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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE ~~1.189~~
~~(Draft was issued as DG-1097)~~

~~FIRE PROTECTION~~
~~FOR OPERATING~~DG-1170
(Proposed Revision 1 of Regulatory Guide 1.189, dated April 2001)

FIRE PROTECTION
FOR NUCLEAR POWER PLANTS

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received staff review or approval and does not represent an official NRC staff position.

Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rules and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted electronically through the NRC's interactive rulemaking Web page at http://www.nrc.gov/what-we-do/regulatory/rulemaking.html. Copies of comments received may be examined at the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by **December 24, 2006**.

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~~A. INTRODUCTION~~

A. INTRODUCTION

The primary objectives of fire protection program~~s~~(FPPs) at U.S. nuclear plants are to minimize both the probability of occurrence and the consequences of fire. To meet these objectives, the ~~fire protection programs~~FPPs for operating nuclear power plants are designed to provide reasonable assurance, through defense~~-~~-in~~-~~-depth, that a fire will not prevent the performance of necessary saf~~e~~e shutdown functions, and ~~that~~ radioactive releases to the environment in the event of a fire will be minimized.

The ~~NRC's~~ regulatory framework that the U.S. Nuclear Regulatory Commission (NRC) has established for nuclear plant ~~fire protection programs is~~FPPs consists of a number of regulations and supporting guidelines, including, but not limited to, General Design Criterion ~~3~~ (GDC~~ 3), 10 CFR 50.48, Appendix R~~) 3, “Fire Protection,” as set forth in Appendix A, “General Design Criteria for Nuclear Power Plants,” to Title 10, Part 50, “Domestic Licensing of Production and Utilization Facilities,” of the *Code of Federal Regulations* (10 CFR Part 50); 10 CFR 50.48, “Fire Protection”; Appendix R, “Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979,” to 10 CFR Part 50~~,~~; regulatory guides~~,~~; generic communications ~~(~~[e.g., ~~G~~generic ~~Letters, Bulletins, and Information Notices), NUREG reports, the Standard~~letters (GLs), regulatory issue summaries (RISs), bulletins, and information notices (INs)]; NUREG-series reports, including NUREG-0800, “Standard Review Plan ~~(NUREG-0800) and associated Branch Technical Positions,~~for the Review of Safety Analysis Reports for Nuclear Power Plants” (NUREG-0800 or SRP)~~,~~ and industry standards. Since all of the fire protection regulations promulgated by the NRC ~~are~~do not ~~applicable~~apply to all plants, ~~they have~~this guide does not ~~been characterized~~categorize them as regulations ~~in this guide~~. Licensees should refer to their plant-specific licensing bases to determine the applicability of a specific regulation to a specific plant.

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Section B, ~~Discussion~~“Discussion,~~ of this guide~~” provides a brief history and discussion of the development and application of fire protection regulations and guidelines in the U.S. commercial nuclear power industry. The discussion includes summaries of the applicable regulations, the primary fire protection objectives, the varied licensing and design bases, and the primary assumptions relative to postulated fire events for nuclear power reactors.

Section C, ~~Regulatory~~“Regulatory Position,~~ provides~~” identifies staff positions and guidance ~~relative~~relevant to providing an acceptable level of fire protection for~~ operating~~ nuclear power plants. The positions and guidance provided are a compilation of the fire protection requirements and guidelines from the existing regulations and staff guidance. In addition, as appropriate, this section offers new guidance ~~is provided~~ where the existing guidance is weak or nonexistent.

Section D, ~~Implementation~~“Implementation,” describes how the NRC staff will use this guide.

~~This~~The NRC staff developed this regulatory guide ~~has been developed~~ to provide a comprehensive fire protection guidance document and to identify the scope and depth of fire protection that the staff would consider acceptable for nuclear ~~plants currently operating as of January~~power plants. The original issue of this guide addressed only plants operating as of January 1, 2001. This revision provides guidance for new reactor designs. In addition, this revision incorporates the guidance previously included in Branch Technical Position (BTP) SPLB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants (Formerly BTP CMEB 9.5-1)." This regulatory guide may be used for licensee self-assessments and as the deterministic basis for future rulemaking.

Many existing nuclear plants are adopting risk-informed, performance-based FPPs in accordance with 10 CFR 50.48(c) and National Fire Protection Association (NFPA) Standard 805, "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants," 2001 Edition. While much of the guidance provided here has been incorporated in the FPP of these plants and will continue to be appropriate for a risk-informed, performance-based FPP, the guidance provided in Regulatory Guide 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," will take precedence over the guidance provided in this regulatory guide for plants that adopt a risk-informed, performance-based FPP in accordance with 10 CFR 50.48(c).

Risk-informed and performance-based alternatives to the guidance presented in this ~~r~~document that are in accordance with Regulatory ~~g~~Guide 1.205 may be acceptable to the NRC staff.

~~The~~ for plants that do not modify their licenses in accordance with 10 CFR 50.48(c). Licensees that do not adopt a program based on NFPA 805 may use risk-informed, performance-based methods to determine the acceptability of a plant change; however, licensees should submit the methodology, including acceptance criteria, for NRC review and approval as a license amendment request in accordance with 10 CFR 50.90, "Application for Amendment of License or Construction Permit," before implementing the change.

Regulatory Guide 1.191, "Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown," provides specific criteria and guidelines for FPPs for shutdown and decommissioning of nuclear power plants.

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with regulatory guides is not required. The NRC issues regulatory guides in draft form to solicit public comment and involve the public in developing the agency's regulatory positions. Draft regulatory guides have not received complete staff review and, therefore, they do not represent official NRC staff positions.

This regulatory guide contains information collections ~~contained in this regulatory guide~~that are covered by the requirements of 10 CFR Part 50, which ~~were approved by~~ the Office of Management and Budget~~, approval~~ (OMB) approved under OMB control number 3150-0011. ~~If a means used to impose an information collection does not display a currently valid OMB control number,~~ The NRC may ~~not~~neither conduct ~~or~~nor sponsor, and a person is not required to respond to ~~the information~~an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

B. DISCUSSION

~~BACKGROUND~~ Background

During the initial implementation of the U.S. nuclear reactor program, regulatory acceptance ~~of fire protection programs~~of FPPs at nuclear power plants was based on the broad performance objectives of ~~General Design Criterion 3 (~~GDC 3~~)~~ in Appendix A to~~-~~ 10 CFR Part 50. Appendix A establishes the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components (SSCs) important to safety. GDC 3 addresses fire protection requirements and specifies, in part, that (1)~~ structures, systems, and components~~ SSCs important to safety must be designed and located to minimize the probability and effects of fires and explosions, (2) noncombustible and heat-resistant materials must be used wherever practical, and (3) fire detection and suppression systems must be provided to minimize the adverse effects of fires on ~~structures, systems, and components~~SSCs important to safety. However~~, during this early stage of nuclear power regulation~~, given the lack of detailed implementation guidance for this ~~general design criterion~~GDC during this early stage of nuclear power regulation, the level of fire protection was generally ~~found to be~~considered acceptable if the facility complied with local fire codes and received an acceptable rating from its fire insurance underwriter. Thus, the fire protection features installed in early U.S. nuclear power plants were very similar to those installed in conventional fossil-fuel power generation stations.

A fire at the Browns Ferry Nuclear Power Plant, Unit 1, on March 22, 1975, was a pivotal event that brought fundamental change to fire protection and its regulation in the U.S. nuclear power industry. The fire started when plant workers in the cable spreading room used an open flame to test for air leakage through a non-fire-rated (polyurethane foam) penetration seal that led to the reactor building. The fire ignited both the seal material and the electrical cables that passed through it, and burned for almost 7 hours before ~~it was~~being extinguished ~~using~~by a water hose stream. The greatest~~ amount of~~ fire damage actually occurred on the reactor building side of the penetration, in an area roughly 12.2 ~~m~~meters (m) [40 feet (ft)] by 6.1 m (20~~-~~ ~~feet~~ft). ~~M~~The fire affected more than ~~1600~~1,600 cables, routed in 117 conduits and 26 cable trays~~, were~~; of the affected ~~and, of those~~ cables~~ affected~~, 628 were important to safety. The fire damage to electrical power, control systems, and instrumentation cables impeded the functioning of both normal and standby reactor cooling systems and degraded plant monitoring capability for the operators. Given the loss of multiple safety systems, operators had to initiate emergency repairs ~~in order~~ to restore the systems needed to place the reactor in a safe~~-~~ shutdown condition.

The investigations that followed the Browns Ferry fire identified significant deficiencies, in both ~~in~~ the design of fire protection features and ~~in~~the licensee's procedures for responding to a fire event. The investigators concluded that the occupant safety and property protection concerns of fire insurance underwriters did not sufficiently encompass nuclear safety issues, especially in terms of the potential for fire damage to cause the failure of redundant success paths of systems and components important for safe reactor shutdown. In its report (NUREG-0050, ~~February 1976,~~ "Recommendations Related to Browns Ferry ~~Fire"~~Fire," February 1976), the NRC's Browns Ferry special review team recommended that the ~~NRC~~agency (1) develop detailed guidance for implementing the general design criterion for fire protection and (2) conduct a detailed review of the ~~fire protection program~~FPP at each operating nuclear power plant, ~~comparing it~~which would compare the FPP to the guidance developed.

In May 1976, the NRC issued ~~Branch Technical Position (~~BTP~~)~~ APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," dated May 1, 1976, which incorporated the recommendations from the Browns Ferry fire special review team and provided technical guidelines to assist licensees in preparing their ~~fire protection programs~~FPPs. As part of this action, the staff ~~requested~~asked each licensee to provide an analysis ~~that divided~~dividing the plant into distinct fire areas and ~~demonstrated~~demonstrating that redundant success paths of equipment required to achieve and maintain safe shutdown conditions for the reactor were adequately protected from fire damage. However, the guidelines of APCSB 9.5-1 applied only to those licensees that filed for a construction permit after July 1, 1976.

In September 1976, in an effort to establish defense-in-depth ~~fire protection programs~~FPPs, without significantly affecting the design, construction, or operation of existing plants that were either already operating or well past the design stage and into construction, the NRC modified the guidelines in APCSB 9.5-1 and issued Appendix A to APCSB 9.5-1. This guidance provided acceptable alternatives in areas where strict compliance with APCSB 9.5-1 would require significant modifications. Additionally, the NRC informed each plant that the staff would use the guidance in Appendix A ~~would be used~~ to analyze the consequences of a postulated fire within each area of the plant and requested licensees to provide results of the fire hazards analysis performed for each unit and the technical specifications for the present fire protection systems.

Early in 1977, each licensee responded with ~~a fire protection program~~an FPP evaluation that included a fire hazards analysis. ~~These~~The staff reviewed these analyses ~~were reviewed by the staff~~ using the guidelines of Appendix A to APCSB 9.5-1. The staff also ~~conducted inspections of~~inspected operating reactors to examine the relationship of ~~structures, systems, and components~~SSCs important to safety with the fire hazards, potential consequences of fires, and the fire protection features. After reviewing licensees' responses to the BTP, the staff determined that additional guidance on the management and administration of ~~fire protection programs~~FPPs was necessary~~;~~ and, in mid-1977, issued ~~Generic Letter 77-002,~~GL 77-02, "Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance," which provided criteria used by the staff ~~in~~to review ~~of~~ specific elements of a licensee's ~~fire protection program~~FPP, including organization, training, combustible and ignition source controls, firefighting procedures, and quality assurance (QA). ~~M~~The BTP review process resolved many fire protection issues ~~were resolved during the BTP review process, and agreements were included~~, as reflected in the NRC-issued safety evaluation reports (SERs).

By the late 1970s to early 1980, ~~the majority of~~most operating plants had completed their analyses and implemented ~~most~~much of the ~~fire protection program~~FPP guidance and recommendations specified in Appendix A to the BTP. In most cases, the NRC had found the licensees' proposed modifications resulting from these analyses to be acceptable. In certain instances, however, technical disagreements between licensees and the NRC staff led ~~to~~ some licensees~~' opposition~~ to oppose t~~o~~he adopt~~some~~ion of ~~the~~certain specified fire protection recommendations, such as the requirements for fire brigade size and training; water supplies for fire suppression systems; alternative, dedicated, or backup shutdown capability; emergency lighting; qualifications of penetration seals used to enclose places where cables penetrated fire barriers; and the prevention of reactor coolant pump (RCP) oil system fires. Following deliberation, the Commission determined that, given the generic nature of some of the disputed issues, a rulemaking was necessary to ensure proper implementation of the NRC's fire protection requirements.

In November 1980, the NRC published the ~~"Fire~~"Fire Protection~~"~~" rule, 10 CFR 50.48, which specified broad performance requirements, as well as Appendix R~~, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979,"~~ to 10 CFR Part 50, which specified detailed regulatory requirements for resolving the disputed issues.

As originally proposed (*Federal Register*, ~~Vol.~~Volume 45, ~~No. 1&5~~Numbers 1 and 5, May 22, 1980), Appendix R would have applied to all plants licensed ~~prior to~~before January 1, 1979, including those for which the staff had previously accepted the fire protection features as meeting the provisions of Appendix A to APCSB 9.5~~-~~-1. After analyzing comments on the proposed rule, the Commission determined that only ~~three~~3 of the ~~fifteen~~15 items in Appendix R were of such safety~~-~~-significance that they should apply to all plants (licensed ~~prior to~~before January 1, 1979), including those for which the staff had previously approved alternative fire protection actions~~ had been approved previously by the staff~~. These three items are fire protection of safe~~-~~-shutdown capability (including alternative, dedicated, or backup shutdown systems), emergency lighting, and the ~~reactor coolant pump~~RCP oil system. Accordingly, the final rule required all reactors licensed to operate before January 1, 1979, to comply with these three items even if the NRC had previously approved alternative fire protection features in these areas (*Federal Register*, ~~Vol.~~Volume 45, ~~Nov.~~November 19, 1980).

In addition, the rule provided an exemption process~~ that can be requested by a~~. A licensee can request an exemption, provided that a required fire protection feature to be exempted would not enhance fire protection safety in the facility, or that such modifications may be detrimental to overall safety ~~(~~[10 CFR 50.48(c)(6)~~)~~]. Under this process, if the Director~~,~~ of the NRC's Office of Nuclear Reactor Regulation~~,~~ (NRR) determine~~d~~s that a licensee has made a prima facie showing of a sound technical basis for such an assertion, ~~then the~~the Commission would delay implementation ~~dates~~ of the rule ~~were delayed~~ until it took final~~ Commission~~ action on the exemption request. Appendix R to 10 CFR Part 50 and 10 CFR 50.48 became effective on February 17, 1981.

During the initial backfit of the fire protection regulation, the NRC approved ~~a large number of~~many plant-specific exemptions (i.e., alternative methods to achieve the underlying purpose of the regulation) at about 60 nuclear power plants. Since the mid-1980s, as licensees' programs have bec~~a~~ome more compliant with the fire protection regulations, the number of exemptions requested and approved has decreased. Even so, the ongoing review of licensee ~~fire protection programs~~FPPs, the licensee efforts to save costs while maintaining an acceptable level of safety, and the emergence of additional technical issues (such as the deliberations over the adequacy of Thermo-Lag as a fire protection barrier) have resulted in several hundred exemptions to specific elements of the NRC fire protection requirements. This progression, the broad provisions of the ~~general design criterion~~GDC, the detailed implementing guidance, the plant-by-plant review, and finally the issuance and backfit of the fire protection regulation and the prescriptive requirements of Appendix R resulted in a complex regulatory framework for fire protection in U.S. nuclear power plants licensed ~~prior to~~before 1979 and resulted in the issuance~~ of a number~~ of additional guidelines, clarifications, and interpretations, primarily as generic letters. Plants licensed after January 1, 1979, were not required to meet the provisions of Appendix R unless ~~specified~~directed to do so in specific license conditions. These plants were typically reviewed ~~to~~using the guidelines of Section 9.5.1, "Fire Protection Program," of the ~~Standard Review Plan~~SRP (NUREG-0800), which subsumed the criteria specified in Appendix R. In July 1981, the NRC issued a major revision to NUREG-0800 for use in the review of new license applications. This revision included ~~Standard Review Plan~~SRP Section 9.5.1 with ~~Branch Technical Position~~BTP CMEB 9.5-1 as an update to the earlier fire protection BTPs.

Following promulgation of 10 CFR 50.48 and Appendix R, the staff issued ~~Generic Letter~~GL 81-12, "Fire Protection Rule (~~February 20~~45 FR 76602, November 19, 198~~1~~0)," and later its associated clarification letter (March 22, 1982). In these letters, the staff identified the information necessary to perform ~~their~~its reviews of licensee compliance with the alternative or dedicated shutdown requirements of Section III.G.3 of Appendix R. Staff guidance provided in these letters defined safe~~-~~-shutdown objectives, reactor performance goals, necessary safe~~-~~-shutdown systems and components, and associated circuit identification and analysis methods. ~~Generic Letter~~GL 81-12 also requested that licensees develop technical specifications ~~be developed~~ for safe~~-~~-shutdown equipment that ~~was~~were not already included in the existing plant technical specifications.

Most licensees requested and ~~were granted~~received additional time to perform their reanalysis, propose modifications to improve post~~-~~-fire safe~~-~~-shutdown capability, and identify exemptions for certain fire protection configurations. In reviewing some exemption requests, the staff noted that a number of ~~-~~licensees had ~~made~~ significantly different interpretations of certain requirements. ~~These~~The staff identified these differences ~~were identified~~ in the ~~staff's~~ draft SERs and ~~were~~ discussed them on several occasions with the cognizant licensees. These discussions culminated in the issuance of ~~Generic Letter 83-33 (October 19, 1983).~~GL 83-33, "NRC Positions on Certain Requirements of Appendix R to 10 CFR Part 50."

Certain licensees disagreed with, or found it difficult to implement, the interpretations provided in ~~Generic Letter~~GL 83-33. To pursue the matter with senior NRC management, the industry formed the Nuclear Utility Fire Protection Group. Subsequently, the staff formed the Steering Committee on Fire Protection Policy.

Following staff inspections of operating plants, which identified a number of significant items of ~~non-compliance,~~noncompliance and disagreements in the implementation of interpretations provided in ~~Generic Letter~~GL 83-33, the Nuclear Utility Fire Protection Group requested interpretations of certain Appendix R requirements and ~~provided~~prepared a list of questions to be discussed with the industry. The NRC responded by holding workshops in each ~~R~~region to assist the industry in understanding the NRC's requirements and to improve the staff's understanding of the industry's concerns. The Fire Protection Policy Steering Committee documented the results of these workshops and the ~~S~~steering ~~C~~committee's findings and recommendations for addressing ongoing fire protection issues ~~were documented in Generic Letter 85-01~~in the Fire Protection Policy Steering Committee Report. ~~Generic Letter 85-01~~The report included a proposed ~~G~~generic ~~L~~letter that provided additional interpretations related to compliance with Appendix R and staff answers to the industry's list of questions from the workshops. ~~This proposed Generic Letter was~~The staff revised and later issued ~~as G~~this proposed generic ~~L~~letter as GL 86~~-~~-10, "Implementation of Fire Protection Requirements," on April 24, 1986.

Also included in ~~Generic Letter~~GL 86-10 was a "standard license condition" for adoption by licensees. Through the implementation and adoption of a standard license condition, a licensee was allowed to make changes to its ~~fire protection program~~FPP without ~~prior notification to~~first notifying the NRC in accordance with the provisions of 10~~-~~ CFR~~-~~ 50.59, "Changes, Tests and Experiments," provided that the changes did not adversely affect the plant's ability to achieve and maintain ~~post-fire~~ safe shutdown after a fire. ~~The licensee, u~~Upon modification of the license to adopt the standard condition, the licensee could also amend the license to remove the fire protection technical specifications. ~~Generic Letter~~GL 88-12, "Removal of Fire Protection Requirements from Technical ~~Specifications"~~ ~~(~~Specifications," dated August 2, 1988~~)~~, gave licensees additional guidance for ~~implementation of~~implementing the standard license condition and ~~removal of~~removing the technical specifications associated with fire detection and suppression, fire barriers, and fire brigade staffing. ~~T~~Licensees were to retain the technical specifications associated with safe~~-~~-shutdown equipment and the administrative controls related to fire protection audits ~~were to be retained~~ under the guidance of the generic letter.

~~As illustrated~~Beginning in the ~~preceding discussion~~late 1990s, the ~~Commission's~~Commission provided the NRC staff with guidance for identifying and assessing performance-based approaches to regulation. In SECY-98-0058, "Development of a Risk-Informed, Performance-Based Regulation for Fire Protection at Nuclear Power Plants," dated March 26, 1998, the NRC staff proposed to the Commission that the staff work with the NFPA and industry to develop a performance-based, risk-informed consensus standard for fire protection ~~requirements and guidelines consist of a multitude of rules, generic communications, staff guidance, and other related documents. Current industry and~~

regulatory issues have prompted action on the part of the NRC to compile the current fire protection regulations and guidelines for operating reactors into this comprehensive guide.

REGULATORY REQUIREMENTS

There are a number of regulatory requirements with applicability to the development and implementation of fire protection programs for nuclear power plants currently operating as of January 1, 2001. The primary requirements are summarized in this section.

Appendix A to 10 CFR Part 50

Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 establishes for those plants for which its provisions apply, the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety (see Glossary). The following subsections summarize those GDC with specific application to fire protection of nuclear power plants.

GDC 3, Fire Protection

GDC 3 requires that structures, systems, and components important to safety be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat resistant materials are required to be used wherever practical, particularly in locations such as the containment and control room. Fire detection and fighting systems of appropriate capacity and capability are required to be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. GDC 3 also requires that firefighting systems be designed to ensure that their failure, rupture, or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components.

GDC 5, Sharing of Structures, Systems, and Components

GDC 5 requires that structures, systems, and components important to safety not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

GDC 19, Control Room

GDC 19 requires that a control room be provided from which actions can be taken to operate the nuclear power unit under normal and accident conditions, while limiting radiation exposure to control room personnel under accident conditions for the duration of the accident. GDC 19 also requires that equipment and locations outside the control room be provided with the design capability to accomplish hot shutdown of the reactor and with a potential capability for subsequent cold shutdown of the reactor.

GDC 23, Protection System Failure Modes

GDC 23 requires that the protection system be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or postulated adverse environments (e.g., extreme heat or cold, fire, pressure, steam, water, radiation) are experienced.

10 CFR 50.48

Section 50.48 of 10 CFR Part 50 requires that each operating nuclear power plant have a fire protection plan that satisfies General Design Criterion 3 of Appendix A to 10 CFR Part 50. It specifies what should be contained in such a plan and lists the basic fire protection guidelines for the plan.

Section 50.48 also requires that all plants with operating licenses prior to January 1, 1979, satisfy the requirements of Sections III.G, III.J, and III.O, and other sections of Appendix R to 10 CFR Part 50, where approval of similar features had not been obtained prior to the effective date of Appendix R.

Plants licensed to operate after January 1, 1979, must meet the provisions of 10 CFR 50.48(a).

As discussed later in this guide in the Licensing and Design Basis section, deviations from NRC fire protection requirements are documented and reviewed under different processes depending on the date of the operating license. Appendix R requirements for pre-1979 plants are processed under the exemption process. Deviations from other applicable guidelines are identified and evaluated in the staff's Safety Evaluation Reports. For post-1979 plants, where fire protection features do not meet applicable NRC requirements or commitments, or alternative approaches are proposed, the condition is documented as a deviation.

Appendix R to 10 CFR Part 50

Appendix R to 10 CFR Part 50 applies to licensed nuclear power electric generating stations that were operating prior to January 1, 1979, except as noted in 10 CFR 50.48(b). With respect to certain generic issues for such facilities, Appendix R identifies fire protection features required to satisfy Criterion 3 of Appendix A. There are two categories of Appendix R provisions that are applicable to the fire protection features of these facilities.

The first category consists of those provisions that were required to be backfit in their entirety, regardless of whether alternatives to the specific requirements had been previously approved by the NRC. The requirements are identified in Sections III.G, "Fire Protection of Safe Shutdown Capability"; III.J, "Emergency Lighting"; and III.O, "Oil Collection System for Reactor Coolant Pump." Those plants subject to the requirements of Section III.G.3 must also meet the requirements of Section III.L.

The second category consists of requirements concerning the open items of previous NRC staff fire protection reviews. Open items are defined as fire protection features that had not been previously approved by the NRC staff as satisfying the provisions of Appendix A to APCSB 9.5-1, as reflected in SERs.

Except as specified in the license conditions of individual plants, Appendix R was not required to be implemented by plants that were licensed to operate after January 1, 1979. Rather, fire protection programs at these later plants were typically reviewed against the licensing review guidelines of Section 9.5-1 to the Standard Review Plan (NUREG-0800). SRP Section 9.5-1 and the associated CMEB 9.5-1 consolidated the guidance of the previous BTP, Appendix A to APCSB 9.5-1, Appendix R, and other staff guidance.

10 CFR Parts 50.72 and 50.73

These regulations prescribe the notification and reporting requirements for nuclear power plant licensees, including those related to fire protection programs. Section 50.72 provides for immediate

~~notification requirements via the emergency notification system (ENS), and Section 50.73 provides for 60-day written~~that, if the standard was acceptable, would be endorsed by the staff in a rulemaking. The NFPA Standards Council issued NFPA 805, 2001 Edition, on January 13, 2001. The NRC published 10 CFR 50.48(c) endorsing NFPA 805 on June 16, 2004 (69 FR 33536). Regulatory Guide 1.205 provides staff guidance for licensees that elect to adopt a risk-informed, performance-based FPP in accordance with 10 CFR 50.48(c) and NFPA 805.

In 1997, the NRC staff noticed that a series of licensee event reports (LERs)~~.~~

~~The information reported under 10 CFR 50.72 and 50.73 is used by the NRC staff in responding to emergencies, monitoring ongoing events, confirming licensing bases, studying potentially generic safety problems, assessing trends and patterns of operational experience, monitoring performance, identifying precursors of more significant events, and providing operational experience to the industry. The two rules have identical reporting thresholds and similar language whenever possible. They are complementary and of equal importance, with necessary dissimilarities in reporting requirements to meet their different purposes.~~

~~The regulation, 10 CFR 50.72, is structured to provide telephone notification of reportable events to the NRC Operations Center within a time frame established by the relative importance of the events. Events are categorized as either emergencies (immediate notifications, but no later than 1 hour) or non-emergencies. Non-emergencies are further categorized into 1-hour and 4-hour notifications; non-emergency events requiring 4-hour notifications generally have slightly less urgency and safety significance than those requiring 1-hour notifications. Immediate telephone notification to the NRC Operations Center of declared emergencies is necessary so the NRC may immediately respond. Reporting of non-emergency events and conditions is necessary to permit timely NRC follow-up via event monitoring, special inspections, generic communications, or resolution of public or media concerns.~~

~~According to 10 CFR 50.73, written LERs must be submitted on reportable events within 60 days of their occurrence, after a thorough analysis of the event, its root causes, safety assessments, and corrective actions are available, to permit NRC engineering analyses and studies.~~

~~LICENSING AND DESIGN BASIS~~

~~The fire protection licensing and design basis is dependent on a number of factors that may differ considerably for individual plants. However, with the issuance of the fire protection rule, 10 CFR 50.48, and Appendix R to 10 CFR 50, the applicability of certain fire protection requirements, including those within the rule, was established on the basis of the licensing date for a given plant being before or after January 1, 1979.~~

~~Plants Licensed Prior to January 1, 1979~~

~~The primary licensing basis for plants licensed to operate prior to January 1, 1979, is comprised of the plant license conditions, Appendix R and any approved exemptions, and the staff's Safety Evaluation Reports (SERs) on the fire protection program.~~

~~Safety Evaluation Reports~~

~~The SERs document the staff acceptance of the plant fire protection program or elements thereof. For plants licensed to operate prior to January 1, 1979, the staff's SERs also establish the extent to which the requirements of Appendix R to 10 CFR Part 50 apply. Plants whose fire protection features were~~

accepted by the NRC as satisfying the provisions of Appendix A to Branch Technical Position (BTP) APCSB 9.5-1, or were accepted in comprehensive SERs issued prior to publication of Appendix A to BTP APCSB 9.5-1 in August 1976, were only required to meet the provisions of Sections III.G (III.L), III.J, and III.O of Appendix R.

Exemptions to Appendix R

Effective February 17, 1981, the NRC amended its regulations by adding 10 CFR 50.48 and Appendix R to 10 CFR Part 50, requiring certain provisions for fire protection in nuclear power plants licensed to operate before January 1, 1979.

Plants with previously approved fire protection features (see Safety Evaluation Reports above) were exempted from the requirements of Appendix R with the exception of Sections III.G, III.J, and III.O.

The required schedules for licensees to comply with the provisions of Appendix R were established in 10 CFR 50.48(c). Provisions were also included in the rule to allow licensees to file exemptions from Appendix R requirements on the basis that the required modifications would not enhance fire protection safety in the facility or would be detrimental to overall facility safety. These exemptions, upon approval by the staff, become a part of the fire protection licensing basis. The provisions of 10 CFR 50.48(c) have since expired and have been deleted from the regulations. Future exemptions should be requested in accordance with 10 CFR 50.12, as discussed below. (See Regulatory Position 1.8.2.)

Exemptions from fire protection requirements may also be requested in accordance with the provisions of 10 CFR 50.12. Under 10 CFR 50.12, the Commission may grant exemptions from the requirements of the regulations in 10 CFR Part 50, which are:

1. Authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security.

2. The Commission will not consider granting an exemption unless special circumstances are present. Special circumstances are present whenever;

- Application of the regulation in the particular circumstances conflicts with other rules or requirements of the Commission; or
- Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule; or
- Compliance would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted, or that are significantly in excess of those incurred by others similarly situated; or
- The exemption would result in benefit to the public health and safety that compensates for any decrease in safety that may result from the grant of the exemption; or

- The exemption would provide only temporary relief from the applicable regulation and the licensee or applicant has made good faith efforts to comply with the regulation; or

- There is present any other material circumstance not considered when the regulation was adopted for which it would be in the public interest to grant an exemption. If such condition is relied on exclusively for satisfying criteria (2) above, the exemption may not be granted until the Executive Director for Operations has consulted with the Commission.

Operating License Conditions

Most operating plant licenses contain a section on fire protection. License conditions for plants licensed prior to January 1, 1979, typically contain a condition requiring implementation of modifications committed to by the licensee as a result of the fire protection program review with respect to the branch technical position. These license conditions were added by amendments issued between 1977 and February 17, 1981, the effective date of 10 CFR 50.48 and Appendix R.

As a result of numerous compliance, inspection, and enforcement issues associated with the various plant license conditions, the staff developed a standard licensing condition. The standard license condition, and the NRC's recommendation that it be adopted by licensees, was transmitted to licensees in Generic Letter 86-10. Additional guidance regarding removal of the fire protection requirements from the plant technical specifications was provided to licensees in Generic Letter 88-12. The changes were promulgated to provide licensees greater flexibility in the management and implementation of the fire protection program and to clarify the fire protection licensing basis for the specific facility.

Plants Licensed After January 1, 1979

Plants licensed after January 1, 1979, are subject to the requirements of 10 CFR 50.48(a) only, and as such must meet the provisions of GDC 3 as specified in their license conditions and as accepted by the NRC in their SERs. These plants are typically reviewed to the guidance of SRP Section 9.5-1. For these plants, where commitments to specific guidelines cannot be met, or alternative approaches are proposed, the differences between the licensee's program and the guidelines are documented in deviations (see Regulatory Position 1.4.4).

FIRE PROTECTION PROGRAM GOALS/OBJECTIVES

Defense in Depth

Fire protection for nuclear power plants uses the concept of defense in depth to achieve the required degree of reactor safety by using echelons of administrative controls, fire protection systems and features, and safe shutdown capability. These defense-in-depth principles are aimed at achieving the following objectives.

- To prevent fires from starting,

- To detect rapidly, control, and extinguish promptly those fires that do occur, and

- To provide protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe shutdown of the plant.

Assumptions

Postulated Fire

Fire damage to safe shutdown equipment is assessed on the basis of a single fire, including an exposure fire. An exposure fire is a fire in a given area that involves either in situ or transient combustibles and has the potential to affect structures, systems, and components important to safety located in or adjacent to that same area. The effects of such fire (e.g., smoke, heat, or ignition) can adversely affect those structures, systems, and components important to safety. Thus, a fire involving one success path of safe shutdown equipment may constitute an exposure fire for the redundant success path located in the same area, and a fire involving combustibles other than either redundant success path may constitute an exposure fire to both redundant success paths located in the same area.

Three levels of fire damage limits are established according to the safety function of the structure, system, or component. Damage limits for hot shutdown and cold shutdown systems and components are described in Regulatory Positions 5.3 and 5.4, respectively. Redundant systems necessary for mitigation of consequences following design basis accidents, but not required for safe shutdown may be damaged by a single exposure fire as discussed below in the Safety-Related Structures, Systems, and Components section.

The most stringent fire damage limit should apply for those systems that fall into more than one category.

The fire event for considering the need for alternative or dedicated shutdown is a postulated fire in a specific fire area containing redundant safe shutdown cables/equipment where it has been determined that fire protection means specified in Regulatory Position 5.5 cannot be provided to ensure that safe shutdown capability will be preserved.

Conditions of Fire Occurrence

It is assumed that a fire may occur at any time, but is not postulated to occur simultaneously with plant accidents or the most severe natural phenomena.

On multiple reactor sites, unrelated fires in two or more units need not be postulated to occur simultaneously. Fires involving facilities shared between units and fires caused by man-made site-related events that have a reasonable probability of occurring and affecting more than one reactor unit (such as an aircraft crash) should be considered.

Loss of Offsite Power/Station Blackout

In evaluating the capability to accomplish post-fire safe shutdown, offsite power may or may not be available and consideration should be given to both cases. However, loss of offsite power need not be considered for a fire in non-alternative or dedicated shutdown areas if it can be shown that offsite power cannot be lost due to a fire in that area.

In accordance with the guidelines in Regulatory Position 5.6 of this guide, the capability to accomplish safe shutdown should be demonstrated for a loss of offsite power with a duration of 72 hours. However, in evaluating safe shutdown circuits, including associated circuits, the availability of uninterrupted power (i.e., offsite power available) may impact the ability to control the safe shutdown of the plant by increasing the potential for associated circuit interactions resulting from fire damage to energized power and control circuits.

Several licensees have alternative post-fire safe shutdown methodologies that may result in loss of all ac power (i.e., station blackout). Some of these plants voluntarily enter station blackout (SBO) as a means to cope with the potential for spurious operations and to provide positive (manual) control of safe shutdown equipment. Others have procedures that may cause a SBO condition to be created as a result of fire effects (e.g., procedures that direct operators to manually trip the credited safe shutdown emergency diesel generator (EDG) in the event of fire damage to circuits of vital EDG support systems).

The ability to cope with SBO as part of the post-fire safe shutdown methodology is dependent on such issues as timeline logic; assumptions and bases for plant and operator response relative to component realignment; the ability of plant operators to monitor and control plant parameters and align plant components before, during, and after SBO control room evacuation and abandonment; and the practicality and reliability of EDG start and load (and restart, if applicable) under post-fire safe shutdown SBO conditions. The relative risk of self-imposed SBO may greatly exceed the actual risk posed by the fire and should be given appropriate consideration when evaluating the plant safe shutdown design and procedures.

Fragility of Structures, Systems, and Components to Fire Damage

Fire damage to structures, systems, and components can result from heat, smoke, or ignition. Fire is assumed to damage safe shutdown structures, systems, and components within the fire area of concern as discussed in the Postulated Fire section above and subject to the guidelines in Regulatory Positions 5.3 and 5.4 of this guide and as determined by the fire hazards analysis. When using a performance-based or risk-informed alternative approach, the fragility of structures, systems, and components to fire damage, including the ability to repair affected structures, systems, and components, should be considered.

Fire Protection Program Performance Goals

Safety-Related Structures, Systems, and Components

Because fire may affect safe shutdown systems, and because the loss of function of systems used to mitigate the consequences of design basis accidents under post-fire conditions does not per se impact public safety, the need to limit fire damage to systems required to achieve and maintain safe shutdown conditions is greater than the need to limit fire damage to those systems required to mitigate the consequences of design basis accidents.

Post-Fire Safe Shutdown

The performance objectives of the fire protection program relative to post-fire safe shutdown are to ensure that one success path of structures, systems, and components necessary for hot shutdown is free of fire damage, and to limit fire damage such that one success path of structures, systems, and components necessary to achieve and maintain cold shutdown can be repaired or made operable within a specified time period using onsite capabilities (see Regulatory Position 5.3).

Prevention of Radiological Release

The fire protection program, including the fire hazards analysis, should demonstrate that the plant will maintain the ability to minimize the potential for radioactive releases to the environment in the event of a fire. Fires are expected to occur over the life of a nuclear power plant and thus should be treated as anticipated operational occurrences. Requirements for protection against radiation during normal operations are in 10 CFR Part 20. Anticipated operational occurrences should not result in radiological consequences, and the exposure criteria of 10 CFR Part 20 apply.

Post-Fire Safe Shutdown Reactor Safety/Performance Goals

Power Operations

One success path of cables and had identified plant-specific problems related to potential fire-induced electrical circuit failures that could prevent operation or cause maloperation of equipment necessary to achieve and maintain hot shutdown is to be maintained free of fire damage. The reactor safety and performance goals for post-fire safe shutdown should ensure that the specified acceptable fuel design limits are not exceeded. Post-fire reactor safety and performance goals for alternative or dedicated shutdown are. The NRC staff documented these problems in IN 99-17, "Problems Associated with Post-Fire Safe-Shutdown Circuit Analysis." Because of the number of similar LERs, the NRC treated the issue generically. In 1998, the NRC staff began interacting with interested stakeholders to understand the problem and develop an effective risk-informed solution to the circuit analysis issue. Because of the number of different stakeholder interpretations of the regulations, the NRC issued Enforcement Guidance Memorandum (EGM) 98-002, which provided enforcement discretion for circuit-related findings. Also, the NRC temporarily suspended circuit-related fire protection inspections in 2000.

In 2000, the NRC implemented the Reactor Oversight Process which included systematic inspections of licensees' safe-shutdown capability. During these inspections, fire protection inspectors noticed that many licensees had not upgraded or replaced Thermo-Lag 330-1 fire barrier material[1] or had not provided the separation distance between redundant safe-shutdown success paths necessary to satisfy the requirements in Section III.G.2 of Appendix R to 10 CFR Part 50. Some licensees compensated for the lack of or degraded fire barriers by relying on operator manual actions which had not been reviewed and approved by the NRC through the exemption process of 10 CFR 50.12, "Specific Exemptions." Other licensees misinterpreted Section III.G.1 to allow the use of operator manual actions in lieu of the means specified in Section III.LG.2 although redundant safe-shutdown success paths were in the same fire area.

In 2001, the Electric Power Research Institute (EPRI) and Nuclear Energy Institute (NEI) performed a series of cable functionality fire tests to advance the nuclear industry's knowledge of fire-induced circuit failures, particularly the potential for spurious equipment actuations initiated by hot shorts. EPRI coordinated this effort and issued the final report, "Spurious Actuation of Electrical Circuits Due to Cable Fires: Results of an Expert Elicitation" (Report No. 1006961, May 2002).[2] NEI considered the results of the testing in preparing an industry guidance document for circuit analysis, NEI 00-01, "Guidance for Post-Fire Safe-Shutdown Circuit Analysis."

The variety of interpretations with respect to circuit analysis issues stemmed partly from the previous lack of knowledge of the potential for certain types of circuit failure mechanisms. The cable fire tests performed by EPRI/NEI significantly increased the knowledge available to the industry and the NRC with respect to fire-induced circuit failures and their potential to cause multiple spurious actuations

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1 During the 1980s, many licensees used Thermo-Lag 330-1 as a fire barrier material to satisfy the requirements of Appendix R, Section III.G. In December 1992, the staff issued GL 92-08, "Thermo-Lag 330-1 Fire Barriers," which discussed issues with the Thermo-Lag 330-1 fire barrier material.

2 The concept of using a potential heat release limit of 8141 kJ/kg (3500 Btu/lb) is similar to the "limited combustible" concept with its like limit, as set forth in NFPA 220, "Standard on Types of Building Construction." Additional analysis of the EPRI/NEI test results appears in NUREG/CR-6776, "Cable Insulation Resistance Measurements Made During Cable Fire Tests," ML022600200 and ML022600307.

that could affect safe shutdown after a fire. To bring closure to these issues and support the resumption of circuit analysis inspections, the NRC staff issued RIS 2005-30, "Clarification of Post-Fire Safe-Shutdown Circuit Regulatory Requirements." The staff issued this generic communication to clarify regulatory requirements related to post-fire safe-shutdown circuit analyses and protection, particularly the requirements of Appendix R to 10 CFR 50.

Shutdown/Refueling Operations

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C. REGULATORY POSITION

1. FIRE PROTECTION PROGRAM

In accordance with 10 CFR 50.48, a fire protection program must be established at each nuclear power plant. The program should establish the fire protection policy for the protection of structures, systems, and components important to safety at each plant and the procedures, equipment, and personnel required to implement the program at the plant site.

The fire protection program should extend the concept of defense in depth to fire protection in fire areas important to safety, with the following objectives.

- To prevent fires from starting;
- To detect rapidly, control, and extinguish promptly those fires that do occur;
- To provide protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe shutdown of the plant.

In accordance with 10 CFR 50.48, the fire protection program must:

- Identify the various positions within the licensee's organization that are responsible for the program and state the authorities delegated to these positions (see Regulatory Position 1.1);

- Describe specific features such as administrative controls and personnel requirements for fire prevention (see Regulatory Position 2);

- Outline the plans for fire detection and suppression capability, and limitation of fire damage (see Regulatory Positions 1.2, 3, and 4);

- Describe personnel requirements for manual fire suppression activities (see Regulatory Position 3.5); and

- Describe the means to limit fire damage to structures, systems, and components important to safety so that capability to safely shut down the plant is ensured (see Regulatory Positions 1.3 and 5).

On reactor sites with an operating reactor and with construction, modification, or decommissioning of other units under way, the fire protection program should provide for continuing evaluation of fire hazards associated with these activities. Additional fire barriers, fire protection capability, and administrative controls should be provided as necessary to protect the operating unit from construction or decommissioning fire hazards.

