The PSAR should state the qualification requirements for the fire protection engineer or consultant who will assist in the design and selection of equipment, inspect and test the completed physical aspects of the system, develop the fire protection program, and assist in the fire-fighting training for the operating plant. Subsequently the FSAR should discuss the training and the updating provisions such as fire drills provided for maintaining the competence of the station fire-fighting and operating crew, including personnel responsible for maintaining and inspecting the fire protection equipment.

This staff should be responsible for:

(a) coordination of building layout and systems design with fire requirements, including consideration of potential hazards associated with postulated design basis fires.

(b) design and maintenance of fire detection, suppression, and extinguishing systems.

(c) fire prevention activities.

(d) plant personnal and fire brigade training and manual fire fighting activities.

(NOTE: NFPA 6, "Recommendations for Organization of Industrial Fire Loss Prevention," contains useful guidance for organization and operation of the entire fire loss prevention program.)

2. The overall fire protection program should be based upon evaluation of potential fire hazards throughout the plant and the effect of postulated design basis fires relative to maintaining ability to perform safety shutdown functions and minimize radioactive releases to the environment.

3. Total reliance should not be placed on a single automatic fire suppression system. Appropriate backup fire suppression capability should be provided.

4. A single failure in the fire suppression system should not impair both the primary and backup fire suppression capability. For example, redundant fire water pumps with independent power supplies and controls should be provided. Postulated fires or fire protection system failures need not be considered concurrent with other plant accidents or the most severe natural phenomena. However, in the event of the most severe earthquake; namely, the safe shutdown earthquake (SSE), the fire suppression system should be capable of delivering water to manual hose stations located within hose reach of areas containing equipment required for safe plant shutdown. The fire protection systems should, however, retain their original design capability for (1) natural phenomena of less severity and greater frequency (approximately once in 10 years) such as tornadoes, hurricanes, floods, ice storms or small intensity earthquakes which are characteristic of the site geographic region and (2) for potential man-created site related events such as oil barge collisions, aircraft crashes which have a reasonable probability of occurring at a specific plant site. The effects of lightning strikes should be included in the overall plant fire protection program.

5. Failure or inadvertent operation of the fire suppression system should not incapacitate safety related systems or components. Fire suppression systems that are pressurized during normal plant operation should meet the guidelines contained in APCSB Branch Technical Position 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."

6. The fire protection program (plans, personnel and equipment) for buildings storing new reactor fuel and for adjacent fire zones which could affect the fuel storage zone should be fully operational before fuel is received at the site.

7. The fire protection program for an entire reactor unit should be fully operational prior to initial fuel loading in that reactor unit.

8. On multiple reactor unit sites where there are operating reactor units and construction of remaining units is being completed, the fire protection program should provide continuing evaluation and include additional fire barriers, fire protection capability and administrative controls necessary to protect the operating units from construction fire hazards. The operating plant superintendent should have the lead responsibility for site fire protection.

B. General Guidelines for Plant Protection

1. Building Design

(a) Plant Layouts should be arranged to:

(1) Isolate safety related systems from unacceptable fire hazards, and

(2) Separate redundant safety related systems from each other so that both are not subject to damage from a single fire hazard.

(b) In order to accomplish 1.(a) above, safety related systems and fire hazards should be identified throughout the plant. Therefore, a detailed fire hazard analysis should be made during initial plant design.

(c) For multiple reactor unit sites, cable spreading rooms should not be shared between reactors. Each cable spreading room should be separated from other areas of the plant by barriers (walls and floors) having a minimum fire resistance of three hours. Cabling for redundant safety divisions should be separated by walls having three hour fire barriers.

(d) Interior wall and structural components, thermal insulation materials and radiation shielding materials and soundproofing should be noncombustible.

Interior finishes should be non-combustible or listed by a nationally recognized testing laboratory, such as Factory Mutual or Underwriters Laboratory, Inc. for flame spread, smoke and fuel contribution of 25 or less in its use configuration (ASTM E-84 Test, "Surface Burning Characteristics of Building Materials.")

std is 450 for

Class A

(e) Metal deck roof construction should be non-combustible (see Underwriters Laboratory, Inc., building materials directory), or listed as Class I by Factory Mutual System Approval Guide.

(f) Suspended ceilings and their supports should be of non-combustible construction. Concealed spaces should be devoid of combustibles.

(g) High voltage - high amperage transformers installed inside buildings containing safety related systems should be dry type or insulated and cooled with non-combustible liquid.

(h) Buildings containing safety related systems should be protected from exposure or spill fires involving oil filled transformers by:

*locating such transformers at least 50 feet distant; or

*assuring that such building walls within 50 feet of oil filled transformers are without openings and have a fire resistance rating of at least three hours.

(i) Floor drains, sized to remove expected fire fighting water flow should be provided in those areas where fixed water fire suppression systems are installed. Drains should also be provided in other areas where hand hose lines may be used if such fire fighting water could cause unacceptable damage to other equipment in the area. Equipment should be either installed on pedestals, or curbs should be provided as required to contain water and direct it to floor drains. (See NFPA 92, "Waterproofing and Draining of Floors.") Drains in areas containing combustible liquids should have provisions for preventing the spread of the fire throughout the drain system. Water drainage from areas which may contain radioactivity should be sampled and analyzed before discharge to the environment.

(j) Floors, walls and ceilings enclosing separate fire areas should have minimum three-hour fire rating. Penetrations in these fire barriers, including conduits and piping, should be sealed or closed to provide fire resistance rating at least equal to that of the barrier itself. Door openings should be protected with equivalent rated doors, frames and hardware that have been tested and approved by a nationally recognized laboratory. Such doors should be normally closed and locked or alarmed with alarm and annunciation in the control room. Penetrations for ventilation systems should be protected by a standard "fire door damper" where required. (Refer to NFPA 80, "Fire Doors and Windows.")