The guidance in Regulatory Position 1 is based on 10 CFR 50.48, Appendix R to 10 CFR Part 50, and CMEB 9.5-1.

1.1 Organization, Staffing, and Responsibilities

The fire protection program should be under the direction of an individual who has been delegated authority commensurate with the responsibilities CFR Part 50, which licensees had interpreted in a manner inconsistent with regulatory expectations. The bases of the position and who has available staff personnel knowledgeable in both positions presented in the generic communication are the current regulations applicable to these circuits, which are supported by the industry cable fire test results. The NRC staff resumed inspection of fire-induced safe-shutdown circuits in January 2005.

The NRC issued RIS 2006-10, "Regulatory Expectations with Appendix R Section III.G.2 Operator Manual Actions," to inform the licensees about the staff's expectations, schedule, and enforcement policy for resolving issues related to crediting operator manual actions and the subsequent termination of EGM 98-02, "Enforcement Guidance Memorandum—Disposition of Violations of Appendix R, Sections III.G and III.L Regarding Circuit Failures."

As illustrated in the preceding discussion, the Commission's fire protection and nuclear safety.

Responsibility for the overall fire protection program should be assigned to a person who has management control over all organizations involved in fire protection activities. Formulation and assurance of program implementation may be delegated to a staff composed of personnel prepared by training and experience in fire protection and personnel prepared by training and experience in nuclear

~~plant safety to provide a comprehensive approach in directing the fire protection program for the nuclear power plant.~~

~~The following positions or organizations should be designated.~~

~~a. The upper level management position that has management responsibility for the formulation, implementation, and assessment of the effectiveness of the nuclear plant~~requirements and guidelines consist of rules, generic communications, staff guidance, and other related documents. Recent industry and regulatory issues have prompted the NRC to update this comprehensive guide to provide additional clarification of regulatory expectations with respect to FPPs. This revision reflects the staff positions documented in the recent generic communications.

For new reactor designs, the overall maturity of fire protection ~~program.~~

~~b. The management positions directly responsible for formulating, implementing, and periodically assessing the effectiveness of the~~regulations, the many years of nuclear plant operating experience, the improvement of analysis methodologies, and the opportunity to incorporate these benefits in the original plant design provide the bases for enhanced fire protection ~~program for the licensee's~~.

Regulatory Requirements

A number of regulatory requirements apply to the development and implementation of FPPs for nuclear power plant, including fire drills and training conducted by the fire brigade and plant personnel. The results of these assessments should be reported to the upper level management position responsible for fire protection with recommendations for improvements or corrective actions as deemed necessary.

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d. The onsite positions that:

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ii. Are responsible for the firefighting training for operating plant personnel and the plant's fire brigade, design and selection of equipment, periodic inspection and testing of fire protection systems and equipment in accordance with established procedures s. This section summarizes the primary requirements.

Appendix A to 10 CFR Part 50

Appendix A to 10 CFR Part 50 establishes, and evaluation of test results and determination of the acceptability of the systems under test.

iii. Assist in the critique of all fire drills to determine how well the training objectives have been met.

iv. Are responsible for the in-plant fire protection review of proposed work activities to identify potential transient fire hazards and specify required additional fire protection in the work activity procedure.

v. Implement a program for indoctrination of allthose plant contractor personnel in appropriate administrative procedures that implements to which its provisions apply, the fire protection program and the emergency procedures relative to fire protection.

vi. Implement a program for instruction of personnel on the proper handling of accidental events such as leaks or spills of flammable materials that are related to fire protection.

vii. Are responsible for review of hot work.

e. The onsite position responsible for fire protection quality assurance. This position is responsible for ensuring the effective implementation of the fire protection program by planned inspections, scheduled auditsnecessary design, fabrication, construction, testing, and verification that the results of these inspections and audits are promptly reported to cognizant management personnel.

f. The positions that are part of the plant fire brigade (also see Regulatory Position 3.5.1).

i. The plant fire brigade positions should be responsible for fighting fires. The authority and responsibility of each fire brigade position relativeperformance requirements for SSCs important to safety. The following subsections summarize those GDCs with specific application to fire protection should be clearly defined.

ii. The responsibilities of each fire brigade position should correspond with the actions required by the firefighting procedures.

iii. Collateral responsibilities of the fire brigade members should not conflict with their responsibilities related to the fire brigade during a fire emergency.

iv. The minimum number of trained fire brigade members available onsite for each operating shift should beof nuclear power plants.

GDC 3, Fire Protection

GDC 3 requires that SSCs important to safety be designed and located to minimize, consistent with the activities required to combat credible and challenging fires, but no less than 5 members. The size of the fire brigade should be based upon the functions required to fight fires with adequate allowance for injuries. Fire brigade staffing should account for all operational and emergency response demands on shift personnel in the event of a significant fire.

The guidance in Regulatory Position 1.1 is based on CMEB 9.5-1, IN 91-77, IN 95-48, and Stello Letter to Bixel (1978).

1.2 Fire Hazards Analysis

A fire hazards analysis should be performed to demonstrate that the plant will maintain the ability to perform safe shutdown functions and minimize radioactive material releases to the environment in the event of a fire. This analysis should be revised as necessary to reflect plant design and operational changes.

The fire hazards analysis accomplishes the following objectives:

a. Considers potential in situ and transient fire hazards;

b. Determines the consequences of fire in any location in the plant on the ability to safely shut down the reactor or on the ability to minimize and control the release of radioactivity to the environment; and

c. Specifies measures for fire prevention, fire detection, fire suppression, and fireother safety requirements, the probability and effect of fires and explosions. Noncombustible and heat-resistant materials must be used wherever practical, particularly in locations such as the containment and alternative shutdown capability for each fire area containing structures, systems, and components important to safety in accordance with NRC guidelines and regulations.

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The fire hazards analysis should address the following elements and attributes.

- The NRC fire protection requirements and guidance that apply.

- Amounts, types, configurations, and locations of cable insulation and other combustible materials.

- In situ fire hazards.

- Automatic firecontrol room. Fire detection and suppression capability. The effects of lightning strikes should be included in the design of fire detection systems.

- Layout and configurations of structures, systems, and componentsfirefighting systems of appropriate capacity and capability must be provided and designed to minimize the adverse effects of fires on SSCs important to safety. The protection for safe shutdown systems (see Regulatory Positions 5.5 and 5.6) within a fire area should be determined on the basis of the worst case fire that is likely to occur and the resulting damage. The extent of such damage should be justified in the fire hazards analysis. The analysis should consider the degree of spatial separation between redundant shutdown systems, the presence of in situ and transient combustibles, the available fire protection systems and features, sources of ignition, and the susceptibility to fire damage of the safe-shutdown-related cables, equipment, systems, and features in the area.

- Reliance on and qualifications of fire barriers, including fire test results, the quality of the materials and barrier system, and the quality of the barrier installation.

- Fire area construction (walls, floor, ceiling, dimensions, volume, ventilation, and congestion). The fire hazard analysis should be the mechanism to determine that fire areas have been properly selected. Guidelines for fire areas and zones are provided in Regulatory Position 4.1.2 of this guide.

- Location and type of manual firefighting equipment and accessibility for manual fire fighting.

- Potential disabling effects of fire suppression systems on shutdown capability. The term "damage by fire" in Appendix R also includes damage to equipment from the normal or inadvertent operation of fire suppression systems. The fire hazards analysis should address the effects of firefighting activities. GDC 3 of Appendix A to 10 CFR Part 50 states that "Fire-fightingGDC 3 also requires that firefighting systems shall be designed to assureensure that their failure, rupture, or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components."

- Availability of oxygen (for example, inerted containment).

- Alternative, dedicated, or backup shutdown capability.

Fire initiation should be postulated at the location within each fire area/zone that will produce the most severe fire with the potential to adversely impact structures, systems, and componentsSSCs.

GDC 5, Sharing of Structures, Systems, and Components

GDC 5 requires that nuclear power units do not share SSCs important to safety. Fire development should consider the potential for involvement of other combustibles, both fixed and transient, in the fire area. Where automatic suppression systems are installed, unless the licensees can show that such sharing will not significantly impair the units' ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

GDC 19, Control Room

GDC 19 requires that the licensee provide a control room from which personnel can operate the nuclear power unit under normal and accident conditions and which limits radiation exposure to control room personnel under accident conditions for the duration of the accident. GDC 19 also requires that equipment and locations outside the control room be designed to accomplish hot shutdown of the reactor and have a potential capability for subsequent cold shutdown of the reactor.

GDC 23, Protection System Failure Modes

GDC 23 requires that the protection system be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if the plant experiences conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or postulated adverse environments (e.g., extreme heat or cold, fire, pressure, steam, water, radiation).

10 CFR 50.48, "Fire Protection"

In accordance with 10 CFR 50.48, each operating nuclear power plant must have an FPP that satisfies GDC 3 of Appendix A to 10 CFR Part 50. The regulation specifies what an FPP should contain and lists the basic fire protection guidelines for the plan.

As stated in 10 CFR 50.48(b), all plants that had operating licenses before January 1, 1979, must satisfy the requirements of Sections III.G, III.J, and III.O, and other sections of Appendix R to 10 CFR Part 50, in cases in which licensees had not obtained approval of similar features before the effective date of Appendix R. Plants licensed to operate after January 1, 1979, must meet the provisions of 10 CFR 50.48(a).

All currently licensed plants may voluntarily adopt a risk-informed, performance-based FPP in accordance with 10 CFR 50.48(c) and NFPA 805. The regulation in 10 CFR 50.48(c), which the Commission adopted in 2004 (69 FR 33536; June 16, 2004), incorporates NFPA 805 by reference, with certain exceptions, and allows licensees to voluntarily adopt and maintain an FPP that meets the requirements of NFPA 805 as an alternative to meeting the requirements of 10 CFR 50.48(b) or the plant-specific fire protection license conditions.

Appendix R to 10 CFR Part 50, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979"

Appendix R to 10 CFR Part 50 applies to licensed nuclear power electric generating stations that were operating before January 1, 1979, except as noted in 10 CFR 50.48(b). With respect to certain generic issues for such facilities, Appendix R identifies fire protection features required to satisfy

Criterion 3 of Appendix A. Two categories of Appendix R provisions apply to the fire protection features of these facilities.

The first category consists of those provisions that licensees were required to backfit in their entirety, regardless of whether the NRC had previously approved alternatives to the specific requirements. The requirements appear in Sections III.G, "Fire Protection of Safe-Shutdown Capability"; III.J, "Emergency Lighting"; and III.O, "Oil Collection System for Reactor Coolant Pump." Those plants subject to the requirements of Section III.G.3 must also meet the requirements of Section III.L.

The second category consists of requirements concerning the open items of previous NRC staff fire protection reviews. Open items are defined as fire protection features that the NRC staff had not previously approved as satisfying the provisions of Appendix A to BTP APCSB 9.5-1, as reflected in SERs.

Except as specified in the license conditions of individual plants, plants that were licensed to operate after January 1, 1979, were not required to implement Appendix R. Rather, the NRC staff typically reviewed the FPPs for these plants against the licensing review guidelines of SRP Section 9.5.1. Previous revisions of SRP Section 9.5.1 and the associated CMEB 9.5-1 consolidated the guidance of the previous BTP, Appendix A to APCSB 9.5-1, Appendix R, and other staff guidance. (The staff has removed that guidance from Revision 5 of SRP Section 9.5.1 and included it in this regulatory guide.)

10 CFR 50.72 and 10 CFR 50.73

These regulations prescribe the notification and reporting requirements for nuclear power plant licensees, including those related to FPPs. The regulation in 10 CFR 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors," provides immediate notification requirements via the Emergency Notification System (ENS), and 10 CFR 50.73, "Licensee Event Report System," provides for 60-day written LERs.

The NRC staff uses the information reported under 10 CFR 50.72 and 10 CFR 50.73 in responding to emergencies, monitoring ongoing events, confirming licensing bases, studying potentially generic safety problems, assessing trends and patterns of operational experience, monitoring performance, identifying precursors of more significant events, and providing operational experience to the industry.

Licensing and Design Basis

The fire protection licensing and design basis depends on several factors that may differ considerably for individual plants. However, the issuance of the Fire Protection rule, 10 CFR 50.48, and Appendix R to 10 CFR Part 50 established the applicability of certain fire protection requirements, including those within the rule, on the basis of whether the licensing date for a given plant is before or after January 1, 1979 [except for plants that have adopted an NFPA 805 licensing basis in accordance with 10 CFR 50.48(c)].

The current licensing basis (CLB) is the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect. The CLB includes the NRC regulations contained in 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 54, 55, 70, 72, 73, 100 and appendices thereto; orders; license conditions; exemptions; and technical specifications. It also includes the plant-specific design-basis information defined in 10 CFR 50.2 as documented in the most recent final safety analysis report (FSAR) as required by 10 CFR 50.71 and the licensee's commitments remaining in effect that were made in docketed licensing correspondence such as licensee responses to NRC bulletins, generic letters, and enforcement actions, as well as licensee commitments documented in NRC safety evaluations or licensee event reports.

Design bases means that information which identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints derived from generally accepted "state-of-the-art" practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of ~~the postulated fire should be evaluated with and without actuation of the automatic suppression system.~~

~~"Worst case" fires need not be postulated to be concurrent with non-fire-related failures in safety systems, other~~a postulated accident for which a structure, system, or component must meet its functional goals.

Plants Licensed before January 1, 1979

The primary licensing basis for plants licensed to operate before January 1, 1979, comprises the plant license conditions, Appendix R, approved exemptions, and the staff's SERs on the FPP.

Safety Evaluation Reports

The SERs document the staff acceptance of the plant FPP or its elements. For plants licensed to operate before January 1, 1979, the staff's SERs also establish the extent to which the requirements of Appendix R to 10 CFR Part 50 apply. Plants for which the NRC accepted the fire protection features as satisfying the provisions of Appendix A to BTP APCSB 9.5-1, or were accepted in comprehensive SERs issued before the publication of Appendix A to BTP APCSB 9.5-1 in August 1976, were required to meet only the provisions of Sections III.G (III.L), III.J, and III.O of Appendix R.

For pre-1979 licensees, a staff decision in an SER that approves an aspect of the FPP that does not comply with regulatory requirements does not eliminate the need for an exemption. For example, pre-1979 licensees who have SERs, but not a corresponding exemption that approves operator manual actions credited with meeting the protection requirements of Appendix R, Section III.G.2, must request an exemption under 10 CFR 50.12 by (1) highlighting the special circumstances of 10 CFR 50.12(a)(2)(ii), (2) citing the SER as the safety basis, and (3) confirming that the safety basis established in the SER remains valid.

Exemptions from Appendix R

Effective February 17, 1981, the NRC amended its regulations by adding 10 CFR 50.48 and Appendix R to 10 CFR Part 50, requiring certain provisions for fire protection in nuclear power plants licensed to operate before January 1, 1979.

Plants with previously approved fire protection features (see the above section on SERs) were exempt from the requirements of Appendix R with the exception of Sections III.G, III.J, and III.O.

The licensee may also request exemptions from fire protection requirements in accordance with the provisions of 10 CFR 50.12. Under that regulation, the Commission may grant exemptions from the requirements of the regulations in 10 CFR Part 50 in the following cases:

a. The exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security.

b. The Commission will not consider granting an exemption unless special circumstances are present. Special circumstances include the following:

    i. Application of the regulation in the particular circumstances conflicts with other rules or requirements of the Commission.

    ii. Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule.

    iii. Compliance would result in undue hardship or other costs that significantly exceed those contemplated when the regulation was adopted, or that significantly exceed those incurred by others similarly situated.

    iv. The exemption would result in benefit to the public health and safety that compensates for any decrease in safety that may result from granting the exemption.

v. The exemption would provide only temporary relief from the applicable regulation, and the licensee or applicant has made good faith efforts to comply with the regulation.

vi. There is present any other material circumstance not considered when the regulation was adopted for which it would be in the public interest to grant an exemption. If the request relies exclusively on such condition to satisfy criterion (2) above, the exemption may not be granted until the Executive Director for Operations has consulted with the Commission.

Operating License Conditions

Fire protection license conditions for plants licensed before January 1, 1979, typically require implementation of modifications committed to by the licensee as a result of the FPP review with respect to the BTP. These license conditions appear in amendments issued between 1977 and February 17, 1981, the effective date of 10 CFR 50.48 and Appendix R.

As a result of numerous compliance, inspection, and enforcement issues associated with the various plant license conditions, the staff developed a standard licensing condition for fire protection. The NRC transmitted this license condition, and the recommendation that licensees adopt it, in GL 86-10. The licensees received additional guidance regarding removal of the fire protection requirements from the plant technical specifications in GL 88-12. The NRC promulgated these changes to give licensees greater flexibility in the management and implementation of the FPP and to clarify the fire protection licensing basis for the specific facility.

Plants Licensed after January 1, 1979

Existing plants licensed after January 1, 1979, are subject to the requirements of 10 CFR 50.48(a) [except those plants that have adopted a performance-based FPP in accordance with 10 CFR 50.48(c)] and, thus, must meet the provisions of GDC 3 as specified in their license conditions and as accepted by the NRC in the SERs. The NRC staff typically reviews these plants according to the guidance and acceptance criteria of SRP Section 9.5.1. For plants that cannot meet commitments to specific guidelines or that have proposed alternative approaches, the differences between the licensee's program and the guidelines are documented in deviations. (See Regulatory Position 1.8 of this guide.)

License Renewal

The fire protection licensing and design basis under license renewal should not differ significantly from that in effect before renewal, with the exception that licensees must include fire protection SSCs in license renewal scoping and aging management programs as appropriate. Licensees must submit an application for renewal of a nuclear power plant operating license in accordance with the provisions of 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Regulatory Guide 1.188, "Standard Format and Content for Applications To Renew Nuclear Power Plant Operating Licenses," provides additional information and guidelines on the renewal process. The regulatory guide endorses the methods contained in NEI 95-10, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54—The License Renewal Rule," Revision 6, issued in March 2005. Regulatory Position 9 of this document provides guidance regarding the fire protection aspects of license renewal.

Power Uprates

The fire protection licensing and design basis for plants requesting power uprates should not differ significantly from the basis in effect before the uprate request. The review of changes resulting from the power uprate must ensure that the post-fire safe-shutdown capability is maintained and that SSCs important to safety are protected from the effects of fire and explosion.

Shutdown and Decommissioned Plants

For those plants that are permanently shutdown and/or are undergoing decommissioning, the licensing basis changes in accordance with the requirements in 10 CFR 50.82. For permanently shutdown reactors, 10 CFR Part 50, 10 CFR 50.48(f), and Regulatory Guide 1.191 govern fire protection. The fire protection objectives listed in 10 CFR 50.48(f) are to (1) reasonably prevent fires from occurring, (2) rapidly detect, control, and extinguish those fires that do occur, and (3) minimize the risk of fire-induced radiological hazards to the public, environment, and plant workers.

Code of Record

When existing plants were originally licensed, the licensee generally committed to complying with a specific edition of applicable industry codes and standards such as the NFPA fire codes. The specific edition to which the licensee originally committed is still the "code of record." Licensees are not required to comply with later editions of these codes and standards, except when they specifically adopt a later edition in accordance with regulatory guidelines or when new fire protection systems protecting SSCs important to safety are installed. The code of record for the new fire protection system should be the edition that is in effect when the system is designed or when a commitment to add the system is made to the staff. The code of record for the unchanged fire protection systems will not change. In general, for modifications to an existing fire protection system that are permitted by the code of record, the staff does not require that the system be brought into compliance with the current edition of the code.

New Reactors

The FPPs for new reactor plants that submit applications in accordance with 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," are subject to 10 CFR 50.48(a) and the criteria for enhanced fire protection in accordance with SECY-90-016, "Evolutionary Light-Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements"; SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs"; and SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs." SECY-90-016 established enhanced fire protection criteria for evolutionary light-water reactors. SECY-93-087 recommended that the enhanced criteria be extended to include passive reactor designs. The Commission approved SECY-90-016 and SECY-93-087 in staff requirements memoranda (SRM). SECY-94-084, in part, establishes criteria defining safe-shutdown conditions for passive light-water reactor designs. The NRC staff uses the guidance and acceptance criteria of SRP Section 9.5.1 in reviewing new reactor FPPs.

Fire Protection Program Goals and Objectives

Defense-in-Depth

Fire protection for nuclear power plants uses the concept of defense-in-depth to achieve the required degree of reactor safety. This concept entails the use of echelons of administrative controls, fire protection systems and features, and safe-shutdown capability to achieve the following objectives:

- to prevent fires from starting
- to detect rapidly, control, and extinguish promptly those fires that do occur
- to protect SSCs important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe shutdown of the plant or result in release of radioactive materials to the environment

Assumptions

Postulated Fire

Analysts assess fire damage to safe-shutdown equipment or fires with the potential to result in release of radioactive materials to the environment on the basis of a single fire, including an exposure fire. An exposure fire is a fire in a given area that involves either in situ or transient combustibles and has the potential to affect SSCs important to safety or release of radioactive materials located in or adjacent to that same area. The effects of such fire (e.g., smoke, heat, or ignition) can adversely affect those SSCs important to safety, or the ability to prevent release of radioactive materials. Thus, a fire involving one success path of safe-shutdown equipment may constitute an exposure fire for the redundant success path located in the same area, and a fire involving combustibles not in either redundant success path may constitute an exposure fire for both redundant success paths located in the same area.

There is no regulatory requirement to prevent fire-induced failure of redundant systems necessary for mitigation of consequences following design-basis accidents if the system is not required to operate for safe shutdown after a fire. However, the licensee is required to prevent (or mitigate, where permitted by regulatory requirements) fire-induced failures of these systems if the failure could prevent safe shutdown (e.g., because of spurious actuations). The most stringent fire damage limit should apply to those systems that fall into more than one category.

For the application of fire protection regulatory requirements, redundant trains of systems may be two or more similar trains of equivalent capacity in the same system powered by separate electrical divisions or they may be two or more separate systems designed to perform the same post-fire safe-shutdown function. In cases where the regulatory requirements for protection (e.g., fire barriers, separation, suppression, and/or detection) of at least one of the redundant trains in a single fire area cannot be met or where the post-fire safe-shutdown function of the train or system is not the design function, the regulatory requirements for alternative/dedicated shutdown systems apply. In the context of post-fire safe-shutdown, the redundant train or alternative/dedicated shutdown system credited with performing the required functions are also referred to as success paths.

Conditions of Fire Occurrence

The analysis assumes that a fire may occur at any time but does not postulate a fire occurring simultaneously with and independently from plant accidents, or the most severe natural phenomena.

On multiple-reactor sites, such as floods or high winds. However, severe natural phenomena, such as earthquakes, may initiate a fire event and should be considered in evaluating the design capability of fire protection systems and features.

On multiple reactor sites, the analysis need not postulate the simultaneous occurrence of unrelated fires in two or more units need not be postulated to occur simultaneously. F. The licensee should consider fires involving facilities shared between units and fires caused by man-made site-relatedrandom natural or manmade events that have a reasonable probability of occurring and affecting more than one reactor unit (such as an aircraft crash) should be considered.

The fire hazards analysis should separately identify hazards and provide appropriate protection in locations where losses of structures, systems, and components .

Loss of Offsite Power/Station Blackout

In evaluating the capability to accomplish safe shutdown after fires, the licensee should consider whether offsite power will be available. However, the licensee need not consider loss of offsite power for a fire in nonalternative or dedicated shutdown areas if it can show that offsite power cannot be lost because of a fire in that area.

As described in Regulatory Position 5.4.1 of this guide, alternative shutdown capability should accommodate post-fire conditions when offsite power is available and conditions when offsite power is not available for 72 hours. In an evaluation of safe-shutdown circuits, the availability of uninterrupted power (i.e., offsite power remains available) may impact the ability to control the safe shutdown of the plant by increasing the potential for circuit interactions resulting from fire damage to energized power and control circuits that may result in spurious actuations.

Several operating plant licensees have alternative methodologies that rely on intentional disconnection of alternating current (ac) power to specific equipment or to the entire plant as a means to achieve safe shutdown after a fire. The purpose of these self-induced station blackouts (SISBOs) is to eliminate potential spurious actuations that could prevent safe shutdown and allow manual control of required equipment. Some licensees have procedures that cause a SISBO condition to be created as a result of fire effects [e.g., procedures that direct operators to manually trip the credited safe-shutdown emergency diesel generator (EDG) in the event of fire damage to circuits of vital EDG support systems]. The acceptability of safe-shutdown procedures that voluntarily enter, or otherwise create, a SISBO condition is determined on a case-by-case basis.

The ability to cope with SISBO as part of the post-fire safe-shutdown methodology depends on such issues as time-line logic; assumptions and bases for plant and operator response relative to component realignment; the ability of plant operators to monitor and control plant parameters and align plant components before, during, and after SISBO control room evacuation and abandonment; and the practicality and reliability of EDG start and load (and restart, if applicable) under post-fire safe-shutdown SISBO conditions.

The risk of self-imposed SISBO may greatly exceed the actual risk posed by the fire, and the licensee should consider the risk carefully when evaluating the plant safe-shutdown design and procedures. A plant typically uses this approach to avoid or minimize the need for operator manual actions after a fire. However, acceptable operator manual actions that are implemented in accordance with Regulatory Position 5.3.3 and NUREG-1852, "Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire," may present a lower risk than the SISBO approach.

New reactor designs should not rely on SISBO to mitigate potential fire damage to safe-shutdown systems.

Fragility of Structures, Systems, and Components Exposed to Fire Damage

Fire damage to SSCs important to safety can occur as a result of the following.

1. Concentrations of combustible contents, including transient fire hazards of combustibles expected to be used in normal operations such as refueling, maintenance, and modifications,

2. Continuity of combustible contents, furnishings, building materials, or combinations thereof in configurations conducive to fire spread,

3. Exposures to fire,result from heat, smoke, or water, including those that may necessitate evacuation from areas that are required to be attended for safe shutdown,

4. Fire in control rooms or other locations having critical functions important to safety,

5. Lack of adequate access or smoke removal facilities that impede plant operations or fire extinguishment in plant areas important to safety,

6. Lack of explosion-prevention measures,

7. Loss of electric power or control and instrumentation circuits,

8. Inadvertent operation of fire suppression systems.

Theignition. Fire is assumed to damage safe-shutdown SSCs within the fire area of concern as discussed in the "Postulated Fire" section (above) and as determined by the fire hazards analysis should be performed by qualified fire protection and reactor systems engineers.

Experienced judgment is necessary to identify fire hazards and.

Fire Protection Program Performance Goals

Safety-Related Structures, Systems, and Components

GDC 3 of Appendix A to 10 CFR Part 50 requires that the FPP protect SSCs important to safety from the effects of fire. However, the post-fire loss of function of systems used to mitigate the consequences of a postulated fire starting at any location in the plant. Evaluation ofdesign-basis accidents does not per se impact public safety. The FPP must protect all equipment important to safety; however, the need to limit fire damage to systems required to achieve and maintain post-fire safe-shutdown conditions is greater than the need to limit fire damage to those systems required to mitigate the consequences of the postulated fire on nuclear safety should be performed by persons thoroughly trained and experienced in reactor safety. The person conducting the analysis of fire hazards should be thoroughly trained and experienced in the principles of industrial fire prevention and control and in fire phenomena from fire initiation, through its development, to propagation into adjoining spaces. The fire hazard analysis should be conducted by or under the direct supervision of an engineer with the qualifications indesign-basis accidents.

Post-Fire Safe-Shutdown

The performance objectives of the FPP related to safe shutdown after a fire are to ensure that one success path of SSCs necessary for hot shutdown is free of fire damage and to limit fire damage such that one success path of SSCs necessary to achieve and maintain cold shutdown can be repaired or made operable within a specified time period using onsite capabilities.

For reactor designs certified in 10 CFR Part 52, the plant should achieve safe shutdown with the assumption that fire will render all equipment in any one fire area inoperable, recognizing that post-fire reentry for repairs or operator actions will not be possible. For passive light-water reactor designs that rely on natural circulation and heat transfer to remove reactor decay heat, SECY-94-084 and Regulatory Position 1.6.1.a.

The guidance in Regulatory Position 1.2 is based on GDC 3,8.3 define "safe shutdown."

Prevention of Radiological Release

The FPP, including the fire hazards analysis, should demonstrate that the plant will maintain the ability to minimize the potential for radioactive releases to the environment in the event of a fire. Fires are expected to occur over the life of a nuclear power plant and, thus, should be treated as anticipated operational occurrences as defined in Appendix A to 10 CFR Part 50. Requirements for protection against radiation during normal operations appear in 10 CFR Part 20, "Standards for Protection Against Radiation." Anticipated operational occurrences should not result in unacceptable radiological consequences, and the exposure criteria of 10 CFR Part 20 apply. Prevention of a radiological release that could result in a radiological hazard to the public, environment, or plant personnel becomes the primary objective for the shutdown and decommissioning FPP.

Post-Fire Safe-Shutdown Reactor Safety/Performance Goals

Power Operations

One success path of cables and equipment necessary to achieve and maintain safe shutdown should be maintained free of fire damage. The reactor safety and performance goals for safe shutdown after a fire should ensure that the specified acceptable fuel design limits are not exceeded. Section III.L of Appendix R to 10 CFR Part 50, ASB 9.5-1, CMEB 9.5-1, GL 86-10, IN 83-41, and IN 86-106.

1.3 Safe Shutdown Analysis

Part 50 specifies post-fire reactor safety and performance goals for alternative or dedicated shutdown.

Shutdown/Refueling Operations

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During shutdown operations, particularly during maintenance or refueling outages, fire conditions can change significantly as a result of work activities. Redundant systems important to safety may not be available as allowed bydescribed in plant Ttechnical Sspecifications and plant procedures. Fire protection during shutdown or refueling conditions should minimize the potential for fire events to impact safety functions (e.g., reactivity control, reactor decay heat removal, spent fuel pool cooling), or result in the release of radioactive materials, under the differingunusual conditions that may be present during these operations.

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C. REGULATORY POSITION

1. Fire Protection Program

In accordance with 10 CFR 50.48, each operating nuclear power plant must providehave an FPP. The plan should establish the fire protection policy for the protection of SSCs important to safety at each plant and the procedures, equipment, and personnel required to implement the program at the plant site.

The FPP should extend the concept of defense-in-depth to fire protection in fire areas important to safety, with the following three objectives:

a. to prevent fires from starting

b. to detect rapidly, control, and extinguish promptly those fires that do occur

c. to provide protection for SSCs important to safety so that if the fire suppressions activities are unable to promptly extinguish a fire, safe shutdown of the plant can still be achieved

In accordance with 10 CFR 50.48, the FPP must do the following:

a. Identify the various positions within the licensee's organization that are responsible for the program and state the authorities delegated to these positions. (See Regulatory Position 1.1 of this guide.)

b. Describe specific features such as administrative controls and personnel requirements for fire prevention. (See Regulatory Position 2 of this guide.)

c. Outline the plans for fire detection and suppression capability and limitation of fire damage. (See Regulatory Positions 1.2, 3, and 4 of this guide.)

d. Describe personnel requirements for manual fire suppression activities. (See Regulatory Position 3.5 of this guide.)

e. Describe the means to limit fire damage to structures, systems, and componentsSSCs important to safety so thatto ensure the capability to safely shut down the reactor is ensured.

A safe shutdown analysis should be developed that demonstrates the capability of the plant to safely shut down for a fire in any given area. The safe shutdown performance goals and reactor performance criteria applicable to safe shutdown are identified in Regulatory Positions 5.1 and 5.2 of this guide. Recommended systems and instrumentation for accomplishing safe shutdown are identified in Regulatory Positions 5.3 and 5.4 for hot shutdown and cold shutdown, respectively. The selected systems should be demonstrated to accomplish the safe shutdown functions within the fire damage guidelines of Regulatory Positions 5.3 and 5.4.

The analysis should identify the safe shutdown components and associated non-safety circuits for each fire area and demonstrate that the guidelines of Regulatory Position 5.5 are met or that alternative, dedicated, or backup shutdown is provided in accordance with Regulatory Position 5.6 of this guide. For each plant, the combinations of systems that provide the shutdown functions may be unique for each area; however, the shutdown functions provided should ensure that the safe shutdown performance objectives are achieved.

Procedures necessary to implement safe shutdown should also be developed and implemented as appropriate (see Regulatory Position 5.7).

1.4 Fire Test Reports and Fire Data

Fire reports and data (e.g., fire barrier testing results and cable derating data) that are used to demonstrate compliance with NRC fire protection requirements should be evaluated to ensure that the information is applicable and representative of the conditions for which the information is being applied.

NFPA 251, "Standard Methods of Tests of Fire Endurance of Building Construction and Materials," advises that the test conditions should be evaluated carefully because variations from the construction of the test specimen or from the condition in which it is tested may substantially change the performance characteristics of the tested assembly.

Relative to testing of fire barrier assemblies, not all possible configurations can be tested, and additional guidance is provided inplant. (See Regulatory Positions 1.8.3 and 4.2 of this guide for evaluation of installed configurations that deviate from tested conditions.

The guidance in Regulatory Position 1.4 is based on GL 92-08.

1.5 Compensatory Measures

Temporary changes to specific3 and 5 of this guide.)

For reactor sites that have both an operating reactor, as well as construction, modification, or decommissioning of other units under way, the FPP should provide for continuing evaluation of fire hazards associated with these activities. The licensee should provide additional fire barriers, fire protection features that may be necessary to accomplish maintenance or modifications are acceptable provided interim compensatory measures, such as fire watches, temporary fire barriers, or backup suppression capability, are implemented. For common types of deficiencies, the specific compensatory measures are generally noted in technical specifications or the NRC-approvedcapability, and administrative controls as necessary to protect the operating unit(s) from any fire hazards associated with construction or decommissioning activities.

1.1 Organization, Staffing, and Responsibilities

The FPP should describe the organizational structure and responsibilities for its establishment and implementation. These responsibilities include FPP policy; program management (including program development, maintenance, updating, and compliance verification); fire protection program. For unique situations, the appropriate compensatory measures are determined by the licensee.

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The guidance in Regulatory Position 1.5 is based on CMEB 9.5-1, GL 86-10, GL 91-18, and IN 97-48.

1.6 Fire Protection Training and Qualifications

The fire protection program should be under the direction of an individual staffing and qualifications; engineering and modification; inspection, testing, and maintenance of fire protection systems, features, and equipment; fire prevention; emergency response (e.g., fire brigades and offsite mutual aid); and general employee, operator, and fire brigade training.

The licensee should assign direction of the FPP to an individual who has been delegated authority commensurate with the responsibilities of the position and who has available staff personnel knowledgeable in both fire protection and nuclear safety. Plant personnel should be adequately trained in

The licensee should assign overall responsibility for the FPP to a person who has management control over all organizations involved in fire protection activities. Formulation and assurance of program implementation may be delegated to a staff composed of personnel prepared by training and experience in fire protection and personnel prepared by training and experience in nuclear plant safety to provide a comprehensive approach in directing the FPP for the nuclear power plant.

The following positions or organizations should be designated:

a. The upper-level management position has responsibility for the formulation, implementation, and assessment of the effectiveness of the nuclear plant FPP.

b. Other management positions have direct responsible for formulating, implementing, and periodically assessing the effectiveness of the FPP for the licensees nuclear power plant, including fire drills and training conducted by the fire brigade and plant personnel. The results of these assessments should be reported to the upper-level management position responsible for fire protection with recommendations for improvements or corrective actions as deemed necessary.

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c. TheAn onsite management position is responsible for the overall administration of the plant operations and emergency plans that include the fire protection and prevention program and that provide a single point of control and contact for all contingencies. On sites with an operating reactor, and withs well as ongoing construction, modification, or decommissioning of other units under way, the superintendent of the operating plant should have the lead responsibility for site fire protection.

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d. Additional onsite positions have responsibility for the following:

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i. Implement periodic inspections to minimize the amount of combustibles in plant areas important to safety; determine the effectiveness of housekeeping practices; ensure the availability and acceptable condition of all fire protection systems/equipment, emergency breathing apparatuses, emergency lighting, communication equipment, fire stops, penetration seals, and fire retardant coatings; and ensure that prompt and effective corrective actions are taken to correct conditions adverse to fire protection and preclude their recurrence.

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ii. Provide firefighting training for operating plant personnel and the plant's fire brigade; design and select equipment; periodically inspect and test fire protection systems and equipment in accordance with established procedures; and evaluate test results and determine the acceptability of the systems under test.

iii. Assist in the critique of all fire drills to determine how well the training objectives have been met.

iv. Review proposed work activities with regard to in-plant fire protection, identify potential transient fire hazards, and specify required additional fire protection in the work activity procedure.

v. Implement a program to indoctrinate all plant contractor personnel in appropriate administrative procedures that implement the fire protection programFPP and the emergency procedures relative to fire protection.

The guidance in Regulatory vi. Implement a program to instruct personnel on the proper handling of accidental events such as leaks or spills of flammable materials that are related to fire protection.

vii. Review hot work.

e. An onsite position is responsible for fire protection QA. This position ensures the effective implementation of the FPP by planned inspections, scheduled audits, and verification that the results of these inspections and audits are promptly reported to cognizant management personnel.

f. The plant's fire brigade positions should be identified with the following in mind (see also Regulatory Position ~~1.6 is based on Appendix R~~3.5.1 of this guide):

i. The plant fire brigade positions should be responsible for fighting fires. The authority and responsibility of each fire brigade position relative to fire protection should be clearly defined.

ii. The responsibilities of each fire brigade position should correspond with the actions required by the firefighting procedures.

iii. Collateral responsibilities of the fire brigade members should not conflict with their responsibilities related to the fire brigade during a fire emergency.

iv. The minimum number of trained fire brigade members available on site for each operating shift should be consistent with the activities required to combat credible and challenging fires, but should be no less than five members. The size of the fire brigade should be based upon the functions required to fight fires, with adequate allowance for injuries. Fire brigade staffing should account for all operational and emergency response demands on shift personnel in the event of a significant fire.

1.2 Fire Hazards Analysis

A fire hazards analysis should be performed to demonstrate that the plant will maintain the ability to perform safe-shutdown functions and minimize radioactive material releases to the environment in the event of a fire. This analysis should be revised as necessary to reflect plant design and operational changes.

The fire hazards analysis accomplishes the following objectives:

a. considers potential in situ and transient fire hazards

b. determines the effects of a fire in any location in the plant on the ability to safely shut down the reactor or to minimize and control the release of radioactivity to the environment

c. specifies measures for fire prevention, fire detection, fire suppression, and fire containment and alternative shutdown capability for each fire area containing SSCs important to safety in accordance with NRC guidelines and regulations

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The fire hazards analysis verifies that the applicable NRC ~~fire protection program guidelines~~regulatory requirements and guidance for the FPP have been met. The analysis lists applicable elements of the program, with explanatory statements as needed to identify location, type of system, and design criteria. The analysis should identify and justify any deviations from the regulatory guidelines. Justification for deviations from the regulatory guidelines should ~~show~~demonstrate that an equivalent level of protection will be achieved. (~~s~~See Regulatory Position 1.8 of this guide regarding when such deviations are subject to the exemption request process.)~~:~~ Deletion of a protective feature without compensating alternative protection measures is typically unacceptable, unless it is clearly demonstrated that the protective measure is not needed because of the design and arrangement of the particular plant.

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The fire hazards analysis should address the following elements and attributes:

a. The applicability of NRC fire protection requirements and guidance should be evaluated.

b. In situ and potential transient fire and explosion hazards, including amounts, types, configurations, and locations of flammable and combustible materials (e.g., electric cable insulation and jacketing material, lube oil, diesel fuel oil, flammable gases, chemicals, building materials and finishes) associated with operations, maintenance, and refueling activities should be identified. The continuity of combustible materials (e.g., exposed electrical cables that span the distance between redundant trains), the potential for fire spread, and sources of ignition should be identified and described in the analysis.

c. External exposure hazards (e.g., flammable and combustible liquid or gas storage, auxiliary boiler units, adjacent industrial facilities or transportation systems, natural vegetation, and adjacent plant support facilities) that could potentially expose SSCs important to safety to damage from the effects (e.g., heat, flame, smoke) of fires should be identified. Wildfire hazards should be addressed if there is the potential for a wildfire to damage SSCs important to safety.

d. The design, installation, operation, testing, and maintenance of automatic fire detection and suppression capability should be addressed. The fire hazards analysis should describe the level of automatic protection (e.g., water spray density, gaseous agent concentration) provided relative to the specific fire hazards that have been identified. The effects of lightning strikes should be included in the design of fire detection systems.

e. The layout and configurations of SSCs important to safety should be depicted. The protection for safe-shutdown systems (see Regulatory Positions 5.3 and 5.4 of this guide) within a fire area should be determined on the basis of the worst-case fire that is likely to occur and the resulting damage. The fire hazards analysis should explain and document the extent of such damage. The analysis should consider the degree of spatial separation between redundant shutdown systems, the presence of in situ and transient combustibles, the available fire protection systems and features, sources of ignition, and the susceptibility to fire damage of the safe-shutdown-related cables, equipment, systems, and features in the area. Where automatic suppression systems are installed, the fire hazards analysis should evaluate the effects of the postulated fire with and without actuation of the automatic suppression system.

f. Reliance on and qualifications of fire barriers, including fire test results, the quality of the materials and barrier system, and the quality of the barrier installation should be described. Regulatory Position 4.3 of this guide provides detailed guidelines for testing and qualification of electrical raceway fire barrier systems.

g. Fire area construction (walls, floor, and ceiling materials, including coatings and thicknesses; fireproofing of structural members; area dimensions and volume; normal ventilation and smoke removal capability; and level of congestion as it applies to access for manual firefighting activities) should be described. The fire hazards analysis should provide sufficient information to determine that fire areas have been properly selected based on the fire hazards present and the need for separation of SSCs important to safety. Regulatory Position 4.1.2 provides guidelines for fire areas and zones.

h. Manual suppression capability, including systems (e.g., hydrants, standpipes, extinguishers), fire brigades, manual firefighting equipment, plans and procedures, training, drills, mutual aid, and accessibility of plant areas for manual firefighting should be identified. The fire hazards analysis should list the location and type of manual firefighting equipment and accessibility for manual firefighting.

i. Potential fire impacts on operations should be identified, including:

   i. fire in control rooms or other locations where operations important to safety are performed

   ii. fire conditions that may necessitate evacuation from areas that are required to be attended for safe shutdown

   iii. lack of adequate access or smoke removal facilities that impede plant operations or fire extinguishment in plant areas important to safety

j. Potential disabling effects of fire suppression systems on safe-shutdown capability should be identified. The term "damage by fire" in Appendix R also includes damage to equipment from the normal or inadvertent operation of fire suppression systems. The fire hazards analysis should address the effects of firefighting activities. GDC 3 of Appendix A to 10 CFR Part 50 and CMEB 9.5-1.

1.6.1 Fire Protection Staffstates that "Fire-fighting systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components."

k. Explosion-prevention measures in areas subject to potential explosive environments from flammable gases or other potentially energetic sources (e.g., chemical treatment systems, ion exchange columns, high-voltage electrical equipment) should be listed.

l. The availability of oxygen (e.g., inerted containment) should be identified.

m. Alternative or dedicated shutdown capability for those fire areas where adequate separation of redundant safe-shutdown systems cannot be achieved should be identified.

Fire initiation should be postulated at the location within each fire area/zone that will produce the most severe fire with the potential to adversely impact SSCs important to safety. Fire development should consider the potential for involvement of other combustibles, both fixed and transient, in the fire area. Where automatic suppression systems are installed, the effects of the postulated fire should be evaluated with and without actuation of the automatic suppression system.

"Worst-case" fires need not be postulated to be concurrent with non-fire-related failures in safety systems, other plant accidents, or the most severe natural phenomena.

On multiple-reactor sites, unrelated fires in two or more units need not be postulated to occur simultaneously. Fires involving facilities shared between units and fires caused by manmade site-related events that have a reasonable probability of occurring and affecting more than one reactor unit (such as an aircraft crash) should be considered.

The fire hazards analysis should separately identify hazards and provide appropriate protection in locations where losses of SSCs important to safety can occur as a result of the following:

a. concentrations of combustible contents, including transient fire hazards of combustibles expected to be used in normal operations, such as refueling, maintenance, and modifications

b. continuity of combustible contents, furnishings, building materials, or combinations thereof in configurations conducive to fire spread

c. exposures to fire, heat, smoke, or water, including those that may necessitate evacuation from areas that are required to be attended for safe shutdown

d. fire in control rooms or other locations having critical functions important to safety

e. lack of adequate access or smoke removal facilities that impede plant operations or fire extinguishment in plant areas important to safety

f. lack of explosion-prevention measures

g. loss of electric power or control and instrumentation circuits

h. inadvertent operation of fire suppression systems

Qualified fire protection and reactor systems engineers should perform the fire hazards analysis. Identifying fire hazards and the consequences of a postulated fire starting at any location in the plant requires experienced judgment. Persons who are thoroughly trained and experienced in reactor safety are able to evaluation the consequences of the postulated fire on nuclear safety. The person conducting the analysis of fire hazards should be thoroughly trained and experienced in the principles of industrial fire prevention and control and in fire phenomena from fire initiation, through its development, to propagation into adjoining spaces. The fire hazards analysis should be conducted by or under the direct supervision of an engineer with the qualifications listed in Regulatory Position 1.6.1.a of this guide.

1.3 Safe-Shutdown Analysis

In accordance with 10 CFR 50.48, each operating nuclear power plant must provide the means to limit fire damage to SSCs important to safety so that the capability to safely shut down the reactor is ensured.

Licensees should develop a safe-shutdown analysis to demonstrate the capability of the plant to safely shut down for a fire in any given area. Regulatory Position 5.1 of this guide identifies the safe-shutdown performance goals. The licensee should demonstrate the ability of the selected systems to accomplish these performance goals.

The analysis should identify the safe-shutdown components and circuits for each fire area and demonstrate that the guidelines of Regulatory Position 5.3 are met or that alternative, dedicated, or backup shutdown is provided in accordance with Regulatory Position 5.4 of this guide. For each plant, the combinations of systems that provide the shutdown functions may be unique for each area; however, the shutdown functions provided should ensure that the safe-shutdown performance objectives are achieved.

The licensee should also develop and implement procedures necessary to implement safe shutdown as appropriate. (See Regulatory Position 5.5 of this guide.)

1.4 Fire Test Reports and Fire Data

The licensee should evaluate fire reports and data (e.g., fire barrier testing results and cable derating data) that are used to demonstrate compliance with NRC fire protection requirements to ensure that the information is applicable and representative of the conditions for which the information is being applied.

NFPA 251 advises that test conditions should be evaluated carefully because variations from the construction of the test specimen or from the condition in which it is tested may substantially change the performance characteristics of the tested assembly.

Relative to testing of fire barrier assemblies, not all possible configurations can be tested; Regulatory Positions 1.8.3 and 4.3 of this guide provide additional guidance for evaluating installed configurations that deviate from tested conditions.

1.5 Compensatory Measures

Temporary changes to specific fire protection features that may be necessary to accomplish maintenance or modifications are acceptable, provided interim compensatory measures, such as fire watches, temporary fire barriers, or backup suppression capability, are implemented. For common types of deficiencies, the technical specifications or the NRC-approved FPP generally note the specific compensatory measures. For unique situations or for measures that the approved FPP does not include, the licensee may determine appropriate compensatory measures. A licensee may opt to implement an alternative compensatory measure, or combination of measures, to the one stated in its FPP. A licensee may implement such alternative measures without prior approval of the Commission if all of the following are available:

a. a documented evaluation showing the impact of the new compensatory measure

b. a documented evaluation comparing the new compensatory measure to the compensatory measure required by the licensee's FPP

c. evaluations showing that the new compensatory measure(s) will not adversely affect the ability of the plant to achieve and maintain safe shutdown in the event of a fire

Any change to the FPP must comply with the GDC and the requirements of 10 CFR 50.48(a) and must be retained as a record pursuant to 10 CFR 50.48(a). The licensee's change to the FPP is subject to inspection by the NRC.

The evaluation of the alternate compensatory measure should incorporate risk insights regarding the location, quantity, and type of combustible material in the fire area; the presence of ignition sources and their likelihood of occurrence; the automatic fire suppression and fire detection capability in the fire area; the manual fire suppression capability in the fire area; and the human error probability where applicable.

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~~C~~The licensee may implement compensatory measures ~~may also be implemented~~ for degraded and nonconforming conditions. In its evaluation of the impact of a degraded or nonconforming condition on plant and individual SSC operation ~~and on operability of structures, systems, and components~~, a licensee may decide to implement a compensatory measure as an interim step to restore operability or to otherwise enhance the capability of ~~structures, systems, and components~~SSCs important to safety until the final corrective action is complete. Reliance on a compensatory measure for operability should be an important consideration in establishing the ~~"reasonable time frame"~~"reasonable timeframe" to complete the corrective action process. ~~As stated in Revision 1 of GL 91-18, t~~The NRC would normally expect ~~that~~ conditions that require interim compensatory measures to demonstrate operability ~~would~~to be resolved more promptly than conditions that are not dependent on compensatory measures to show operability~~, because~~; such reliance suggests a greater degree of degradation. Similarly, if an operability determination is based upon operator action, the NRC staff would expect the nonconforming condition to be resolved expeditiously. (See Regulatory Position 1.8.5 for additional guidance on operability assessments.)

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NRC Inspection Manual Part 9900, "Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety" provides additional guidance on operability assessments that the Reactor Oversight Process will apply when conducting inspections. This guidance supersedes the guidance provided in Revision 1 of GL 91-18, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability."

1.6 Fire Protection Training and Qualifications

The FPP should be under the direction of an individual who has available staff personnel knowledgeable in both fire protection and nuclear safety. Plant personnel should be adequately trained in the administrative procedures that implement the FPP and the emergency procedures relative to fire protection.

1.6.1 *Fire Protection Staff Training and Qualifications*

Fire protection staff should meet the following qualifications:

a. The formulation and assurance of the ~~fire protection program~~FPP and its implementation should be the responsibility of personnel prepared by training and experience in fire protection and in nuclear plant safety to provide a comprehensive approach in directing the ~~fire protection program~~FPP for the nuclear power plant. A fire protection engineer (or a consultant) who is a graduate of an engineering curriculum of accepted standing and satisfies the eligibility requirements as a Member in the Society of Fire Protection Engineers (SFPE) should be a member of the organization responsible for the formulation and implementation of the ~~fire protection program~~FPP.

b. The fire brigade members~~'~~’ qualifications should include satisfactory completion of a physical examination for performing strenuous activity and the fire brigade training as described in Regulatory Position 1.6.4.

c. The personnel responsible for the maintenance and testing of the fire protection systems should be qualified by training and experience for such work.

d. The personnel responsible for the training of the fire brigade should be qualified by knowledge, suitable training, and experience for such work.

~~The guidance in Regulatory Position 1.6.1 is based on CMEB 9.5-1.~~

1.6.2 *General Employee Training*

Each nuclear plant employee has a responsibility ~~in~~to the ~~prevention~~prevent, ~~detection~~detect, and ~~suppression of~~suppress fires. ~~Site g~~General site employee training should introduce all personnel to the elements of the site~~ fire protection program~~’s FPP, including the responsibilities of the fire protection staff. ~~Instruction~~Training should ~~be provided~~also include information on the types of fires and related extinguishing agents, specific fire hazards at the site, and actions in the event of a fire suppression system actuation.

General employee training should provide specific instruction to site and contractor personnel on the following:

a. ~~A~~appropriate actions to take upon discovering a fire, including, for example, notification of the control room, ~~attempt~~attempting to extinguish the fire, and actuation of local fire suppression systems~~;~~

b. ~~A~~actions upon hearing a fire alarm~~;~~

c. ~~A~~administrative controls on the use of combustibles and ignition sources~~; and~~

d. ~~The~~ actions necessary in the event of a combustible liquid spill or gas ~~release/leaks.~~

~~The guidance in Regulatory Position 1.6.2 is based on IP 64704.~~

~~**1.6.3**~~ release or leaks

1.6.3 *Fire Watch Training*

Fire watches provide for observation and control of fire hazards associated with hot work, ~~or~~and they may act as compensatory measures for degraded fire protection systems and features. Specific fire watch training should provide instruction on fire watch duties, responsibilities, and required actions for both 1-hour roving and continuous fire watches. Fire watch qualifications should include hands-on training on a practice fire with the extinguishing equipment to be used while on fire watch. If fire watches are to be used as compensatory actions, the fire watch training should include record~~-~~keeping requirements.

~~The guidance in Regulatory Position 1.6.3 is in GL 93-03 and IP 64704.~~

1.6.4 *Fire Brigade Training and Qualifications*

The fire brigade training program should ~~ensure that~~establish and maintain the capability to fight credible and challenging fires~~ is established and maintained~~. The program should consist of initial classroom instruction followed by periodic classroom instruction, firefighting practice, and fire drills. (~~s~~See Regulatory Position 3.5.1.4 for drill guidance.)~~.~~

Numerous NFPA standards provide guidelines applicable to the training of fire brigades. ~~T~~The NRC staff considers the training recommendations of NFPA 600, ~~"~~"Standard on Industrial Fire Brigades,~~"~~" including the applicable NFPA publications referenced in NFPA 600, ~~are considered~~to be appropriate criteria for training ~~of~~ the plant fire brigade. The licensee may also use NFPA 1410, ~~"Standard~~"Standard on Training for Initial ~~Fire Attack," may also be used as applicable~~Emergency Scene Operations," and NFPA 1500, "Standard on Fire Department Occupational Safety and Health Program" as appropriate. NFPA booklets and pamphlets listed in NFPA 600 may be used, as applicable, for training references. In addition, the licensee should use courses in fire prevention and fire suppression that are recognized or sponsored by the fire protection industry~~ should be used~~.

1.6.4.1 **Qualifications**~~.~~

The brigade leader and at least two brigade members should have sufficient training in or knowledge of plant systems to understand the effects of fire and fire suppressants on safe~~-~~-shutdown capability. The brigade leader should be competent to assess the potential safety consequences of a fire and advise control room personnel. Such competence by the brigade leader may be evidenced by possession of an operator~~'~~'s license or equivalent knowledge of plant systems. Nuclear power plants staffed with a dedicated professional fire department may utilize a fire team advisor to assess the potential safety consequences of a fire and advise the control room and incident commander. The fire team advisor should possess an operator~~'~~'s license or equivalent knowledge of plant systems and be dedicated to supporting the fire incident commander during fire emergency events.

The qualification of fire brigade members should include an annual physical examination to determine their ability to perform strenuous firefighting activities.

1.6.4.2 Instruction. ~~The instruction~~

Instruction should be provided by qualified individuals who are knowledgeable, experienced, and suitably trained in fighting the types of fires that could occur in the plant and in using the types of equipment available in the nuclear power plant. ~~I~~The licensee should provide instruction ~~should be provided~~ to all fire brigade members and fire brigade leaders.

The initial classroom instruction should include the following:

a. ~~I~~indoctrination of the plant firefighting plan with specific identification of each individual's responsibilities.

b. ~~I~~identification of the type and location of fire hazards and associated types of fires that could occur in the plant.

c. ~~T~~the toxic and corrosive characteristics of expected products of combustion

d.

~~d. Identification~~ identification of the location of firefighting equipment for each fire area and familiarization with the layout of the plant, including access and egress routes to each area.

e. ~~T~~the proper use of available firefighting equipment and the correct method of fighting each type of fire, including the following:

i. ~~F~~fires involving radioactive materials;

ii. ~~F~~fires in energized electrical equipment;

iii. ~~F~~fires in cables and cable trays;

iv. ~~H~~hydrogen fires;

v. ~~F~~fires involving flammable and combustible liquids or hazardous process chemicals;

vi. ~~F~~fires resulting from construction or modifications (welding)~~, and~~

vii. ~~R~~record file fires~~.~~

f. ~~T~~the proper use of communication, lighting, ventilation, and emergency breathing equipment~~.~~

g. ~~T~~the proper method for fighting fires inside buildings and confined spaces~~.~~

h. ~~T~~the direction and coordination of the firefighting activities (fire brigade leaders only)~~.~~

i. ~~D~~detailed review of firefighting strategies and procedures~~.~~

j. ~~R~~review of the latest plant modifications and corresponding changes in firefighting plans~~.~~

~~Training~~The licensee should coordinate 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 should be included in the training of the local fire department staff.

Instruction should provide the techniques, equipment, and skills for the use of water in fighting electrical cable fires in nuclear plants, particularly in areas containing a high concentration of electric cables with plastic insulation.

~~Regular~~The licensee should hold regularly planned meetings~~ should be held~~ at least quarterly for all brigade members to review changes in the ~~fire protection program~~FPP and other subjects as necessary.

~~P~~The licensee should offer periodic refresher training sessions~~ should be held~~ to repeat the classroom instruction program for all brigade members over a ~~two-year~~2-year period. These sessions may be concurrent with ~~the~~ regularly planned meetings.

~~R~~The licensee should schedule retraining or broadened training for ~~fire fighting~~firefighting within buildings ~~should be scheduled~~ for all ~~those~~ brigade members whose performance records show deficiencies.

1.6.4.3 Fire Brigade Practice~~:~~

The ~~P~~licensee should hold practice sessions~~ should be held~~ for each shift fire brigade on the proper method of fighting the various types of fires that could occur in a nuclear power plant. These sessions should provide brigade members with experience in actual fire extinguishment and the use of self-contained breathing apparatuses under the strenuous conditions encountered in ~~fire fighting~~firefighting. ~~T~~ The licensee should provide these practice sessions~~ should be provided~~ at least once per year for each fire brigade member.

1.6.4.4 Fire Brigade Training Records~~:~~

The ~~I~~licensee should maintain individual records of training provided to each fire brigade member, including drill critiques,~~ should be maintained~~ for at least 3 years to ensure that each member receives training in all parts of the training program. These records of training should be available for NRC review.

~~The guidance in Regulatory Position 1.6.4 is based on Appendix R to 10 CFR Part 50, APCSB 9.5-1, and CMEB 9.5-1.~~

1.7 Quality Assurance

The ~~quality assurance (~~overall plant QA plan should include the QA~~)~~ program for fire protection ~~should be part of the overall plant QA program~~. For fire protection systems, the licensee should have and maintain a QA program that provides assurance that the fire protection systems are designed, fabricated, erected, tested, maintained, and operated so that they will function as intended. Fire protection systems are not ~~"safety-related"~~“safety-related” and~~ are~~, therefore, are not within the scope of Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50, unless the licensee has committed to include these systems under the plant’s Appendix B program~~ for t~~. The~~ plant.~~ NRC staff generally used guidance for an acceptable QA program for fire protection systems, previously given in Section C.4 of ~~Branch Technical Position~~BTP CMEB 9.5-1, ~~Rev.~~Revision 2, ~~dated~~issued July 1981,~~ was generally used~~ in the review and acceptance of approved ~~fire protection programs~~FPPs for plants licensed after January 1, 1979. This regulatory guide incorporates that guidance and the NRC staff will continue to use it in the review and acceptance of approved FPPs for new reactors. For plants licensed prior to January 1, 1979, ~~similar guidance is specified in~~ APCSB 9.5-1 and Appendix A thereto and ~~in Generic Letter~~GL 77-02, ~~"Nuclear~~“Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance,” specify similar guidance.~~"~~

The ~~QA program should be under the management control of the~~plant's QA organization should manage the fire protection QA program. This control consists of (1) formulating and/or verifying that the fire protection QA program incorporates suitable requirements and is acceptable to the management responsible for fire protection, and (2) verifying the effectiveness of the QA program for fire protection through review, surveillance, and audits. ~~Performance of~~Personnel outside the QA organization may perform other QA program functions ~~for meeting the fire protection program requirements may be performed by personnel outside of the QA organization.~~

to meet the FPP requirements.

To implement the ~~F~~fire ~~P~~protection QA ~~P~~program in this Regulatory Position, licensees have the option of either (1) including the fire protection QA program as part of the plant's overall QA program under Appendix B to 10 CFR Part 50, or (2) providing for NRC review a description of the fire protection QA program and ~~the measures for implementing t~~its implementation measure.

The fire protection QA program~~:~~

~~The fire protection QA program~~ should satisfy the specific criteria~~. These criteria~~ that apply to items within the scope of the ~~fire protection program~~FPP, such as fire protection systems and features, emergency lighting, communication and self-contained breathing apparatuses, ~~as well as~~and the fire protection requirements of applicable equipment important to safety.

1.7.1 ***Design and Procurement Document Control***

~~Measures~~The licensee should ~~be established~~ establish measures to include the guidance ~~of~~presented in this ~~g~~Regulatory Guide in its design and procurement documents ~~and that deviations therefrom are controlled such that:~~

~~a.~~ . The licensee should also control deviations from this guidance such that the following occurs:

a. Design and procurement document changes, including field changes and design deviations, are subject to the same level of controls, reviews, and approvals that were applicable to the original document.

b. ~~Quality standards are specified in t~~The design documents, such as appropriate fire protection codes and standards, specify quality standards, and deviations and changes from these quality standards are controlled.

c. ~~N~~Qualified personnel review new designs and plant modifications, including fire protection systems, ~~are reviewed by qualified personnel~~ to ensure inclusion of appropriate fire protection requirements. These reviews should include items such as the following:

~~D~~ i. design reviews to verify adequacy of wiring isolation and cable separation criteria.

~~D~~

ii. design reviews to verify appropriate requirements for room isolation (sealing penetrations, floors floors, and other fire barriers).

d. A

See Regulatory Position 1.8 for guidance on FPP changes and code deviations.

d. Qualified personnel perform and document the review and approval of the adequacy of fire protection requirements and quality requirements stated in procurement documents are performed and documented by qualified personnel. This review should determine that fire protection requirements and quality requirements are correctly stated, inspectaible, and controllable; there are adequate acceptance and rejection criteria; and the procurement document has been prepared, reviewed, and approved in accordance with applicable QA program requirements.

1.7.2 *Instructions, Procedures, and Drawings*

IDocumented instructions, procedures, or drawings should prescribe inspections, tests, administrative controls, fire drills, and training that govern the fire protection program should be prescribed by documented instructions, procedures, or drawings and should be accomplished in accordance with these documents such that:

FPP and the licensee should ensure the following:

a. Indoctrination and training programs for fire prevention and fire fightingfirefighting are implemented in accordance with documented procedures.

b. Activities such as design, installation, inspection, test, maintenance, and modification of fire protection systems are prescribed and accomplished in accordance with documented instructions, procedures, and drawings.

c. Instructions and procedures for design, installation, inspection, test, maintenance, modification, and administrative controls are reviewed to ensure that the proper fire protection requirements are addressed, such as control of ignition sources and combustibles, provisions for backup fire protection capability, disablingdisablement of a fire protection system, and the restriction on material substitution unless specifically evaluated.

d. The installation or application of penetration seals, fire barrier systems, and fire retardant coatings is performed by trained personnel using approved procedures.

1.7.3 *Control of Purchased Material, Equipment, and Services*

~~Measures~~The licensee should ~~be established~~ establish the following measures to ensure that purchased material, equipment, and services conform to the procurement documents~~. These measures should include~~:

a. ~~P~~provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor, inspections at suppliers, or receipt inspections~~.~~

b. ~~S~~source or receipt inspection, a~~s~~t a minimum, for those items ~~whose quality cannot be verified after installation.~~

~~**1.7.4 Inspection**~~

~~A~~that, once installed, cannot have their quality verified

1.7.4 *Inspection*

The licensee should establish and execute a program for independent inspection of activities affecting fire protection ~~should be established and executed by, or for,~~that allows the organization performing the activity to verify conformance to documented installation drawings and test procedures ~~for accomplishing activities~~. This program should include the following:

a. ~~I~~inspections~~s~~ of~~:~~

- ~~Installation~~ installation, maintenance, and modification of fire protection systems or features

b.

- ~~Emergency~~ inspection of emergency lighting and communication equipment to ensure conformance to design and installation requirements

c.

~~b. Inspection~~ inspection of penetration seals, fire barriers, and fire retardant coating installations to verify the activity is satisfactorily completed~~.~~

~~c~~

d. ~~I~~inspections of cable routing to verify conformance with design requirements~~.~~

~~d~~e. ~~I~~inspections to verify that appropriate requirements for room isolation (sealing penetrations, floors, and other fire barriers) are accomplished during construction

f.

~~e. Measures~~ measures to ensure that inspection personnel are independent from the individuals performing the activity being inspected and are knowledgeable in the design and installation requirements for fire protection~~.~~

~~f~~

g. ~~I~~inspection procedures, instructions, and check lists that provide for the following:~~-~~

~~• I~~ i. identification of characteristics and activities to be inspected~~.~~

~~• I~~

ii. identification of the individuals or groups responsible for performing the inspection operation~~.~~

~~• A~~

iii. acceptance and rejection criteria~~.~~

~~• A~~

iv. a description of the method of inspection~~.~~

~~• R~~

v. recording of evidence of ~~completing~~the completion and ~~verifying~~verification of a manufacturing, inspection, or test operation~~.~~

~~• R~~

vi. recording of inspector or data recorder and the results of the inspection operation

h.~~-~~

~~g. Periodic~~ periodic inspections of fire protection systems, emergency breathing and auxiliary equipment, emergency lighting, and communication equipment to ensure the acceptable condition of these items~~.~~

~~h~~

i. ~~P~~periodic inspection of materials subject to degradation, such as fire barriers, stops, seals, and fire retardant coatings to ensure that these items have not deteriorated or been damaged~~.~~

1.7.5 *Test and Test Control*

~~A test program~~The licensee should~~ be~~ establish~~ed~~ and ~~implemented~~implement a test program to ensure 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; test results should be properly evaluated and corrective act~~ed on~~ions taken as necessary. The test program should include the following:

a. Installation ~~Testing — Following~~Testing—Following construction, modification, repair or replacement, the licensee should perform sufficient testing~~ should be performed~~ to demonstrate that fire protection systems, emergency lighting, and communication equipment will perform satisfactorily in service and that design criteria are met. Written test procedures for installation tests should incorporate the requirements and acceptance limits contained in applicable design documents.

b. Periodic ~~testing — T~~Testing—The licensee should develop and document the schedules and methods for periodic testing~~ are developed and documented~~. ~~F~~Periodic testing of fire protection equipment, emergency lighting, and communication equipment ~~are tested periodically to~~will ensure that the equipment will function properly and continue to meet the design criteria.

~~c. Programs are established for QA/QC~~c. Quality Assurance—The licensee should establish programs for QA and quality control (QC) to verify testing of fire protection systems and features and to ~~verify that~~determine whether test personnel are effectively trained.

~~d. Test~~

d. Documentation—A qualified individual or group should be responsible for ensuring that test results are documented, evaluated, and ~~their acceptability determined by a qualified responsible individual or group.~~

~~1.7.6~~ acceptable.

1.7.6 *Inspection, Test, and Operating Status*

~~Measures~~The licensee should~~ be established~~ establish measures to provide for the documentation or identification of items that have satisfactorily passed required tests and inspections. These measures should include provisions for identification by means of tags, labels, or similar temporary markings to indicate completion of required inspections and tests and operating status.

1.7.7 *Nonconforming Items*

~~Measures~~The licensee should~~ be established~~ establish measures to control items that do not conform to specified requirements to prevent inadvertent use or installation. These measures should include provisions to ensure ~~that~~the following:

a. Nonconforming, inoperative, or malfunctioning fire protection systems, emergency lighting, and communication equipment are appropriately tagged or labeled.

b. The identification, documentation, segregation, review disposition, and notification to the affected organization of nonconforming materials, parts, components, or services are procedurally controlled.

c. Documentation identifies the nonconforming item, describes the nonconformance and the disposition of the nonconforming item, and includes signature approval of the disposition.

d. Provisions are established to identify those individuals or groups delegated the responsibility and authority for the disposition and approval of nonconforming items.

1.7.8 *Corrective Action*

~~Measures~~The licensee should~~ be established~~ establish measures to ensure that conditions adverse to fire protection, such as failures, malfunctions, deficiencies, deviations, defective components, uncontrolled combustible materials, and nonconformances, are promptly identified, reported, and corrected. These measures should ensure ~~that~~the following:

a. Procedures are established for evaluation of conditions adverse to fire protection (such as nonconformance, failures, malfunctions, deficiencies, deviations, and defective material and equipment) to determine the necessary corrective action.

b. In the case of significant or repetitive conditions adverse to fire protection, including fire incidents, the cause of the conditions is determined and analyzed~~,~~ and prompt corrective actions are taken to preclude recurrence. The cause of the condition and the corrective action taken are promptly reported to cognizant levels of management for review and assessment.

1.7.9 *Records*

~~Records~~The licensee should ~~be~~ prepare~~d~~ and ~~maintained~~maintain records to furnish evidence that the plant is meeting the criteria enumerated above ~~are being met~~ for activities affecting the ~~fire protection program such~~FPP so that the following is true:

a. Records are identifiable and retrievable and should demonstrate conformance to fire protection requirements. The records should include results of inspections, tests, reviews, and audits; non-conformance and corrective action reports; construction, maintenance, and modification records; and certified manufacturers'’ data.

b. ~~R~~Established record retention requirements ~~are established.~~

~~1.7.10 Audits~~

~~Audits should be conducted and documented~~exist.

1.7.10 *Audits*

The licensee should conduct and document audits to verify compliance with the ~~fire protection program such that~~FPP and ensure the following:

a. Audits are performed to verify compliance with the administrative controls and implementation of ~~quality assurance~~QA criteria, including design and procurement documents, instructions, procedures, drawings, and inspection and test activities as they apply to fire protection features and safe-shutdown capability. ~~These audits are performed by~~ QA personnel perform these audits in accordance with preestablished written procedures or check lists ~~and conducted by~~. The trained personnel who conduct the audits should not ~~having~~have direct responsibilities in the areas being audited.

b. Audit results are documented and then reviewed with management ~~that has responsibility in~~responsible for the area audited.

c. Follow-up action is taken by responsible management to correct the deficiencies revealed by the audit.

d. Audits are performed annually to provide an overall assessment of conformance to fire protection requirements.

~~F~~A qualified audit team should perform fire protection audits~~ should be performed by a qualified audit team~~. The team should at the least include~~ at least~~ a lead auditor from the licensee~~'~~’s QA organization, a systems engineer, and a fire protection engineer. The lead auditor should be qualified, for example, ~~per ~~in accordance with American Society of Mechanical Engineers (ASME) NQA-1, “Quality Assurance Program Requirements for Nuclear Facilities” (or an alternative consistent with the general ~~quality assurance~~QA program requirements). The systems engineer should be knowledgeable in safety systems, operating procedures, and emergency procedures. The fire protection engineer~~s~~ (or engineering consultant) should meet the qualifications for ~~membership in the Society of Fire Protection Engineers at ~~the grade of ~~m~~Member~~.~~ in the SFPE The fire protection engineer can be a licensee employee who ~~is~~has not been directly responsible for the site~~ fire protection program~~’s FPP for ~~two~~2 out of ~~three~~3 years. However, ~~but should be~~every third year an~~ outside~~ independent fire protection consultant ~~every third year~~should be part of the audit team. This audit team approach will ensure that the technical ~~requirements as well as the~~and QA requirements are adequately assessed.

Insurance company inspections typically do not satisfy any of the fire protection audit requirements because they do not evaluate plant ~~fire protection programs~~FPPs against the NRC requirements, including the requirements for post-fire safe~~-~~-shutdown. Insurance company inspections do not reassess or re~~-~~evaluate the ~~fire protection program~~FPP, since the insurance company has already agreed to insure the licensee~~'~~’s program as it is being implemented. Insurance company inspections are generally limited to checking systems and materials for proper condition and maintenance~~,~~ and inspecting hazardous conditions related to property protection and life. However, if the insurance company develops an inspection that has the proper scope and the inspection team includes a person knowledgeable in nuclear safety, an insurance company may perform these audits in conjunction with a lead auditor from the licensee~~'~~’s QA organization.

~~Three~~The following paragraphs specify three distinct fire protection audits~~ are specified below~~. Originally, licensees were required to incorporate these audits into their ~~T~~technical ~~S~~specifications, consistent with Standardized Technical Specification Section 6.5.2.8, ~~i~~Items h, i, and j. Some licensees may have elected to relocate technical specification requirements related to review and audit requirements to their QA plan. Incorporation of such requirements into the QA plan may revise existing technical specification audit frequencies by implementation of a performance-based schedule. Exceptions to the allowable use of performance-based audit frequencies include the triennial audit of ~~fire protection plans~~FPPs, conducted by outside qualified fire consultants, which should be maintained in accordance with technical specification requirements.

1.7.10.1 Annual Fire Protection Audit~~.~~

For those licensees who have relocated audit requirements from their ~~T~~technical ~~S~~specifications to the QA program, ~~"~~annual~~"~~ fire protection audits may be changed to a ~~"maximum~~“maximum interval of 24 months~~"~~” by implementation of a performance-based schedule, if justified by performance reviews, provided that the maximum audit interval does not exceed the ~~2-year ~~interval specified in ~~ANSI N18.7.~~

The elements that should be incorporated in the American National Standards Institute/American Nuclear Society (ANSI/ANS) 3.2-1994, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants." The annual audit areshould incorporate the following elements:

a. Purpose -- ThePurpose—The purpose of the annual audit is to assess the plant fire protection equipment and program implementation to verify that a level of safety consistent with NRC guidelines continues to be provided.

b. Scope -- EachScope—Each audit should verify that the commitments of the SARsafety analysis report and that the requirements of the Ttechnical Sspecifications and license conditions have been met and that modifications to systems and structures or changes in operating procedures have not decreased the level of safety in the plant. The audit should include inspection of all plant areas for which fire protection is provided and, in particular, examination of fire barriers, fire detection systems, and fire extinguishing systems provided for equipment important to safety. The audit should verify thatthe following:-

i. The installed fire protection systems and barriers are appropriate for the ~~objects protected by comparing them to NRC guidelines and SER-approved alternatives and noting any deviations.~~

SSCs important to safety based on a comparison with NRC regulatory requirements and the approved FPP. Deviations should be noted.

ii. The fire hazard in each fire area has not increased above that which ~~was~~the safety analysis report specified~~ in the SAR~~.

iii. Regularly scheduled maintenance is performed on plant fire protection systems.

iv. Identified deficiencies have been promptly and adequately corrected.

v. Special permit procedures (hot work, valve positioning) are being followed.

vi. Plant personnel are receiving appropriate training in fire prevention and firefighting procedures and the training program is consistent with approved standards. (The audit team should witness a typical training session.)

vii. Plant response to fire emergencies is adequate ~~by analyzing~~based on an analysis of incident records and witnessing an unplanned fire drill.

viii. Administrative controls are limiting transient combustibles in areas important to safety.

ix. Problem areas identified in previous audits have been corrected.

The audit should analyze all problem areas identified ~~by the audit~~ and recommend appropriate fire protection measures to provide a level of safety consistent with NRC guidelines.

1.7.10.2 24-Month Fire Protection Audit

The ~~purpose of the~~ 24-month audit of the ~~fire protection program~~FPP and implementing procedures ~~is to~~should ensure that the requirements for design, procurement, fabrication, installation, testing, maintenance, and administrative controls for the respective programs ~~continue to be~~are included in the plant QA program for fire protection and meet the criteria of the QA/QC program established by the licensee, consistent with this guide. ~~These audits should be performed by p~~Personnel from the licensee's QA organization, who do not have direct responsibility for the program being evaluated, should perform these audit~~ed~~s. These audits would normally encompass an evaluation of existing programmatic documents to verify continued adherence to NRC requirements.

1.7.10.3 Triennial Fire Protection Audit~~.~~

The triennial audit is basically the same as the annual audit; the difference lies in the source of the auditors. ~~The annual audit may be performed by q~~Qualified utility personnel who are not directly responsible for the site ~~fire protection program~~FPP or ~~by~~ an outside independent fire protection consultant~~. T~~ may perform the ~~triennial~~annual audit ~~should be performed by~~. However, an outside independent fire protection consultant should perform the triennial audit. These audits would normally encompass an evaluation of existing documents (other than those addressed under the 24-month audit) ~~plus~~and an inspection of fire protection system operability, inspection of the integrity of fire barriers, and witnessing the performance of procedures to verify that the ~~fire protection program~~licensee has ~~been~~ fully implemented the FPP and that the plan is adequate for the objects protected. Duplicate audits are not required~~,~~ (i.e., the 3-year audit replaces the ~~"~~annual audit~~"~~ for the year in which it is performed).

~~The guidance in Regulatory Position 1.7 is based on CMEB 9.5-1, AL 95-06. GL 82-21, and GL 86-10.~~

1.8 Fire Protection Program Changes/Code Deviations

This section provides guidance relative to the regulatory mechanisms for addressing changes, deviations, exemptions, and other issues affecting compliance with fire protection regulatory requirements. Risk-informed, performance-based methodologies may be used to evaluate the acceptability of FPP changes; however, the licensee should use NRC reviewed and approved methodologies and acceptance criteria for this approach. Regulatory Guide 1.174 includes guidance for risk-informed changes to a plant's current licensing basis. This section provides guidance with respect to fire modeling and Appendix B provides guidance with respect to probabilistic risk assessment.

1.8.1 *Safety Evaluations*

If ~~the~~an existing plant licensee has adopted the standard license condition for fire protection and incorporated the ~~fire protection program~~FPP in the final safety analysis report (FSAR), the licensee may make changes to the approved ~~fire protection program~~FPP without the Commission's prior approval ~~of the Commission~~ only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire as documented in a safety evaluation. In addition to planned changes, a safety evaluation may also be required for nonconforming conditions. An FPP change is any change to plant hardware or plant program documents and procedures that impacts the FPP. In addition to changes directly related to fire protection, this type of change may include plant changes that are not directly associated with the fire protection system or procedures but that could, for example, impact the results of the post-fire, safe-shutdown circuit analysis. Another example of an FPP change is an in situ condition (physical or programmatic) that is an FPP regulatory noncompliance or a fire protection licensing-basis noncompliance and which the licensee does not intend to correct via a plant or programmatic modification.

~~Generic Letter~~GL 86-10 recommended that licensees incorporate the ~~fire protection program~~FPP in the facility ~~Final Safety Analysis Report (~~FSAR~~)~~. Incorporation of the ~~fire protection program~~FPP and major commitments, including the fire hazards analysis, by reference int~~o~~ the FSAR for the facility places the ~~fire protection program~~FPP, including the systems,~~ the~~ administrative and technical controls,~~ the~~ organization, and other plant features associated with fire protection on a consistent status with other plant features described in the FSAR. ~~Generic Letter~~GL 86-10 further recommended the adoption of the standard license condition (see Regulatory Position 1.8.1.2 of this guide), requiring licensees to comply with the provisions of the approved ~~fire protection program~~FPP as described in the FSAR and establishing when NRC approval for changes to the program is required.

The ~~licensee should maintain, in auditable form, a current record of all such changes, including an analysis of the effects of the change on the~~standard fire protection ~~program, and should make such records available to NRC Inspectors upon request. All changes to the approved program should be reported, along with the FSAR revisions required by 10 CFR 50.71(e).~~

~~**1.8.1.1 Non-Standard**~~license condition recommended by GL 86-10 is not applicable to the FPP for new reactors that are licensed in accordance with 10 CFR Part 52. Changes to new reactor FPPs that do not require exemption requests should be evaluated and processed in accordance with 10 CFR 50.59. The appendices to 10 CFR Part 52 include additional requirements for processing changes and exemptions for new reactors that are based on a certified design.

1.8.1.1 Nonstandard License Condition~~.~~

If the ~~fire protection program~~FPP committed to by the licensee is required by a specific license condition and is not part of the FSAR for the facility, the licensee~~s~~ may be required to submit amendment requests even for relatively minor changes to the ~~fire protection program~~FPP.

1.8.1.2 Standard License Condition.

The ~~T~~NRC transmitted the standard license condition for fire protection ~~was transmitted~~ to licensees in April 1986 as part of ~~Generic Letter~~GL 86-10 with information on its applicability to specific plants. The standard license condition reads as follows:

> Fire Protection
>
> (Name of Licensee) shall implement and maintain in effect all provisions of the approved fire-protection program as described in the Final Safety Analysis Report for the facility (or-as-described in submittals dated ----------) and as approved in the SER dated ----------- (and-Supplements dated ---------) subject to the following provision:
>
> > The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

~~The adoption~~GL 88-12 provides additional guidance for implementation of the standard license condition ~~in conjunction with the incorporation of the fire protection program in the FSAR for the facility provides a more consistent approach to evaluating changes to the facility, including those~~and removal of the technical specifications associated with ~~the~~ fire ~~protection program~~detection and suppression, fire barriers, and fire brigade staffing.

Within the context of the standard fire protection license condition, the phrase "not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire," means to maintain sufficient safety margins. ~~See~~Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," defines maintaining sufficient safety margins as either of the following:

a. Codes and standards or their alternatives approved for use by the NRC are met.

b. Safety analysis acceptance criteria in the licensing basis are met or proposed revisions provide sufficient margin to account for analysis and data uncertainty.

It would be considered sufficient to maintain applicable safety margins by relating item (a) above specifically to changes to the FPP under the standard license condition; changes that maintain compliance with the applicable NFPA codes and standards endorsed by the NRC; Appendix R to 10 CFR Part 50; this regulatory guide; and the applicable BTPs, NUREG-series reports, and other NRC-approved or NRC-issued documents.

Other documents approved or issued by the NRC that would provide a basis for compliance would include topical reports endorsed by the staff or other staff-documented generic positions or generic communications. If the licensee has an analysis in a retrievable and auditable format that demonstrates compliance with the applicable NRC-approved document(s), the change is acceptable, provided that the change meets current regulations (e.g., 10 CFR 50.48, Appendix R to 10 CFR Part 50, where applicable, and GDC 3), and is consistent with the defense-in-depth philosophy for fire protection. (See Section II.A of Appendix R to 10 CFR Part 50.) The NRC would not require an assessment of the risk impact of the change to demonstrate compliance with Regulatory Position 1 of Regulatory Guide 1.174~~ for additional information.~~

~~**1.8.1.3 Exemption/Deviation vs**~~.

The NRC would find the substitution of repairs in lieu of installed fire protection systems and features for systems and components required to achieve and maintain cold shutdown acceptable so long as the time to repair the cold shutdown capability did not exceed the limits prescribed in Appendix R to 10 CFR Part 50. An assessment of the risk impact may or may not be necessary for satisfying the provisions under item (b), above, depending upon the nature of the change and the analysis used to justify the change. Regulatory Position 5 of this guide provides additional guidance with respect to acceptable operator manual actions.

The licensee is responsible for demonstrating that the change has not resulted in an adverse effect on safe shutdown or noncompliance with the applicable NRC requirements. An appropriate analysis is required to demonstrate that the change is acceptable. The licensee's failure to conduct the appropriate analysis is a failure to meet the plant's fire protection license condition. The depth and scope of the analysis depends upon the nature of the change and the type of analytical tool relied upon to justify the subject change. A change that does not maintain a sufficient margin of safety fails to meet the plant's license condition.

FPP changes that adversely affect the ability to achieve and maintain safe shutdown in the event of a fire and are not in compliance with regulatory requirements need prior approval by the NRC. Changes submitted to the NRC for review and approval should include a technical justification for the proposed alternative approach.

1.8.1.3 Exemptions, License Amendments, and the Standard License Condition

If a proposed change alters compliance with a rule then an exemption from the rule is required in accordance with 10 CFR 50.12. If a proposed change ~~involves a change to~~alters a license condition or technical specification that was used to satisfy NRC requirements, the licensee should submit a license amendment request~~ should be submitted~~. When a change that falls within the scope of the changes allowed under the standard fire protection license condition is planned, the licensee's evaluation ~~is~~should be made in conformance with the standard fire protection license condition to determine whether the change would adversely affect the ability to achieve and maintain safe shutdown. The assessment should include the effect on the fire hazards analysis and ~~the consideration of~~should consider whether circuits or components~~, including associated circuits,~~ for a success path of equipment needed for safe shutdown are ~~being~~ affected or a new element introduced in the area. If th~~is~~e evaluation concludes that there is no adverse affect, the licensee should document this conclusion and its basis ~~should be documented~~ and ~~be~~make it available for future inspection and reference. If the evaluation finds that there is an adverse affect, or that it is outside the basis for an exemption ~~(or deviation)~~ that was granted

~~(or approved)~~ for the area involved, the licensee should make modifications to achieve conformance, justify and request an exemption, or seek a license amendment from the NRC.