2. Control of Combustibles

(a) Safety related systems should be isolated or separated from combustible materials. When this is not possible due to the nature of the safety system or the combustible material, special protection will be required to prevent a fire defeating the safety system function. Such protection may involve a combination of automatic fire suppression, and construction capable of withstanding and containing a fire that consumes all combustibles present. Examples of such combustible materials which may not be separable from the remainder of its system are:

(1) Emergency diesel generator fuel oil day tanks.
(2) Turbine-generator oil and hydraulic control fluid systems.
(3) Reactor coolant pump lube oil system.

(b) Bulk gas storage (either compressed or cryogenic), should not be permitted inside structures housing safety related equipment. Flammable gas storage such as hydrogen, should be located outdoors or in separate detached buildings so that a fire or explosion will not adversely affect any safety related systems or equipment. (Refer to NFPA 50A, "Gaseous Hydrogen Systems.")

Care should be taken to locate high pressure gas storage containers with the long axis parallel to buildings walls. This will minimize the possibility of wall penetration in the event of a container failure. Use of compressed gases (especially flammable and fuel gases) inside buildings should be controlled. (Refer to NFPA 6, "Industrial Fire Loss Prevention.")

(c) The use of plastic materials should be minimized. Haloginated plastics especially, such as polyvinyl chloride (PVC) and neoprene, should be used only when substitute non-combustible materials are not available. All plastic materials, including flame and fire retardant, will burn with an intensity and BTU production in a range similar to ordinary hydrocarbons. They also produce heavy dense smoke when burning that obscures visibility and can plug air filters, especially charcoal and HEPA. The haloginated plastics also release free chlorine and hydrogen chloride when burning which are toxic to humans and corrosive to equipment.

(d) Flammable liquids storage should, as a minimum, comply with the requirements of NFPA 30, "Flammable and Combustible Liquids Code."

3. Electric Cable Construction, Cable Trays and Cable Penetrations

(a) Only non-combustible materials should be used for cable tray construction.

(b) See Section IV.D.3. for fire protection guidelines for cable spreading rooms.

(c) Automatic water sprinkler systems should be provided for cable trays outside the cable spreading room. Cables should be designed to allow wetting down with deluge water without electrical faulting. Manual hose stations and portable hand extinguishers should be provided as backup. Safety related equipment in the vicinity of such cable trays, which does not itself require water fire protection, but is subject to unacceptable damage if wetted by sprinkler water discharge, should be protected from sprinkler system operation or malfunction.

(d) Cable and cable tray penetration of fire barriers (vertical and horizontal) should be sealed to give protection at least equivalent to the fire barrier. The design of fire barriers for horizontal and vertical cable trays should, as a minimum, meet the requirements of ASTM E-119, "Fire Test of Building Construction and Materials," including the hose stream test.

(e) Fire breaks should be installed at every 10 feet along horizontal and vertical cable routings to prevent the propagation of a fire. Flame or fire retardant coatings may be used as a fire break for grouped electrical cables to limit spread of fire in cable routings.

(Possible cable derating due to use of such coating materials must be considered during design.)

(f) Electric cable constructions should at least pass the current IEEE No. 383 flame test. (This does not infer that cables passing this test will not require additional fire protection.)

(g) To the extent practical cable construction that does not give off corrosive gases while burning should be used.

(h) Cable trays, raceways, conduit, trenches or culverts should be used only for cables. Miscellaneous storage should not be permitted. Piping for flammable or combustible liquids or gases should not be installed in this area.

(i) Areas containing significant concentrations of plastic insulated electric cables such as cable tunnels, culverts and spreading rooms should be provided with automatic or manual smoke venting as required to facilitate manual fire fighting capability.

(j) Cables in the control room should be kept to the minimum necessary for operation of the control room. All cables entering the control room should terminate there. Cables should not be installed in floor trenches or culverts in the control room.

4. Ventilation

(a) The products of combustion which need to be removed from a specific fire area should be evaluated to determine how they will be controlled. Smoke and corrosive gases should generally be automatically discharged directly outside to a safe location. Smoke and gases containing radioactive materials should be monitored in the fire area to determine if release to the environment is within the permissible limits of the plant Technical Specifications.

(b) Any ventilation system designed to exhaust smoke or corrosive gases should be evaluated to assure that inadvertent operation or single failures will not violate the controlled areas of the plant design. This requirement includes containment functions for protection of the public and maintaining habitability for operations personnel.

(c) The power supply and controls for mechanical ventilation systems should be run outside the fire area served by the system.

(d) Fixed automatic sprinkler systems should be installed to protect charcoal filters.

(e) The fresh air supply intakes to areas containing safety related equipment or systems should be located remote from the exhaust air outlets and smoke vents of other fire areas. This is to minimize the possibility of contamination of the intake air with the products of combustion. (IGL).

(f) Stairwells should be designed to minimize smoke infiltration during a fire. Staircases should serve as escape routes and access routes for fire fighting. Fire exit routes should be clearly marked. Stairwells, elevators and chutes should be enclosed in masonry towers with minimum three hour fire rating and automatic fire doors at least equal to the enclosure construction, at each opening into the building. (IGL) Elevators should not be used during fire emergencies.

(g) Smoke and heat vents may be useful in specific areas such as cable spreading room and diesel fuel oil storage areas and switchgear rooms. When used, they should be installed at a minimum ratio of 1 sq. foot of venting area per 200 sq. feet of floor area. (The conversion factor for power venting is 300 CFM equals 1 sq. foot of gravity venting area.) Refer to NFPA No. 204 for additional guidance on smoke control.