1.8.1.4 Nonconforming Conditions~~.~~

In addition to an evaluation of planned changes, ~~a safety~~an evaluation may also be required for nonconforming conditions.

In the case of a degraded or nonconforming condition, ~~a safety~~an evaluation ~~is dependent~~depends on the licensee's compensatory and corrective actions ~~taken by the licensee~~. ~~There are three~~Three potential conditions exist for determining the need for ~~performance of a safety~~an evaluation. These conditions are (1) the use of interim compensatory actions, ~~or~~(2) corrective actions that result in a change, or (3) corrective actions that restore the nonconforming or degraded condition to the previous condition.

If the licensee takes an interim compensatory action ~~is taken~~ to address the condition that falls within the scope of the standard fire protection license condition, it should conduct a review ~~should be conducted and~~which may result in a safety evaluation. The intent of the review is to determine whether the compensatory action itself (not the degraded condition) impacts other aspects of the facility described in the FSAR.

~~In its evaluation of the impact of a degraded or nonconforming condition on plant operation and on operability of structures, systems, and components, a licensee may decide to implement a compensatory measure as an interim step to restore operability or to otherwise enhance the capability of structures, systems, and components until the final corrective action is complete. Reliance on a compensatory measure for operability should be an important consideration in establishing the "reasonable time frame" to complete the corrective action process. In accordance with GL 91-18, NRC would normally expect that conditions that require interim compensatory measures to demonstrate operability would be resolved more promptly than conditions that are not dependent on compensatory measures to show operability, because such reliance suggests a greater degree of degradation. Similarly, if an operability determination is based upon operator action, NRC would expect the nonconforming condition to be resolved expeditiously.~~

If the condition is accepted ~~"as-is~~"as-is,~~"~~" resulting in something different from that described in the FSAR, or is modified to something ~~different~~that differs from ~~that described in~~ the FSAR, the condition should be considered a change and subjected to a safety evaluation.

1.8.1.5 **Reporting Guidelines~~.~~**

The licensee should maintain records of ~~fire protection program-related~~FPP-related changes in the facility, ~~of~~ changes in procedures, and ~~of~~ tests and experiments made in accordance with the standard fire protection license condition. These records should include a written evaluation that provides the bases for the determination that the change does not adversely affect safe~~-~~-shutdown capability.

The licensee should maintain, in auditable form, a current record of all such changes and should make such records available to NRC inspectors upon request. All changes to the approved program should be reported along with the FSAR revisions required by 10 CFR 50.71(e).

In accordance with 10 CFR 50.48, the licensee must maintain records of all changes in the facility ~~must be maintained~~ until the termination of the license. Records of superseded procedures must be maintained for a period of 3 years from the date the record was superseded.

~~The guidance in Regulatory Position 1.8.1 is based on 10 CFR 50.48, GL 86-10, and GL 91-18.~~

1.8.2 *Exemptions to Appendix R ~~of~~to 10 CFR Part 50*

For plants licensed ~~prior to~~before January 1, 1979, the NRC requires requests for exemption ~~requests~~ from the requirements of Appendix R ~~are required~~ for modifications or conditions that do not comply with the applicable sections of Appendix R. The exclusion of the applicability of sections of Appendix R other than Sections III.G, III.J, and III.O (and Section III.L as applicable)~~, III.J, and III.O~~ is limited to those features accepted by the NRC staff as satisfying the provisions of Appendix A to ~~Branch Technical Position~~BTP APCSB 9.5-1 reflected in staff fire protection ~~safety evaluation reports~~SERs issued ~~prior to~~before the effective date of the rule. For these previously approved features, an exemption request is not required except for proposed modifications that would alter previously approved features used to satisfy NRC requirements.

Plant-specific conditions may preclude compliance with one or more of the provisions specified in Appendix R. In such a case, the licensee should demonstrate, by means of a detailed fire hazards analysis, that the existing protection, or ~~that~~ the existing protection in conjunction with proposed modifications, will provide a level of safety equivalent to the technical requirements of Appendix R.

When the fire hazards analysis (see Regulatory Position 1.2 of this guide) shows that ~~adequate fire safety can be provided by~~ an alternative approach can provide adequate fire safety (i.e., an approach different from the specified requirement such as the use of a 1-hour fire~~-~~-rated barrier where a 3-hour barrier is specified), licensees ~~that are~~ required to meet Appendix R may request NRC approval of an exemption from the technical requirements of Appendix R. Any exemption request should include a sound technical basis ~~that~~ clearly ~~demonstrates~~demonstrating that the fire protection defense-in-depth philosophy is appropriately maintained and that the exemption is technically justified. As part of its evaluation, the licensee should provide sound technical justification if it does not propose to install or improve the automatic suppression and/or detection capabilities in the area of concern, and/or if it does not intend to implement other more restrictive fire prevention, detection, or suppression measures.

Generally, the staff will accept an alternative fire protection configuration on the basis of a detailed fire hazards analysis if the following conditions are met:

a. The alternative configuration ensures that one success path of equipment necessary to achieve hot shutdown from either the control room or emergency control stations is free of fire damage.

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b. The alternative configuration ensures that fire damage to equipment necessary to achieve cold shutdown is limited so that itand can be repaired within a reasonable time (minor repair using components stored on the site); and.

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c. Fire-retardant coatings are not used as fire barriers.

d. Modifications required to meet Appendix R requirements would not enhance fire protection safety levels above that provided by either existing or proposed alternatives.

The staff will also accept an alternative fire protection configuration on the basis of a detailed fire hazards analysis if:

a. The alternative ensures that one success path of equipment necessary to achieve hot shutdown from either the control room or emergency control stations is free of fire damage; and

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c. Fire-retardant coatings are not used as fire barriers; and

d. Modification required to meet Appendix R would not enhance fire protection safety levels above that provided by either existing or proposed alternatives.

The staff will also accept an alternative fire protection configuration on the basis of a detailed fire hazards analysis when the licensee can demonstrate that modifications required to meet the requirements of Appendix R would be detrimental to overall facility safety, the alternative configuration satisfies the four aforementionedabove criteria, and the alternative configuration provides an adequate level of fire safety.

EThe licensee should file requests for exemptions to the requirements of 10 CFR 50.48 and Appendix R are to be filed10 CFR Part 50 in accordance with 10 CFR 50.12.

~~The guidance in Regulatory Position 1.8.2 is based on GL 86-10.~~

1.8.3 *Appendix R Equivalency Evaluations*

The NRC interpretations of certain Appendix R requirements allow a licensee to choose not to seek prior NRC review and approval of, for example, a fire area boundary, in which case ~~an evaluation should be performed by~~ a fire protection engineer (assisted by others as needed) ~~and~~should perform an evaluation which should be retained for a future NRC audit. ~~E~~The licensee should ensure that such evaluations ~~of this type should be~~are written and organized to facilitate review by a person not involved in the evaluation. ~~All calculations supporting t~~The evaluation should ~~be available~~include all supporting calculations and clearly state all assumptions ~~clearly stated~~ at the outset. The licensee should retain these evaluations ~~should be retained~~ for subsequent NRC audits. Appendix A to this guide provides examples~~.~~

~~The guidance in Regulatory Position 1.8.3 is based on GL 86-10.~~

~~**1.8.4 Deviations**~~ of previously accepted equivalency evaluations.

1.8.4 *License Amendments*

Plants licensed after January 1, 1979, that have committed to meet the requirements of Sections III.G, III.J, and III.O of Appendix R to 10 CFR Part 50 or other NRC guidance (e.g., CMEB 9.5-1), and are required to do so as a license condition, do not need to request exemptions for alternative configurations. However, the FSAR or fire hazards analysis should identify and justify deviations from the requirements of Sections III.G, III.J, and III.O or other applicable requirements or guidance ~~should be identified and justified in the FSAR or FHA~~, and these deviations may require a license amendment to change the license condition. ~~Deviations submitted to the NRC for review and approval~~Licensees should include a technical justification for the proposed alternative approach in any license amendment it submits to the NRC for review and approval. The technical justification should address the criteria described in Regulatory Positions 1.8.1~~, S~~ for safety ~~E~~evaluations, and 1.8.2 for exemptions.~~.~~

~~The guidance in Regulatory Position 1.8.4 is based on GL 86-10.~~

~~**1.8.5**~~

1.8.5 *Operability Assessments*

~~Structures, systems, and components~~The licensee must subject SSCs that are relied upon in the licensee's ~~fire protection plan required~~FPP under 10 CFR 50.48 ~~are to be subjected~~ to operability assessments and prompt corrective action when inoperable, degraded, or nonconforming conditions are identified. The process of ensuring operability is continuous and consists of the verification of operability by surveillance activities and formal determinations of operability whenever a verification or other indication calls into question the ability of a ~~structure, system, or component~~n SSC to perform its specified function. ~~Prompt action should be taken by the licensee any time a structure, system, or component~~The licensee should take prompt action any time an SSC important to safety is found to be inoperable. If an immediate threat to public health and safety is identified, action to place the plant in a safe condition should begin as soon as possible.

A~~ structure, system, or component~~n SSC is considered operable when it can perform its intended function (e.g., a fire pump that is rated for 2500 ~~GPM~~gpm at 120 psi is capable of meeting or exceeding that flow and pressure). The definition of operability includes the principle that a system can perform its specified safety functions only when all its necessary support systems are capable of performing their related support functions (e.g., an automatic fire suppression system is operable only if the detection system that is used to actuate the fire suppression system is also operable). If a necessary support system is inoperable, the corresponding ~~structure, system, or component~~SSC should also be declared inoperable. The operability determination may be based on analysis, testing, operating experience, engineering judgment, or a combination of these methods. In the absence of a reasonable expectation that a ~~structure, system, or component~~n SSC is operable, the ~~structure, system, or component~~SSC should be declared inoperable.

Full qualification of a required ~~structure, system, or component~~SSC is defined as conforming to all aspects of the current licensing basis, including the applicable codes and standards (e.g., NFPA), design criteria, and commitments~~ (e.g., Branch Technical Positions)~~. The fact that a~~ structure, system, or component~~n SSC is not fully qualified may render the ~~structure, system, or component~~SSC degraded or nonconforming, but does not in all cases render th~~at structure, system, or component~~e SSC unable to perform its specified function. A degraded condition exists when ~~there has been an~~a loss of quality or functional capability of a~~ structure, system or component~~n SSC (e.g., a fire test has determined that a fire barrier that was credited with a fire~~ ~~-resistance rating of 3 hours ~~has been determined by a fire test to~~only provides a fire~~ ~~-resistance rating of ~~only two~~2 hours) has occurred. A nonconforming condition exists when there is a failure to meet requirements or licensee commitments (e.g., missing the performance of the weekly fire pump test as required by NFPA 20, "Standard for the Installation of Centrifugal Fire Pumps"). If a~~ structure, system, or component~~n SSC important to safety is degraded or nonconforming but operable, the licensee should establish an acceptable basis for its continued operability. The licensee should promptly identify and correct the condition that resulted in the degraded or nonconforming condition.

Automatic actuation of ~~structures, systems, or components~~a system is frequently provided as a design feature for mitigating fire events (e.g., automatic suppression systems). When the licensee is considering the substitution of a manual action for an automatic actuation, ~~the licensee's~~its determination of operability should consider the differences in the performance between the automatic and manual action and the ability of the manual action to accomplish the specified function. The licensee should have written procedures in place and conduct training ~~prior to~~before the substitution of any manual action for the loss of an automatic feature.

~~C~~The licensee may use compensatory measures~~ may be used~~ as an interim step to restore operability or to enhance the capability of ~~structures, systems, or components~~SSCs that are degraded or nonconforming until the final corrective action is complete~~d~~. Reliance on compensatory measures should be considered in establishing ~~the~~a reasonable ~~time frame~~timeframe to complete the corrective action process. Generally, conditions that require compensatory measures to restore or enhance operability should be resolved more promptly than conditions that are not dependent upon compensatory measures. The compensatory measures selected should be appropriate to the adverse condition identified (e.g., use of mobile fire apparatuses to compensate for a fire pump that is degraded). (See Regulatory Position 1.5 for additional guidance regarding compensatory actions.~~ ~~

~~The guidance in Regulatory Position 1.8.5 is based on GL 91-18 and IM STS-10.~~

~~**1.8.6**~~)

1.8.6 *10 CFR 50.72 Notification and 10 CFR 50.73 Reporting*

The requirements of 10 CFR 50.72 and 10 CFR 50.73 ~~have applicability~~apply to reporting certain events and conditions related to fire protection at nuclear power plants. ~~F~~Licensees should report fire events or fire protection deficiencies that meet the criteria of 10 CFR 50.72 and 10 CFR 50.73~~ should be reported~~ to the NRC as appropriate~~,~~ and in accordance with the requirements of these regulations. ~~Guidance for meeting the requirements of 10 CFR 50.72 and 50.73 is provided in~~ NUREG-1022, "Event Reporting Guidelines: 10 CFR 50.72 and 50.73," ~~which was prepared by the NRC staff to clarify~~Revision 1, issued January 1998 provides guidance for meeting the requirements of these two sections. The NRC staff prepared NUREG-1022 to clarify the implementation of ~~the~~ 10 CFR 50.72 and 10 CFR 50.73 rules and consolidate important NRC reporting guidelines into one reference document. The document is structured to assist licensees in achieving prompt and complete reporting of specified events and conditions.

~~A~~The Statements of Consideration for the rules include additional reporting guidance for 10 CFR 50.72 and~~ 50.73 was contained in the Statements of Considerations for the rules.~~

~~The guidance in Regulatory Position 1.8.6 is based on 10 CFR 50.72,~~ 10 CFR 50.73~~, and NUREG-1022~~.

~~1.8.7~~ *NFPA Code and Standard Deviation Evaluations*

For those fire protection ~~structures, systems, and components~~SSCs installed to satisfy the NRC requirements and designed to NFPA codes and standards, the code of record is the code edition in force at the time of the design ~~and installation is the code of record to which the design is evaluated. Deviations~~or at the time the commitment is made to the NRC for a fire protection feature. The FSAR or the fire hazards analysis should identify and justify deviations from the codes~~ should be identified and justified in the FSAR or FHA~~. Deviations should not degrade the performance of fire protection systems or features. The ~~code~~standards of record ~~is determined by the licensee~~related to the design and installation of fire protection systems and features required to satisfy NRC requirements in all new reactor designs are those NFPA codes and standards in effect 180 days prior to the submittal of the application under 10 CFR Part 50 or 10 CFR Part 52.

A licensee may apply the equivalency concept in meeting the provisions of the NFPA codes and standards. Nothing in the NFPA codes or standards is intended to prevent the use of methods, systems, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety as alternatives to those prescribed by the codes or standards, provided technical documentation demonstrates equivalency and the method, system, or device is listed or approved for the intended purpose.

An exemption is not required for deviation from NFPA codes. The NRC guidelines reference certain NFPA codes as providing guidance acceptable to the staff, and; therefore, such codes may be accorded the same status as regulatory guides. More recent editions of the NFPA codes require submittal of technical documentation to the "authority having jurisdiction" (AHJ) to demonstrate equivalency of an alternative system, method or device for AHJ approval. Whether or not the code of record includes this requirement, the NRC does not require review and approval of equivalency evaluations. However, the licensee should document these evaluations and make them available for NRC review.

When the applicant/licensee states that its design "meets"meets" the NFPA code(s)"" or "meets"meets the intent of the NFPA code(s)"" and does not identify any deviations from such codes, the NRC expects that the design conforms to the codes and the design is subject to inspection against the NFPA codescode of record.

The "Authority Having Jurisdiction" AHJ (as described in NFPA documents) refers to the Director, of the NRC's Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (or Director of the Office of New Reactors, for new reactors), or designee, consistent with the authority specified in 10 CFR 1.43.—

The guidance in Regulatory Position 1.8.7 is based on GL 86-10.

2. FIRE PREVENTION

Administrative, "Office of Nuclear Reactor Regulation."

1.8.8 *Fire Modeling*

Where the evaluation of an FPP change is based on fire modeling, licensees should document that the fire models and methods used meet the NRC requirements. The licensee should also document that the models and methods used in the analyses were used within their limitations and with the rigor required by the nature and scope of the analyses. These analyses may use simple hand calculations or more complex computer models, depending on the specific conditions of the scenario being evaluated. Appendix C to NFPA 805 and Appendix D to NEI 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)," contain discussions that are useful in determining which fire models to use and applying those fire models within their limitations. However, the NRC only endorses the fire models, methodologies, data, and examples in these appendices to the extent that they have been or can be adequately verified and validated or to the extent they are appropriate for the specific application.

The NRC's Office of Nuclear Regulatory Research (RES) and EPRI have documented the verification and validation (V&V) process for parts of five fire models in draft NUREG-1824/EPRI 1011999, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications." The specific fire models documented are (1) NUREG-1805, "Fire Dynamics Tools (FDTs)"; (2) Fire-Induced Vulnerability Evaluation (FIVE), Revision 1; (3) the National Institute of Standards and Technology (NIST) Consolidated Model of Fire Growth and Smoke Transport (CFAST); (4) the Electricité de France (EdF) MAGIC code; and (5) the NIST Fire Dynamics Simulator (FDS).

Licensees may propose the use of fire models that have not specifically undergone V&V by the NRC; however, licensees are responsible for providing evidence of acceptable V&V of these fire models. The V&V documents for licensee-proposed fire models are subject to NRC review and approval.

2. Fire Prevention

Fire prevention is the first line of defense-in-depth for fire protection. The fire prevention attributes of the program are directly related to the fire protection objective to minimize the potential for fire to occur. These attributes involve design and administrative measures that provide a reasonable level of assurance that fire hazards are adequately protected and managed and that fire consequences will be limited for those fires that do occur.

The licensee should establish administrative controls and procedures should be established to minimize fire hazards in areas containing structures, systems, and componentsSSCs important to safety. Normal and abnormal conditions or other anticipated operations such as modifications (e.g., breaching fire barriers or fire stops, impairment of fire detection and suppression systems) and transient fire hazard conditions, such as those associated with maintenance activities, should be reviewed by appropriate levels of management, and. The licensee should implement appropriate compensatory measures such as fire watches or temporary fire barriers should be implemented to ensure adequate fire protection and reactor safety.

For plants that have permanently ceased operations and are in the process of decommissioning, the fire hazards are constantly changing and fire protection systems and features are being dismantled. Fire prevention attributes of the program are key to minimizing the potential for fire and subsequent release of radioactive materials under these dynamic conditions.

The following sections provide guidance relative to fire prevention measures, including control of combustibles and ignition sources; and housekeeping inspections. ORegulatory Position 1.1 discusses organizational responsibilities for implementation of fire prevention measures are discussed in Regulatory Position 1.1. Portions of NFPA 1, "“Uniform Fire Prevention Code," including Chapters 3-8, 28, and 34,” contain additional guidance that may be used in the development and implementation of fire prevention measures.

2.1 Control of Combustibles

Fire prevention administrative controls should include procedures to control handling and use of combustibles, prohibit storage of combustibles in plant areas important to safety~~ or~~, establish designated storage areas with appropriate fire protection, and control use of specific combustibles (e.g., wood) in plant areas important to safety.

2.1.1 *Transient Fire Hazards*

Bulk storage of combustible materials should be prohibited inside or adjacent to buildings or systems important to safety during all modes of plant operation. Procedures should govern the handling of and limit transient fire hazards such as combustible and flammable liquids, wood and plastic products, high-efficiency particulate air (HEPA) and charcoal filters, dry ion exchange resins, or other combustible materials in buildings containing systems or equipment important to safety during all phases of operation, ~~and especially~~particularly during maintenance, modification, or refueling operations.

Transient fire hazards that cannot be eliminated should be controlled and suitable protection should be provided. Specific controls and protective measures include the following:

a. Unused ion exchange resins should not be stored in areas that contain or expose equipment important to safety.

b. Hazardous chemicals should not be stored in areas that contain or expose equipment important to safety.

c. Use of wood inside buildings containing systems or equipment important to safety should be permitted only when suitable noncombustible substitutes are not available. All wood smaller than 152 ~~mm~~millimeters (mm) x 152 mm ~~(~~[6 inch (in.) x 6 in~~ch)~~.] used in plant areas important to safety during maintenance, modification, or refueling operation (such as lay-down blocks or scaffolding) should be treated with a flame retardant. (For guidance, see NFPA 703, ~~"Standard~~"Standard for Fire~~-~~-Retardant ~~Impregnated~~Treated Wood and Fire~~-~~-Retardant Coatings for Building Materials~~," for guidance~~.")~~.~~ Wood should be allowed into plant areas important to safety only when it is to be used immediately.

d. The use of plastic materials should be minimized. Halogenated plastics such as polyvinyl chloride ~~(PVC)~~ and neoprene should be used only when substitute noncombustible materials are not available. All plastic materials, including flame and fire retardant materials, will burn with an intensity and BTU production in a range similar to that of ordinary hydrocarbons. When burning, they produce heavy smoke that obscures visibility and can plug air filters, especially charcoal and HEPA filters. ~~The h~~Halogenated plastics also release free chlorine and hydrogen chloride when burning, which are toxic to humans and corrosive to equipment. NFPA 701, ~~"Standard~~"Standard Methods of Fire Tests for ~~Flame-Resistant~~Flame Propagation of Textiles and Films,~~"~~" provides guidance on fire testing of flame-resistant plastic films (e.g., plastic sheeting, tarpaulins).

e. Use of combustible material such as HEPA and charcoal filters, dry ion exchange resins, or other combustible supplies in areas important to safety should be controlled. Such materials should be allowed into areas important to safety only when they are to be used immediately.

f. Equipment or supplies (such as new fuel) shipped in untreated combustible packing containers may be unpacked in areas containing equipment or systems important to safety if required for valid operating reasons. However, all combustible materials should be removed from the area immediately following unpacking. Such transient combustible material, unless stored in approved containers, should not be left unattended. Loose combustible packing material, such as wood or paper excelsior or polyethylene sheeting, should be placed in metal containers with tight-fitting, self-closing metal covers.

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

~~**2.1.2 Modifications**~~

~~The~~

h. Temporary power cables used during maintenance outages are transient combustibles and potential ignition sources. Procedures should adequately address fire protection for temporary electrical power supply and distribution.

2.1.2 *Modifications*

Fire prevention elements of the FPP should be maintained when plant modifications are made. The modification procedures should contain provisions that evaluate the impacts of modifications on the fire prevention design features and programs. The licensee should follow the guidelines of Regulatory Position 4.1.1 ~~should be followed~~ in the design of plant modifications. ~~Modifications of structures, systems, and components should be reviewed by p~~Personnel in the fire protection organization should review modifications of SSCs to ensure that fixed fire loadings are not increased beyond those accounted for in the fire hazards analysis, or if increased, suitable protection is provided and the fire hazards analysis is revised accordingly.

2.1.3 *Flammable and Combustible Liquids and Gases*

Flammable and combustible liquids and gases are potentially significant fire hazards and procedures should clearly define the use, handling, and storage of these hazards. The handling, use, and storage of flammable and combustible liquids should, as a minimum, comply with the provisions of NFPA 30, ~~"Flammable~~"Flammable and Combustible Liquids Code.~~"~~"

Miscellaneous storage and piping for flammable or combustible liquids or gases should not create a potential fire exposure hazard to systems important to safety.

Systems important to safety should be isolated or separated from combustible materials. When this is not possible because of the nature of the safety system or the combustible material, special protection should be provided to prevent a fire from 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 that may not be separable from the remainder of its system are ~~emergency diesel generator~~EDG fuel oil day tanks, turbine-generator oil and hydraulic control fluid systems, and ~~reactor coolant pump~~RCP lube oil systems.

Diesel fuel oil tanks should meet the guidelines of Regulatory Positions 6.1.8 and 7.4~~ of this guide.~~. Turbine-generator lube oil and hydraulic systems should meet the guidelines in Regulatory Position 7.2. ~~Reactor coolant pump~~Regulatory Position 7.1 provides guidelines for RCP oil collection ~~system guidelines are provided in Regulatory Position 7.1~~systems.

Bulk gas storage and use should meet the guidelines of Regulatory Position 7.5~~ of this guide~~.

2.1.4 *External/Exposure Fire Hazards*

When a~~ structure, system or component~~n SSC important to safety is near installations~~,~~ such as flammable liquid or gas storage, the licensee should evaluate the risk of exposure fires (originating in such installations) to the ~~structures, systems,~~SSCs and ~~components should be evaluated and~~take appropriate protective measures~~ taken~~. NFPA 80A, ~~"Recommended~~"Recommended Practice for Protection of Buildings from Exterior Fire Exposures,~~"~~" provides guidance on such exposure protection. NFPA 30 provides guidance relative to minimum separation distances from flammable and combustible liquid storage tanks. NFPA 50A5, "Standard for Gaseous Hydrogen Systems at Consumer Sites," and NFPA 50B, "Standard for Liquefied Hydrogen Systems at Consumer Sites," providethe Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks," provides separation distances for gaseous and liquefied hydrogen, respectively. (sSee Regulatory Position 7.5 of this guide.). NFPA 58, "Liquefied Petroleum Gas Code," provides guidance for liquefied petroleum gas.

Miscellaneous areas, such as shops, warehouses, auxiliary boiler rooms, fuel oil tanks, radwaste buildings, and flammable and combustible liquid storage tanks, should be located and protected such that a fire or the effects of a fire, including smoke, will not adversely affect any systems or equipmentSSCs important to safety. (See the previous section for guidelines relativerelated to location oflocating diesel fuel oil tanks and compressed gas supplies external to structures important to safety.)

In geographic areas where there is a potential for damage from wildfires (i.e., forest, brush, vegetation), the licensee should evaluate the risk potential from wildfire should be evaluated for structures that contain systems or componentsSSCs important to safety, and take appropriate measures should be taken. NFPA 2991144, "Standard for Protection of Life and Property from Wildfire," provides guidance on assessing wildfire severity and appropriate protection measures.

The guidance in Regulatory Position 2.1 is based on Appendix R to 10 CFR Part 50 and CMEB 9.5-1.

2.2 Control of Ignition Sources

Fire protection administrative controls should establish procedures to govern use of

Electrical equipment (permanent and temporary), hot work activities (e.g., open flame, welding, cutting and grinding), high-temperature equipment and surfaces, heating equipment (permanent and temporary installation), reactive chemicals, static electricity, and smoking are all potential ignition sources. Design, installation, modification, maintenance, and operational procedures and practices should control potential ignition sources.

Engineering design practices should provide assurance that electrical equipment is properly designed and installed in accordance with industry standards, heat generating equipment or equipment with hot surfaces is properly cooled or separated from combustible materials, and systems containing flammable and combustible liquids or gases are properly designed and located to minimize the exposure of these materials to ignition sources.

Regulatory Position 3.5 of Regulatory Guide 1.191 contains similar guidelines for those plants that have permanently ceased operation.

2.2.1 *Open Flame, Welding, Cutting, and Grinding (Hot Work)*

Work involving ignition sources such as welding and flame cutting should be done under closely controlled conditions. Persons performing and directly assisting in such work should be trained and equipped to prevent and combat fires. If this is not possible, a person qualified in fire protection should directly monitor the work and function as a fire watch.

The use of ignition sources should be governed by use of a hot work permit system to control open flame, welding, cutting, brazing, or soldering operations. A separate permit should be issued for each area where work is to be done. If work continues over more than one shift, the permit should be valid for not more than 24 hours when the plant is operating or for the duration of a particular job during plant shutdown. NFPA-51BNFPA 51B, "Standard“Standard for Fire Prevention in Use ofDuring Welding, Cutting and Welding ProcessesOther Hot Work,"” includes guidance for safeguarding the hazards associated with welding and cutting operations.

2.2.2 *Temporary Electrical Installations*

The use of temporary services at power reactor facilities is routine, especially into support of maintenance and other activities during outages. In view of the magnitude and complexity of some temporary services, proper engineering and, once installed, maintenance of the design basis become significant. Plant administrative controls should provide for engineering review of temporary installations. These reviews should ensure that appropriate precautions, limitations, and maintenance practices are established for the term of such installations. The Institute of Electrical and Electronics Engineers (IEEE) Standard 835, "Standard“Standard Power Cable Ampacity Tables,"” ANSI/IEEE C.2, “National Electrical Safety Code,®” ®” and NFPA 70, "National“National Electrical Code,"” provide guidance on temporary electrical installations, including derating of closely spaced cables.

2.2.3 *Other Sources*

Leak testing and similar procedures such as airflow determination should not use one of the commercially available techniques. Openopen flames or combustion-generated smoke should not be permitted.

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Procedures and practices should provide for control of temporary heating devices. Use of space heaters and maintenance equipment (e.g., tar kettles for roofing operations) in plant areas should be strictly controlled and reviewed by the plant’s fire protection staff. Engineering procedures and practices should provide assurance that temporary heating devices are properly installed according to the listing, including required separations from combustible materials and surfaces. Temporary heating devices should be placed so as to avoid overturning and installed in accordance with their listing, including clearance to combustible material, equipment, or construction. Asphalt and tar kettles should be located in a safe place or on a fire-resistive roof at a point where they avoid ignition of combustible material below. Continuous supervision should be maintained while kettles are in operation and metal kettle covers and fire extinguishers should be provided.

~~The guidance in Regulatory Position 2.2 is based on ASB 9.5-1, CMEB 9.5-1, IN 91-17, and IP 64704.~~

2.3 Housekeeping

~~A~~The licensee should establish administrative controls ~~should be established~~ to minimize fire hazards in areas containing ~~structures, systems, and components~~SSCs important to safety. These controls should ~~establish procedures to~~ govern removal of waste, debris, scrap, oil spills, and other combustibles after completion of a work activity or at the end of the shift. Administrative controls should also include procedures for performing and ~~to maintain housekeeping inspections. Periodic~~ maintaining periodic housekeeping inspections ~~should be performed~~ to ensure continued compliance with fire protection ~~administrative controls~~controls. Housekeeping practices should ensure that drainage systems, especially drain hub grills, in areas containing fixed water-based suppression systems remain free of debris to minimize flooding if the systems discharge. Regulatory Guide 1.39, "Housekeeping Requirements for Water-Cooled Nuclear Power Plants," Revision 2, issued September 1977, provides guidance on housekeeping, including the disposal of combustible materials.

~~The guidance in Regulatory Position 2.3 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, and Regulatory Guide 1.39.~~

2.4 Fire Protection System Maintenance and Impairments

~~F~~The licensee should establish fire protection administrative controls ~~should be established~~ to address the following:

a. Fire protection features should be maintained and tested by qualified personnel. (~~see Regulatory Position~~See Regulatory Position 1.6.1.c of this guide.)

b. Impairments to fire barriers, fire detection, and fire suppression systems should be controlled by a permit system. Compensatory measures (see Regulatory Position 1.5 of this guide) should be established in areas where systems are so disarmed.

c. Successful fire protection requires inspection, testing, and maintenance of the fire protection equipment. A test plan that lists the individuals and their responsibilities in connection with routine tests and inspections of the fire protection systems should be developed. The test plan should contain the types, frequency, and detailed procedures for testing. Frequency of testing should be based on the code of record for the applicable fire protection system. Procedures should also contain instructions on maintaining fire protection during those periods when the fire protection system is impaired or during periods of plant maintenance, (e.g., fire watches).

d. Fire barriers, including dampers, doors, and penetration seals, should be routinely inspected. Penetration seals may be inspected on a frequency and relative sample basis that provides assurance that the seals are functional. Sample size and inspection frequency should be determined by the total number of penetrations and observed failure rates. Inspection frequency should ensure that all seals will be inspected every 10 years.

The guidance in Regulatory Position 2.4 is based on Appendix R to 10 CFR Part 50 and CMEB 9.5-1.

3. FIRE DETECTION AND SUPPRESSION

3.13. Fire Detection (Design Objectives and Performance Criteria)

Fireand Suppression

3.1 Fire Detection

In general, the fire hazards analysis and regulatory requirements determine the scope of fire detection and suppression in the plant, whereas the applicable industry codes and standards (generally NFPA codes, standards, and recommended practices) determine the design, installation, and testing requirements of the systems and components. The design of fire detection systems should be designed to minimize the adverse effects of fires on structures, systems, and componentsSSCs important to safety. Automatic fire detection systems should be installed in all areas of the plant that contain or present an exposure fire hazard to structures, systems, and componentsSSCs important to safety. These fire detection systems should be capable of operating with or without offsite power.

With regard to protection of safe--shutdown systems, Regulatory Positions 5.5.b and 5.5.c of this guide state that "In, "In addition, fire detectors and an automatic fire suppression system should be installed in the fire area."" See Regulatory Position 1.8.3 and the information in Appendix A for guidance relative toWhere automatic fire detection is installed, it should provide complete protection throughout the fire area. For those areas where less than full-area coverage is provided.

~~3.1.1~~ only partial coverage is installed, the fire hazards analysis should demonstrate the adequacy of the design to provide the necessary protection.

3.1.1 *Fire Detection and Alarm Design Objectives and Performance Criteria*

The fire detection and alarm system should be designed with the following objectives:

a. Detection systems are to be provided for all areas that contain or present a fire exposure to equipment important to safety.

b. Fire detection and alarm systems should comply with the requirements of Class A systems as defined in NFPA 72, ~~"National~~ "National Fire Alarm Code," and Class I circuits as defined in NFPA 70.

c. Fire detectors are selected and installed in accordance with NFPA 72. Pre-operational and periodic testing of pulsed-line-type heat detectors demonstrate that the frequencies used will not affect the actuation of protective relays in other plant systems.

d. Fire detection and alarm systems give audible and visible alarm and annunciation in the control room. Where zoned detection systems are used in a given fire area, local means are provided to identify which detector zone has actuated.

e. Fire alarms are distinctive and unique ~~so they will not be confused~~ to avoid confusion with any other plant system alarms.

f. Primary and secondary power supplies are provided for the fire detection system and for electrically operated control valves for automatic suppression systems. Such primary and secondary power supplies ~~are to~~ should satisfy the provisions of NFPA 72. This can be accomplished by using normal offsite power as the primary supply with a 4-hour battery supply as a secondary supply and by providing the capability for manual connection to the Class 1E emergency power bus within 4 hours of loss of offsite power. Such connection should follow the applicable guidance in Regulatory Guides 1.6, ~~1.32, and 1.75.~~

"Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems," issued March 1971; 1.32, "Criteria for Power Systems for Nuclear Power Plants," Revision 3, issued March 2004; and 1.75, "Physical Independence of Electric Systems," Revision 3, issued February 2005.

g. In areas of high seismic activity, the need to design the fire detection and alarm systems to be functional following ~~the~~ a safe-shutdown earthquake should be considered.

h. The fire detection and alarm systems should retain their original design capability for (1) natural phenomena of less severity and greater frequency than the most severe natural phenomena (approximately once in 10 years) such as tornadoes, hurricanes, floods, ice storms, or small-intensity earthquakes that are characteristic of the geographic region, and (2) potential man~~-~~made site-related events such as oil barge collisions or aircraft crashes that have a reasonable probability of occurring at a specific plant site.

~~i. Redundant cable systems important to safety located in cable trays should be provided with fire detection. (Also see Regulatory Positions 4.1.3.3 and 6.1.3.)~~

~~j~~i. Containment fire detection systems should be provided for non~~-~~inerted containments in accordance with the guidance in Regulatory Position 6.1.1.3 of this guide.

~~k~~j. Control room fire detection and alarms should be provided in accordance with the guidance in Regulatory Position 6.1.2 of this guide.

~~l~~k. The following areas that contain equipment important to safety should be provided with automatic fire detectors that alarm and annunciate in the control room~~:~~—plant computer rooms, switchgear rooms, remote shutdown panels, battery rooms, diesel generator areas, pump rooms, new and spent fuel areas, and radwaste and decontamination areas. (~~A~~See also ~~see~~ Regulatory Positions 6.1 and 6.2~~.)~~

~~The guidance in Regulatory Position 3.1 is based on GDC 3, Appendix R to 10 CFR Part 50, and CMEB 9.5-1.~~

~~3.2~~ of this guide.)

3.2 Fire Protection Water Supply Systems ~~(Design Objectives and Performance Criteria)~~

3.2.1 *Fire Protection Water Supply*

NFPA 22, ~~"Standard~~“Standard for Water Tanks for Private Fire Protection,~~"~~” and NFPA 24, ~~"Standard~~“Standard for the Installation of Private Fire Service Mains and Their Appurtenances,~~"~~” provide guidance for fire protection water supplies. The fire protection water supply system should meet the following criteria.

a. Two separate, reliable freshwater supplies should be ~~provided~~available. Saltwater or brackish water should not be used unless all freshwater supplies have been exhausted.

b. The fire water supply should be calculated on the basis of the largest expected flow rate for a period of 2 hours, but not less than 1,136,000 liters (L) (300,000 gallons). This flow rate should be based (conservatively) on 1900 liters per meter (L/m) (500 gpm) for manual hose streams plus the largest design demand of any sprinkler or deluge system as determined in accordance with NFPA 13, ~~"Standard~~“Standard for the Installation of Sprinkler Systems,~~"~~” or NFPA 15, ~~"Standard~~“Standard for Water Spray Fixed Systems for Fire Protection.~~" The fire water supply should be capable of delivering this design demand over the longest piping route of the water supply system.~~

”

c. If tanks are used for water supply, two ~~100%~~100-percent system capacity tanks [minimum of 1,136,000 L (300,000 gallons) each] should be installed. They should be ~~so~~ interconnected ~~that~~to allow pumps ~~can~~to take suction from either or both. However, a failure in one tank or its piping should not cause both tanks to drain. Water supply capacity should be capable of refilling either tank in 8 hours or less.

d. Common water supply tanks are acceptable for fire and sanitary or service water storage. When this is done, however, minimum fire water storage requirements should be dedicated by passive means, for example, use of a vertical standpipe for other water services. Administrative controls, including locks for tank outlet valves, are unacceptable as the only means to ensure minimum water volume.

e. Freshwater lakes or ponds of sufficient size may qualify as the sole source of water for fire protection but require separate redundant suctions in one or more intake structures. These supplies should be separated so that a failure of one supply will not result in a failure of the other supply.

f. When a common water supply is permitted for fire protection and the ultimate heat sink, the following conditions should also be satisfied:

i. The additional fire protection water requirements are designed into the total storage capacity~~, and~~

.

ii. Failure of the fire protection system should not degrade the function of the ultimate heat sink.

g. Other water systems that may be used as one of the two fire water supplies should be permanently connected to the fire main system and should be capable of automatic alignment to the fire main system. Pumps, controls, and power supplies in these systems should satisfy the requirements for the main fire pumps. The use of other water systems for fire protection should not be incompatible with their functions required for safe plant shutdown. Failure of the other system should not degrade the fire main system.

h. For multi-unit nuclear power plant sites with a common yard fire main loop, common water supplies may be utilized.

i. Fire water supplies should be filtered and treated as necessary to prevent or control biofouling or microbiologically induced corrosion of fire water systems. If the supply is raw service water, fire water piping runs should be periodically flushed and flow tested.

j. Provisions should be made to supply water to at least two standpipes and hose connections for manual firefighting in areas containing equipment required for safe plant shutdown in the event of a safe~~-~~-shutdown earthquake. The piping system serving such hose stations should be analyzed for safe~~-~~-shutdown earthquake loading and should be provided with supports to ensure system pressure integrity. The piping and valves for the portion of hose standpipe system affected by this functional requirement should, a~~s~~t a minimum, satisfy ~~ASME/ANSI~~ASME B31.1, "Power Piping." The water supply for this condition may be obtained by manual operator actuation of valves 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~~1) capable of providing flow to at least two hose stations [approximately 284 L/m (75 gpm) per hose station], and (~~b~~2) designed to the same standards as the seismic Category I water system~~;~~ (i.e., it should not degrade the performance of the seismic Category I water system).

3.2.2 *Fire Pumps*

Fire pump installations should conform to NFPA 20, ~~"Standard for the Installation of Centrifugal Fire Pumps,"~~ and should meet the following criteria~~.~~

:

a. If fire pumps are required to meet system pressure or flow requirements, a sufficient number of pumps is provided to ensure that ~~100%~~100-percent capacity will be available assuming failure of the largest pump or loss of offsite power (e.g., three ~~50%~~50-percent pumps or two ~~100%~~100-percent pumps). This can be accomplished, for example, by providing either electric motor-driven fire pumps and diesel-driven fire pumps or two or more seismic Category I Class 1E electric motor-driven fire pumps connected to redundant Class 1E emergency power buses. (~~s~~See Regulatory Guides 1.6, ~~1.32, and 1.75.)~~

"Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems," issued March 1971; 1.32, "Criteria for Power Systems for Nuclear Power Plants," Revision 3, issued March 2004; and 1.75, "Physical Independence of Electric Systems," Revision 3, issued February 2005.)

b. Individual fire pump connections to the yard fire main loop are separated with sectionalizing valves between connections. Each pump and its driver and controls are located in a room separated from the remaining fire pumps by a fire wall with a minimum rating of 3 hours.

c. The fuel for the diesel fire pumps is separated so that it does not provide a fire source exposing equipment important to safety.

d. Alarms or annunciators to indicate pump running, driver availability, failure to start, and low ~~fire-main~~fire main pressure are provided in the control room.