(h) Self-contained breathing apparatus, using full face positive pressure masks, approved by NIOSH (National Institute for Occupational Safety and Health - approval formerly done by U.S. Bureau of Mines) should be provided for fire brigade, damage control and control room personnel. Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir if practical. Service or operating life should be a minimum of one half hour for the self contained units.

At least two extra air bottles should be located onsite for each self contained breathing unit. In addition an on-site reserve air 6-hour supply should be provided and so arranged to quickly and fully replenish exhausted supply air bottles as they are returned. If compressors are used as a source of breathing air, only units approved for breathing air should be used. Also special care must be taken to locate the compressor in areas free of dust and contaminants.

(i) Where total flooding gas extinguishing systems are used, area intake and exhaust ventilation dampers should close upon initiation of gas flow to maintain necessary gas concentration. (See NFPA 12 , "Carbon Dioxide Systems," and 12A, "Halon 1301 Systems.")

5. Lighting and Communication

Lighting and two way voice communication are vital to safe shutdown and emergency response in the event of fire. Suitable fixed and portable emergency lighting and communication devices should be provided to satisfy these requirements.

(a) Fixed emergency lighting should consist of sealed beam units with individual 8-hour minimum battery power supplies.

(b) Suitable sealed beam battery powered portable hand lights should be provided for emergency use.

(c) Fixed emergency communication should use voice powered head sets at pre-selected stations.

(d) Fixed repeaters installed to permit use of portable radio communication units should be protected from exposure fire damage.

6. Administrative Procedures, Controls and Fire Brigade

(a) Administrative procedures consistent with the need for maintaining the performance of the fire protection system and personnel in nuclear power plants should be provided.

Guidance is contained in the following NFPA publications:

(1) No. 4 - Organization for Fire Services
(2) No. 4A - Organization of a Fire Department
(3) No. 6 - Industrial Fire Loss Prevention
(4) No. 7 - Management of Fire Emergencies
(5) No. 8 - Management Responsibility for Effects of Fire on Operations
(6) No. 27 - Private Fire Brigades

(b) Effective administrative measures should be implemented to prohibit bulk storage of combustible materials inside or adjacent to safety related buildings or systems during operation or maintenance periods.

(b) Normal and abnormal conditions or other anticipated operations such as modifications (e.g., breaking fire stops, impairment of fire detection and suppression systems) and refueling activities should be reviewed by appropriate levels of management and appropriate special action and procedures such as fire watches or temporary fire barriers implemented to assure adequate fire protection and reactor safety. In particular;

(1) Work involving ignition sources such as welding and flame cutting should be done under closely controlled conditions. Procedures governing such work should be reviewed and approved by persons trained and experienced in fire protection. Persons performing and directly assisting in such

work should be trained and equipped to prevent and combat fires. A person trained in fire protection should directly monitor the work and function as a fire watch.

(2) Leak testing, and similar procedures such as air flow determination, should use one of the commercially available aeresol techniques. Open flames or combustion generated smoke should not be permitted.

(3) Use of combustible material, e.g., HEPA and charcoal filters, dry ion exchange resins or other combustible supplies, in safety related areas should be controlled. Use of wood inside buildings containing safety related systems or equipment should be permitted only when suitable noncombustible substitutes are not available. If wood must be used, only fire retardant treated wood (scaffolding, lay down blocks) should be permitted. Such materials should be allowed into safety related areas only when they are to be used immediately. Their possible and probable use should be considered in the fire hazard analysis to determine adequacy of the installed fire protection systems.

(d) Nuclear power plants are usually located in remote areas, at some distance from public fire departments. Also, first response fire departments are often volunteer. Public fire department response should be considered in the overall fire protection program. However, the plant should be designed to be self sufficient with respect to fire fighting activities and rely on the public response only for supplemental or backup capability.

(e) The need for good organization, training and equipping of fire brigades at nuclear power plant sites requires effective measures be implemented to assure proper discharge of these functions. The guidance in Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants," should be followed as applicable.

(1) Successful fire fighting requires testing and maintenance of the fire protection equipment, emergency lighting and communication, as well as practice as brigades for the people who must utilize the equipment. A test plan should be developed which lists the individuals and their responsibilities in connection with routine tests and inspections of the fire detection and protection systems. The test plant should contain the types, frequency and detailed procedures for testing. Procedures should also contain instructions on maintaining fire protection during those periods of fire protection system impairment or maintenance such as fire watches or temporary hose connections to water systems.

(2) Basic training is a necessary element in effective firefighting operation. In order for a fire brigade to operate effectively, it must operate as a team. Each member must know what his duties are. The fire brigade must be familiar with equipment location and operation, the layout of the plant during times when a particular area is filled with smoke, and contains insufficient lighting. Such training can only be accomplished by conducting drills several times a year (at least quarterly) so that all members of the fire brigade have had the opportunity to train as a team, testing itself in the major areas of plant. The drills should include the simulated use of equipment in each area and should be preplanned and post-critiqued to establish the training objective of the drills and determine how well these objectives have been met. These drills should periodically (at least annually) include local fire department participation where possible. Such drills also permit

supervising personnel to evaluate the effectiveness of communications within the fire brigade, the on scene fire team leader, the reactor operator in the control room, and the offsite command post.

(3) To have proper coverage during all phases of operation, members of each shift crew should be trained in fire protection. Training of the plant fire brigade should be coordinated with the local fire department so that responsibilities and duties are delineated in advance. This coordination should be part of the training course and implemented into the training of the local fire department staff. Local fire departments should be educated in the operational precautions when fighting fires on nuclear power plant sites. Local fire departments should be made aware of the need for radioactive protection of personnel and the special hazards associated with a nuclear power plant site.

(4) NFPA No. 27, "Private Fire Brigade," should be followed in organization, training, and fire drills. This standard also is applicable for the inspection and maintenance of fire fighting equipment. Standards referenced from this document which should be utilized are NFPA 194, "Standards for Screw Threads and Gaskets for Fire Hose Couplings," NFPA 196, "Standard for Fire Hose, NFPA 197, "Training Standard on Initial Fire Attacks, " NFPA 601, "Recommended Manual of Insturctions and Duties for the Plant Watchman on Guard." NFPA booklets and pamphlets listed on page 27-11 of Volume 8, 1971-72, are also applicable for good training references. In addition, courses in fire prevention and fire suppression which are recognized and/or sponsored by the fire protection industry should be utilized.

7. Quality Assurance Program

Quality assurance (QA) programs of applicants, and contractors should be developed and implemented to assure that the requirements for design, procurement, installation, and testing and administrative controls for the fire protection program for safety-related areas as defined in this Branch Position are satisfied. The program should be under the management control of the QA organization. The QA program criteria that apply to the fire protection program should include the following:

(a) Design Control and Procurement Document Control - Measures should be established to assure that all design-related guidelines of the Branch Technical Position are included in design and procurement documents and that deviations therefrom are controlled.

(b) Instructions, Procedures, and Drawings - Inspections, tests, administrative controls, fire drills and training which govern the fire protection program should be prescribed by documented instructions, procedures or drawings and should be accomplished in accordance with these documents.

(c) Control of Purchased Material, Equipment, and Services - Measures should be established to assure that purchased material, equipment and services conform to the procurement documents.

(d) Inspection - A program for independent inspection of activities affecting fire protection should be established and executed by, or or for, the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.

(e) Test and Test Control - A test program should be established and implemented to assure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures and test results properly evaluated and acted on.

(f) Inspection, Test and Operating Status - Measures should be established to provide for the identification of items which have satisfactorily passed required tests and inspections.

(g) Nonconforming Items - Measures should be established to control items which do not conform to specified requirements to prevent inadvertent use of installation.

(h) Correction Action - Measures should be established to assure that conditions adverse to fire protection, such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible material and nonconformances, are promptly identified, reported and corrected.

(i) Records - Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities affecting the fire protection program.

(j) Audits - Audits should be conducted and documented to verify compliance with the fire protection program, including design and procurement documents; instructions; procedures and drawings; and inspection and test activities.

C. Fire Detection and Suppression

1. Fire Detection

(a) Fire detection systems should as a minimum comply with NFPA 72D, "Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems."

(b) Fire detection systems should give audible and visual alarm and annunciation in the control room. Local audible alarms should also sound at the location of the fire.

(c) Fire alarms should be distinctive and unique. They should not be capable of being confused with any other plant working system.

(d) Fire detection and actuation systems should be connected to the plant emergency power supply.

2. Fire Protection Water Supply Systems

(a) An underground yard fire main loop should be installed to furnish anticipated fire water requirements. NFPA 24, "Standard for Outside Protection," gives necessary guidance for such installation. It references other design codes and standards such as ANSI and AWWA (American Water Works Association). Lined steel or cast iron pipe should be used to reduce internal tuberculation. Such tuberculation deposits in an unlined pipe over a period of years can significantly reduce water flow through the combination of increased friction and reduced pipe diameter. Means for treating and flushing the systems should be provided.

Approved visually indicating sectional control valves, such as Post Indicator Valves, should be provided to isolate portions of the main for maintenance or repair without shutting off the entire system.

The fire main system piping should be separate from service or sanitary water system piping.

(b) A common yard fire main loop may serve multi-unit nuclear power plant sites, if cross-connected between units. Sectional control valves should permit maintaining independence of the individual loop around each unit. For such installations, common water supplies may also be utilized. The water supply should be sized for the largest single expected flow. For multiple reactor unit sites with widely separated plants (approaching 1 mile or more), separate yard fire main loops should be used.

Simultaneous fires in more than one reactor unit need not be considered. Due to separation requirements, a fire involving more than one reactor unit need not be considered except for facilities shared between units.

(c) If pumps are required to provide pressure and/or flow requirements, redundant 100% capacity pumps should be provided. Each pump should have its own independent water supply. The connection to the yard fire main loop from each fire pump should be widely separated, preferably located on opposite sides of the plant. Each pump should have its own driver with independent power supplies and control. At least one pump should be driven by non-electrical means, preferably diesel engine. Pumps and drivers should be located in rooms, separated from the remaining pumps and equipment by a minimum three-hour fire wall. Alarms indicating pump running, driver availability or failure to start should be provided in the control room.

Details of the fire pump installation should as a minimum conform to NFPA 20, "Standard for the Installation of Centrifugal Fire Pumps."

(d) Two separate reliable water supplies should be provided. If tanks are used, two 100% (minimum of 300,000 gallons each) system capacity tanks should be installed. They should be so interconnected that pumps can take suction from either or both. However, a leak in one tank or its piping should not cause both tanks to drain. The main plant fire water supply capacity should be capable of refilling either tank in a minimum of eight hours.

Common tanks are permitted for fire and sanitary or service water storage. When this is done, however, minimum fire water storage requirements should be dedicated by means of a vertical standpipe for other water services.