3.2.3 *Fire Mains*

An underground yard fire main loop should be installed to furnish anticipated water requirements. NFPA 24 provides appropriate guidance for such installation. NFPA 24 references other design codes and standards developed by such organizations as the American National Standards Institute (ANSI) and the American Water Works Association~~ (AWWA)~~. The following specific criteria should be addressed:

a. ~~Type~~The type of pipe and water treatment are design considerations with tuberculation as one of the parameters.

b. ~~M~~The means for inspecting and flushing the fire main are provided.

c. Sectional control valves should be visually indicating~~,~~ (e.g., post~~-~~ indicator valves).

d. Control and sectionalizing valves in fire mains and water-based fire suppression systems are electrically supervised or administratively controlled (e.g., locked valves with key control, tamper-proof seals). The electrical supervision signal indicates in the control room. All valves in the fire protection system are periodically checked to verify position. (For guidance, see NFPA 25, ~~"Standard~~“Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems~~," for guidance~~.”)~~.~~

e. The fire main system piping is separate from service or sanitary water system piping, except as described in Regulatory Position 3.2.1 of this guide with regard to providing seismically designed water supply for standpipes and hose connections.

f. A common yard fire main loop may serve multi~~-~~unit nuclear power plant sites if cross-connected between units. Sectional control valves permit~~ maintaining~~ independence of the individual loop around each unit. For multiple-reactor sites with widely separated plants [approaching 1.6 ~~km~~kilometer (km) (1- mile (mi)) or more], separate yard fire main loops are used.

g. Sectional control valves are provided to isolate portions of the fire main for maintenance or repair without shutting off the supply to primary and backup fire suppression systems serving areas that contain or expose equipment important to safety.

h. Valves are installed to permit isolation of outside hydrants from the fire main for maintenance or repair without interrupting the water supply to automatic or manual fire suppression systems in any area containing or presenting a fire hazard to equipment important to safety.

i. Sprinkler systems and manual hose station standpipes have connections to the yard main system so that a single active failure or a line break cannot impair both the primary and backup fire suppression systems. Alternatively, headers fed from each end are permitted inside buildings to supply both sprinkler and standpipe systems, provided steel piping and fittings meeting the requirements of ~~ASME/ANSI~~ASME B31.1 are used for the headers up to and including the first valve supplying the sprinkler systems whe~~re~~n such headers are part of the seismically analyzed hose standpipe system. When provided, such headers are considered an extension of the yard main system. Each sprinkler and standpipe system should be equipped with ~~OS&Y (~~an outside screw and yoke~~)~~ gate valve or other approved shutoff valve and water flow alarm.

~~The guidance in Regulatory Position 3.2 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, Supplement 1 to GL 89-13, and IE Bulletin BL 81-03.~~

3.3 Automatic Suppression Systems~~ (Design Objectives and Performance Criteria)~~

Automatic suppression should be installed as determined by the fire hazards analysis and as necessary to protect redundant systems or components necessary for safe shutdown and SSCs important to safety. (~~s~~See Regulatory Positions 5.5.b, 5.5.c, and ~~1~~6 of this guide.~~3.1~~)~~.~~

In areas of high seismic activity, the need to design the fire suppression systems to be functional following the safe~~-~~-shutdown earthquake should be considered.

The fire suppression systems should retain their original design capability for (1) natural phenomena of less severity and greater frequency than the most severe natural phenomena (approximately once in 10 years) such as tornadoes, hurricanes, floods, ice storms, or small-intensity earthquakes that are characteristic of the geographic region, and (2) potential man~~-~~made site-related events such as oil barge collisions or aircraft crashes that have a reasonable probability of occurring at a specific plant site.

For water suppression systems and fire detection systems that use metal plates for heat collection above individual sprinkler heads or detectors that are located well below the ceiling of a fire area (e.g., at some intermediate height in the room, below ceiling-mounted pipe and cable tray), it should be demonstrated that this design will ensure acceptable actuation times. IN 2002-24, "Potential Problems with Heat Collectors on Fire Protection Sprinklers," provides a discussion of this issue. In general, the use of such plates has not been demonstrated to provide adequate heat collection to effectively activate the sprinkler head or detector and may impair system response.

3.3.1 *Water-~~b~~Based Systems*

Equipment important to safety that does not itself require protection by water-based suppression systems, but is subject to unacceptable damage if wetted by suppression system discharge, should be appropriately protected (e.g., water shields or baffles). Drains should be provided as required to protect equipment important to safety from flooding damage.

3.3.1.1 Sprinkler and Spray Systems~~.~~

Water sprinkler and spray suppression systems are the most widely used means of implementing automatic water-based fire suppression. Sprinkler and spray systems should, a~~s~~t a minimum, conform to requirements of appropriate standards such as NFPA 13 and ~~NFPA15~~NFPA 15.

3.3.1.2 Water Mist Systems~~.~~

Water mist suppression systems may be useful in specialized situations, particularly in those areas where the application of water needs to be restricted. Water mist systems should conform to appropriate standards such as NFPA 750, ~~"Standard~~"Standard on Water Mist Fire Protection Systems.~~"~~"

3.3.1.3 Foam-Water Sprinkler and Spray Systems~~.~~

Certain fires, such as those involving flammable liquids, respond well to foam suppression. Consideration should be given to the use of foam sprinkler and spray systems. Foam sprinkler and spray systems should conform to appropriate standards such as NFPA 16, ~~"Standard~~"Standard for the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems,~~" NFPA 16A, "Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems," NFPA 11, "Standard~~" and NFPA 11, "Standard for ~~Low-Expansion Foam," and NFPA 11A, "Standard for Medium- and High-Expansion Foam Systems."~~

~~3.3.2~~ Low-, Medium-, and High-Expansion Foam."

3.3.2 *Gaseous Fire Suppression*

Gaseous systems should be evaluated for potential impacts on the habitability of areas containing equipment important to safety where operations personnel perform safe-shutdown actions or where fire-fighting activities may become necessary. Where gas suppression systems are installed, openings in the area should be adequately sealed or the suppression system should be sized to compensate for the loss of the suppression agent through floor drains and other openings. (~~A~~See also~~ see~~ Regulatory Position 4.1.5~~.)~~ of this guide.)

The design of gaseous suppression systems should consider the following, as applicable:

a. the minimum required gas concentration, distribution, soak time, and ventilation control

b. the anoxia and toxicity hazards associated with the gas

c. the possibility of secondary thermal shock (cooling) damage

d. conflicting requirements for venting during system discharge to prevent overpressurization versus sealing to prevent loss of agent

e. location and selection of the activating detectors

f. the toxicity and corrosive characteristics of the thermal decomposition products of the agent

Where total flooding gas extinguishing systems are used, area intake and exhaust ventilation dampers should be controlled in accordance with appropriate standards to maintain the necessary gas concentration. (See NFPA 12, ~~"Standard~~“Standard on Carbon Dioxide Extinguishing Systems,~~"~~” NFPA 12A, ~~"Standard~~“Standard on Halon 1301 Fire Extinguishing Systems,~~"~~” and NFPA 2001, ~~"Standard~~“Standard on Clean Agent Fire Extinguishing Systems.”~~)~~ ~~(~~Also, see Regulatory Position 4.1.4.4 of this guide.)

The adequacy of gas suppression systems and protected area boundary seals to contain the gas suppressant should be tested as specified in the applicable NFPA ~~S~~standards.

Manually actuated gaseous suppression systems should not be used as the primary suppression system for protecting ~~structures, systems, and components~~SSCs important to safety. Manually actuated gaseous systems are acceptable as a backup to automatic water-based fire suppression systems.

3.3.2.1 **Carbon Dioxide (CO_2) Systems~~.~~**

Carbon dioxide extinguishing systems should comply with the requirements of NFPA 12~~, "Carbon Dioxide Extinguishing Systems."~~. Where automatic carbon dioxide systems are used, they should be equipped with a pre~~-~~discharge alarm system and a discharge delay to permit personnel egress. Provisions for locally disarming automatic carbon dioxide systems should be key locked and under strict administrative control. Automatic carbon dioxide extinguishing systems should not be disarmed unless controls as described in Regulatory Position 2.4 of this guide are provided.

In addition to the guidelines of NFPA 12, preventive maintenance and testing of the systems, including verifying agent quantity of high-pressure CO_2 cylinders, should be done.

~~Particular consideration should also be given to:~~

~~a. The minimum required CO_2 concentration, distribution, soak time, and ventilation control;~~

~~b. The anoxia and toxicity hazards associated with CO_2;~~

~~c. The possibility of secondary thermal shock (cooling) damage;~~

~~d. Conflicting requirements for venting during CO_2 injection to prevent over pressurization versus sealing to prevent loss of agent; and~~

~~e. Location and selection of the activating detectors.~~

3.3.2.2 Halon

Halon fire extinguishing systems should comply with the requirements of NFPA 12A. Where automatic Halon systems are used, they should be equipped with a pre-discharge alarm and a discharge delay to permit personnel egress. Provisions for locally disarming automatic Halon systems should be key locked and under strict administrative control. Automatic Halon extinguishing systems should not be disarmed unless controls as described in Regulatory Position 2.4 of this guide are provided.

In addition to the guidelines of NFPA 12A, preventive maintenance and testing of the systems, including verifying agent quantity of the Halon cylinders, should be done.

~~Particular consideration should also be given to:~~

~~a. The minimum required Halon concentration, distribution, soak time, and ventilation control,~~

~~b. The toxicity of Halon,~~

~~c. The toxicity and corrosive characteristics of the thermal decomposition products of Halon, and~~

~~d. The location and selection of the activating detectors.~~

3.3.2.3 Clean Agents

Halon alternative (or ~~"clean~~“clean agent~~"~~”) fire extinguishing systems should comply with applicable standards such as NFPA 2001. Only listed or approved agents should be used. Provisions for locally disarming automatic systems should be key locked and under strict administrative control. Automatic extinguishing systems should not be disarmed unless controls as described in Regulatory Position 2.4 of this guide are provided.

In addition to the guidelines of NFPA 2001, preventive maintenance and testing of the systems, including verifying agent quantity of the clean agent cylinders/containers, should be done.

~~Particular consideration should also be given to:~~

~~a. The minimum required clean agent concentration, distribution, soak time, and ventilation control,~~

~~b. The toxicity of the clean agent,~~

~~c. The toxicity and corrosive characteristics of the thermal decomposition products of the clean agent,~~

~~d. Conflicting requirements for venting during clean agent injection to prevent over pressurization versus sealing to prevent the loss of agent, and~~

~~e. The effectiveness of the particular clean agent at its design concentration for the protected hazard.~~

~~f. The location and selection of the activating detectors.~~

~~The guidance in Regulatory Position 3.3 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, and IN 92-28.~~

3.4 Manual Suppression Systems and Equipment

~~A~~The licensee should provide a manual firefighting capability ~~should be provided~~ throughout the plant to limit the extent of fire damage. Standpipes, hydrants, and portable equipment consisting of hoses, nozzles, and extinguishers should be provided for use by properly trained firefighting personnel.

3.4.1 *Standpipes and Hose Stations*

Interior manual hose installations should be able to reach any location that contains, or could present a fire exposure hazard to, equipment important to safety with at least one effective hose stream. To accomplish this, standpipes with hose connections equipped with a maximum of 30.5 m (100 f~~ee~~t) of 38-mm (~~1-1/2-inches~~1.5-in.) woven-jacket, lined fire hose and suitable nozzles should be provided in all buildings on all floors. These systems should conform to NFPA 14, ~~"Standard~~"Standard for the Installation of Standpipe and Hose Systems,~~"~~" for sizing, spacing, and pipe support requirements for Class III standpipes.

Water supply calculations should demonstrate that the water supply system can meet the standpipe pressure and flow requirements of NFPA 14.

Hose stations should be located as dictated by the fire hazards analysis to facilitate access and use for firefighting operations. Alternative hose stations should be provided for an area if the fire hazard could block access to a single hose station serving that area.

The proper type of hose nozzle to be supplied to each area should be based on the fire hazards analysis. The usual combination spray/straight-stream nozzle should not be used in areas where the straight stream can cause unacceptable mechanical damage. Fixed fog nozzles should be provided at locations where high-voltage shock hazards exist. All hose nozzles should have shutoff capability. ~~G~~Volume II, Section 10, Chapter 1, of the 19th Edition of the " NFPA Fire Protection Handbook," provides guidance on safe distances for water application to live electrical equipment~~ may be found in the "NFPA Fire Protection Handbook," Chapter 6, Eighteenth Edition~~.

Fire hose should meet the recommendations of NFPA 1961, ~~"Standard~~"Standard on Fire Hose,~~"~~" and should be hydrostatically tested in accordance with the recommendations of NFPA 1962, ~~"Standard~~"Standard for the Inspection, Care, and Use~~,~~ of Fire Hose Couplings and Nozzles and the Service Testing of Fire Hose~~ Including Couplings and Nozzles~~.~~"~~"

3.4.2 *Hydrants and Hose Houses*

Outside manual hose installations should be sufficient to provide an effective hose stream to any onsite location where fixed or transient combustibles could jeopardize equipment important to safety. Hydrants should be installed approximately every 76 m (250 ft) on the yard main system. A hose house equipped with hose and combination nozzle and other auxiliary equipment recommended in NFPA 24 should be provided as needed, but at least every 305 m (1,000 ft). Alternatively, a mobile means of providing hose and associated equipment, such as hose carts or trucks, may be used. When provided, such mobile equipment should be equivalent to the equipment supplied by three hose houses.

Mobile equipment should be maintained in good working order and should be readily available for fire-fighting activities.

Threads compatible with those used by local fire departments should be provided on all hydrants, hose couplings, and standpipe risers. Alternatively, a sufficient number of hose thread adapters may be provided.

Fire hose should be hydrostatically tested in accordance with the recommendations of NFPA 1962. Fire hose stored in outside hose houses should be tested annually.

3.4.3 *Manual Foam*

For flammable and combustible liquid fire hazards, consideration should be given to the use of foam systems for manual fire suppression protection. These systems should comply with the requirements of NFPA 11~~, NFPA 11A, and NFPA 11C, "Standard for Mobile Foam Apparatus," as applicable~~.

3.4.4 *Fire Extinguishers*

Fire extinguishers should be provided in areas that contain or could present a fire exposure hazard to equipment important to safety. ~~Dry chemical e~~Extinguishers should be installed with due consideration given to possible adverse effects on equipment important to safety installed in the area. NFPA 10, ~~"Standard~~“Standard for Portable Fire Extinguishers,~~"~~” provides guidance on the installation (including location and spacing) and the use and application of fire extinguishers.

~~The guidance in Regulatory Position 3.4 is based on~~**3.4.5** ***Fixed Manual Suppression***

Some fixed fire suppression systems may be manually actuated (e.g., fixed suppression systems provided in accordance with Section III.G.3 of Appendix R to 10 CFR Part 50~~ and CMEB 9.5-1.~~

~~3.5~~). Manual actuation is generally limited to water spray systems and should not be used for gaseous suppression systems except when the system provides backup to an automatic water suppression system. Fixed manual suppression systems should be designed in accordance with applicable guidance of the appropriate NFPA standards. A change from an automatic system to a manually actuated system should be supported by an appropriate evaluation.

3.5 Manual Firefighting Capabilities

3.5.1 *Fire Brigade*

A site fire brigade trained and equipped for ~~fire fighting~~firefighting should be established and should be on site at all times to ensure adequate manual firefighting capability for all areas of the plant containing ~~structures, systems, and components~~SSCs important to safety. The fire brigade leader should have ready access to keys for any locked doors.

~~G~~Regulatory Position 1.6.4 of this guide provides guidance on fire brigade training and ~~qualification is provided in Regulatory Position 1.6.4~~qualifications.

The guidelines of NFPA 600 are considered appropriate criteria for organizing, training, and operating a plant fire brigade.

3.5.1.1 Fire Brigade Staffing~~.~~

The fire brigade should ~~be~~include at least five members on each shift. The shift supervisor should not be a member of the fire brigade.

3.5.1.2 Equipment

The equipment provided for the brigade should consist of personal protective equipment such as turnout coats, bunker pants, boots, gloves, hard hats, emergency communications equipment, portable lights, portable ventilation equipment, and portable extinguishers. Self-contained breathing apparatuses using full-face positive-pressure masks approved by ~~NIOSH (~~the National Institute for Occupational Safety and Health ~~—~~(approval formerly given by the U.S. Bureau of Mines) should be provided for fire brigade, damage control, and control room personnel. At least 10 masks should be available for fire brigade personnel. Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir if practical. Service or rated operating life should be at least ~~one-half hour~~30 minutes for the self-contained units. ~~Additional guidance is provided in~~ NFPA 1404, "Standard for a Fire ~~Department Self-Contained Breathing Apparatus Program."~~

Service Respiratory Protection Program," provides additional guidance.

Fire brigade equipment should be stored in accordance with manufacturers' recommendations (e.g., firefighter clothing should not to be stored where it will be subjected to ultraviolet light from the sun, welding, or fluorescent lights).

At least a 1-hour supply of breathing air in extra bottles should be located on the plant site for each ~~unit of~~ self-contained breathing apparatus. In addition, an onsite 6-hour supply of reserve air should be provided for the fire brigade personnel and arranged to permit quick and complete replenishment of exhausted air supply bottles as they are returned. If compressors ~~are used~~serve as a source of breathing air, only units approved for breathing air should be used and the compressors should be operable ~~assuming~~in the event of a loss of offsite power. Special care should be taken to locate the compressor in areas free of dust and contaminants.

During refueling and maintenance periods, adequate self-contained breathing apparatuses should be provided near the containment entrances for firefighting and damage control personnel. These units should be independent of any breathing apparatuses or air supply systems provided for general plant activities and should be clearly marked as emergency equipment.

3.5.1.3 **Procedures and Pre-fire Plans.**

Procedures should be established to control actions by the fire brigade ~~on~~upon notification by the control room of a fire~~,~~ and to define firefighting strategies. These procedures should include the following:

a. ~~A~~actions to be taken by control room personnel to notify the fire brigade upon report of a fire or receipt of an alarm on the control room fire alarm panel~~, for example~~ (e.g., announcing the location of the fire over the ~~PA~~public address system, sounding fire alarms, and notifying the shift supervisor and the fire brigade leader of the type, size, and location of the fire~~.~~

)

b. ~~A~~actions to be taken by the fire brigade after notification by the control room of a fire (e.g., ~~for example, assembling~~ assembling in a designated location, receiving directions from the fire brigade leader, and discharging specific firefighting responsibilities, including selection and transportation of firefighting equipment to the fire location, selection of protective equipment, operating instructions for use of fire suppression systems, and use of preplanned strategies for fighting fires in specific areas~~.~~

)

c. ~~Define the~~ strategies for fighting fires in all plant areas~~. These strategies should designate~~, including the following:

   i. ~~F~~fire hazards in each area covered by the specific pre-fire plans~~.~~

   ii. ~~F~~SSCs credited for fire safe shutdown.

   iii. fire suppression agents best suited for extinguishing the fires associated with the fire hazards in that area and the nearest location of these suppression agents~~.~~

   i~~ii~~v. ~~M~~most favorable direction from which to attack a fire in each area in view of the ventilation direction, access hallways, stairs, and doors that are most likely to be free of fire, and the best station or elevation for fighting the fire~~. A~~, as well as all access and egress routes ~~that involve~~involving locked doors ~~should be specifically identified in the procedure with~~and the appropriate precautions and methods for access specified~~.~~

   ~~iv~~v. ~~P~~plant systems that should be managed to reduce the damage potential during a local fire and the location of local and remote controls for such management (e.g., any hydraulic or electrical systems in the zone covered by the specific firefighting procedure that could increase the hazards in the area because of ~~over pressurization~~overpressurization or electrical hazards)~~.~~

vi. ~~V~~vital heat-sensitive system components that need to be kept cool while fighting a local fire~~. I~~, in particular, hazardous combustibles that need cooling~~ should be designated.~~

vii. ~~O~~organization of firefighting brigades and the assignment of special duties ~~according to job title so that all firefighting functions are covered by any complete shift personnel complement. These duties include~~(including command control of the brigade, transporting fire suppression and support equipment to the fire scenes, applying the extinguishing agent to the fire, communication with the control room, and coordination with outside fire departments~~.~~

~~vii. Potential~~, according to job title so that all firefighting functions are covered by any complete shift personnel complement

viii. potential radiological and toxic hazards in fire zones~~.~~

~~viii~~ix. ~~V~~ventilation system operation that ensures desired plant air distribution when the ventilation flow is modified for fire containment or smoke clearing operation~~.~~

~~ix~~x. ~~O~~operations requiring control room and shift engineer coordination or authorization~~.~~

xi. ~~I~~instructions for plant operators and general plant personnel during fire~~.~~

xii. ~~C~~communications between the fire brigade leader, fire brigade, offsite mutual aid responders, control room, and licensee's emergency response organization~~.~~

Appropriate firefighting procedures should identify the techniques and equipment for the use of water in fighting electrical cable fires in nuclear plants, particularly in areas containing a high concentration of electric cables with plastic insulation. ~~Additional guidance on pre-fire planning is provided in NFPA 1620~~NFPA 1620, ~~"Recommended~~"Recommended Practice for Pre-Incident Planning," provides additional guidance on prefire planning.~~"~~

3.5.1.4 Performance Assessment/Drill Criteria~~.~~

Fire brigade drills should be performed in the plant so that the fire brigade can practice as a team. Drills should be performed quarterly for each shift fire brigade. Each fire brigade member should participate in at least two drills ~~per year~~annually.

A sufficient number of these drills, but not less than one for each shift's fire brigade per year, should be unannounced to determine the firefighting readiness of the plant's fire brigade, brigade leader, and fire protection systems and equipment. Persons planning and authorizing an unannounced drill should ensure that the responding shift fire brigade members are not aware that a drill is being planned until it has begun. At least one drill per year should be performed on a ~~"back~~"back shift~~"~~" for each shift's fire brigade.

The ~~drills~~licensee should ~~be preplanned~~preplan the drills to establish~~ the~~ training objectives ~~of the drill ~~and~~ should be critiqued~~ critique them to determine how well the training objectives have been met. ~~Unannounced drills should be planned and critiqued by m~~ Members of the management staff responsible for plant safety and fire protection should plan and critique unannounced drills. Performance deficiencies of a fire brigade or of individual fire brigade members should be remedied by scheduling additional training for the brigade or members.

Unsatisfactory drill performance should be followed by a repeat drill within 30 days.

The local fire department should be invited to participate in drills at least annually.

At 3-year intervals,~~ a randomly selected unannounced drill should be critiqued by~~ qualified individuals independent of the licensee~~'~~'s staff should critique a randomly selected unannounced drill. A copy of the written report from such individuals should be available for NRC review.

Drills should include the following:

a. ~~Assessment of fire alarm~~The effectiveness of the fire alarms, time required to notify and assemble the fire brigade, and selection, placement, and use of equipment and firefighting strategies~~.~~

should b.~~ Assessment of each~~e assessed.

b. Each brigade member~~'~~'s knowledge of his or her role in the firefighting strategy for the area assumed to contain the fire~~. Assessment of~~, and the brigade ~~members'~~member's conformance with established plant firefighting procedures and use of firefighting equipment, including self-contained emergency breathing apparatuses, communication, lighting, and ventilation should be assessed.~~-~~

c. The simulated use of firefighting equipment required to cope with the situation and type of fire selected for the drill should be evaluated. The area and type of fire chosen for the drill should differ from those used in the previous drills so that brigade members are trained in fighting fires in various plant areas. The situation selected should simulate the size and arrangement of a fire that could reasonably occur in the area selected, allowing for fire development during the time required to respond, obtain equipment, and organize for the fire, assuming loss of automatic suppression capability.

d. ~~Assessment of t~~The brigade leader~~'~~'s direction of the firefighting effort ~~as~~should be assessed with regard to thoroughness, accuracy, and effectiveness.

Drill records should be retained for a period of 3 years and made available for NRC inspection. (See Regulatory Position 1.6.4 of this guide for additional ~~guidance~~direction on drill records.)

3.5.2 *Offsite Manual Fire~~-F~~fighting Resources*

Onsite fire brigades typically fulfill the role of first responder, but may not have sufficient personnel, equipment, and capability to handle all possible fire events. Arrangements with offsite fire services may be necessary to augment onsite firefighting capabilities, consistent with the fire hazards analysis and pre~~-~~fire planning documents. The FPP should describe the capabilities (e.g., equipment compatibility, training, drills, and command control) of offsite responders.

3.5.2.1 Capabilities~~.~~

The local offsite fire departments ~~providing~~that provide back up manual firefighting resources should have the following capabilities:

a. ~~P~~personnel and equipment with capacities consistent with those assumed in the plant~~'~~'s fire hazards analysis and pre~~-~~fire plans~~.~~

b. ~~H~~hose threads or adapters to connect with onsite hydrants, hose couplings, and standpipe risers~~.~~ (Regulatory Position 3.4.2 states that onsite fire suppression water systems should have threads compatible with those used by local fire departments or a sufficient number of thread adapters available~~.~~)

3.5.2.2 Training~~.~~

Local offsite fire department personnel ~~providing~~who provide back up manual firefighting resources should be trained in the following:

a. ~~O~~operational precautions when fighting fires on nuclear power plant sites and the need for radiological protection of personnel and the special hazards associated with a nuclear power plant site~~.~~

b. ~~T~~the procedures for notification and expected roles of the offsite responders~~.~~

c. ~~S~~site access procedures and the identity (by position and title) of the individual in the onsite organization who will control the responders~~'~~’ support activities~~. O~~ (offsite response support personnel should be provided with appropriate identification cards where required~~.~~

)

d. ~~F~~fire protection authorities, responsibilities, and accountabilities with regard to responding to a plant fire, including the fire event command structure between the plant fire brigade and offsite responders~~.~~

e. ~~P~~plant layout, plant fire protection systems and equipment, plant fire hazards, and pre~~-~~fire response plans and procedures~~.~~

3.5.2.3 Agreement/Plant Exercise~~.~~

The ~~W~~licensee should establish written mutual aid agreements ~~should be established~~ between the utility and the offsite fire departments that are ~~assumed~~listed in the fire hazards analysis and pre~~-~~fire plans ~~to~~as providing a support response to a plant fire. These agreements should delineate fire protection authorities, responsibilities, and accountabilities with regard to responding to plant fire or emergency events, including the fire event command structure between the plant fire brigade and offsite responders.

The plant fire brigade drill schedule should provide for periodic local fire department participation (at least annually). These drills should effectively exercise the fire event command structure between the plant fire brigade and offsite responders. (See Regulatory Position 3.5.1.4 for guidance on conduct and evaluation of fire brigade drills.) Offsite fire department response should be tested periodically in conjunction with the required exercises of the radiological emergency response plan required by 10 CFR 50.47~~.~~

~~The guidance in Regulatory Position 3.5 is based on Appendix R to 10 CFR Part 50, NUREG-0654, and CMEB 9.5-1.~~

~~**4. BUILDING DESIGN/PASSIVE FEATURES**~~

~~**4.1**~~ , “Emergency Plans.”

4. Building Design/Passive Features

4.1 General Building and Building System Design

This section provides guidance on building layout (e.g., fire areas and zones), materials of construction, and building system design (e.g., electrical, HVAC, lighting, and communication systems) important to effective fire prevention and protection. ~~G~~Regulatory Position 4.2 provides guidance for passive fire barriers~~ is provided in Regulatory Position 4.2~~.

4.1.1 ***Combustibility of Building Components and Features***

According to GDC 3, noncombustible and heat~~-~~-resistant materials must be used wherever practical throughout the unit. Interior wall and structural components, thermal insulation materials, radiation shielding materials, and soundproofing should be noncombustible. The fire hazards analysis should identify in situ combustible materials used in plant SSCs and specify suitable fire protection.

Metal deck roof construction should be noncombustible and listed as ~~"acceptable~~"acceptable for fire~~"~~" in the ~~UL Building~~Underwriters Laboratories, Inc. (UL), "Building Materials Directory," or listed as Class I in the Factory Mutual~~ Research~~ Approval Guide.

4.1.1.1 Interior Finish.

Interior finishes should be noncombustible. The following materials are acceptable for use as interior finish without evidence of test and listing by a recognized testing laboratory:

a. Pplaster, acoustic plaster, and gypsum plasterboard (gypsum wallboard), either plain, wallpapered, or painted with oil- or water-base paint;

b. Cceramic tile; and ceramic panels;

c. Gglass; and glass blocks;

d. Bbrick, stone, and concrete blocks, plain or painted;

e. Ssteel and aluminum panels, plain, painted, or enameled, and

f. Vvinyl tile, vinyl-asbestos tile, linoleum, or asphalt tile on concrete floors.

Suspended ceilings and their supports should be of noncombustible construction. Concealed spaces should be devoid of combustibles except as noted in Regulatory Position 6.1.2; Control Room Complex of this guide.

In situ fire hazards should be identified and suitable protection provided.

4.1.1.2 Testing and Qualification.

Interior finishes should be noncombustible (see Definitionsthe "Glossary" section of this guide) or listed by an approving laboratory for the following:

a. Ssurface flame spread rating of 25 or less; and a smoke development rating of 450 or less, when tested under American Society for Testing and Materials (ASTM) E-84, "Standard"Standard Test Method for Surface Burning Characteristics of Building Materials," and Materials"

b. Ppotential heat release of 8141 kilojoules per kilogram (kJ/kg) (3500 Btu/lb3,500 Btu per pound/) or less when tested under ASTM D3286 or NFPA 259, "StandardASTM D-3286, "Standard Test Method for Gross Calorific value of Coal and Coke by the Isoperibol Bomb Calorimeter," or NFPA 259, "Standard Test Method for Potential Heat of Building Materials.""[3]

c. Ffloor covering critical radiant flux should beas determined by testing in accordance with NFPA 253, "Test"Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source."

The guidance in Regulatory Position 4.1.1 is based on GDC 3, Appendix R to 10 CFR Part 50, ASB 9.5-1, and CMEB 9.5-1.

4.1.2 CompartmentationSource"

4.1.2 *Compartmentalization, Fire Areas, and Zones*

In accordance with GDC 3, structures, systems, and componentsSSCs important to safety must be designed and located to minimize the probability and effect of fires and explosions. The concept of compartmentationcompartmentalization meets GDC 3, in part, by utilizing passive fire barriers to subdivide the plant into separate areas or zones. These fire areas or zones serve the primary purpose of confining the effects of fires to a single compartment or area, thereby minimizing the potential for adverse effects from fires on redundant structures, systems, and componentsSSCs important to safety.

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[3] Trays exceeding 610 mm (24 inches) should be counted as two trays; trays exceeding 1220 mm (48 inches) should be counted as three trays, regardless of tray fill.The concept of using a potential heat release limit of 8141 kJ/kg (3,500 Btu/lb) is similar to the "limited combustible" concept with its like limit, as set forth in NFPA 220, "Standard on Types of Building Construction."

4.1.2.1 Fire Areas~~.~~

A fire area is defined as that portion of a building or plant that is separated from other areas by fire barriers, including components of construction such as beams, joists, columns, penetration seals or closures, fire doors, and fire dampers. Fire barriers that define the boundaries of a fire area should have a fire~~-~~-resistance rating of 3 hours or more and should ~~be provided~~achieve the following:

a. ~~To separate structures, systems, and components~~separation of SSCs important to safety from any potential fires in non-safety-related areas that could affect their ability to perform their safety function~~;~~

b. ~~To separate~~separation of redundant ~~success paths~~trains of systems and components important to safety from each other so that both are not subject to damage from a single fire~~;~~

c. ~~To separate~~separation of individual units on a ~~multiple-unit~~multiunit site unless the requirements of ~~General Design Criterion 5~~GDC 5, “Sharing of Structures, Systems, and Components,” are met with respect to fires~~.~~

~~Fire areas should be established on the basis of t~~The fire hazards analysis should be used to establish fire areas. Particular design attention to the use of separate, isolated fire areas for redundant cables will help to avoid loss of redundant cables important to safety. Separate fire areas should also be employed to limit the spread of fires between components, including high concentrations of cables important to safety that are major fire hazards within a safety division.

Where fire area boundaries are not 3-hour rated, or not wall-to-wall or floor-to-ceiling boundaries with all penetrations sealed to the fire rating of the boundaries, the licensee should perform an evaluation ~~should be performed~~ to assess the adequacy of the fire area boundaries (i.e., barriers) to determine whether the boundaries will withstand the hazards associated with the area and, as necessary, protect important equipment within the area from a fire outside the area. Unsealed openings should be identified and considered when evaluating the overall effectiveness of the barrier ~~(See Regulatory Position 1.4.3 for positions related to barrier evaluations~~. (See Regulatory Position 4.2.1 of this guide for positions related to fire barrier testing and acceptance.)

If a wall or floor/ceiling assembly contains major unprotected openings, such as hatchways and stairways, plant locations on either side of such a barrier should be considered a~~s~~ part of a single fire area. If success path A is separated by a cumulative horizontal distance of 6.1 m (20 f~~ee~~t) from success path B, with no intervening combustible materials or fire hazards, and both elevations are provided with fire detection and suppression, the area would be considered acceptable.

Exterior walls, including penetrations, should be qualified as rated fire barriers if they are required to separate safe-shutdown equipment on the interior of the plant from the redundant equipment located in the immediate vicinity of the exterior wall, if they separate plant areas important to safety from non-safety-related areas that present a significant fire exposure to the areas important to safety, or if otherwise designated by the FSAR or fire hazards analysis.

An exterior yard area without fire barriers should be considered as one fire area. The area may consist of several fire zones. (~~s~~See Regulatory Position 4.1.2.2 of this guide.)~~.~~

4.1.2.2 Fire Zones~~.~~

Fire zones are subdivisions of a fire area and are typically based on fire hazards analyses that demonstrate that the fire protection systems and features within the fire zone provide an appropriate level of protection for the associated hazards. Fire zone concepts may be used to establish zones within fire areas where further subdivision into additional fire areas is not practical on the basis of existing plant design and layout (e.

g., inside containment).

Evaluations by some licensees made ~~prior to~~before Appendix R to 10 CFR Part 50 was published were based on fire zones that do not meet the strict definition of fire areas. In some cases, the separation of redundant success paths within the fire zone boundaries and the separation between fire zones do not comply with the separation requirements of Appendix R. Such configurations may be acceptable under the exemption process.

An exterior yard area considered as one fire area may consist of several fire zones. The fire hazards analysis should be used to determine the boundaries of the fire zones ~~should be determined by a fire hazards analysis~~. The protection for redundant, alternative, dedicated, or backup shutdown systems within a yard area should be determined on the basis of the largest postulated fire that is likely to occur and the resulting damage. The boundaries of such damage should be justified with a fire hazards analysis. The analysis should consider the degree of spatial separation between divisions; the presence of in situ and transient combustibles, including vehicular traffic; grading; available fire protection; sources of ignition; and the vulnerability and criticality of the shutdown-related systems.

4.1.2.3 Access and Egress Design. Provisions should be made for personnel access to and escape routes from each fire area. Under emergency conditions, prompt ingress into certain areas important to safety should be ensured to enable

The plant layout should provide adequate means of access to all plant areas for manual fire suppression and safe shutdown of a nuclear power plant.

. The plant layout should also allow for safe access and egress to areas for personnel performing safe-shutdown operations. Considerations should include fire and post-fire habitability in safe-shutdown areas, protection or separation from fire conditions of access and egress pathways to safe-shutdown SSCs, and potential restrictions or delays to safe-shutdown area access potentially caused by security locking systems.

Stairwells outside primary containment serving as escape routes, access routes for firefighting, or access routes to areas containing equipment necessary for safe shutdown should be enclosed in masonry or concrete towers with a minimum fire rating of 2 hours and self-closing Class B fire doors. Fire exit routes should be clearly marked.

Prompt emergency ingress into electrically locked areas by essential personnel should be ensured through the combined use and provision of the following features.

a. Rreliable and uninterruptible auxiliary power to the entire electrical locking system, including its controls.

b. Eelectrical locking devices that are required to fail in the secure mode for security purposes, with secure mechanical means and associated procedures to override the devices upon loss of both primary and auxiliary power (e.g., key locks with keys held by appropriate personnel who know when and how to use them).

c. Pperiodic tests of all locking systems and mechanical overrides to confirm their operability and their capability to switch to auxiliary power.

Also see Regulatory Positions 4.1.6 and 4.1.7 for guidanceof this guide provide direction related to emergency lighting and communication capabilities during fires.

The guidance in Regulatory Position 4.1.2 is based on GDC 3, Appendix R to 10 CFR Part 50, CMEB 9.5-1, GL 83-33, GL 86-10, BL 81-03, and IN 84-09.

4.1.3 *Electrical Cable System Fire Protection Design*

4.1.3.1 Cable Design.

Electric cable construction should pass the flame test in IEEE Standard 383, "“IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations,"” or IEEE Standard 1202, "“IEEE Standard for Flame Testing of Cables for Use in Cable Trays in Industrial and Commercial Occupancies."” (This does not imply that cables passing either test will not require additional fire protection.) For cable installations in operating plants and plants under construction prior tobefore July 1, 1976, that do not meet the IEEE Standard 383 flame test requirements, all cables should be covered with an approved flame retardant coating and properly derated, or be protected by automatic suppression.

4.1.3.2 Although cable coatings have been shown to reduce flame spread, coated cables are considered intervening combustibles when determining the protection requirements of Section III.G.2 of Appendix R to 10 CFR Part 50. Coated cables do not have higher damage thresholds and, therefore, are not equivalent to IEEE 383 cables. In addition, coated cables can and do ignite in fires.

New reactor fiber optic cable insulation and jacketing should also meet the fire and flame test requirements of IEEE 383 or IEEE 1202.

4.1.3.2 Raceway/Cable Tray Construction.

Only metal should be used for cable trays. Only metallic tubing should be used for conduit. Thin-wall metallic tubing should not be used. Flexible metallic tubing should only be used in short lengths to connect components to equipment. Other raceways should be made of noncombustible material. Cable raceways should be used only for cables.

4.1.3.3 Electrical Cable System Fire Detection and Suppression.

Redundant cable systems important to safety outside the cable spreading room should be separated from each other and from potential fire exposure hazards in non-safety-related areas by fire barriers with a minimum fire rating of 3 hours to the extent feasible. Theose fire areas that contain cable trays important to safety should be provided with fire detection. Cable trays should be accessible for manual fire fightingfirefighting and cables should be designed to allow wetting down with fire suppression water without electrical faulting. Manual hose stations and portable hand extinguishers should be provided.

Manual hose standpipe systems may be relied upon to provide the primary fire suppression (in lieu of automatic water suppression systems) for cable trays of a single -division important to safety that are separated from redundant safety divisions by a fire barrier with a minimum rating of 3 hours and are normally accessible for manual fire fightingfirefighting if all of the following conditions are met.:

a. The number of equivalent[4] standard 610-mm- (~~24-inch-~~24-in.-) wide cable trays (both important to safety and non-safety-related) in a given fire area is ~~6~~six or less~~;~~

.

b. The cabling does not provide instrumentation, control, or power to systems required to achieve and maintain hot shutdown~~; and~~

.

c. Smoke detectors are provided in the area of these cable routings, and continuous line-type heat detectors are provided in the cable trays.

In other areas where it may not be possible because of other overriding design features necessary for ~~reasons of~~ nuclear safety to separate redundant cable systems important to safety by 3-hour-rated fire barriers, or if cable trays are not accessible for manual firefighting, cable trays should be protected by an automatic fire suppression system.

4.1.3.4 **Electrical Cable Separation.**

Redundant systems used to mitigate the consequences of design-basis accidents but not necessary for safe shutdown may be lost to a single exposure fire. However, protection should be provided so that a fire within only one such system will not damage the redundant system. Therefore, the separation ~~criteria~~guidelines of Regulatory Position 5.~~5~~3 of this guide apply only to the electrical cabling needed to support the systems that are used for post-fire safe-shutdown. All other redundant Class 1E ~~and associated~~ electrical cables should meet the separation ~~criteria~~guidelines of Regulatory Guide 1.75.

When the electrical cabling is covered by separation criteria required for both post-fire safe-shutdown and accident mitigation, the more stringent criteria of Regulatory Position 5.~~5~~3 apply. [Note that compliance with post-fire safe-shutdown requirements may be achieved without separation of redundant Class 1E cabling by providing alternative, dedicated, or backup shutdown capability (see Regulatory Position 5.~~6~~4); however, this does not preclude the separation criteria of Regulatory Guide 1.75 for redundant Class 1E ~~and associated~~ cables used in accident mitigation.]

For plants with a ~~C~~construction ~~P~~permit issued ~~prior to~~before July 1, 1976, where cables important to safety do not satisfy the provisions of Regulatory Guide 1.75, all exposed cables should be covered with an approved fire retardant coating or a fixed automatic water fire suppression system ~~should be provided~~.

4.1.3.5 **Transformers.**

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4 T~~he 181°C [325°F] temperature condition was established by allowing the temperature of the unexposed side of the fire barrier to rise 139°C [250°F] above the assumed 24°C [75°F] ambient air temperature, as measured by the thermocouples within the test specimen at the onset of the fire exposure during the fire test.o~~rays exceeding 610 mm (24 in.) should be counted as two trays; trays exceeding 1,220 mm (48 in.) should be counted as three trays, regardless of tray fill.

Transformers that present a fire hazard to equipment important to safety should be protected as described in Regulatory Position 7.3 of this guide.

4.1.3.6 **Electrical Cabinets**~~.~~

Electrical cabinets present an ignition source for fires and a potential for explosive electrical faults that can result in damage not only to the cabinet of origin, but also to equipment, cables, and other electrical cabinets in the vicinity of the cabinet of origin. Fire protection systems and features provided for the general area containing the cabinet may not be adequate to prevent damage to adjacent equipment, cables, and cabinets following an energetic electrical fault. Energetic electrical faults are more of a concern with high-voltage electrical cabinets ~~(~~[i.e., 480 volts (V) and above~~)~~]. ~~High- voltage~~High-voltage cabinets should be provided with adequate spatial separation or substantial physical barriers to minimize the potential for an energetic electrical fault to damage adjacent equipment, cables, or cabinets important to safety.

Rooms containing electrical cabinets important to safety should be provided with area~~-~~wide automatic fire detection, automatic fire suppression, and manual fire suppression capability.

Electrical cabinets containing a quantity of combustible materials (e.g., cabling) sufficient to propagate a fire outside the cabinet of fire origin should be provided with in-cabinet automatic fire detection.

~~The guidance in Regulatory Position 4.1.3 is based on APCSB 9.5-1, CMEB 9.5-1, and Mattson Memo 1983.~~

4.1.4 *HVAC Design*

Suitable design of the ventilation systems can limit the consequences of a fire by preventing the spread of the products of combustion to other fire areas. It is important that means be provided to ventilate, exhaust, or isolate the fire area as required and that consideration be given to the consequences of ~~failure of~~ ventilation ~~systems~~system failure caused by the fire, ~~causing~~resulting in a loss of control for ventilating, exhausting, or isolating a given fire area.

Special protection for ventilation power and control cables may be necessary. The power supply and controls for mechanical ventilation systems should be run outside the fire area served by the system where practical.

Release of smoke and gases containing radioactive materials to the environment should be monitored in accordance with emergency plans as described in the guidelines of Regulatory Guide 1.101, "Emergency Planning and Preparedness for Nuclear Power Reactors." Any ventilation system designed to exhaust potentially radioactive smoke or gases should be evaluated to ensure that inadvertent operation or single failures will not violate the radiologically controlled areas of the plant design. This should include containment functions for protecting the public and maintaining habitability for operations personnel.