(e) The fire water supply (total capacity and flow rate) should be calculated on the basis of largest expected flow rate for a period of two hours, but not less than 300,000 gallons. This flow rate should be based (conservatively) on 1,000 gpm for manual hose streams plus the greater of:

(1) all sprinkler heads opened and flowing in the largest designed fire area; or

(2) the largest open head deluge system(s) operating.

(f) Lakes or fresh water ponds of sufficient size may qualify as sole source of water for fire protection, but require at least two intakes to the pump supply. When a common water supply is permitted for fire protection and the ultimate heat sink, the following conditions should also be satisfied:

(1) The additional fire protection-water requirements are designed into the total storage capacity; and

(2) Failure of the fire protection system should not degrade the function of the ultimate heat sink.

(g) Outside manual hose installation should be sufficient to reach any location with an effective hose stream. To accomplish this, hydrants should be installed approximately every 250 feet on the yard main system. The lateral to each hydrant from the yard main should be controlled by a visually indicating or key operated (curb) valve. A hose house, equipped with hose and combination nozzle, and other auxiliary equipment recommended in NFPA No. 24, "Outside Protection," should be provided as needed but at least every 1,000 feet.

Threads compatible with those used by local fire departments should be provided on all hydrants, hose couplings and standpipe risers.

3. Water Sprinkler and Hose Standpipe Systems

(a) Each automatic sprinkler system and manual hose station standpipe should have an independent connection to the plant underground water main. Headers fed from each end are permitted inside buildings to supply multiple sprinkler and standpipe systems. When provided, such headers are considered an extension of the yard main system. Such headers should be located in separate valve rooms with three hour fire rated walls and with interior and exterior access. Each sprinkler and standpipe system should be equipped with OS&Y (outside screw and yoke) gate valve, or other approved shut off valve, and water flow alarm.

Safety related equipment which does not itself require sprinkler water fire protection, but is subject to unacceptable damage if wetted by sprinkler water discharge should be protected by water shields or baffles

(b) All valves in the fire water systems should be electrically supervised. The electrical supervision signal should indicate in the control room and other appropriate command locations in the plant. (Refer to NFPA 26, "Supervision of Valves.")

(c) Automatic sprinkler systems should as a minimum conform to requirements of appropriate NFPA Standards such as No. 13, "Standard for the Installation of Sprinkler Systems," and No. 15, "Standard for Water Spray Fixed Systems."

(d) Interior manual hose installation should be able to reach any location with at least one effective hose stream. To accomplish this, standpipes with hose connections, equipped with a maximum of 75 feet of 1 1/2 inch woven jacket-lined fire hose and suitable nozzles should be provided in all buildings, including containment, on all floors and should be spaced at not more than 100-foot intervals. Individual standpipes should be of at least 4-inch diameter for multiple hose connections and 2 1/2-inch diameter for single hose connections. These systems should follow the requirements of NFPA No. 14, "Standpipe and Hose Systems," for sizing, spacing and pipe support requirements (NELPIA).

Hose stations should be located outside entrances to normally unoccupied areas and inside normally occupied areas. Standpipes serving hose stations in areas housing safety related equipment should have shut-off valves and pressure reducing devices (if applicable) outside the area.

Provisions should be made to supply water at least to standpipes and hose connections for manual fire fighting in areas within hose reach of equipment required for safe plant shutdown in the event of a safe shutdown earthquake (SSE). The standpipe

system serving such hose stations should be analyzed for SSE loading and be provided with supports to assure system pressure integrity. The piping and valves for the portion of hose standpipe system affected by this functional requirement should at least satisfy ANSI Standard B31.1, "Power Piping." The water supply for this condition may be obtained by manual operator actuation of valve(s) in a connection to the hose standpipe header from a normal seismic Category I water system such as the Essential Service Water System. The cross connection should be (a) capable of providing flow to at least two hose stations (approximately 150 gpm/hose station); (b) designed to the same standards as the seismic Category I water system and should not degrade the performance of the seismic Category I water system.

(e) The proper type of hose nozzle to be supplied in each area should be based on the fire hazard analysis. The usual combination spray straight stream may cause unacceptable mechanical damage, (for instance delicate electronic equipment in the control room) and be unsuitable. Electrically safe nozzles should be provided at locations where electrical equipment or cabling is located.

(f) Certain fires such as those involving flammable liquids respond well to foam suppression. Consideration should be given to use of any of the available foams for such specialized protection application. These include the more common chemical and mechanical low expansion foams, high expansion foam and the relatively new aqueous film forming foam (AFFF).

4. Halon Suppression Systems

The use of Halon fire extinguishing agents should as a minimum comply with the requirements of NFPA Nos. 12A and 12B, "Halogenated Fire Extinguishing Agent Systems - Halon 1301 and Halon 1211." Only UL or FM approved agents should be used.

In addition to the guidelines of NFPA Nos. 12A and 12B, preventative maintenance and testing of the systems, including check weighing of the Halon cylinders should be done at least quarterly.

Particular consideration should also be given to:

(a) minimum required Halon concentration and soak time.

(b) toxicity of Halon.

(c) toxicity and corrosive characteristics of thermal decompositions products of Halon.

5. Carbon Dioxide Suppression Systems

The use of carbon dioxide extinguishing systems should as a minimum comply with the requirements of NFPA No. 12, "Carbon Dioxide Extinguishing Systems."

Particular consideration should also be given to:

(a) minimum required CO_2 concentration and soak time;

(b) toxicity of CO_2;

(c) possibility of secondary thermal shock (cooling) damage;

(d) offsetting requirements for venting during CO_2 injection to prevent overpressurization versus sealing to prevent loss of agent.