Fresh air supply intakes to areas containing equipment or systems important to safety should be located ~~remote~~away from the exhaust air outlets and smoke vents of other fire areas to minimize the possibility of contaminating the intake air with the products of combustion.

Where total-flooding gas-extinguishing systems are used, area intake and exhaust ventilation dampers should be controlled in accordance with NFPA 12~~ and~~, NFPA 12A, or NFPA 2001 to maintain the necessary gas concentration. (~~A~~See also~~ see~~ Regulatory Position 3.3.2 of this guide.)

4.1.4.1 Combustibility of Filter Media.

Filters for particulate and gaseous effluents may be fabricated of combustible media (e.g., HEPA and charcoal filters). The ignition and burning of these filters may result in a direct release of radioactive material to the environment~~;~~ or may provide an unfiltered pathway upon failure of the filter. Filter combustion may spread fire to other areas.

Engineered safety feature filters should be protected in accordance with the guidelines of Regulatory Guide 1.52, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup System Light-Water-Cooled Nuclear Power Plants.” Any filter that includes combustible materials and is a potential exposure fire hazard that may affect components important to safety should be protected as determined by the fire hazards analysis.

4.1.4.2 Smoke Control/Removal.

Smoke from fires can be toxic, corrosive, and may obscure visibility for emergency egress and access to plant areas. Smoke control and removal may be necessary to support manual suppression activities and safe-shutdown operations.

Consideration should be given to the installation of automatic suppression systems ~~as a means of limiting~~to limit smoke and heat generation. Smoke and corrosive gases should generally be discharged directly outside to an area that will not affect plant areas important to safety. The normal plant ventilation system may be used for this purpose, if capable and available. To facilitate manual firefighting, separate smoke and heat vents should be ~~provided~~considered in~~ specific~~ areas such as cable spreading rooms, diesel fuel oil storage areas, switchgear rooms, and other areas where the potential exists for heavy smoke conditions. (~~s~~See NFPA 204, ~~"Guide~~“Standard for Smoke and Heat Venting~~," for additional guidance on smoke control~~.”)~~.~~

4.1.4.3 Habitability.

Protection of plant operations staff from the effects of fire and fire suppression (e.g., gaseous suppression agents) may be necessary to ensure safe shutdown of the plant. For control room evacuation, egress pathways and remote control stations should also be habitable.

Consideration should be given to protection of safe~~-~~-shutdown areas from infiltration of gaseous suppression agents. The capability to ventilate, exhaust, or isolate is particularly important to ensure the habitability of rooms or spaces that should be attended in an emergency. In the design, provision should be made for personnel access to and escape routes from each fire area. Habitability of the following areas should be considered~~.~~:

~~•~~ ~~C~~a. control room

b. ~~P~~post-fire safe~~-~~-shutdown areas

c. ~~P~~personnel access and egress pathways

Stairwells should be designed to minimize smoke infiltration during a fire. Staircases may serve as escape routes and access routes for ~~fire fighting~~firefighting. Fire exit routes should be clearly marked. Stairwells, elevators, and chutes should be enclosed in fire-rated construction with automatic fire doors at least equal to the enclosure construction~~,~~ at each opening into the building. Elevators should not be used during fire emergencies.

4.1.4.4 **Fire Dampers.**

Redundant safe~~-~~-shutdown components may be separated by fire-resistant walls, floors, enclosures, or other types of barriers. For the fire barriers to be effective in limiting the propagation of fire, ventilation duct penetrations of fire barriers should be protected by means of fire dampers that are arranged to automatically close in the event of fire. ~~Additional guidance is provided in~~ NFPA 90A, ~~"Standard~~"Standard for the Installation of Air Conditioning and Ventilating Systems," provides additional guidance.~~"~~ (~~A~~See also~~ see~~ Regulatory Position 4.2.1.3~~.)~~

~~The guidance in Regulatory Position 4.1.4 is based on CMEB 9.5-1 and IN 83-69.~~

~~**4.1.5 Drainage**~~ of this guide.)

4.1.5 *Drainage*

Floor drains sized to remove expected firefighting water without flooding equipment important to safety should be provided in areas where fixed water fire suppression systems are installed. Floor drains should also be provided in other areas where hand hose lines may be used if such firefighting water could cause unacceptable damage to equipment important to safety in the area. Facility design should ensure that fire water discharge in one area does not impact equipment important to safety in adjacent areas. Housekeeping procedures should ensure that drains are not blocked by accumulated dirt or other debris.

Where ~~gas~~gaseous suppression systems are installed, the drains should be provided with adequate seals or the gas suppression system should be sized to compensate for the loss of the suppression agent through the drains. (~~s~~See Regulatory Position 3.3.2 of this guide.)~~.~~

~~Drains~~Drainage in areas containing ~~combustible liquids should have provisions for preventing the backflow of~~equipment important to safety should be designed to minimize the potential to propagate fire from areas containing flammable or combustible liquids ~~to plant areas important to safety through~~via the ~~interconnected drain~~ drainage system~~s~~.

Water drainage from areas that may contain radioactivity should be collected, sampled, and analyzed before discharge to the environment.

~~The guidance in Regulatory Position 4.1.5 is based on CMEB 9.5-1.~~

4.1.6 *Emergency Lighting*

Emergency lighting should be provided throughout the plant as necessary to support fire suppression actions~~,~~ and safe-shutdown operations, including access and ~~emergency~~ egress pathways to safe-shutdown areas during a fire event.

4.1.6.1 Egress Safety.

Emergency lighting should be provided in support of the emergency egress design guidelines in outlined in Regulatory Position 4.1.2.3 of this guide.

4.1.6.2 Post-Fire Safe~~-~~-Shutdown~~.~~

Lighting is vital to post-fire safe~~-~~-shutdown and emergency response in the event of fire. ~~S~~The licensee should provide suitable fixed and portable emergency lighting~~ should be provided~~, as follows~~.~~

:

a. Fixed, self-contained lighting consisting of fluorescent or sealed-beam units with individual 8-hour minimum battery power supplies should be provided in areas needed for operation of safe~~-~~-shutdown equipment and for access and egress routes thereto.

The level of illumination provided by emergency lighting in access routes to and in areas where shutdown functions are performed~~ is a level that~~ is sufficient to enable an operator to reach that area and perform the shutdown functions. At the remote shutdown panels, the illumination levels should be sufficient for control panel operators.~~ The bases for estimating these levels of lighting are the guidelines contained in Section 9.5.3 of the Standard Review Plan, NUREG-0800.~~ If a licensee has provided emergency lighting ~~per~~in accordance with Section III.J of Appendix R to 10 CFR Part 50, the licensee should verify by field testing that this lighting is adequate to perform the intended tasks.

Routine maintenance and initial and periodic field testing of emergency lighting systems should ensure their ability to support access, egress, and operations activities for the full 8-hour period accounting for anticipated environmental conditions, battery conditions, and bulb life.

b. Suitable sealed-beam battery-powered portable hand lights should be provided for emergency use by the fire brigade and other operations personnel required to achieve safe plant shutdown.

If ~~emergency lights are powered from~~ a central battery or batteries power the emergency lights, the distribution system should contain ~~such~~ protective devices ~~that~~necessary to preclude a fire in one area ~~will not cause~~from causing a loss of emergency lighting in any unaffected area ~~needed~~required for safe~~-~~-shutdown operations.

~~The guidance in Regulatory Position 4.1.6 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, GL 86-10, IN 95-36, IP 64100, TI 2515/62, and Vollmer Memo 1983b.~~

4.1.7 *Communications*

The communication system design should provide effective communication between plant personnel in all vital areas during fire conditions under maximum potential noise levels.

Two-way voice communications are vital to safe shutdown and emergency response in the event of fire. Suitable communication devices should be provided, as follows~~.~~:

a. Fixed emergency communications independent of the normal plant communication system should be installed at preselected stations.

b. A portable radio communications system should be provided for use by the fire brigade and other operations personnel required to achieve safe plant shutdown. This system should not interfere with the communications capabilities of the plant security force. Fixed repeaters installed to permit use of portable radio communication units should be protected from exposure fire damage. Pre~~-~~operational and periodic testing should demonstrate that the frequencies used for portable radio communication will not affect the actuation of protective relays.

~~The guidance in Regulatory Position 4.1.7 is based on NUREG-0800 and CMEB 9.5-1.~~

4.1.8 *Explosion Prevention*

In situ and transient explosion hazards should be identified and suitable protection provided. Transient explosion hazards that cannot be eliminated should be controlled and suitable protection provided. (See Regulatory Position 2.1 of this guide regarding control of combustibles.)

Miscellaneous storage and piping for flammable or combustible liquids or gases should not create a potential exposure hazard to systems important to safety or the fire protection systems that serve those areas. (~~A~~See also ~~see~~ Regulatory Positions 2.1.3 and 7.5 of this guide.)

Systems or processes that involve hydrogen supplies (e.g., generator cooling systems and reactor coolant hydrogen addition systems) and those that may evolve hydrogen or explosive gases (e.g., waste gas and solid radioactive waste processing systems) should be designed to prevent development of explosive mixtures by limiting the concentration of explosive gases and vapors within enclosures to less than ~~50%~~50 percent of the lower explosive limit, or by limiting oxygen within systems containing hydrogen. Hydrogen distribution and supply systems should include design features that mitigate the consequences of system damage, such as excess flow valves or flow restrictors, double-walled pipe with annulus leak detection, and rupture diaphragms. (~~A~~See also ~~see~~ Regulatory Position 7.5 of this guide.)

The construction, installation, operation, and maintenance of bulk gas (including liquefied gas) storage and the related loading and dispensing systems should comply with good industry practice and the relevant NFPA ~~S~~standards, as applicable (e.g., NFPA ~~50A, "Standard for Gaseous Hydrogen Systems at Consumer Sites," NFPA 50B, "Standard for Liquefied Hydrogen Systems at Consumer Sites,"~~54 and NFPA ~~54, "National Fuel Gas Code"~~55).

If the potential for an explosive mixture of hydrogen and oxygen exists in ~~off gas~~offgas systems, the systems should either be designed to withstand the effects of a hydrogen explosion or be provided with dual gas analyzers with automatic control functions to preclude the formation or buildup of explosive mixtures.

The guidance in Regulatory Position 4.18 is in NUREG-0800 and CMEB 9.5-1.

4.2 Passive Fire ResistiveNFPA 69 is the applicable standard for explosion prevention systems.

Revision 1of Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," provides guidance for the assessment of explosion hazards related to transportation near the plant site.

4.2 Passive Fire-Resistive Features

4.2.1 *Structural Fire Barriers*

Fire barriers are those components of construction (walls, floors, and their supports), including beams, joists, columns, penetration seals or closures, fire doors, and fire dampers that are rated by approving laboratories in hours of resistance to fire and are used to prevent the spread of fire.

Where exact replication of a tested configuration cannot be achieved, the field installation should meet all of the following criteria.:

a. The continuity of the fire barrier material is maintained;.

b. The thickness of the barrier is maintained;.

c. The nature of the support assembly is unchanged from the tested configuration;.

d. The application or "end"“end use"” of the fire barrier is unchanged from the tested configuration;.

e. The configuration has been reviewed by a qualified fire protection engineer and found to provide an equivalent level of protection.

New reactor designs should be based on providing structural barriers between redundant safe-shutdown success paths wherever feasible and should minimize the reliance on localized electrical raceway fire barrier systems, as described in Regulatory Position 4.2.3 of this guide. This approach is in accordance with the enhanced fire protection criteria for new reactors described in Regulatory Position 8.2 of this guide.

See Regulatory Position 4.1.2 of this guide for additional guidance on the design of fire barriers relative to ~~compartmentation~~compartmentalization and separation of equipment.

4.2.1.1 **Wall, Floor, and Ceiling Assemblies~~.~~**

Wall, floor, and ceiling construction should be noncombustible. (~~s~~See Regulatory Position 4.1.1 of this guide.)~~.~~ NFPA 221, ~~"Standard~~"Standard for High-Challenge Fire Walls and Fire Barrier Walls,~~"~~" can be used as guidance for construction of fire barrier walls. Materials of construction for walls, floors, and ceilings serving as fire barriers should be rated by approving laboratories in hours of resistance to fire.

Building design should ensure that openings through fire barriers are properly protected. Openings through fire barriers that separate fire areas should be sealed or closed to provide a fire -resistance rating at least equal to that required of the barrier itself. The construction and installation techniques for penetrations through fire barriers should be qualified by fire endurance tests. (~~see Regulatory~~See Regulatory Position 4.2.1.5~~, Testing and Qualification~~ of this guide.)~~.~~

4.2.1.2 **Fire Doors~~.~~**

Building design should ensure that door openings are properly protected. These openings should be protected with fire doors that have been qualified by a fire test. The construction and installation techniques for doors and door openings through fire barriers should be ~~in accordance~~consistent with the door manufacturer's recommendations and the tested configuration.

Modifications to fire doors should be evaluated. Where a door is part of a fire area boundary, and a modification does not affect the fire rating (~~for example~~e.g., installation of security ~~"contacts"~~"contacts"), no further analysis need be performed. If the modifications could reduce the fire rating (~~for example~~e.g., installation of a vision panel), the fire rating of the door should be reassessed to ensure that it continues to provide ~~an equivalent~~a level of protection equivalent to a rated fire door.

Fire doors should be self-closing or provided with closing mechanisms and should be inspected semiannually to verify that automatic hold-open, release, and closing mechanisms and latches are operable. One of the following measures should be provided to ensure ~~they~~that the fire doors will protect the opening as required in case of fire~~.~~:

a. Fire doors should be kept closed and electrically supervised at a continuously manned location~~;~~.

b. Fire doors should be locked closed and inspected weekly to verify that the doors are in the closed position~~;~~

.

c. Fire doors should be provided with automatic hold-open and release mechanisms and inspected daily to verify that doorways are free of obstructions~~; or~~.

d. Fire doors should be kept closed and inspected daily to verify that they are in the closed position.

Areas protected by automatic total flooding gas suppression systems should have electrically supervised self-closing fire doors or should satisfy option (a) above.

Additional guidance for fire doors is provided in NFPA 80, ~~"Standard~~"Standard for Fire Doors and Fire Windows.~~"~~"

4.2.1.3 Fire Dampers~~.~~

Building design should ensure that ventilation openings are properly protected. These openings should be protected with fire dampers that have been fire tested. In addition, the construction and installation techniques for ventilation openings through fire barriers should be qualified by fire endurance tests. For ventilation ducts that penetrate or terminate at a fire wall, guidance in NFPA 90A indicates that ventilation fire dampers should be installed within the fire wall penetration for barriers with a fire rating greater than or equal to 2 hours. NFPA 90A requires that fire dampers be installed in all air transfer openings within a rated wall.

Until recently, the only industry standard governing the design, fabrication, and testing of fire dampers was ~~Underwriters Laboratories, Inc. (UL)~~UL Standard 555, ~~"Fire~~"Fire Dampers~~ and Ceiling Dampers~~.~~"~~" The standard does not evaluate whether or not fire dampers will close under ~~air flow~~airflow conditions. Therefore, the UL fire damper rating only indicates whether a fire damper in the closed position will maintain its integrity under fire conditions for a specific time period.

Fire damper testing methods that do not simulate the actual total differential pressure at the damper (i.e., visual inspection or drop testing with duct access panels open) may not show operability under ~~air flow~~airflow conditions. Fire damper surveillance testing should model ~~air flow~~airflow to ensure that the dampers will close fully when called upon to do so. This can be addressed by (1) type testing ~~"worst-case" air flow~~"worst-case" airflow conditions of plant-specific fire damper configurations, (2) testing under ~~air flow~~airflow conditions all dampers installed in required fire barriers, or (3) administratively shutting down the ventilation systems to an area upon confirmation of a fire. The ~~last approach should be incorporated into~~ plant emergency procedures should incorporate the latter approach.

4.2.1.4 Penetration Seals~~.~~

Openings through fire barriers for pipe, conduit, and cable trays that separate fire areas should be sealed or closed to provide a fire~~-~~-resistance rating at least equal to that required of the barrier itself. Openings inside conduit larger than 102 mm (4 ~~inches~~in.) in diameter should be sealed at the fire barrier penetration. Openings inside conduit 102 mm (~~4 inches~~4 in.) or less in diameter should be sealed at the fire barrier unless the conduit extends at least 1.5 m (5 f~~ee~~t) on each side of the fire barrier and is sealed either at both ends or at the fire barrier with material to prevent the passage of smoke and hot gases. Fire barrier penetrations that maintain environmental isolation or pressure differentials should be qualified by test to maintain the barrier integrity under such conditions.

Penetration seals should be installed by qualified individuals~~,~~ who are trained and ~~a~~certified by the manufacturer. Appropriate ~~quality assurance/quality control~~QA/QC methods should be in force during installation. As part of the installation process, penetration seals should be specifically labeled and documented then inspected to ensure that the seal does not contain voids, gaps, and ~~splits~~has been installed in accordance with its design.

4.2.1.5 Testing and Qualification

a. Structural ~~F~~fire ~~Barriers~~

~~The~~barriers—The design adequacy of fire barrier walls, floors, ceilings, and enclosures should be verified by fire endurance testing. The NRC fire protection guidance refers to the guidance of NFPA 251 and ASTM E-119, ~~"Standard~~"Standard Test Methods for Fire Tests of Building Construction and Materials,~~"~~" as acceptable test methods for demonstrating fire endurance performance. The guidance of NFPA 251 and ASTM E-119 should be consulted with regard to construction, materials, workmanship, and details such as dimensions of parts and the size of the specimens to be tested. In addition, NFPA 251 and ASTM E-119 should be consulted with regard to the placement of thermocouples on the specimen.

The following represent the fire endurance test acceptance criteria for wall, floor, ceiling, and enclosure fire barriers~~ are~~:

- i. The fire barrier design has withstood the fire endurance test without the passage of flame or the ignition of cotton waste on the unexposed side for a period of time equivalent to the fire~~-~~-resistance rating required of the barrier~~;~~.

- ii. The temperature levels recorded on the unexposed side of the fire barrier are analyzed and demonstra~~bl~~te that the maximum temperature does not exceed 139~~°~~ °C ~~[250°F]~~(250 °F) above the ambient~~; and~~

atmosphere.

iii. The fire barrier remains intact and does not allow projection of water beyond the unexposed surface during the hose stream test.

If the above criteria are met for fire barrier walls, floors, ceilings, and free--standing equipment enclosures separating safe--shutdown functions within the same fire area, the barrier is acceptable.

b. Penetration Ffire Barriers

Penetrationbarriers—Penetration fire barriers should be qualified by tests conducted by an independent testing authority in accordance with the provisions of NFPA 251 and ASTM E-119, "Standard Test Methods for Fire Tests of Building Construction and Materials."or ASTM E-119. In addition, ASTM E-814, "Standard"Standard Test Method for Fire Tests of Through-Penetration Fire Stops,"" or IEEE Standard 634, ""IEEE Standard Cable Penetration Fire Stop Qualification Test,"" could be used in the development of a standard fire test.

The acceptance criteria for the test are as follows:

i. The fire barrier design has withstood the fire endurance test without passage of flame or the ignition of cables on the unexposed side for a period of time equivalent to the fire resistance rating required of the barrier.

ii. The temperature levels recorded for the unexposed side of the fire barrier are analyzed and demonstrate that the maximum temperature does not exceed 181 °C (325 °F) or 139 °C (250 °F) above the ambient temperature. Higher temperatures at through-penetrations may be permitted when justified in terms of cable insulation ignitability.

iii. The fire barrier remains intact and does not allow projection of water beyond the unexposed surface during the hose stream test. The stream should be delivered ~~through~~(1) through a 38-mm (~~1-1/2-inch~~1.5-in.) nozzle set at a discharge angle of ~~30%~~30 percent with a nozzle pressure of 517 kPa (75 psi) and a minimum discharge of 284 L/m (75 gpm) with the tip of the nozzle a maximum of 1.5 m (5 ft) from the exposed face~~;~~, or ~~the stream should be delivered~~(2) through a 38-mm (~~1-1/2-inch~~1.5-in.) nozzle set at a discharge angle of ~~15%~~15 percent with a nozzle pressure of 517 kPa (75 psi) and a minimum discharge of 284 L/m (75 gpm) with the tip of the nozzle a maximum of 3 m (10 ft) from the exposed face~~;~~, or ~~the stream should be delivered~~(3) through a 64-mm (~~2-1/2-inch~~2.5-in.) national standard playpipe equipped with 29-mm (~~1-1/8-inch~~1⅛-in.) tip, nozzle pressure of 207 kPa (30 psi), located 6.1 m (20 ft) from the exposed face.

The construction and installation techniques for door and ventilation openings and other penetrations through fire barriers should be qualified by fire endurance tests. The test specimen should be truly representative of the construction for which classification is desired as to materials, workmanship, and details such as dimensions of parts, and should be built under conditions representative of those ~~obtaining as~~ practically applied in building construction and operation. The physical properties of the materials and ingredients used in the test specimen should be determined and recorded.

In view of the large number of possible penetration seal configurations, it may not be practical to test every penetration configuration. The following section provides guidance on ~~evaluation of~~evaluating penetration seal designs against the results of limited fire test programs.

4.2.1.6 Evaluation of Penetration Seal Designs with Limited Testing

The results of fire test programs that include a limited selection of test specimens that have been specifically designed to encompass or bound the entire population of in-plant penetration seal configurations may be acceptable. In such cases, the engineering evaluation performed to justify the seal designs should consider the following~~.~~

:

a. Size of sealed ~~opening — In~~opening—In some cases, a successful fire endurance test of a particular fire barrier penetration seal configuration for a particular size opening may be used to justify the same configuration for smaller openings.

b. Penetrating ~~items — A~~items—A satisfactory test of a seal configuration that contains a particular pattern of penetrating items can be used to qualify variations on the tested pattern. Variations that are acceptable include eliminating or repositioning one or more of the penetrating items, reducing the size (cross-sectional area) of a particular penetrating item, or increasing the spacing between penetrating items. However, since penetrating items provide structural support to the seal, the free area of the seal material and the dimensions of the largest free span may also be factors that affect the fire-resistive performance of the seal assembly. The thickness of the seal material needed to obtain a particular fire rating may also be a function of the free area or the distance between the penetrating items and the outside edge of the seal assembly. In other cases, consideration of the penetrating items takes on special ~~performance~~importance because of the heat sink they provide.

c. Cable type and ~~fill — A~~fill—A satisfactory test of a seal configuration with certain electrical penetrations containing a specified fill ratio and cable type can be used to qualify similar configurations containing the same or a smaller cable fill ratio and the same cable jacket material or a less combustible jacket material. The thermal conductivity of the penetrating cables is also important.

d. Damming ~~materials — The~~materials—The fire~~-~~-resistive performance of a given seal configuration can be improved if a fire-resistant damming material covers one or both surfaces of the seal. A satisfactory test of a seal configuration without a permanent fire-resistant dam can be used to qualify the same configuration with a permanent fire-resistant dam, all other seal attributes being equal. The converse is not true.

e. Configuration ~~orientation — A~~orientation—A satisfactory test of a particular seal configuration in the horizontal orientation (with the test fire below the seal) can be used to qualify the same configuration in a vertical orientation if the symmetry of the design configurations are comparable. For example, if a non-symmetric penetration seal configuration (e.g., a seal with a damming board on the bottom~~,~~ but not on the top) is qualified for a floor-ceiling orientation with the damming board on the fire side of the test specimen, the configuration could only be qualified for a wall orientation if a damming board was installed on both sides of the seal or if the potential fire hazard is limited to the side with the damming board.

f. Material type and ~~thickness — Satisfactory~~thickness—Satisfactory testing of a particular seal configuration with a specific seal material thickness can be used to qualify the same configuration with a greater seal material thickness of the same type of seal material. The converse is not true.

g. Type ~~testing — In~~testing—In cases in which a single test of a particular seal configuration is to serve as a qualification test for the same or similar design configurations with different design parameters, the tested configuration should be the worst-case design configuration with the worst-case combination of design parameters. This would test and qualify a condition that would fail first, if failure occurs at all. Successful testing of the worst-case condition can then serve to qualify the same or similar design configurations for design parameters within the test range. It would be appropriate to conduct multiple tests to assess a range of design parameters.

~~The guidance in Regulatory Position 4.2.1 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, NUREG-1552, Supplement 1 to NUREG 1552, GL 86-10, Supplement 1 to GL 86-10, IN 83-69, IN 88-04, IN 88-56, and IN 89-52.~~

~~4.2.2~~ 4.2.2 *Structural Steel Protection*~~.~~

Structural steel forming a part of or supporting fire barriers should be protected to provide fire resistance equivalent to that required of the barrier. Where the structural steel is not protected and has a lower fire rating than the required rating of the fire barrier, the ~~configuration should be justified by a~~ fire hazards analysis ~~that shows~~should justify the configuration by demonstrating the temperature that the steel will reach during fire and the ability of the steel to carry the required loads at that temperature. The need to protect structural steel that forms a part of or supports fire barriers is consistent with sound fire protection engineering principles as delineated in NFPA codes and standards and the NFPA ~~Fire~~"Fire Protection Handbook."

Structural steel whose sole purpose is to carry dynamic loads from a seismic event need not be protected ~~solely~~ to meet fire barrier requirements, unless the failure of any structural steel member owing to a fire could result in significant degradation of the fire barrier.

~~The guidance in Regulatory Position 4.2.2 is based on CMEB 9.5-1, GL 88-33, and GL 86-10.~~

~~**4.2.3 Fire Resistive**~~

4.2.3 *Fire-Resistive Protection for Electrical Circuits*

4.2.3.1 Electrical Raceway Fire Barrier Systems~~.~~

Redundant cable systems important to safety should be separated from each other and from potential fire exposure hazards in ~~non-safety-related areas in~~ accordance with the separation means of Regulatory Position 5.5.~~a-c~~a–c of this guide. ~~For~~In areas where the separation of electrical circuits important to post-fire safe-shutdown cannot be accomplished ~~via~~by means of rated structural fire barriers, cable protection assemblies ~~have~~should be~~en~~ applied to conduit and cable trays to meet 1-hour and 3-hour separation requirements, as required. Where 1-hour fire-resistive barriers are applied, automatic fire detection and suppression should also be installed.

The design of fire barriers for horizontal and vertical cable trays should meet the requirements of ASTM ~~E119,~~E-119 including a hose stream test. ~~T~~Regulatory Position 4.3.2 of this guide discusses the acceptance criteria for raceway fire barriers~~ is discussed in Regulatory Position 4.3.2 to this guide~~.

4.2.3.2 Fire-Rated Cables~~.~~

Licensees should request an exemption or deviation, as appropriate, when relying on fire-rated cables to meet NRC requirements for protection of safe-shutdown systems or components from the ~~affects~~effects of fire. (See Regulatory Position 1.8 of this guide.)

4.2.3.3 Fire Stops for Cable Routing~~.~~

Fire stops should be installed every 6.1 m (20 f~~ee~~t) along horizontal cable routings in areas important to safety that are not protected by automatic water systems. Vertical cable routings should have fire stops installed at each floor-ceiling level. Between levels or in vertical cable chases, fire stops should be installed at the mid-height if the vertical run is 6.1 m (20 f~~ee~~t) or more, but less than 9.1 m (30 f~~ee~~t) or at 4.6-m (15-f~~oo~~t) intervals in vertical runs of 9.1 m (30 f~~ee~~t) or more unless such vertical cable routings are protected by automatic water systems directed on the cable trays. Individual fire stop designs should prevent the propagation of a fire for a minimum period of 30 minutes when tested for the largest number of cable routings and maximum cable density.

4.3 Testing and Qualification of Electrical Raceway Fire Barrier Systems

4.3.1 *Electrical Raceway Fire Barrier Systems: General Guidelines*

Fire barriers relied upon to protect post-fire shutdown-related systems and to meet the separation means ~~of~~discussed in Regulatory Position 5.~~5~~3 should have a fire rating of either 1 or 3 hours. Fire rating is defined as the endurance period of a fire barrier or structure~~; it defines~~, which relates to the period of resistance to a standard fire exposure before the first critical point in behavior is observed.

Fire endurance ratings of building construction and materials are demonstrated by testing fire barrier assemblies in accordance with the provisions of the applicable sections of NFPA 251 and ASTM E-119. Assemblies that pass specified acceptance criteria (e.g., standard time-temperature fire endurance exposure, unexposed side temperature rise, and hose stream impingement) are considered to have a specific fire--resistance rating.

The basic premise of the fire--resistance criteria is that those fire barriers that do not exceed 181º °C [325ºF](325 °F) cold--side temperature(5) and pass the hose stream test provide reasonable assurance that the shutdown capability is protected without further analyses. If the temperature criterion is exceeded, sufficient additional information is needed to perform an engineering evaluation to demonstrate that the shutdown capability is protected.

4.3.2 *Fire Endurance Test Acceptance Criteria for Electrical Raceway and Component Fire Barrier Systems for Separating Safe--Shutdown Functions Wwithin the Same Fire Area*

The fire endurance qualification test for fire barrier materials applied directly to a raceway or component is considered to be successful if all three of the following conditions are met.:

1. a. The average unexposed side temperature of the fire barrier system, as measured on the exterior surface of the raceway or component, did not exceed 139º °C [250ºF](250 °F) above its initial temperature; and

.

(NFPA 251 and ASTM E-119 allow this temperature to be determined by averaging thermocouple temperature readings. For the purposes of this criterion, the licensee may use thermocouple averaging can be used providedif similar series of thermocouples (e.g., cable tray side rail) are averaged together to determine temperature performance of the raceway fire barrier system. In addition, conditions of acceptance are placed on the temperatures measured by a single thermocouple. If any single thermocouple exceeds 30 percent of the maximum allowable temperature rise (i.e., 139º °C + 42º °C = 181º °C [(250º °F + 75º °F = 325ºF]325 °F), the test exceeded the temperature criteria limit.)

2. b. Irrespective of the unexposed side temperature rise during the fire test, if cables or components are included in the fire barrier test specimen, a visual inspection is

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5 WhenThe 181 °C (325 °F) temperature condition was established by allowing the temperature criteria are exceeded or damage occurs, component operability at the temperatures experiencedof the unexposed side of the fire barrier to rise 139 °C (250 °F) above the assumed 24 °C (75 °F) ambient air temperature, as measured by the thermocouples within the test specimen at the onset of the fire exposure during the fire test should be assessed. Fire endurance tests that are judged acceptable on the basis of a visual inspection of specific components or cables included in the test specimen may not be applied to other components or cables without a specific evaluation.

performed.[6] Cables should not show signs of degraded conditions[7] resulting from the thermal effects of the fire exposure; and

.

(When signs of thermal degradation are present, the fire barrier did not perform its intended fire-resistive function. For barriers that are not capable of performing their intended function, an engineering analysis that demonstrates that the functionality of thermally degraded cables or components was maintained and that the cables or components would have adequately performed their intended functions during and after a postulated fire exposure should be performed. A methodology for demonstrating the functionality of cables during and after a fire test exposure is provided below. The purpose of the functionality tests is to justify observed deviations in fire barrier performance. For fire barrier test specimens that are tested without cables, an engineering analysis justifying internal fire barrier temperature conditions greater than allowed can be based on a comparison of the fire barrier internal temperature profile measured during the fire endurance test to existing cable specific performance data, such as environmental qualification (EQ) tests.)

3. c. The cable tray, raceway, or component fire barrier system remained intact during the fire exposure and water hose stream test without developing any openings through which the cable tray, raceway, or component (e.g., cables) is visible. (See Regulatory Position 4.3.3 of this guide regarding acceptable hose stream test methods.)

The test specimen should be representative ofrepresent the construction for which the fire rating is desired as to materials, workmanship, and details, such as dimensions of parts, and should be built under representative conditions. Raceway fire barrier systems being subjected to qualification fire endurance tests should be representative ofrepresent their end use. For example, if it isthe licensee intendeds to install a cable tray fire barrier system in the plant without protecting the cable tray supports, the test program should duplicate these field conditions. In addition, the fire test program should encompass or bound raceway sizes and the various configurations for those fire barrier systems installed in the plant. It should be noted that sSeveral test specimens will be required in order to qualify various sizes of horizontal and

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6 Examples of thermal cable degradation are jacket swelling, splitting, cracking, blistering, melting, or discoloration; shield exposed; conductor insulation exposed, degraded, or discolored; bare copper conductor exposed. When the temperature criteria are exceeded or damage occurs, component operability at the temperatures experienced during the fire test should be assessed. Fire endurance tests that are judged acceptable on the basis of a visual inspection of specific components or cables included in the test specimen may not be applied to other components or cables without a specific evaluation.

7 For the thermocouples installed on conduits, cable tray side rails,Examples of thermal cable degradation are jacket swelling, splitting, cracking, blistering, melting, or discoloration; shield exposed; conductor insulation exposed, degraded, or discolored; and bare copper conductors, a ±13 mm [± ½ inch] installation tolerance is acceptable.conductor exposed.

vertical runs of cable trays and conduits, junction boxes and pull boxes, ~~etc~~and similar configurations. The cable tray or raceway design used for the tests should be constructed with materials and configurations representative of in-plant conditions (e.g., the mass associated with typical steel conduits and cable trays, representative internal and external penetration seals). If cables are included in the raceway fire barrier test specimen, these cables should ~~be representative of~~represent the installed plant-specific cables.

Measuring cable temperatures is not a reliable means for determining excessive temperature conditions that may occur at any point along the length of the cable during the fire test. In lieu of measuring the unexposed surface temperature of the fire barrier test specimen, methods that will measure the surface temperature of the raceway (e.g., exterior of the conduit, side rails of cable trays, bottom and top of cable tray surfaces, junction box external surfaces) can be considered ~~as~~ equivalent if the raceway components used to construct the fire test specimen represent plant-specific components and configurations. The metal surfaces of the raceway, under fire test conditions, exhibit good thermal conductivity properties. Temperatures measured on these surfaces provide an indication of the actual temperature rise within the fire barrier system.

In 1979, American Nuclear Insurers (ANI) issued a fire endurance test method for raceway fire barrier systems for insurance purposes. This method~~, "Fire Endurance Protective Envelope Systems for Class 1E Electrical Circuits" (ANI Test),~~ specified that cable temperatures be monitored by thermocouples. Since cable jackets have a low thermal conductivity, the actual local temperatures of the cable jackets' indications of barrier failure and internal fire barrier temperature rise conditions during the fire exposure are masked. Monitoring cable temperatures can give indications of low internal fire barrier temperature conditions during the fire endurance test. Using this temperature monitoring approach, cable damage can occur without indication of excessive temperatures on the cables. This, linked with no loss of circuit integrity, ~~would give indications of~~indicates a successful test. The staff considers monitoring the cable temperature as the primary means of determining cable tray or raceway fire barrier performance to be nonconservative. Therefore, the staff has incorporated the provision for a post-fire visual inspection of cables that are installed in fire barrier test specimens. As discussed above, temperatures monitored on the exterior surface of the raceway provide a more representative indication of fire barrier performance.

Fire endurance tests of raceway fire barrier systems ~~should~~may be performed with or without cables in the raceway. ~~This method is preferred because by e~~Excluding cables from the test specimen ~~it~~ eliminates bias in the test results created by the thermal mass of the cables and is the NRC-preferred method. Without th~~is~~e thermal mass of the cables, the internal temperature conditions measured by the test specimen thermocouples during the fire exposure will provide a more accurate determination of fire barrier thermal performance. The following sections provide guidance for both approaches.

4.3.2.1~~—~~ Thermocouple ~~Placement — Test~~Placement—Test Specimens Containing Cables.~~—~~

The following are acceptable placements of thermocouples for determining the thermal performance of raceway or cable tray fire barrier systems that contain cables during ~~the~~ fire exposure~~.~~:

a. ~~**Conduits — The**~~Conduits—The temperature rise on the unexposed surface of a fire barrier system installed on a conduit should be measured by placing the thermocouples every 152 mm ~~[~~(6 ~~inches]~~in.)[8] on the exterior conduit surface underneath the fire barrier material. The thermocouples should be attached to the exterior conduit surface located opposite the test deck and closest to the furnace fire source. Thermocouples should also be placed immediately adjacent to all structural members, supports, and barrier penetrations.

b. Cable trays—The temperature rise on the unexposed surface of a fire barrier system installed on a cable tray should be measured by placing the thermocouples on the exterior surface of the tray side rails between the cable tray side rail and the fire barrier material. In addition to placing thermocouples on the side rails, thermocouples should be attached to two AWG 8-stranded bare copper conductors. The first copper conductor should be installed on the bottom of the cable tray rungs along the entire length and down the longitudinal center of the cable tray run. The second conductor should be installed along the outer top surface of the cables closest to the top and toward the center of the fire barrier. Thermocouples should be placed every 152 mm (6 in.) down the longitudinal center along the outside surface of the cable tray side rails and along the bare copper conductors. Thermocouples should also be placed immediately adjacent to all structural members, supports, and barrier penetrations.

~~**b. Cable Trays —**~~c. Junction boxes—The temperature rise on the unexposed surface of a fire barrier system installed on junction boxes should be measured by placing thermocouples on either the inside or the outside of each junction box surface. Each junction box surface or face should have a minimum of one thermocouple, located at its geometric center. In addition, one thermocouple should be installed for every 0.9 m^2 (1 ft^2) of junction box surface area. These thermocouples should be located at the geometric centers of the 0.9-m^2 (1-ft^2) areas. At least one thermocouple should also be placed within 25 mm (1 in.) of each penetration connector/interface.

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8 ~~The review guidance for Megger and Hi-Pot test voltages was derived from IEEE 383-1974 and IEEE 690-1984.~~For the thermocouples installed on conduits, cable tray side rails, and bare copper conductors, a +13 mm [+ 0.5 in.] installation tolerance is acceptable.

d. Airdrops—The internal airdrop temperatures should be measured by thermocouples placed every 305 mm (12 in.) on the cables routed within the airdrop and by a stranded AWG 8 bare copper conductor routed inside and along the entire length of the airdrop system with thermocouples installed every 152 mm (6 in.) along the length of the copper conductor. The copper conductor should be in close proximity to the unexposed surface of the fire barrier material. Thermocouples should also be placed immediately adjacent to all supports and barrier penetrations.

4.3.2.2 Thermocouple Placement—Test Specimens without Cables

The following are acceptable thermocouple placements for determining the thermal performance of raceway or cable tray fire barrier systems that do not contain cables.

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a. ~~**Conduits** — The~~ Conduits—The temperature rise of the unexposed surface of a fire barrier system installed on a conduit should be measured by placing thermocouples every 152 mm ~~[~~(6 ~~inches]~~in.) on the exterior conduit surface between the conduit and the unexposed surface of the fire barrier material. These thermocouples should be attached to the exterior conduit surface opposite the test deck and closest to the furnace fire source. The internal raceway temperatures should be measured by a stranded AWG 8 bare copper conductor routed through the entire length of the conduit system with thermocouples installed every 152 mm ~~[~~(6 ~~inches]~~in.) along the length of the copper conductor. Thermocouples should also be placed immediately adjacent to all structural members, supports, and barrier penetrations.

b. Cable trays—TheEnd Of Moved Text

~~The~~ temperature rise on the unexposed surface of a fire barrier system installed on a cable tray should be measured by placing ~~the~~ thermocouples every 152 mm (6 in.) on the exterior surface of ~~the~~each tray's side rails between the ~~cable tray~~ side rail and the fire barrier material. ~~In addition to placing thermocouples on the side rails, thermocouples should be attached to two AWG 8 stranded~~Internal raceway temperatures should be measured by a stranded AWG 8 bare copper conductor~~s. The first copper conductor should be installed~~ routed on the ~~bottom~~top of the cable tray rungs along the entire length and down the longitudinal center of the cable tray run~~. The second conductor should be installed along the outer top surface of the cables closest to the top and toward the center of the fire barrier~~ with thermocouples installed every 152 mm (6 in.) along the length of the copper conductor. Thermocouples should ~~be placed every 152 mm (6 inches) down the longitudinal center along the outside surface of the cable tray side rails and along the bare copper conductors. Thermocouples should also~~ be placed immediately adjacent to all structural members, supports, and barrier penetrations.

c. Junction ~~Boxes (JBs) — The~~boxes—The temperature rise on the unexposed surface of a fire barrier system installed on junction boxes should be measured by placing thermocouples on either the inside or the outside of each ~~JB~~junction box surface. Each ~~JB~~junction box surface or face should have a minimum of one thermocouple, located at its geometric center. In addition, one thermocouple should be installed for every ~~one square foot~~0.9 m^2 (1 ft^2) of ~~JB~~junction box surface area. These thermocouples should be located at the geometric centers of the ~~one square foot~~0.9-m^2 (1-ft^2) areas. At least one thermocouple should also be placed within 25 mm (1 in~~ch~~.) of each penetration connector/interface.

d. ~~Airdrops — The~~Airdrops—The internal airdrop temperatures should be measured ~~by thermocouples placed every 305 mm (12 inches) on the cables routed within the air drop and~~ by a stranded AWG 8 bare copper conductor routed inside and along the entire length of the airdrop system with thermocouples installed every 152 mm (6 ~~inches~~in.) along the length of the copper conductor. The copper conductor should be in close proximity ~~with~~to the unexposed surface of the fire barrier material. Thermocouples should also be placed immediately adjacent to all supports and ~~barrier~~ penetrations.

~~**4.3.2.2 Thermocouple Placement -- Test Specimens Without Cables**. The following are acceptable thermocouple placements for determining the thermal performance of raceway or cable tray fire barrier systems that do not contain cables.~~

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~~**b. Cable Trays** — The temperature rise on the unexposed surface of a fire barrier system installed on a cable tray should be measured by placing thermocouples every 152 mm [6 inches] on the exterior surface of each tray side rails between the side rail and the fire barrier material. Internal raceway temperatures should be measured by a stranded AWG 8 bare copper conductor routed on the top of the cable tray rungs along the entire length and down the longitudinal center of the cable tray run with thermocouples installed every 152 mm [6 inches] along the length of the copper conductor. Thermocouples should be placed immediately adjacent to all structural members, supports, and barrier penetrations.~~

~~**c. Junction Boxes** — The temperature rise on the unexposed surface of a fire barrier system installed on junction boxes (JBs) should be measured by placing thermocouples on either the inside or the outside of each JB surface. Each JB surface or face should have a minimum of one thermocouple, located at its geometric center. In addition, one thermocouple should be installed for every one square foot of JB surface area. These thermocouples should be located at the geometric centers of the one square foot areas. At least one thermocouple should also be placed within 25 mm [1 inch] of each penetration connector/interface.~~

~~**d. Airdrops** — The internal airdrop temperatures should be measured by a stranded AWG 8 bare copper conductor routed inside and along the entire length of the airdrop system with thermocouples installed every 152 mm [6 inches] along the length of the copper conductor. The copper conductor should be in close proximity with the unexposed surface of the fire barrier material. Thermocouples should also be placed immediately adjacent to all supports and penetrations.~~

4.3.2.3 Criteria for Averaging Temperatures

Temperature conditions on the unexposed surfaces of the fire barrier material during the fire test will be determined by averaging the temperatures measured by the thermocouples installed in or on the raceway. ~~In determining~~ To determine these temperature conditions, the thermocouples measuring similar areas of the fire barrier should be averaged together.

Acceptance will be based on the individual averages. The following methods of averaging should be followed.

a. ~~**Conduits** — The~~ Conduits—The thermocouples applied to the outside metal surface of the conduit should be averaged together.

b. Cable ~~Trays — The~~trays—The thermocouples on each cable tray side rail should be averaged separately. For example, thermocouples placed on one side rail will be averaged separately from the other side rail. In addition, the temperature conditions measured by thermocouples on the bare copper conductor should be averaged separately from the side rails.

c. Junction ~~Boxes — For JBs~~boxes—For junction boxes that have only one thermocouple on each ~~JB~~junction box surface, the individual ~~JB~~junction box surface thermocouples should be averaged together. For ~~JBs~~junction boxes that have more than one thermocouple on each ~~JB~~junction box surface, the thermocouples on the individual ~~JB~~junction box surfaces should be averaged together.

d. ~~**Airdrops** — The~~ Airdrops—The thermocouples placed on the copper conductor within the airdrop fire barrier should be averaged together.

The average of any thermocouple group should not exceed 139~~º~~ °C ~~[250ºF]~~(250 °F) above the unexposed side temperature within the fire barrier test specimen at the onset of the fire endurance test. In addition, the temperature of each individual thermocouple will be evaluated. Individual thermocouple conditions should not exceed the 139~~º~~ °C ~~[250ºF]~~(250 °F) temperature rise by more than 30 percent ~~(~~[i.e., 181~~º~~ °C ~~[375ºF~~(325 °F)]~~)~~.

If a fire barrier test specimen without cables does not meet the average or maximum single point temperature criteria, the internal raceway temperature profile as measured by the instrumented bare copper conductors during the fire exposure can be used to assess cable functionality through air oven tests of plant-specific cable types and construction, as discussed below.

4.3.3 *Hose Stream Tests*

NFPA 251 and ASTM E-119 allow flexibility in hose stream testing. The standards allow the hose stream test to be performed on a duplicate test specimen subjected to a fire endurance test for a period equal to one-half of that indicated as the fire-resistance rating, but not for more than 1 hour (e.g., ~~30-minute~~ 30-minute fire exposure to qualify a 1-hour fire-rated barrier).

For safe~~-~~-shutdown-related fire barrier systems and duplicate electrical cable tray or raceway and component fire barrier test specimens that have been exposed to the ~~½-duration~~one-half-duration test fire exposure, the staff finds the hose stream application specified by NFPA 251 to be acceptable. NFPA 251 requires the stream of water to be delivered through a 64-mm ~~[2½-inch]~~(2.5-in.) hose discharging through a standard 29-mm ~~[1½-inch]~~(1.5-in.) playpipe nozzle onto the test specimen after the fire exposure test. The stream is applied with the nozzle orifice positioned 6.1 meters ~~[~~(20 ~~feet]~~ft) away from the center of the test specimen at a pressure of 207~~-~~ kPa ~~[~~(30 psi~~]~~). The application of the stream is to all exposed parts of the specimen for a duration of at least 1 minute for a 1-hour barrier and 2~~½~~.5 minutes for a 3-hour barrier.

As an alternative ~~for~~to electrical raceway fire barrier test specimens, the application of the hose stream test can be performed immediately after the completion of the full fire endurance test period. If~~-~~ this method is used to satisfy the hose stream test criteria, any one of the following hose stream applications is acceptable~~.~~:

a. The stream applied at random to all exposed surfaces of the test specimen through a 64-mm ~~[2½-inch]~~(2.5-in.) national standard playpipe with a 29-mm ~~[~~(1~~½- inch]~~.5-in.) orifice at a pressure of 207 kPa ~~[~~(30~~-~~ psi~~]~~) at a distance of 6.1 meters ~~[~~(20 ~~feet]~~ft) from the specimen. (Durations of the hose stream applications ~~—~~= 1 minute for a 1-hour barrier and 2~~½~~.5 minutes for a 3-hour barrier.) ~~or~~

b. The stream applied at random to all exposed surfaces of the test specimen through a 38-mm ~~[1½-inch]~~(1.5-in.) fog nozzle set at a discharge angle of 30 degrees with a nozzle pressure of 517 kPa ~~[~~(75~~-~~ psi~~]~~) and a minimum discharge of 284 ~~lpm [~~L/m (75 gpm~~]~~) with the tip of the nozzle at a maximum of 1.5 meters ~~[~~(5 ~~feet]~~ft) from the test specimen. (Duration of the hose stream application ~~—~~= 5 minutes for both 1-hour and 3-hour barriers.) ~~or~~

c. The stream applied at random to all exposed surfaces of the test specimen through a 38-mm ~~[1½-inch]~~(1.5-in.) fog nozzle set at a discharge angle of 15 degrees with a nozzle pressure of 517 kPa ~~[~~(75~~-~~ psi~~]~~) and a minimum discharge of 284 ~~lpm [~~L/m (75 gpm~~]~~) with the tip of the nozzle at a maximum of 3 ~~meters [~~m (10 ~~feet]~~ft) from the test specimen. (Duration of the hose stream application ~~—~~= 5 minutes for both 1-hour and 3-hour barriers.)

4.3.4 *Demonstrating Functionality of Cables Protected by Raceway Fire Barrier Systems ~~D~~during and ~~A~~after Fire Endurance Test Exposure*

During fire tests of raceway fire barrier systems, thermal damage to the cables has led to cable jacket and insulation degradation without the loss of circuit integrity as monitored using ANI criteria ~~(~~[applied voltage of ~~8 to 10 volts~~ 8–10V direct current (dc)]. Since cable voltages used for ANI circuit integrity tests do~~-~~ not replicate cable operating voltages, loss of cable insulation conditions can exist during the fire test without a dead short occurring. It is expected that if the cables were at rated power and current, a fault would propagate. The use of circuit integrity monitoring during the fire endurance test is not a valid method for demonstrating that the protected shutdown circuits are capable of performing their required function during and after the test fire exposure. Therefore, the NRC does not require circuit integrity monitoring using the ANI criteria ~~is not required~~ to satisfy ~~NRC~~its acceptance criteria for fire barrier qualification. The following approaches are acceptable for ~~evaluation of~~evaluating cable functionality.

4.3.4.1 Use of Environmental Qualification Data~~.~~

Comparison of the fire barrier internal time-temperature profile measured during the fire endurance test to existing cable performance data, such as data from ~~environmental qualification (~~EQ~~)~~ tests, could be proposed to the staff as a method for demonstrating cable functionality. EQ testing is typically performed to rigorous conditions, including rated voltage and current. By correlating the EQ test time-temperature profile to the fire test time-temperature profile, the EQ test data would provide a viable mechanism to ensure cable functionality. A large body of EQ test data for many cable types exists today. The use of EQ data represents a cost-effective approach for addressing cable functionality for fire tests for those cases ~~where~~in which the 181 °C ~~[325°F]~~(325 °F) limit is exceeded. A comparison of fire test temperature profiles to existing EQ and loss-of-coolant accident (LOCA) test results or air oven test results is an acceptable approach to ~~demonstrate~~demonstrating cable functionality provided that the subject analysis incorporates the anticipated temperature rise ~~that is due to~~caused by the self heating effects of installed power cables with the fire test results.

4.3.4.2 Cable Insulation Tests~~.~~

The nuclear industry uses two principal materials ~~used~~ as cable insulation and cable jackets ~~by the nuclear industry are~~, thermoplastics and thermosetting polymeric materials. A thermoplastic material can be softened and re-softened by heating and reheating. Conversely, thermosetting cable insulation materials cure by chemical reaction and do not soften when heated. Under excessive heating, thermosetting insulation becomes stiff and brittle. Electrical faults may be caused by softening and flowing of thermoplastic insulating materials at temperatures as low as 149 °C ~~[300°F]~~(300 °F). Thermosetting electrical conductor insulation materials usually retain their electrical properties under short-term exposures to temperatures as high as 260 °C ~~[500°F]~~(500 °F). Insulation resistance (Megger) tests provide indications of the condition of the cable insulation resistance, whereas the high-potential (Hi-Pot) test provides assurance that the cable has sufficient dielectric strength to withstand the applied rated voltage. A cable insulation failure usually results from two breakdown modes~~:~~. One failure mode is excessive dielectric loss ~~that is due to~~resulting from low insulation resistance, and the other failure mode is overpotential stress ~~that is due to~~caused by loss of dielectric strength of the insulation material.

To provide reasonable assurance that the cables would have functioned during and after the fire exposure, Megger tests need to be performed before the fire test, at multiple time intervals during the fire exposure (i.e., every 20 minutes during the 1-hour fire test and every hour during the 3-hour fire test) for instrumentation cables only~~,~~ and immediately after the fire endurance test to assess the cable insulation resistance levels. This testing will ~~assure~~ensure that the cables will maintain the insulation resistance levels necessary for proper operation of instruments.

The Megger tests ~~(~~[pre~~-~~fire, during the fire ~~[~~(if performed~~]~~), and immediately after the fire test conditions~~)~~] should be done conductor-to-conductor for multi~~-~~conductor and conductor-to-ground for all cables. The minimum acceptable insulation resistance (IR) value, using the test voltage values as shown in the table below, is determined by using the following expression:

IR (Mega-ohms) = {[K+1 Mega-ohm] * 1000 (ft)~~-~~} ~~/ Length~~/Length (ft)

Where K = 1 Mega-ohm/KV * Operating Voltage (expressed in KV)

In addition, to determine the ~~insulation resistance~~IR levels required for nuclear instrumentation cables, an assessment of the minimum ~~insulation resistance~~IR value (e.g., one mega-ohm) and its potential impact on the functionality of these cables should be evaluated. An ac or dc ~~high potential (~~Hi-Pot~~)~~ test for power cables greater than 1000 ~~volts (~~V~~)~~ should also be performed after the post~~-~~-fire Megger tests to assess the dielectric strength. This test provides assurance that the cable will withstand the applied voltage during and after a fire. The ~~high potential~~Hi-Pot test should be performed for a 5~~-~~-minute duration at 60 percent of either 80 V/mil ac or 240 V/mil dc (e.g., 125 mil conductor insulation thickness x 240 V/mil dc x 0.6 = 18,000 V dc).

~~The table below~~Table 1 summarizes the Megger and Hi-Pot test voltages[9] that, when applied to power, control, and instrumentation cables, would constitute an acceptable cable functionality test.

Table 1. Functionality Test Voltages

9 ~~A Megger test voltage of 1000 V dc is acceptable provided a Hi-Pot test is performed after the Megger test for power cables rated at less than 1000 V ac.~~The review guidance for Megger and Hi-Pot test voltages was derived from IEEE 383 and IEEE 690, "IEEE Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations."

TYPE OPERATING VOLTAGE   MEGGER TEST VOLTAGE   HIGH-POTENTIAL TEST VOLTAGE

Power   >1000 V ac   2500 V dc   60% x 80 V/mil (ac) 60% x 240 V/mil (dc)

Power   ~~<1000~~<1,000 V ac   ~~1500~~1,500 V dc[10]   None

Instrument and Control   <250 V dc

<120 V ac   500 V dc   None

The electrical cable functionality tests recommended above are one acceptable method~~. Alternative methods~~ to assess degradation of cable functionality. The NRC staff will ~~be evaluated~~ evaluate alternative methods on a case-by-case basis. The above table ~~summarizing~~summarizes the "typical" Megger and Hi-Pot test voltages ~~are "typical"~~, and the applicant can follow the applicable industry standards and manufacturer's recommendations for the specific cable application in the performance of the ~~insulation resistance~~IR and Hi-Pot tests.

4.3.4.3 Air Oven Tests.

Air oven tests can ~~be used to~~ evaluate the functionality of cables for those cable tray or raceway fire barrier test specimens tested without cables. This testing method consists of exposing insulated wires and cables at rated voltage to elevated temperatures in a circulating air oven. The temperature profile for regulating the temperature in the air oven during this test is the temperature measured by the AWG 8 bare copper conductor during the fire exposure of those cable tray or raceway test specimens that were tested without cables.

The test method described by UL Subject 1724, "Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems," Issue Number 2, August 1991, Appendix B, "Qualification Test for Circuit Integrity of Insulated Electrical Wires and Cables in Electrical Circuit Protection Systems," is acceptable, with the following modifications:

a. During the air oven test the cables are to be energized at rated voltage. The cables are to be monitored for conductor-to-conductor faults in multi-conductor cables and conductor-to-ground faults in all conductors.

b. The cables being evaluated should be subjected to the Megger and ~~high potential~~Hi-Pot tests, previously recommended ~~above~~ in Regulatory Position 4.3.4.2~~, "Cable Insulation Tests."~~.

~~c.~~

10 A Megger test voltage of 1,000 V dc is acceptable provided a Hi-Pot test is performed after the Megger test for power cables rated at less than 1,000 V ac.

c. The impact force test, which simulates the force of impact imposed on the raceway by the solid stream test, described in UL 1724, Appendix B, paragraph B3.16, ~~is~~does not ~~required~~need to be performed.

4.3.4.4 Cable Thermal Exposure Threshold~~.~~

The following analysis, which is based on determining whether a specific insulation material will maintain electrical integrity and operability within a raceway fire barrier system during and after an external fire exposure, is an acceptable method for evaluating cable functionality. ~~In order t~~To determine cable functionality, it is necessary to consider the operating cable temperatures within the fire barrier system at the onset of the fire exposure and the thermal exposure threshold (TET) temperature of the cable. For example, if the TET of a specific thermoplastic cable insulation (Brand X) is 149~~º~~ °C ~~[300°F]~~(300 °F) and the normal operating temperature within the fire barrier system is 66~~º~~ °C ~~[150°F]~~(150 °F), the maximum temperature rise within the fire barrier system should not exceed 83~~º~~ °C ~~[150°F]~~(150 °F) during exposure to an external fire of a duration equal to the required fire~~ ~~-resistance rating of the barrier. For this example, the TET limit for Brand X cable is 83~~º~~ °C ~~[150°F]~~(150 °F) above the cable operating temperatures within the fire barrier system at the onset of the external fire exposure. The cable TET limits in conjunction with a post~~-~~test visual cable inspection and the Hi-Pot test described above should readily demonstrate the functionality of the cable circuit during and after a fire.

The normal cable operating temperature can be determined by loading cable specimens installed within a thermal barrier system in the test configuration with rated voltage and current. The TET temperature limits for most cable insulation may be obtained from the manufacturer~~'~~'s published data, which ~~is~~are given as the short-circuit rating limit. With the known TET and normal operating temperature for each thermal barrier system configuration, the maximum temperature rise limit within a fire barrier system may then be determined.

~~The guidance in Regulatory Position 4.3.4 is based on Appendix R to 10 CFR Part 50, APCSB 9.5-1, ASB 9.5-1, CMEB 9.5-1, GL 86-10, and Supplement 1 to GL 86-10.~~

~~**4.3.5 Cable Qualification**~~

~~Electric cable construction should, as a minimum, pass the flame test in IEEE Standard 383 or IEEE Standard 1202. (This does not imply that cables passing either test will not require additional fire protection.) For cable installations in operating plants and plants under construction prior to July 1, 1976, that do not meet the IEEE 383 flame test requirements, the cables should be covered with an approved flame retardant coating and properly derated.~~

~~Non-qualified cable that is not covered with an approved flame retardant coating should be protected with an automatic fire suppression system.~~

~~**5. SAFE SHUTDOWN CAPABILITY**~~

5. Safe-Shutdown Capability

When considering the consequences of a fire in a given fire area during the evaluation of safe~~-~~-shutdown capabilities of the plant, it should be demonstrated that one success path of equipment and electrical circuits that can be used to bring the reactor to hot ~~shutdown conditions in the case of BWRs, or hot standby in the case of PWRs, remains unaffected by the fire~~shutdown/standby conditions, remains free of fire damage. It should also be demonstrated that fire damage to one success path of equipment needed for achieving cold shutdown will be limited so that equipment will be returned to an operating condition within 72 hours, or for areas requiring alternate, dedicated, or backup shutdown, the licensee should demonstrate that cold shutdown capability can be restored and cold shutdown achieved within 72 hours.

~~One of the objectives of the fire protection program is to demonstrate that one success path of systems necessary to achieve and maintain hot shutdown (e.g., hot standby for a PWR, hot shutdown for a BWR) are maintained free of fire damage. The~~ For reactor designs that cannot safely remain in hot standby/shutdown for 72 hours, it should be demonstrated that a cold shutdown condition can be achieved and maintained within the required period of time.

For existing reactor plants, the success path of safe~~-~~-shutdown systems should be capable of meeting Regulatory Positions 5.1 ~~and~~or 5.2 of this guide and performing the necessary shutdown functions. The capability of the required shutdown functions should be based on a previous analysis, if possible (e.g., those analyses in the FSAR). The equipment required for alternative or dedicated shutdown should have the same or equivalent capability as that relied on in the above-referenced ~~analysis.~~

~~5.1 Safe Shutdown~~analyses.

The FPP should include an analysis to demonstrate that the SSCs important to safety can accomplish their respective post-fire safe-shutdown functions. The safe-shutdown analysis should demonstrate that redundant safe-shutdown systems and components, including electrical circuits for which fire-induced failure could directly or indirectly prevent safe shutdown, are adequately protected such that one success path remains free of fire damage in the event of postulated fires. This protection should be provided by fire barriers, physical separation with no intervening combustibles, and/or automatic detection and suppression, as required by applicable regulations. Where one redundant success path cannot be adequately protected, an alternative or dedicated shutdown success path should be identified and protected to the extent necessary to ensure post-fire safe-shutdown.

The safe-shutdown analysis for new reactor designs must demonstrate that safe shutdown can be achieved assuming that all equipment in any one fire area (except for the control room and containment) will be rendered inoperable by fire and that reentry into the fire area for repairs and operator actions is not possible. (See Regulatory Position 8.2 of this guide.) Consequently, new reactors should not credit physical separation or local fire barriers (e.g., electrical raceway fire barrier systems) within these fire areas as providing adequate protection. The control room is excluded from this approach, provided the design includes an independent alternative shutdown capability that is physically and electrically independent of the control room. New reactors must provide fire protection for redundant shutdown systems in the reactor containment building that will ensure, to the extent practicable, that at least one post-fire shutdown success path will be free of fire damage.

The safe-shutdown analysis should evaluate a fire in each fire area containing SSCs important to safety and identify a post-fire safe-shutdown success path (i.e., all trains or systems that are required to remain free of fire damage to perform the necessary safe-shutdown functions). The analysis also identifies all fire-induced circuit failures that could directly or indirectly (e.g., by causing a spurious actuation) prevent safe shutdown.

5.1 Post-Fire Safe-Shutdown Performance Goals ~~for Redundant Systems~~

~~**Ensure that fuel integrity is maintained and that there are no adverse consequences on the reactor pressure vessel integrity or the attached piping. Fuel integrity is maintained provided the fuel design limits are not exceeded.**~~

~~**The guidance in Regulatory Position 5.1 is based on the Richards Letter (2000).**~~

~~**5.2 Alternative or Dedicated Shutdown Design and Performance Goals**~~

~~**5.2.1 Alternative or Dedicated Safe Shutdown System Design Goals**~~
~~**During the**~~

During post-fire shutdown, the reactor coolant system process variables ~~should~~must be maintained within those predicted for a loss of normal ac power, and the fission product boundary integrity ~~should~~shall not be affected~~;~~, i.e., there ~~should~~shall be no fuel clad damage, rupture of any primary coolant boundary, or rupture of the containment boundary.

~~The systems used for alternative or dedicated~~ Licensees should ensure that fire protection features are provided for structures, systems, and components important to safe shutdown that are capable of limiting fire damage so that one success path of systems necessary to achieve and maintain hot shutdown conditions from either the control room or emergency control station(s) is free of fire damage.

As noted in IN 84-09, "Lessons Learned from NRC Inspections of Fire Protection Safe-Shutdown Systems (10 CFR Part 50, Appendix R)," the post-fire safe-shutdown performance goals are the same for both redundant success paths and alternative/dedicated shutdown ~~need not be designed to (1) seismic Category I criteria, (2) single failure criteria, or (3) other design basis accident criteria, except the portions of these systems that interface with or impact existing safety systems.~~

~~**5.2.2 Safe Shutdown Performance Goals for Alternative or Dedicated Systems**~~

~~The~~ systems. Section III.L of Appendix R provides the following specific performance goals ~~for~~to achieve the ~~shutdown functions should be~~post-fire safe-shutdown goals:

a. The reactivity control function should be capable of achieving and maintaining cold shutdown reactivity conditions.

b. The reactor coolant makeup function should be capable of maintaining the reactor coolant level above the top of the core for boiling-water reactors (BWRs) and within the level indication of the pressurizer for pressurized-water reactors (PWRs).

c. The reactor heat removal function should be capable of achieving and maintaining decay heat removal.

d. The process monitoring function should be capable of providing direct readings of the process variables necessary to perform and control the above functions.

e. The supporting functions should be capable of providing the process cooling, lubrication, ~~etc.,~~and other activities necessary to permit the operation of the equipment used for safe-shutdown functions.

~~The guidance for Regulatory Position 5.2 is in Appendix R to 10 CFR Part 50 and CMEB 9.5-1.~~

~~**5.3 Hot Standby (PWR) Hot Shutdown (BWR) Systems and Instrumentation**~~

~~One success path of equipment necessary to achieve hot standby (PWR) or hot shutdown (BWR) from either the control room or emergency control stations should be maintained free of fire damage by a single fire, including an exposure fire. Manual operation of valves, switches, and circuit breakers is allowed to operate equipment and isolate systems and is not considered a repair. Damage considerations should also include damage to equipment from the normal or inadvertent operation of fire suppression systems.~~

~~Recovery actions are allowed to systems and components not used for hot shutdown, but whose fire or fire suppressant-induced maloperations may adversely affect hot shutdown capability. These recovery actions should be achievable prior to the maloperations causing an unrecoverable plant condition.~~

~~**5.3.1 PWR Systems and Instrumentation**~~
~~In accordance with GL 81-12,~~

GL 81-12 describes the systems and instrumentation ~~with the following capabilities~~that are generally necessary for achieving ~~hot standby of PWRs.~~

~~**5.3.1.1 Reactivity Control**. Reactor trip capability (scram) and boration capability (e.g., charging pump, makeup pump or high-pressure injection pump taking suction from concentrated borated water supplies, as well as letdown system if required).~~

5.3.1.2 **Reactor Coolant Makeup**. Reactor coolant makeup capability, e.g., charging pumps or the high-pressure injection pumps. Power-operated relief valves may be required to reduce pressure to allow use of the high-pressure injection pumps.

5.3.1.3 **Reactor Coolant System Pressure Control**. Reactor pressure control capability, e.g., charging pumps or pressurizer heaters and use of the letdown systems if required.

5.3.1.4 **Decay Heat Removal**. Decay heat removal capability, e.g., power-operated relief valves (steam generator) or safety relief valves for heat removal with a water supply and emergency or auxiliary feedwater pumps for makeup to the steam generator. Service water or other pumps may be required to provide water for auxiliary feed pump suction if the condensate storage tank capacity is not adequate for 72 hours.

5.3.1.5 **Process Monitoring Instrumentation**. The following instrumentation is considered necessary to achieve hot standby for PWRs.

- Pressurizer pressure and level
- Reactor coolant cold leg temperature and core exit thermocouples or hot leg temperature
- Steam generator pressure and wide-range level
- Source-range flux monitor
- Diagnostic instrumentation for shutdown systems
- Level indication for all tanks used (e.g., CST).

5.3.1.6 **Support**. The equipment required to support operation of the above described shutdown equipment, e.g., instrument air, component cooling water, service water, and onsite power sources (ac, dc), and associated electrical distribution systems.

5.3.2 BWR Systems and Instrumentation

In accordance with GL 81-12,post-fire safe-shutdown for existing PWRs and BWRs. The systems and instrumentation with the following capabilities are generally necessary for achieving hot shutdown of BWRs.

5.3.2.1 **Reactivity Control.**. Reactor trip capability (scram).

5.3.2.2 **Reactor Coolant Makeup.** Reactor coolant inventory makeup capability, e.g., reactor core isolation cooling system (RCIC), the high-pressure coolant injection system (HPCI), low pressure coolant injection (LPCI), and core spray.

5.3.2.3 **Reactor Pressure Control and Decay Heat Removal.** Depressurization system valves or safety relief valves for venting to the suppression pool. The residual heat removal system in steam condensing mode and the service water system may also be used for heat removal to the ultimate heat sink.

5.3.2.4 **Suppression Pool Cooling.** Residual heat removal system (in suppression pool cooling mode) service water system to maintain hot shutdown.

5.3.2.5 **Process Monitoring.** The following instrumentation is considered necessary to achieve hot shutdown for BWRs.

- Reactor water level and pressure,
- Suppression pool level and temperature,
- Emergency or isolation condenser level,
- Diagnostic instrumentation for shutdown systems,
- Level indication for all tanks used.

5.3.2.6 **Support.** The equipment required to support operation of the above described shutdown equipment, e.g., instrument air, closed loop cooling water, service water, and onsite power sources (ac and dc), and associated electrical distribution systems.

The guidance in Regulatory Position 5.3 is based on Appendix R to 10 CFR Part 50, GL 81-12, GL 86-10, and Richards Letter (2000).

5.4 Cold Shutdown Systems and Instrumentation required for specific plants is included in the plant licensing basis and the operating parameters that determine post-fire safe-shutdown are included in the plant Technical Specifications.

5.2 Cold Shutdown and Allowable Repairs

For normal safe shutdown, redundant systems necessary to achieve cold shutdown may be damaged by a single fire, but damage should be limited so that at least one success path can be repaired or made operable within 72 hours using onsite capability or within the time period required to achieve a safe-shutdown condition, if less than 72 hours.

For alternative or dedicated shutdown, equipment or systems that are the means to achieve and maintain cold shutdown conditions should not be damaged by fire, or the fire damage to such equipment and systems should be limited so that the systems can be made operable and cold shutdown achieved within 72 hours (or less, if required) using only onsite power. Systems and components used for safe shutdown after 72 hours (or less, if required) may be powered from offsite power only.

Cold shutdown capability repairs (e.g., the replacement of fuses and the replacement of cabling) are permitted. Selected equipment replacement is also allowed if practical. Procedures should be prepared for repairing damaged equipment (see Regulatory Position 5.75.3 of this guide), and dedicated replacement equipment should be stored on site and controlled. Repairs should be of sufficient quality to ensure safe operation until the normal equipment is restored to an operating condition.

Repairs not permitted include the use of clip leads in control panels (i.e., hard-wired terminal lugs should be used) and the use of jumper cables other than those fastened with terminal lugs.

When repairs are necessary in the fire area, the licensee should demonstrate that sufficient time is available to allow the area to be re-entered, that expected fire and fire suppressant damage will not prevent the repairs from taking place, and that the repair procedures will not adversely impact operating systems.

5.4.1 PWR Systems and Instrumentation for Cold Shutdown

Regulatory Position 5.4.1 provides guidance on equipment and capability that is generally necessary to achieve cold shutdown, in addition to that already described in Regulatory Positions 5.3.1 and 5.3.2, to maintain hot standby (PWR) or hot shutdown (BWR).

5.4.1.1 Reactor Coolant System Pressure Reduction to Residual Heat Removal System (RHR) Capability. Reactor coolant system pressure reduction by cooldown using steam generator power operated relief valves or atmospheric dump valves.

5.4.1.2 Decay Heat Removal. Decay heat removal capability, e.g., residual heat removal system, component cooling water system, and service water system to remove heat and maintain cold shutdown.

5.4.1.3 Support. Support capability, e.g., offsite power and the associated electrical distribution system to supply the above equipment.

5.4.2 BWR Systems and Instrumentation

At this point the equipment necessary for hot shutdown has reduced the primary system pressure and temperature to the point that the RHR system may be placed in service in RHR cooling mode. Decay heat removal and associated support systems are generally needed The combination of an automatic depressurization system and low-pressure safety injection system can provide cold shutdown capability. The application of regulatory allowance for repairs or manual actions for cold shutdown.

5.4.2.1 Decay Heat Removal. Residual heat removal system in the RHR cooling mode, service water system.

5.4.2.2 Support. Support capability, e.g., offsite power and the associated distribution systems, to provide for shutdown equipment.

The guidance in Regulatory Position 5.4 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, GL 81-12, GL 86-10, IN 84-09, and Mattson Memo (1982).

5.5 systems does not extend to these systems when they are credited for achieving and maintaining hot shutdown.

5.3 Fire Protection of Safe-Shutdown Capability

Fire barriers or automatic suppression, or both, should be installed as necessary to protect redundant systems or components necessary for safe shutdown. Except wherein those circumstances in which alternative or dedicated shutdown systems are required, or where ~~cables or~~ equipment~~,~~ or cables (including ~~associated non-safety~~electrical circuits that could prevent operation or cause maloperation due to hot shorts, open circuits, or shorts to ground) of redundant success paths of systems necessary to achieve and maintain hot shutdown conditions are located within the same fire area outside of primary containment, the licensee should provide for currently operating reactor plants one of the following means of ensuring that one of the success paths (of equipment for hot shutdown) is free of fire damage ~~should be provided.~~

(Regulatory Position 8.2 of this guide provides the protection requirements for redundant post-fire safe-shutdown success paths in new reactor plants):

a. Separation of cables and equipment ~~and associated non-safety circuits~~of redundant success paths by a fire barrier having a 3-hour rating should be achieved. Structural steel forming part of or supporting the fire barrier should be protected to provide fire resistance equivalent to that of the barrier.

b. Separation of cables and equipment ~~and associated non-safety circuits~~ of redundant success paths by a horizontal distance of more than 6.1 m (20 f~~ee~~t) with no intervening combustible or fire hazards should be achieved. In addition, fire detectors and an automatic fire suppression system should be installed in the fire area.

Insulation of electrical cables, including those with fire~~-~~-resistive coatings, should be considered as intervening combustibles in other than negligible quantities (i.e., isolated cable runs) as determined by engineering and fire hazards analysis. Cables in conduit are not considered intervening combustibles.

c. Enclosure of cable and equipment ~~and associated circuits~~of one redundant success path in a fire barrier having a 1-hour rating should be achieved. In addition, fire detectors and an automatic fire suppression system should be installed in the area where the fire ~~area~~is postulated.

In meeting the provisions of ~~I~~items b and c above, the installation of fire suppression and detection in a fire area should be sufficient to protect against the hazards of the area. In this regard, detection and suppression providing less than full area coverage may be evaluated as adequate to comply with the regulation. (~~s~~See Regulatory Position 1.8.3.)~~.~~

Inside non-inerted containments, the licensee should provide fire protection ~~should be provided~~ that is in accordance with the criteria above~~,~~ or as specified in Regulatory Position 6.1.1~~.1 of this guide.~~

~~The guidance in Regulatory Position 5.5 is in Appendix R to 10 CFR Part 50, CMEB 9.5-1, GL 83-33, GL 86-10, and IN 84-09.~~

5.5.1 **Associated Circuits of Concern**

Any (associated) non-safety or safety circuits in a fire area that could adversely affect the identified shutdown equipment by feeding back potentially disabling conditions (e.g., hot shorts or shorts to ground) to power supplies or control circuits of that equipment should be evaluated. Such disabling conditions should be prevented to provide assurance that the identified safe shutdown equipment will function as designed.

Circuits within a fire area may be subject to fire damage that can affect or prevent post-fire safe shutdown capability. Associated circuits of concern are defined as those cables (safety-related, non-safety-related Class 1E and non-Class 1E) that have a physical separation less than that specified in a through c of Regulatory Position 5.5 and have one of the following.

a. A common power source with the shutdown equipment (redundant or alternative) and the power source is not electrically protected from the circuit of concern by coordinated breakers, fuses, or similar devices.

b. A connection to circuits of equipment whose spurious operation would adversely affect the shutdown capability (e.g., RHR/RCS isolation valves, ADS valves, PORVs, steam generator atmospheric dump valves, instrumentation, steam bypass).

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Hot short conditions are assumed to exist until action has been taken to isolate the circuit from the fire area, or other actions as appropriate have been taken to negate the effects of the spurious actuation.

c. A common enclosure (e.g., raceway, panel, junction) with the shutdown cables (redundant or alternative) (1) that is not electrically protected by circuit breakers, fuses, or similar devices or (2) will allow propagation of the fire into the common enclosure.

The guidance in Regulatory Position 5.5.1 is based on GL 81-12, GL 86-10, and Holahan Memo (1990).

5.5.2 of this guide.

5.3.1 *Identification and Evaluation of ~~Associated Circuits of Concern~~*

~~It is recognized that there are different approaches that may be used to reach the same objective of determining the interaction of associated circuits with shutdown systems. One approach is to start with the fire area, identify what is in the fire area, and determine the interaction between what is in the fire area and the shutdown systems that are outside the fire area. This approach has been designated the "Fire Area Approach." A second approach, designated the "Systems Approach," would be to identify the shutdown systems outside a fire area and then determine those circuits that are located in the fire area and that are~~ Post-Fire Safe-Shutdown Circuits

The post-fire safe-shutdown analysis must ensure that one success path of shutdown SSCs remains free of fire damage for a single fire in any single plant fire area. The NRC acknowledges Chapter 3 of industry guidance document, NEI-00-01, Revision 1, in RIS 2005-30, as providing an acceptable deterministic methodology for analysis of post-fire safe-shutdown circuits, when applied in conjunction with the RIS. (The guidance provided in RIS 2005-30 is also included in this regulatory guide.) All circuits for which fire-induced failure could prevent safe shutdown must be addressed in the analysis and appropriate protection must be provided.

5.3.2 *Hi/Low Pressure Interface*

The licensee should evaluate the circuits associated with ~~the shutdown system.~~

~~High impedance faults should be considered for all associated circuits located in the fire area of concern. Thus, simultaneous high impedance faults (below the trip point for the breaker on each individual circuit) for all associated circuits located in the fire area should be considered in the evaluation of the safe shutdown capability. Clearing such faults on associated circuits that may~~ Hi/Low pressure interfaces for the potential to adversely affect safe shutdown ~~may be accomplished by manual breaker trips governed by written procedures. Circuit coordination studies need not be performed if it is assumed that shutdown capability will be disabled by such high impedance faults and appropriate written procedures for clearing them are provided.~~

~~5.5.2.1 Fire Area Approach.~~

~~a. For each fire area, identify (1) the power cables that connect to the same power supply of the alternative, dedicated, or backup shutdown system and the function of each power cable, (2) the cables that are considered for possible spurious operation that could adversely affect safe shutdown and the function of each cable, and (3) the cables that share a common enclosure with circuits of the alternative or dedicated shutdown systems and the function of each cable.~~

~~b. Demonstrate that fire-induced failures (e.g., hot shorts, open circuits, or shorts to ground) of each of the cables identified above will not prevent operation or cause maloperation of the alternative or dedicated shutdown method.~~

c. For each cable where electrical isolation has been provided, drawings should be developed that illustrate how electrical isolation is accomplished.

5.5.2.2 Systems Approach.

a. Develop a methodology to assess the potential of associated circuits that adversely affect the alternative or dedicated shutdown systems. The methodology should provide for identification of circuits that share a common power supply or common enclosure with the alternative or dedicated shutdown system and the circuits whose spurious operation would affect shutdown. Additionally, the method for determining whether these circuits are associated circuits of concern for the fire area should be included.

b. Identify the associated circuits of concern in the fire area and demonstrate that fire-induced failures (e.g., hot shorts, open circuits, or shorts to ground) of each of the cables will not prevent operation or cause maloperation of the alternative or dedicated shutdown method.

c. For each cable where electrical isolation has been provided, drawings should be developed that illustrate how electrical isolation is accomplished.

The guidance in Regulatory Position 5.5.2 is based on GL 81-12 and GL 86-10.

5.5.3 Hi/Low Pressure Interface

For either approach described in Regulatory Position 5.5.2.1 or 5.5.2.2, an evaluation of Hi/Low pressure interfaces should be performed. Circuits associated with Hi/Low pressure interfaces should be evaluated for the potential to adversely affect safe shutdown. For example, the residual heat removal (RHR) system is generally a low-pressure system that interfaces with the high-pressure primary coolant system. Thus, the interface most likely consists of two redundant and independent motor-operated valves. TBoth of these two motor-operated valves and their associatedpower and control cables may be subject to damage from a single fire. This single fire could cause the two valves to spuriously open, resulting in an interfacing system LOCA through the subject Hi/Low--pressure system interface. To ensure that this interface and other Hi/Low pressure interfaces are adequately protected from the effects of a single fire, the followinglicensee should be performed.

perform an evaluation, as follows:

a. Identify each Hi/Low--pressure interface that uses redundant electrically controlled devices (such- as two series motor--operated valves) to isolate or preclude rupture of any primary coolant boundary.

b. For each set of redundant valves identified~~ in this Regulatory Position 5.5.3~~, verify that the redundant cabling (power and control) ha~~ve~~s adequate physical separation as stated by Regulatory Position 5.~~5~~3 of this guide.

c. ~~For each case w~~Where adequate separation is not provided, demonstrate that fire-induced failures (multiple hot shorts, open circuits, and shorts to ground) of the cables will not cause maloperation and result in an interfacing systems LOCA.

~~The guidance in Regulatory Position 5.5.3 is based on GL 81-12.~~

~~**5.5.4 Protection of Associated Circuits of Concern**~~

~~The shutdown capability may be protected from the adverse effect of damage to associated circuits of concern by the separation and protection guidelines of Regulatory Position 5.5 of this guide, or alternatively by the following methods as applied to each type of associated circuit.~~

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5.3.3 *Operator Manual Actions*

The ~~associated circuit of concern interrupting devices (breakers or fuses) time-overcurrent trip characteristic for all circuit faults~~post-fire safe-shutdown analysis should ~~cause~~describe the ~~interrupting device to interrupt the fault current prior to initiation of a trip of any upstream interrupting device that will cause a loss of the common power source.~~

~~The power source should supply the~~methodology necessary ~~fault current for sufficient time~~ to ~~ensure the proper coordination without loss of function of the~~accomplish safe shutdown~~ loads.~~

~~The acceptability of a particular interrupting device is considered demonstrated if~~, including any operator actions required. Manual actions may not be credited in lieu of providing the ~~following criteria are met:~~

~~The interrupting device design should be factory tested to verify overcurrent~~required protection ~~as designed~~of redundant systems located in the same fire area required by Section III.G.2 of Appendix R to 10 CFR Part 50, unless the NRC has reviewed and approved a specific operator manual action for a specific plant through the exemption process of 10 CFR 50.12. If permitted by the plant license, plants that were licensed after January 1979 may credit operator manual actions for these areas if it can be shown that the use of the operator manual action does not adversely affect safe shutdown.

If one of the redundant success paths in the same fire area is maintained free of fire damage by one of the specified means in Appendix R, Section III.G.2, then the use of operator manual actions, or other means necessary, to mitigate fire-induced operation or maloperation to the second success path may be considered in accordance with the ~~applicable UL, ANSI, or NEMA standards.~~

- For low and medium voltage switchgear (480V and above), circuit breaker/protective relay periodic testing should demonstrate that the overall coordination scheme remains within the limits specified in the design criteria. This testing may be performed as a series of overlapping tests.

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- Fuses, when used as interrupting devices, do not require periodic testing because of their stability, lack of drift, and high reliability. Administrative controls should ensure that replacement fuses with ratings other than those selected for proper coordinating are not accidentally used.

5.5.4.2 Spurious Operation Circuits. Provide a means to isolate the equipment and components from the fire area prior to the fire (i.e., remove power, open circuit breakers).

Provide electrical isolation that prevents spurious operation. Potential isolation devices include breakers, fuses, amplifiers, control switches, current transformers, fiber optic couplers, relays, and transducers.

Provide a means to detect spurious operations and develop procedureslicensee's FPP and license condition because Section III.G.2 has been satisfied (e.g., to stop a pump that spuriously starts and could prevent or adversely impact safe shutdown if allowed to continuously operate). Operator manual actions may also be credited when alternate or dedicated shutdown capability is provided.

For pre-1979 licensees, a staff decision in an SER that approves the use of operator manual actions, in lieu of one of the means specified in Section III.G.2 of Appendix R, does not eliminate the need for an exemption. Pre-1979 licensees that have SERs, but not a corresponding exemption, and that approve operator manual actions must request an exemption under 10 CFR 50.12, highlighting the special circumstances of 10 CFR 50.12(a)(2)(ii), citing the SER as the safety basis, and confirming that the safety basis established in the SER remains valid.

RIS 2006-10 provides additional guidance on regulatory expectations for operator manual actions. All fire-related operator manual actions must be feasible and reliable. NUREG-1852 provides technical bases in the form of criteria and technical guidance for justifying that operator manual actions are feasible and can reliably be performed under a wide range of plant conditions that an operator might encounter during a fire. NUREG-1852 only addresses operator manual actions and does not address the additional regulatory requirements associated with operator manual actions, e.g., requirements for detection and suppression. Use of operator manual actions does not obviate the detection and automatic suppression capabilities that are required by the regulations. In addition, the omission or elimination of these capabilities in an area containing SSCs (including circuits) important to safety would generally be considered an adverse effect on safe shutdown since it would reduce, at a minimum, fire protection defense-in-depth.