(e) design requirements from overpressurization; and

(f) possibility and probability of CO_2 systems being out-of service due to personnel safety consideration. CO_2 systems are disarmed whenever people are present in an area so protected. Areas entered frequently (even though duration time for any visit is short) have often been found with CO_2 systems shut off.

6. Portable Extinguishers

Fire extinguishers should be provided in accordance with guidelines of National Fire Protection Association No. 10 and 10 A, "Portable Fire Extinguishers, Installation" and "Portable Fire Extinguishers, Maintenance and Use." Dry chemical extinguishers should be installed with due consideration given to cleanup problems after use and possible adverse effects on equipment installed in the area.

D. Guidelines for Specific Plant Areas

1. Primary and Secondary Containment

a. Normal Operation

Fire protection requirements for the primary and secondary containment areas should be provided on the basis of specific identified hazards. For example:

- Lubricating oil or hydraulic fluid system for the primary coolant pumps
- Cable tray arrangements and cable penetrations
- Charcoal filters

Due to the general inaccessability of these areas during normal plant operation, protection should be from automatic fixed systems. Automatic sprinklers should be installed for those hazards identified as requiring fixed suppression.

Operation of the fire protection systems should not compromise containment integrity and/or the other safety related systems. Fire protection activities in the containment areas should function in conjunction with total containment requirements such as ventilation, control of contaminated liquid and gaseous release.

Fire detection systems should alarm and annunciate in the control room. These systems should utilize detection and location most suitable to the particular type of fire expected from the identified hazard. A primary containment general area fire detection capability should be provided as backup for the above described hazard detection. To accomplish this, suitable smoke detection (e.g., visual

obscuration, light scattering, and particle counting) should be installed in the air recirculation system ahead of any filters.

Automatic fire suppression capability need not be provided in the primary containment atmospheres that are inerted during normal operation. However, special fire protection requirements during refueling and maintenance operations should be satisfied as provided below.

b. Refueling and Maintenance

Refueling and maintenance operations in containment may introduce additional hazards such as contamination control materials, decontamination supplies, wood planking, temporary wiring, welding and flame cutting (with portable compressed fuel gas supply). Possible fires would not necessarily be in the vicinity of fixed detection and suppression systems.

Management procedures and controls necessary to assure adequate fire protection are discussed in Section IV B.6.

In addition, manual fire fighting capability should be permanently installed in containment. Standpipes with hose stations, and portable fire extinguishers, should be installed at strategic locations throughout containment for any required manual fire fighting operations.

Adequate self contained breathing apparatus should be provided for fire fighting and Damage Control personnel and located near the containment entrances. These units should be independent of any breathing apparatus or air supply systems provided for general plant activities.

2. Control Room

The control room is essential to safe reactor operation. It must be protected against disabling fire damage and should be separated from other areas of the plant by floors, walls and roof having minimum fire resistance ratings of three hours.

Control room cabinets and consoles are subject to damage from two distinct fire hazards:

(a) Fire originating within a cabinet or console; and

(b) Exposure fires involving combustibles in the general room area.

Manual fire fighting capability should be provided for both hazards. Hose stations and portable extinguishers should be located in the control room to eliminate the need for operators to leave the control room. An additional hose piping shut off valve and pressure reducing device should be installed outside the control room.

Nozzles which are compatible with the hazards and equipment in the control room should be provided for the manual hose station. The nozzles chosen should satisfy actual fire fighting needs and satisfy electrical safety and minimize physical damage to electrical equipment from hose stream impingement.

Fire detection in the control room, cabinets, and consoles should be provided by smoke and heat detectors in each fire area. Alarm and annunciation should be provided in the control room. Fire alarms in other parts of the plant should also be alarmed and annunciated in the control room.

Breathing apparatus for control room operators should be readily available. Control room floors, floor-ceiling structures and walls including penetrations and doors, should be designed to a minimum three-hour fire rating. All penetration seals should be air tight.

The control room ventilation intake should be provided with smoke detection capability to automatically alarm locally and isolate the control room ventilation system to protect operators by preventing smoke from entering the control room. Manually operated venting of the control room should be available so that operators have the option of venting for visibility.

Cables should not be located in concealed floor and ceiling spaces. All cables which enter the control room should terminate in the control room. That is, no cabling should be simply routed through the control room from one area to another.

Safety related equipment should be mounted on pedestals or the control room should have curbs and drains to direct water away from such equipment. Such drains should be provided with means for closing to maintain integrity of the control room in event of other accidents requiring control room isolation.

3. Cable Spreading Room

The primary fire suppression in the cable spreading room should be an automatic water system such as closed head sprinklers, open head deluge, or open directional spray nozzles. Deluge and open spray systems should have provisions for manual operation at a remote station; however, there should be provision to preclude inadvertent operation. Location of sprinkler heads or spray nozzles should consider cable tray sizing and arrangements to assure adequate water coverage. Cables should be designed to allow wetting down with deluge water without electrical faulting.

Open head deluge and open directional spray systems should be zoned so that a single failure will not deprive automatic fire suppression capability to the entire area.

The use of foam is acceptable, provided it is of a type capable of being delivered by a sprinkler or deluge system, such as an Aqueous Film Forming Foam (AFFF).

An automatic water suppression system with manual hoses and portable extinguisher backup is acceptable, provided:

(a) At least two remote and separate entrances are provided to the room for access by fire brigade personnel; and

(b) Aisle separation provided between tray stacks should be at least three feet wide and eight feet high.

Alternately, gas systems (Halon or CO_2) may be used for primary fire suppression if they are backed up by an installed water spray system and hose stations and portable extinguishers immediately outside the room and the access requirements stated above are met.

Electric cable construction should as a minimum pass the IEEE No. 383 (IEEE Standard Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations) flame test.

Drains to remove fire fighting water should be provided with adequate seal when gas extinguishing systems are also installed.

Redundant safety related cable divisions should be separated by three-hour fire rated walls.

For multiple reactor unit sites, cable spreading rooms should not be shared between reactors. Each cable spreading room of each unit should have divisional cable separation as stated above and be separated from the other and the rest of the plant by a minimum three-hour rated fire wall. (Refer to NFPA 251, "Fire Tests, Building Construction and Materials" or ASTM E-119, "Fire Test of Building Construction and Materials" for fire test resistance rating.)

The ventilation system to the cable spreading room should be designed to isolate the area upon actuation of any gas extinguishing system in the area. In addition, smoke venting of the cable spreading room may be desirable. Such smoke venting systems should be controlled automatially by the fire detection and/or suppression system as appropriate. Capability for remote manual control should also be provided.

4. Plant Computer Room

Computer rooms should be separated from other areas of the plant by barriers having minimum three-hour fire resistance rating. Automatic fire detection should be provided to alarm and annunciate in the control room and alarm locally. Manual hose stations and portable water and halon fire extinguishers should be provided.

5. Switchgear Rooms

Switchgear rooms should be separated from the remainder of the plant by minimum three-hour rated fire barriers. Redundant switchgear safety divisions should be separated by three hour fire rated barriers. Automatic fire detectors should alarm and annunciate in the control room and alarm locally. All cables which enter the switchgear rooms should terminate there. These rooms should not be used for any other purpose. Fire hose stations and portable fire extinguishers should be readily available.

Equipment should be located on pedestals or curbs and drains should be provided to direct water away from safety related equipment. (Refer to NFPA 92M, "Waterproofing and Draining of Floors.") Remote manual actuated ventilation should be provided for venting smoke when manual fire suppression effort is needed.

6. Remote Safety Related Panels

The general area housing remote safety related panels should be provided with automatic fire detectors that alarm locally and alarm and annunciate in the control room. Combustible materials should be controlled and limited to those required for operation. Portable extinguishers and manual hose stations should be provided.

7. Station Battery Rooms

Battery rooms should be protected against fire explosions. Battery rooms should be separated from each other and other areas of the plant by barriers having a minimum three-hour fire rating inclusive of all penetrations and openings. (Refer to NFPA 69, "Standard on Explosion Prevention Systems.") Battery Rooms should be provided with hydrogen concentration detectors which should alarm and annunciate in the control room and alarm locally. The detector alarm set point should be no greater than 2 v/o hydrogen concentration. Ventilation systems in

the battery rooms should be capable of maintaining the hydrogen concentration well below the detector alarm set point. Standpipe and hose and portable extinguishers should be provided.

8. Turbine Lubrication and Control Oil Storage and Use Areas

A blank fire wall having a minimum resistance rating of three hours should separate all areas containing safety related systems and equipment from the turbine oil systems.

9. Diesel Generator Areas

Diesel generators should be separated from each other and other areas of the plant by fire barriers having a minimum three-hour fire resistance rating.

Automatic fire suppression such as AFFF (Aqueous Film Forming Foam), foam or sprinklers should be installed to combat any diesel generator and/or lubricating oil fires. Automatic fire detection should be provided to alarm and annunciate in the control room and alarm locally. Drainage for fire fighting water and means for local manual venting of smoke should be provided.

Day tanks with total capacity up to 1100 gallons are permitted in the diesel generator area under the following conditions:

(a) The day tank is located in a separate enclosure, with minimum fire resistance rating of three hours, including doors or penetrations. These enclosures should be capable of containing the entire contents of the day tanks. The enclosure should be ventilated to avoid accumulation of oil fumes.

(b) The enclosure should be protected by automatic fire suppression system such as AFFF or sprinklers.

10. Diesel Fuel Oil Storage Areas

Diesel oil fuel tanks greater than 1100 gallons capacity should not be located inside buildings containing safety related equipment. They should be located at least 50 feet distant from any building containing safety related equipment, or if located within 50 feet, they should be housed in a separate building with construction having minimum fire resistance rating of three hours. Buried tanks are considered as meeting the three hour fire separation requirements. See NFPA No. 30, "Flammable and Combustible Liquids Code," for additional guidance.

When located in a separate building, the tank should be protected by an automatic fire suppression system such as AFFF or sprinklers.

Tanks should not be located directly above or below safety related systems or equipment regardless of the fire rating of separating floors or ceilings.

11. Safety Related Pumps

Pump houses and rooms housing safety related pumps, or other safety related equipment, should be separated from other areas of the plant by fire barriers having at least three-hour ratings. These rooms should be protected by automatic sprinkler protection unless a fire hazards analysis can demonstrate that a fire will not endanger other safety related equipment required for safe plant shutdown. Early warning fire detection should be installed with alarm and annunciation locally and in the control room. Local hose stations and portable extinguishers should also be provided.

Equipment pedestals or curbs and drains should be provided to remove and direct water away from safety related equipment.

Provisions should be made for manual control of the ventilation system to facilitate smoke removal if required for manual fire fighting operation.

12. New Fuel Area

Hand portable extinguishers should be located within this area. Also, local hose stations should be located outside but within hose reach of this area. Automatic fire detection should alarm and annunciate in the control room and alarm locally. Combustibles should be limited to a minimum in the new fuel area. The storage area should be provided with a drainage system to preclude accumulation of water.

Storage configuration of new fuel should always be maintained to preclude criticality for any water density that might occur during fire water application.

13. Spent Fuel Pool Area

Protection for the spent fuel pool area should be provided by local hose stations and portable extinguishers. Automatic fire detection should be provided to alarm and annunciate in the control room and to alarm locally.

14. Radwaste Building

The radwaste building should be separated from other areas of the plant by fire barriers having at least three-hour ratings. Automatic sprinklers should be used in all areas where combustible materials are located. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally. During a fire, the ventilation systems in these areas should be capable of being isolated. Water should drain to liquid radwaste building sumps.

15. Decontamination Areas

The decontamination areas should be separated from other areas of the plant by fire barriers having at least three-hour ratings. These areas should be protected by automatic sprinklers. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally. The ventilation system should be capable of being isolated. Local hose stations and hand portable extinguishers, should be provided as backup to the sprinkler system.

16. Safety Related Water Tanks

Storage tanks which supply water for safe shutdown should be protected from the effects of fire. Local hose stations and portable extinguishers should be provided. Portable extinguishers should be located in nearby hose houses. Combustible materials should not be stored next to outdoor tanks. A minimum of 50 feet of separation should be provided between outdoor tanks and combustible materials where feasible.

17. Records Storage Areas

Records storage areas should be protected with automatic preaction sprinkler systems. Early warning fire detectors should be provided to alarm and annunciate in the control room and to alarm locally. Local hose stations and portable extinguishers should serve as backup. Refer to NFPA 232AM, "Manual for Fire Protection for Archives and Record Centers," Regulatory Guide 1.88, "Collection, Storage and Maintenance of Nuclear Power Quality Assurance Records" and ANSI N45.2.9, "Requirements for Collecting, Storage and Maintenance of Quality Assurance Records for Nuclear Power Plants."

18. Cooling Towers

Cooling towers should be of non-combustible construction or so located that a fire will not adversely affect any safety related systems or equipment. Cooling towers should be of non-combustible construction when the basins are used for the ultimate heat sink or for the fire protection water supply.

19. Miscellaneous Areas

Miscellaneous areas such as shops, warehouses and auxiliary boiler rooms should be so located that a fire or effects of a fire, including smoke, will not adversely affect any safety related systems or equipment. Fuel oil tanks for auxiliary boilers should be buried or provided with dikes to contain the entire tank contents.

E. Special Protection Guidelines

1. Welding and Cutting, Acetylene - Oxygen Fuel Gas Systems

This equipment is used in various areas throughout the plant. Storage locations should be chosen to permit fire protection by automatic sprinkler systems. Local hose stations and portable equipment should be provided as backup. The requirements of NFPA 51 and 51B are applicable to these hazards. A permit system should be required to utilize this equipment. (Also refer to IV.B.6 herein.)

2. Storage Areas for Dry Ion Exchange Resins

The storage of dry ion exchange resins should be kept away from essential safety related systems. Dry unused resins should be protected by automatic wet pipe sprinkler installations. Detection by smoke and heat detectors should alarm and annunciate in the control room and alarm locally. Local hose stations and portable extinguishers should provide backup for these areas. Storage areas of dry resin should have curbs and drains. (Refer to NFPA 92M, "Waterproofing and Draining of Floors.")

3. Hazardous Chemicals

Hazardous chemicals should be stored and protected in accordance with the recommendations of NFPA No. 49, "Hazardous Chemicals Data." Chemicals storage areas should be well ventilated and protected against flooding conditions since some chemicals may react with water to produce ignition.

4. Materials Containing Radioactivity

Materials which collect and contain radioactivity such as spent ion exchange resins, charcoal filters, and HEPA filters should be stored in closed metal tanks or containers which are located in areas free from ignition sources of combustibles. These materials should be protected from exposure to fires in adjacent areas as well. Consideration should be given to requirements for removal of isotopic decay heat from entrained radioactive materials.

VI. REFERENCES

1. National Fire Protection Association References

NFPA 4 - Organization of Fire Services

NFPA 4A - Fire Department Organization

NFPA 6 - Industrial Fire Loss Prevention

NFPA 7 - Fire Emergencies Management

NFPA 8 - Effects of Fire on Operations, Management Responsibility for

NFPA 10 - Portable Fire Extinguishers, Installation

NFPA 10A - Portable Fire Extinguishers, Maintenance and Use

NFPA 11 - Foam Extinguishing Systems

NFPA 12 - Carbon Dioxide Systems

NFPA 12A - Halon 1301 Systems

NFPA 12B - Halon 1211 Systems

NFPA 14 - Standpipe and Hose Systems

NFPA 15 - Water Spray Fixed Systems

NFPA 20 - Centrifugal Fire Pumps

NFPA 24 - Outside Protection

NFPA 26 - Supervision of Valves

NFPA 27 - Private Fire Brigade

NFPA 30 - Flammable Combustible Liquids Code

NFPA 49 - Hazardous Chemicals Data

NFPA 50A - Gaseous Hydrogen Systems

NFPA 69 - Explosion Prevention System

NFPA 72D - Proprietary Signaling Systems

NFPA 80 - Fire Doors and Windows

NFPA 92M - Waterproofing and Draining of Floors

NFPA 194 - Fire Hose Connections

NFPA 196 - Fire Hose

NFPA 197 - Initial Fire Attack, Training, Standard on

NFPA 204 - Smoke and Heat Venting Guide

NFPA 232 AM - Archives and Record Centers

NFPA 251 - Fire Tests, Building Construction and Materials

NFPA 601 - Guard Service in Fire Loss Prevention

OTHER REFERENCES

ANSI Standard B31.1, "Power Piping"

ANSI N45.2.9, "Requirements for Collection, Storage, and Maintenance of Quality Assurance Records for Nuclear Power Plants"

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