Because the fire protection requirements, including the protection of safe-shutdown capability and the prevention of radiological release, can be integrated in the planning and design phase, a new reactor plant should have minimal reliance on operator manual actions and alternative/dedicated shutdown systems (protection for fires in the main control room will require alternative shutdown capability).

5.3.4 *Spurious Actuations*

The post-fire safe-shutdown circuit analysis must address all possible fire-induced failures, including multiple spurious actuations. Although some licensees have based this analysis on the assumption that multiple spurious actuations will not occur simultaneously or in rapid succession, cable fire testing performed by the industry had demonstrated that multiple spurious actuations occurring in rapid succession (without sufficient time to mitigate the maloperation of equipment (e.g., closure of the block valve if a PORV spuriously operates, opening of the breakers to removeconsequences) have a relatively high probability of occurring. The success path SSCs, including circuits, must be protected from fire damage that could prevent safe shutdown.

Note that the crediting of operator manual actions is not an acceptable approach for mitigating spurious operation of safety injection).

5.5.4.3 Common Enclosures. Provide appropriate measures to prevent propagation of the fire.

Provide electrical protection (e.g., breakers, fuses, or similar devices).

The guidanceoperations of components in redundant safe-shutdown trains or systems (i.e., the primary, not the alternative/dedicated, safe-shutdown trains or systems), except as previously discussed in Regulatory Position 5.5.4 is based on GL 81-12 and IN 88-45.

5.6 Alternative, Dedicated, or Backup3.3. (Also, refer to RIS 2005-30 for further discussion of this issue.) See the “Glossary” section of this regulatory guide for a definition of redundant trains/systems.

5.4 Alternative and Dedicated Shutdown Capability

5.64.1 *General Guidelines*

Alternative, dedicated, or backup shutdown capability and its associated circuits, independent of cables, systems, or components in the area, room, or zone under consideration, should be provided:

a. ***In areas where the fire protection features cannot ensure safe shutdown capability in the event of a fire in that area (i.e., where the protection of systems whose functions are required for hot shutdown does not satisfy the criteria of Regulatory Position 5.5) or***

b. ***Where redundant success paths of systems required for hot shutdown located in the same fire area may be subject to damage from fire suppression activities or from the rupture or inadvertent operation of fire suppression systems.***

Fire detection and a manually actuated fixed water suppression system or an automatically actuated gaseous suppression system should be installed in the area, room, or zone under consideration.

While independence is clearly achieved where alternative shutdown equipment is outside the fire area under consideration, alternative shutdown equipment in the same fire area but independent of the room or the zone under consideration may be acceptable. Where alternative, dedicated, or backup shutdown is provided for a room or zone, the capability should be physically and electrically independent of that room or zone. The vulnerability of the equipment and personnel required at the location of the alternative, dedicated, or backup shutdown capability to the environments produced at that location as a result of the fire or fire suppressants should be evaluated. These environments may be due to the hot layer, smoke, drifting suppressants, common ventilation systems, common drain systems, or flooding. In addition, other interactions between the locations may be possible in unique configurations. Therefore, the "room" concept should be justified by a detailed fire hazards analysis that demonstrates a single fire will not disable both normal shutdown equipment and the

Appendix R to 10 CFR Part 50 defines alternative shutdown capability as being provided by rerouting, relocating, or modifying *existing* systems, whereas dedicated shutdown is defined as being provided by installing *new* structures and systems for the function of post-fire shutdown. Since post-fire repairs cannot be credited for achieving and maintaining hot shutdown, the licensee should implement the required rerouting, relocating, or modifying of the existing system for alternative shutdown capability in existing plants when the need for additional alternative shutdown capability is identified.

For those fire areas where alternative or dedicated shutdown capability is required, the licensee should provide fixed fire suppression and detection for the fire area containing the redundant success paths (detection and suppression are not necessarily required for the area containing the alternative/dedicated shutdown system except where required by the fire hazards analysis).

The safe-shutdown analysis must demonstrate that alternate or dedicated shutdown systems, components, including electrical circuits, necessary to achieve and maintain hot shutdown are free of fire damage and capable of performing the necessary safe-shutdown functions or prevented from causing actions that prevent safe shutdown.

The alternative~~,~~/dedicated~~, or backup~~ shutdown capability for specific fire areas may be unique for each such area, or it may be one unique combination of systems for all such areas. In either case, the alternative shutdown capability should be independent of the specific fire areas and should accommodate post-fire conditions whe~~re~~n offsite power is available and whe~~re~~n offsite power is not available for 72 hours. ~~P~~The licensee should provide procedures to implement the ~~alternative or dedicated~~alternative/dedicated shutdown capability~~ should be provided~~, as~~-~~ described in Regulatory Position 5.~~7~~5 of this guide.

5.4.2 ~~The performance goals and criteria for~~*Associated Circuits of Concern*

When alternative or dedicated shutdown ~~are described in~~ systems are credited for achieving post-fire safe-shutdown, a specific category of circuits has been defined (referred to as "associated circuits of concern") and acceptable approaches to mitigating the consequences of fire-induced failure of these circuits have been identified. These circuits are nonsafety or safety circuits that could adversely affect the identified shutdown equipment by feeding back potentially disabling conditions (e.g., hot shorts or shorts to ground) to power supplies or control circuits of that equipment and should be evaluated. Such disabling conditions should be prevented to provide assurance that the identified safe-shutdown equipment will function as designed.

Associated circuits of concern are defined as those cables (safety-related, nonsafety-related Class 1E and non-Class 1E) that have a physical separation less than that specified in Regulatory Positions 5.3.a through 5.3.c of this guide, and have one of the following:

a. a common power source with the shutdown equipment (redundant or alternative) that is not electrically protected from the circuit of concern by coordinated breakers, fuses, or similar devices

b. a connection to circuits of equipment that would adversely affect the shutdown capability if spuriously operated (e.g., RHR/reactor coolant system isolation valves, automatic depressurization system valves, power-operated relief valves, steam generator atmospheric dump valves, instrumentation, steam bypass)

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For consideration of spurious actuations, the licensee should evaluate all possible functional failure states should be evaluated, that is, the component could be energized or de-energized by one or more circuit failure modes (i.e., hot shorts, open circuits, and shorts to ground). Therefore, valves could fail open or closed;, pumps could fail running or not running;, or electrical distribution breakers could fail open or closed. For three-phase ac circuits, the probability of getting a hot short on all three phases in the proper sequence to cause spurious operation of a motor is considered sufficiently low as to not require evaluation except for any cases involving Hi/Lo pressure interfaces. For ungrounded dc circuits, if itthe licensee can be shown that onlyat least two hot shorts of the proper polarity without grounding couldare required to cause spurious operation, no further evaluation is necessary except for any cases involving Hi/Lo pressure interfaces. However, two proper polarity faults in ungrounded multi-conductor dc circuits should be considered.

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Hot short conditions are assumed to exist until action has been taken to isolate the circuit from the fire area or other actions as appropriate have been taken to negate the effects of the spurious actuation.

c. a common enclosure (e.g., raceway, panel, junction) with the shutdown cables (redundant or alternative) that (1) is not electrically protected by circuit breakers, fuses, or similar devices, or (2) will allow propagation of the fire into the common enclosure

5.4.3 *Protection of Associated Circuits of Concern*

The shutdown capability may be protected from the adverse effect of damage to associated circuits of concern by the separation and protection guidelines of Regulatory Position 5.2 of this guide.

The guidance in Regulatory Position 5.6.1 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, GL 81-12, GL 86-10, and IN 84-09.

5.6.2 3 of this guide or, alternatively, by the following methods as applied to each type of associated circuit of concern.

5.4.3.1 Common Power Source

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5.5.4.1 Common Power Source. ProvideA load fuse/breaker (i.e., interrupting devices) to feeder fuse/breaker coordination to prevent loss of the redundant or alternative shutdown power source may be necessary. IEEE Standard 242, "IEEE"“IEEE Recommended Practices for Protection and Coordination of Industrial and Commercial Power Systems,"” provides detailed guidance on achieving proper coordination.

To ensure that the coordination criteria are met, the following should apply:

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a. The associated circuit of concern interrupting devices (breakers or fuses) time-overcurrent trip characteristic for all circuit faults should cause the interrupting device to interrupt the fault current before initiation of a trip of any upstream interrupting device that will cause a loss of the common power source.

b. The power source should supply the necessary fault current for sufficient time to ensure the proper coordination without loss of function of the shutdown loads.

The acceptability of a particular interrupting device is considered demonstrated if the following criteria are met:

a. The interrupting device design should be factory tested to verify overcurrent protection as designed in accordance with the applicable UL, ANSI, or National Electrical Manufacturers Association standards.

b. For low- and medium-voltage switchgear (480V and above), circuit breaker/protective relay periodic testing should demonstrate that the overall coordination scheme remains within the limits specified in the design criteria. This testing may be performed as a series of overlapping tests.

c.

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Molded case circuit breakers should periodically be manually exercised and inspected to ensure ease of operation. On a rotating refueling outage basis, a sample of these breakers should be tested to determine that breaker drift is within that allowed by the design criteria. Breakers should be tested in accordance with an accepted ~~quality control~~QC testing methodology.

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d. Fuses, when used as interrupting devices, do not require periodic testing because of their stability, lack of drift, and high reliability. Administrative controls should ensure that replacement fuses with ratings other than those selected for proper coordinating are not accidentally used.

5.4.3.2 Spurious Operation Circuits

Spurious operation is considered mitigated if one of the following criteria are met:

a. A means to isolate the equipment and components from the fire area before the fire (i.e., remove power, open circuit breakers) is provided.

b. Electrical isolation that prevents spurious operation is provided. Potential isolation devices include breakers, fuses, amplifiers, control switches, current transformers, fiber optic couplers, relays, and transducers.

c. A means to detect spurious operations and develop procedures to mitigate the maloperation of equipment (e.g., closure of the block valve if a power-operated relief valve spuriously operates, opening of the breakers to remove spurious operation of safety injection) is provided.

5.4.3.3 Common Enclosures

Appropriate measures to prevent propagation of the fire should be provided.

Electrical protection (e.g., breakers, fuses, or similar devices) should also be provided.

5.4.4 *Control Room Fires*

The control room fire area contains the controls and instruments for redundant shutdown systems in close proximity. (usually sSeparation is usually a few inches.). Remote shutdown capability and its associated circuits for the control room and its required circuits should be independent of the cables, systems, and components in the control room fire area.

The damage to systems in the control room for a fire that causes evacuation of the control room cannot be predicted. AThe licensee should conduct a bounding analysis should be made to assureensure that safe conditions can be maintained from outside the control room. This analysis is dependent on the specific design. The usual assumption areThe following assumptions usually apply:

a. The reactor is tripped in the control room.

b. Offsite power is lost as well as automatic starting of the onsite ac generators and the automatic function of valves and pumps whosewith control circuits that could be affected by a control room fire.

The analysis should demonstrate that the capability exists to manually achieve safe-shutdown conditions from outside the control room by restoring ac power to designated pumps, assuring that valve lineups are correct, and assuming that any malfunctions of valves that permit the loss of reactor coolant can be corrected before un-restorable conditions occur.

The only manual action in the control room ~~prior to~~before evacuation for which credit is usually given ~~credit for~~ is reactor trip. For any additional control room actions deemed necessary ~~prior to~~before evacuation, a demonstration of the capability of performing such actions should be provided for staff review. Additionally, the licensee should provide assurance ~~would have to be provided~~ that such actions could not be negated by subsequent spurious actuation signals resulting from the postulated fire.

Post-fire return to the control room should be governed by those procedures and conditions ~~as~~ described in Regulatory Position 5.~~7~~5.2 ~~of this guide~~.

After returning to the control room, the operators can take any actions compatible with the condition of the control room. Controls in any area (cabinet where the fire occurred) may not be available. Smoke and fire suppressant damage in other areas (cabinets) should also be assessed and corrective action taken before controls in such cabinets are deemed functional. Controls in undamaged areas (cabinets) may be operated as required. Repairs inside the control room may be performed to reach cold shutdown.

~~The guidance in Regulatory Position 5.6.2 is based on GL 86-10.~~

5.~~7~~5 Post-Fire Safe~~-~~-Shutdown Procedures

Procedures for effecting safe shutdown should reflect the results and conclusions of the safe~~-~~-shutdown analysis. Implementation of the procedures should not further degrade plant safety functions. Time-critical operations for effecting safe shutdown identified in the safe~~-~~-shutdown analysis and incorporated in post-fire procedures should be validated.

5.~~7~~5.1 *Safe~~-~~-Shutdown Procedures*

~~The only requirement for p~~Post-fire safe~~-~~-shutdown operating procedures ~~is~~should be developed for those areas where alternative or dedicated shutdown is required. For other areas of the plant, shutdown would normally be achieved using the normal operating procedures or plant emergency operating procedures.

5.~~7~~5.2 *Remote Shutdown Procedures*

Procedures should be in effect that describe the tasks to implement remote shutdown capability whe~~re~~n offsite power is available and whe~~re~~n offsite power is not available for 72 hours. These procedures should also address necessary actions to compensate for spurious operations and high~~-~~-impedance faults if such actions are necessary to effect safe shutdown.

Procedures governing return to the control room should consider the following conditions:

a. The fire has been extinguished and so verified by appropriate fire protection personnel~~;~~

.

b. The control room has been deemed habitable by appropriate fire protection personnel and the shift supervisor;

.

c. Damage has been assessed and, if necessary, corrective action has been taken to ensure that necessary safety, control, and information systems are functional (some operators may assist with these tasks), and the shift supervisor has authorized return of plant control to the control room;

.

d. Turnover procedures that ensure an orderly transfer of control from the remote shutdown panel to the control room have been completed.

5.75.3 ***Repair Procedures***

PThe licensee should develop procedures should be developed for performance of repairs necessary to achieve and maintain cold shutdown conditions. For alternative shutdown, procedures should be in effect to accomplish repairs necessary to achieve and maintain cold shutdown within 72 hours. For plants that must proceed to cold shutdown prior to 72 hours, the procedures should support the required time for initiation of cold shutdown.

The performance of repair procedures should not adversely impact operating systems needed to maintain hot shutdown.

The guidance in Regulatory Position 5.7 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, GL 81-12, GL 86-10, IN 84-09, and IP 64100.

6. FIRE PROTECTION FOR AREAS IMPORTANT TO SAFETY5.6 Shutdown/Low-Power Operations

Safe-shutdown requirements and objectives are focused on achieving shutdown conditions for fires occurring during normal at-power operations. During shutdown operations (i.e., maintenance or refueling outages), fire risk may increase significantly as a result of work activities. In addition, redundant systems important to safety may not be available as allowed by plant technical specifications and plant procedures. The FPP should be reviewed to verify that fire protection systems, features, and procedures will minimize the potential for fire events to impact safety functions (e.g., reactivity control, reactor decay heat removal, spent fuel pool cooling) or result in the unacceptable release of radioactive materials, under the differing conditions that may be present during shutdown operations.

6. Fire Protection for Areas Important to Safety

Several areas within a nuclear power plant present unique hazards or design issues relative to fire protection and safe shutdown. ~~G~~This section provides guidance applicable to specific plant areas~~ is provided in this section~~.

6.1 Areas Related to Power Operation

6.1.1 *Containment*

Fire protection for the primary and secondary containment areas should be provided for the hazards identified in the fire hazards analysis. Under normal conditions, containment fire hazards may include lubricating oils, hydraulic fluids, cables, electrical penetrations, electrical cabinets, and charcoal filters. During refueling and maintenance operations, additional hazards may be introduced, including contamination control and decontamination materials and supplies, scaffolding, plastic sheathing, wood planking, chemicals, and hot work. The fire hazards analysis should evaluate the effects of postulated fires within the primary containment~~ should be evaluated in the Fire Hazard Analysis~~ to ensure that the integrity of the primary coolant system and containment is not jeopardized and the safe~~ ~~-shutdown performance objectives described in Regulatory Position 5.1 of this guide are met, assuming no action is taken to fight the fire.

~~Guidance for reactor coolant pump oil collection is provided in ~~Regulatory Position 7.1 ~~of this guide~~provides guidance for RCP oil collection.

6.1.1.1 Containment Electrical Separation.

For secondary containment areas, cable fire hazards that could affect safety should be protected ~~against ~~as described in Regulatory Position 4.1.3.3 of this guide.

Inside non-inerted containments, one of the fire protection means specified in Regulatory Position 5.~~5~~3, or one of the following, should be provided~~.~~:

~~Separation~~a. separation of cables and equipment and associated non-safety circuits of redundant ~~success paths~~trains by a horizontal distance of more than 6.1 m (20 ft) with no intervening combustibles or fire hazards~~;~~

b. ~~I~~installation of fire detectors and an automatic fire suppression system in the fire area~~; or~~

c. ~~S~~separation of cables and equipment and associated non-safety circuits of redundant ~~success paths~~trains by a noncombustible radiant energy shield having a minimum fire rating of ~~one-half hour. The fire protection capability of the radiant energy shield may be demonstrated~~30 minutes, as demonstrated by testing or analysis~~.~~

6.1.1.2 Containment Fire Suppression~~:~~

The licensee ~~F~~should provide fire suppression systems ~~should be provided~~ on the basis of a fire hazards analysis. During normal operations, containment is generally inaccessible and, therefore, fire protection should be provided by automatic fixed systems.

Automatic fire suppression capability need not be provided in primary containment atmospheres that are inerted during normal operations. However, inerted containments should have manual firefighting capability, including standpipes, hose stations, and portable extinguishers, to provide protection during refueling and maintenance operations.

Standpipe and hose stations should also be installed inside PWR containments and BWR containments that are not inerted. Standpipe and hose stations inside containment may be connected to a high-quality water supply of sufficient quantity and pressure other than the fire main loop if plant-specific features prevent extending the fire main supply inside containment. For BWR drywells, standpipe and hose stations should be placed outside the drywell with adequate lengths of hose, no longer than 30.5~~-~~ m (100 ft), to reach any location inside the drywell with an effective hose stream.

The containment penetration of the standpipe system should meet the isolation requirements of GDC 56, “Primary Containment Isolation,” of Appendix A to 10 CFR Part 50 and should be ~~S~~seismic Category 1 and Quality Group B.

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

~~A~~The licensee should place adequate self-contained breathing apparatus ~~should be provided~~es near the containment entrances for firefighting and damage control personnel. These units should be independent of any breathing apparatuses or air supply systems provided for general plant activities and should be clearly marked as emergency equipment.

6.1.1.3 Containment Fire Detection.

Fire detection systems should alarm and annunciate in the control room. In primary containment, fire detection systems should be provided for each fire hazard. For primary and secondary containment, the type of detection used and the location of the detectors should be the most suitable for the particular type of fire hazard identified by the fire hazards analysis.

A general area fire detection capability should be provided in the primary containment as backup ~~for~~to the above described hazard detection. To accomplish this, suitable smoke or heat detectors compatible with the radiation environment should be installed in the air recirculation system ahead of any filters.

~~The guidance in Regulatory Position 6.1.1 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, and GL 86-10.~~

6.1.2 *Control Room Complex*

The control room complex (including galleys~~,~~ and office spaces~~, etc.~~) should 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 3 hours. Peripheral rooms in the control room complex should have automatic water suppression and should be separated from the control room by noncombustible construction with a fire~~-~~-resistance rating of 1 hour. Ventilation system openings between the control room and peripheral rooms should have automatic smoke dampers that close ~~on~~upon operation of the fire detection or suppression system. If a gas extinguishing system is used for fire suppression, these dampers should be strong enough to support the pressure rise accompanying the agent discharge and seal tightly against infiltration of the agent into the control room. Carbon dioxide total flooding systems are not acceptable for these areas.

Breathing apparatuses for control room operators should be readily available.

All cables that enter the control room should terminate in the control room. That is, no cabling should be routed through the control room from one area to another. Cables in under-floor and ceiling spaces should meet the separation criteria necessary for fire protection.

Equipment that is important to safety 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 a means for closing to maintain integrity of the control room in the event of other accidents requiring control room isolation.

~~There should be no carpeting in the~~The control room should not be carpeted. Where carpeting has been installed (e.g., for sound abatement or other human factors), ~~the carpeting~~it should be tested to standards such as ASTM D2859, ~~"Standard~~"Standard Test Method for Flammability of Finished Textile Floor Covering Materials,~~"~~" to establish the flammability characteristics of the material. ~~These characteristics should be addressed in the~~The fire hazards analysis should address these characteristics.

6.1.2.1 **Control Room Fire Suppression~~.~~**

Manual firefighting capability should be provided for both of the following:

a. ~~F~~fire originating within a cabinet, console, or connecting cables~~; and~~

b. ~~E~~exposure fires involving combustibles in the general room area~~.~~

Portable Class A and Class C fire extinguishers should be located in the control room. A hose station should be installed inside or immediately outside the control room.

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

Fully enclosed electrical raceways located in under-floor and ceiling spaces, if over 0.09 m^2 (~~1 sq ft~~1 ft^2) in cross-sectional area, should have automatic fire suppression inside. Area automatic fire suppression should be provided for under-floor and ceiling spaces if these spaces are used for cable runs, unless all cable is run in 10~~ cm~~-centimeter (4-in~~ch~~.) or smaller steel conduit or the cables are in fully enclosed raceways internally protected by automatic fire suppression.

6.1.2.2 Control Room Fire Detection.

Smoke detectors should be provided in the control room, cabinets, and consoles. If redundant safe-shutdown equipment is located in the same control room cabinet or console, additional fire protection measures should be provided. Alarm and local indication should be provided in the control room.

The outside air intake(s) for the control room ventilation system should be provided with smoke detection capability to alarm in the control room to enable manual isolation of the control room ventilation system and, thus, prevent smoke from entering the control room.

6.1.2.3 Control Room Ventilation.

Venting of smoke produced by fire in the control room by means of the normal ventilation system is acceptable; however, provision should be made to permit isolation of the recirculating portion of the normal ventilation system. Manually operated venting of the control room should be available to the operators.

Air-handling functions should be ducted separately from cable runs in ceiling and floor spaces. If cables are routed in under-floor or ceiling spaces, these spaces should not be used as air plenums for ventilation of the control room.

~~The guidance in Regulatory Position 6.1.2 is based on APCSB 9.5-1 and CMEB 9.5-1.~~

~~6.1.3~~ 6.1.3 *Cable Spreading Room*

A separate cable spreading room should be provided for each redundant division. Cable spreading rooms should not be shared between reactors. Each cable spreading room should be separated from the others and from other areas of the plant by barriers with a minimum fire rating of 3 hours. If this is not possible, an alternative, dedicated, or backup shutdown capability should be provided.

Cable spreading rooms should have the following:

a. ~~A~~at least two remote and separate entrances for access by fire brigade personnel~~;~~
b. ~~A~~an aisle separation between tray stacks at least 0.9 m (3 ft) wide and ~~2~~1.~~4~~5 m (~~8~~5 ft) high~~;~~
c. ~~H~~hose stations and portable extinguishers installed immediately outside the room~~; and~~
d. ~~A~~area fire detection.

If division cables are not separated by 3-hour barriers, separation should meet the guidelines of Regulatory Guide 1.75 and the cables should have a suitable fire retardant coating. (New reactor cables should meet the fire and flame test requirements of IEEE 383 or IEEE 1202.)

The primary fire suppression in the cable spreading room should be an automatic water system, such as closed-head sprinklers, open-head deluge system, or open directional water spray system. Deluge and open spray systems should have provisions for manual operation at a remote station; however, there should be provisions to preclude inadvertent operation. Determination of the location of sprinkler heads or spray nozzles should consider cable tray arrangements and possible transient combustibles to ensure adequate water coverage for areas that could present exposure hazards to the cable system. Cables should be designed to allow wetting down with water supplied by the fire suppression system without electrical faulting.

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

The use of foam is acceptable ~~provided~~so long as it is~~ of~~ a type ~~capable of being~~that can be delivered by a sprinkler or deluge system.

Alternative gas systems (Halon, clean agent, 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 if t~~. The access requirements stated above ~~are~~should also be met.

~~D~~Floor drains should be provided to remove firefighting water~~ should be provided~~. When gas systems are installed, drains should have adequate seals or the gas extinguishing systems should be sized to compensate for losses through the drains.

The ventilation system to each cable spreading room should be designed to isolate the area upon actuation of any gas extinguishing system in the area. Separate manually actuated smoke venting that is operable from outside the room should be ~~provided~~considered for the cable spreading room.

~~The guidance in Regulatory Position 6.1.3 is based on APCSB 9.5-1 and CMEB 9.5-1.~~

~~6.1.4~~ 6.1.4 *Plant Computer Rooms*

Computer rooms for computers performing functions important to safety that are not part of the control room complex should be separated from other areas of the plant by barriers having a minimum fire~~-~~-resistance rating of 3 hours and should be protected by automatic detection and fixed automatic suppression. Computers that are part of the control room complex but are not located in the control room should be separated and protected as described in Regulatory Position 6.1.2 for peripheral rooms. Computer cabinets located in the control room should be protected as other control room equipment and cable runs therein. Non~~-~~safety-related computers outside the control room complex should be separated from plant areas important to safety by fire barriers with a minimum rating of 3 hours and should be protected as needed to prevent fire and smoke damage to equipment important to safety. Manual hose stations and portable extinguishers should be located in areas containing equipment important to safety. NFPA 75, ~~"Standard~~“Standard for the Protection of ~~Electronic Computer/Data Processing~~Information Technology Equipment,~~"~~” provides additional guidance.

~~The guidance in Regulatory Position 6.1.4 is based on CMEB 9.5-1.~~

~~6.1.5~~

6.1.5 *Switchgear Rooms*

Switchgear rooms containing equipment important to safety should be separated from the remainder of the plant by barriers with a minimum fire rating of 3 hours. Redundant switchgear safety divisions should be separated from each other by barriers with a 3-hour fire rating. Automatic fire detectors should alarm and annunciate in the control room and alarm locally. Cables entering the switchgear room that do not terminate or perform a function ~~there~~ should be kept at a minimum to minimize the fire hazard. These rooms should not be used for any other purpose. Automatic fire suppression should be provided consistent with other safety considerations. Fire hose stations and portable fire extinguishers should be readily available outside the area.

Some high-voltage electrical equipment (e.g., switchgear and transformers) have the potential for an energetic electrical fault that can damage SSCs important to safety. The fire hazards analysis should consider the potential for this type of fault.

Equipment should be located to facilitate access for manual firefighting. Drains (see Regulatory Position 4.1.5 of this guide) should be provided to prevent water accumulation from damaging equipment important to safety. Remote, manually actuated ventilation should be

~~provided~~considered for venting smoke when manual fire suppression effort is needed. (~~s~~See Regulatory Position 4.1.4~~).~~

~~The guidance in Regulatory Position 6.1.5 is based on CMEB 9.5-1.~~

~~**6.1.6**~~ of this guide.)

6.1.6 *Remote Shutdown Panels*

~~Panels providing remote shutdown capability should be separated from the control room complex by b~~Barriers having a minimum fire rating of 3 hours should separate panels providing remote shutdown capability from the control room complex. Panels providing remote shutdown capability should be electrically isolated from the control room complex so that a fire in either area will not affect shutdown capability from the other area. The general area housing remote panels important to safety 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 readily available in the general area.

~~The guidance in Regulatory Position 6.1.6 is based on CMEB 9.5-1.~~

~~**6.1.7**~~

Locations containing remote shutdown panels must be habitable under fire and post-fire conditions that require their use. Habitability should also be addressed for remote shutdown panels protected by or adjacent to areas with gaseous fire suppression systems.

6.1.7 *Station Battery Rooms*

Battery rooms important to safety should be protected against fires and explosions. Battery rooms should be separated from each other and other areas of the plant by barriers having a minimum fire rating of 3 hours inclusive of all penetrations and openings. ~~DC~~These battery rooms should not house dc switchgear and inverters~~ should not be located in these battery rooms~~. Automatic fire detection should~~ be provided to~~ alarm and annunciate in the control room and alarm locally. ~~V~~Battery room ventilation systems ~~in the battery rooms~~ should be capable of maintaining the hydrogen concentration well below ~~2%~~2 percent. Loss of ventilation should be alarmed in the control room. Standpipes, hose stations, and portable extinguishers should be readily available outside the room.

~~The guidance in Regulatory Position 6.1.7 is based on CMEB 9.5-1.~~

~~**6.1.8**~~

6.1.8 *Diesel Generator Rooms*

Diesel generators important to safety should be separated from each other and from other areas of the plant by fire barriers that have a ~~fire resistance~~fire-resistance rating of at least 3 hours. Diesel generators that are not important to safety should be separated from plant areas containing equipment and circuits important to safety by fire barriers that have a fire-resistance rating of at least 3 hours.

Automatic fire suppression should be installed to suppress or control any diesel generator or lubricating oil fires. Such systems should be designed ~~for operation when the diesel is running~~to operate without affecting the diesel when it is running. Automatic fire detection should ~~be provided to~~ alarm and annunciate in the control room and alarm locally. Hose stations and portable extinguishers should be readily available outside the area. Drainage for firefighting water should be provided and a means for local manual venting of smoke should be ~~provided~~considered.

Day tanks with a total capacity of up to ~~4164~~4,164 L (~~1100~~1,100 gallons) may be located in ~~the~~rooms with diesel generator~~ area~~s important to safety under the following conditions:

a. The day tank is located in a separate enclosure with a fire~~-~~-resistance rating of at least 3 hours, including doors or penetrations. These enclosures should be capable of containing the entire contents of the day tanks and should be protected by an automatic fire suppression system~~; or~~

.

b. The day tank is located inside the diesel generator room in a diked enclosure that has sufficient capacity to hold ~~110%~~110 percent of the contents of the day tank or is drained to a safe location.

~~The guidance in Regulatory Position 6.1.8 is based on CMEB 9.5-1.~~

6.1.9 *Pump Rooms*

Pump houses and rooms housing redundant pump trains important to safety should be separated from each other and from other areas of the plant by fire barriers having at least 3-hour ratings. These rooms should be protected by automatic fire detection and suppression unless a fire hazards analysis can demonstrate that a fire will not endanger other equipment required for safe plant shutdown. Fire detection should alarm and annunciate in the control room and alarm locally. Hose stations and portable extinguishers should be readily accessible.

Equipment pedestals, curbs, and floor drains should be provided to prevent water accumulation from damaging equipment important to safety. (sSee Regulatory Position 4.1.5 of this guide.).

Provisions should be made for manual control of the ventilation system to facilitate smoke removal if required for manual firefighting operation. (sSee Regulatory Position 4.1.4).

~~The guidance in Regulatory Position 6.1.9 is based on CMEB 9.5-1.~~

~~6.2 Other Areas~~ of this guide.)

6.2 Other Areas

Other areas within the plant may contain hazards or equipment that warrant special consideration relative to fire protection, including areas containing significant quantities of radioactive materials, yard areas containing water supplies or systems important to safety, and the plant cooling tower.

6.2.1 *New Fuel Areas*

Portable hand extinguishers should be located near this area. Also, 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.

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

~~The guidance in Regulatory Position 6.2.1 is based on CMEB 9.5-1.~~

~~6.2.2~~

6.2.2 *Spent Fuel Areas*

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

~~The guidance in Regulatory Position 6.6.2 is based on CMEB 9.5-1.~~

~~**6.2.3**~~ Regulatory Guide 1.191 provides additional guidelines relative to fire protection of spent fuel areas for permanently shut down reactors that have not completed removal of the spent fuel to an independently licensed storage facility.

6.2.3 ***Radwaste Building/Storage Areas and Decontamination Areas***

Radioactive waste buildings, storage areas, and decontamination areas should be separated from other areas of the plant by fire barriers having at least 3-hour ratings. Automatic sprinklers should be used in all areas where combustible materials are located. Alternatively, manual hose stations and portable extinguishers (hand-held and large-wheeled units sized according to the hazards) are acceptable. Automatic fire detection should ~~be provided to~~ annunciate and alarm in the control room and alarm locally. Ventilation systems in these areas should be capable of being isolated to prevent the release of radioactive materials to other areas or the environment. Water from firefighting activities should drain to liquid radwaste collection systems.

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

~~The guidance in Regulatory Position 6.2.3 is based on CMEB 9.5-1.~~

6.2.4 ~~**Dry Cask**~~ ***Independent Spent Fuel Storage Areas***

~~F~~The requirements of 10 CFR 72.122(c) address fire protection of dry cask storage ~~is addressed by~~and other independent spent fuel storage facilities. The fire protection provided for these facilities should be commensurate with the potential fire hazards and with the potential for an unacceptable release of radiation during and following a fire. In addition to the requirements of ~~10 CFR Part 72~~10 CFR Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel ~~and~~, High-Level Radioactive Waste~~.” In addition to the requirements of 10 CFR Part 72~~, and Reactor-Related Greater Than Class C Waste,” fire protection for independent spent fuel storage installations should ensure that fires involving such installations will not impact plant operations and plant areas important to safety.

6.2.5 ***Water Tanks***

Storage tanks that supply water for safe shutdown should be protected from the effects of an exposure fire. Combustible materials should not be stored next to outdoor tanks.

The guidance in Regulatory Position 6.2.5 is based on CMEB 9.5-1.

6.2.6 *Cooling Towers*

Cooling towers should beconstructed of noncombustible construction or sobe located and protected in such a way that a fire will not adversely affect any systems or equipment important to safety. Cooling towers should be of noncombustible construction when the basins are used for the ultimate heat sink or for the fire protection water supply.

The guidance in Regulatory Position 6.2.6 is based on CMEB 9.5-1.

7. PROTECTION OF SPECIAL FIRE HAZARDS EXPOSING AREAS IMPORTANT TO SAFETY

7.1 For the latter, provisions should be made to ensure a continuous supply of fire protection water whenever the cooling tower basin is drained for cleaning or other maintenance.

7. Protection of Special Fire Hazards Exposing Areas Important to Safety

7.1 Reactor Coolant Pump Oil Collection

The reactor coolant pump (RCP)External RCPs with oil lubrication systems should be equipped with an oil collection system if the containment is not inerted during normal operation. The oil collection system should be so designed, engineered, and installed to ensure that failure will not lead to fire during normal or design--basis accident conditions and that there is reasonable assurance that the system will withstand the safe--shutdown earthquake.

Such collection systems should be capable of collecting lube oil from all potential pressurized and unpressurized leakage sites in the RCP lube oil systems. Leakage should be collected and drained to a vented closed container that can hold the entire lube oil system inventory. A flame arrester is required in the vent if the flashpoint characteristics of the oil present the hazard of fire flashback. Leakage points to be protected should include, but are not limited to, lift pump and piping, overflow lines, lube oil cooler, oil fill and drain lines and plugs, flanged connections on oil lines, and lube oil reservoirs wheren such features exist on the RCPs. The drain line should be large enough to accommodate the largest potential oil leak.

One or more tanks need to be provided with sufficient capacity to collect the total lube oil inventory from all RCPs draining to the container.

Alternatives that may be acceptable areinclude the following:

a. One or more tanks are provided with sufficient capacity to hold the total lube oil inventory of one RCP with margin if the tank is located such that any overflow from the tank will be drained to a safe location where the lube oil will not present an exposure fire hazard to or otherwise endanger equipment important to safety; or

.

b. Where the RCP lube oil system is shown, by analysis, to be capable of withstanding the safe--shutdown earthquake (SSE) (eliminating the consideration of simultaneous lube oil system ruptures from a seismic event), protection is provided for random leaks at mechanical joints in the lube oil system (e.g., flanges, RTDresistance temperature detectors connections, sightglasses). Alternative methods of protection may be deemed acceptable for such designs. In RCP lube oil collection systems of such designs, one or more tanks need to be provided with sufficient capacity to hold the total lube oil inventory of one RCP with margin. Because protection is required only against possible leakage resulting from random leaks from the one pump at a time, any overflow from the tanks need not be considered; or .

c. For pumps with the lube oil contained entirely within the pump casing, an oil collection system may not be required provided it can be shown that there are no potentially significant leakage points.

The guidance in Regulatory Position 7.1 is based on Appendix R to 10 CFR Part 50, CMEB 9.5-1, GL 86-10, IN 84-09, and Vollmer Memo (1983a).

7.2 Turbine/Generator Building

The turbine building should be separated from adjacent structures containing equipment important to safety by a fire barrier with a rating of at least 3 hours. The fire barriers should be designed to maintain structural integrity even in the event of a complete collapse of the turbine structure. Openings and penetrations in the fire barrier should be minimized and should not be located where the turbine oil system or generator hydrogen cooling system creates a direct fire exposure hazard to the barrier. Considering the severity of the fire hazards, defense--in--depth may dictate additional protection to ensure barrier integrity.

The guidance in Regulatory Position 7.2 is based on CMEB 9.5-1.

7.2.1 Oil Systems and the potential effect of a major turbine building fire on the ability to maintain operator control of the plant and safely shut down should be evaluated.

7.2.1 Oil Systems

Turbine buildings contain large sources of combustible liquids, including reservoirs and piping for lube oil, seal oil, and electro-hydraulic systems. These systems should be separated from systems important to safety by 3-hour rated barriers. Additional protection should be provided on the basis of the hazard; or where fire barriers are not provided. (See Regulatory Position 2.1.3.)

~~The guidance in Regulatory Position is based on ASB 9.5-1.~~

~~**7.2.2 Hydrogen System**~~
~~Turbine-generators~~ of this guide.)

7.2.2 Hydrogen System

Turbine generators may use hydrogen for cooling. Hydrogen storage and distribution systems should meet the guidelines provided in Regulatory Position 7.5 of this guide.

7.2.3 Smoke Control

Smoke control should be provided in the turbine building to mitigate potential heavy smoke conditions associated with combustible liquid and cable fires. ~~Specific guidance is provided in~~ Regulatory Position 4.1.4 ~~of this guide~~provides specific guidance.

7.3 Station Transformers

Transformers installed inside fire areas containing systems important to safety should be of the dry type or insulated and cooled with noncombustible liquid. Transformers filled with combustible fluid that are located indoors should be enclosed in a transformer vault. ~~A~~NFPA 70 offers additional guidance ~~is provided in NFPA 70~~.

Outdoor oil-filled transformers should have oil spill confinement features or drainage away from the buildings. Such transformers should be located at least 15.2 m (50 ft) distant from the building, or building walls within 15.2 m (50 ft) of oil-filled transformers should be without openings and have a fire-resistance rating of at least 3 hours.

~~The guidance in Regulatory Position 7.3 is based on CMEB 9.5-1.~~

7.4 Diesel Fuel Oil Storage Areas

Diesel fuel oil tanks with a capacity greater than ~~4164~~4,164 L (1,100 gallons) should not be located inside buildings containing equipment important to safety. If above-ground tanks are used, they should be located at least 15.2 m (50 ft) from any building containing equipment important to safety, or if located within 15.2 m (50 ft), they should be housed in a separate building ~~with construction~~constructed with materials having a minimum fire-resistance rating of 3 hours. Potential oil spills should be confined or directed away from buildings containing equipment important to safety. Totally buried tanks are acceptable outside or under buildings. (~~s~~See NFPA 30 for additional guidance.)~~.~~

~~Above-ground~~An automatic fire suppression system should protect aboveground oil storage, including those tanks located in a separate building~~, should be protected by an automatic fire suppression system.~~

~~The guidance in Regulatory Position 7.4 is based on CMEB 9.5-1~~.

7.5 Flammable Gas Storage and Distribution

Bulk gas storage (either compressed or cryogenic) should not be permitted inside structures housing equipment important to safety. Storage of flammable gas such as hydrogen should be located outdoors or in separate, detached buildings so that a fire or explosion will not adversely affect any systems or equipment important to safety.~~ NFPA 50A and 50B provide additional guidance.~~

Care should be taken to locate high-pressure gas storage containers with the long axis parallel to building walls. This will minimize the possibility of wall penetration in the event of a container failure. Acetylene-~~O~~oxygen gas cylinder storage locations should not be in areas that contain or expose equipment important to safety or the fire protection systems that serve those equipment areas. A permit system should be required for use of ~~Acetylene-Oxygen~~acetylene-oxygen gas storage cylinders in areas of the plant important to safety. NFPA 55~~, "Standard for the Storage, Use, and Handling of Compressed and Liquefied Gases in Portable Cylinders,"~~ provides additional guidance.

Risks to equipment important to safety from hydrogen supply systems can be minimized by designing hydrogen lines in plant areas important to safety to ~~S~~seismic Class I requirements, sleeving the piping such that the pipe is directly vented to the outside~~, or~~. Risks can also be minimized through the use of restricting orifices or excess flow valves to limit the maximum flow rate from the storage facility to the areas of concern so that in case of a line break, the hydrogen concentration in the affected areas will not exceed ~~2%~~2 percent. This approach includes pre~~-~~operational testing and subsequent retesting of excess flow valves and measures to prevent buildup of unacceptable amounts of trapped hydrogen and inadvertent operation with the safety features bypassed. A somewhat less cost-effective alternative involves use of a normally isolated supply with intermittent manual makeup. ~~A~~EPRI NP-5283-SR-A, “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations,” provides additional guidelines and criteria for the design, installation, and operation of flammable cryogenic and compressed gas systems~~ are provided in EPRI NP-5283-SR-A.~~

~~The guidance~~.

7.6 Nearby Facilities

The FPP should address plant support facilities (e.g., offices, maintenance shops, warehouses, temporary structures, equipment storage yards), collocated power generating units (e.g., nuclear, coal, natural gas), and nearby industrial facilities (e.g., chemical plants, refineries, manufacturing facilities) to the extent that fires and or explosions in these facilities may affect equipment important to safety. Fire protection systems and features should be adequate to protect against potential exposure fires and explosions from nearby facilities.

8. Fire Protection for New Reactors

8.1 General

Many of the current fire protection requirements and guidelines for operating reactors were issued after Commission approval of construction permits and/or operating licenses. The backfit of these requirements and guidelines to existing plant designs created the need for considerable flexibility in the application of the regulations on a plant-by-plant basis. New reactor designs should integrate fire protection requirements, including the protection of safe-shutdown capability and the prevention of radiological release, into the planning and design phase for the plant. In addition, new reactor designs should minimize or eliminate the use of alternative/dedicated shutdown systems and should only rely on such systems when it is not feasible to provide the required protection for redundant safe-shutdown systems, such as in the main control room. Similarly, when practical, reliance on operator manual actions should be avoided and reliance on localized electrical raceway fire barrier systems should be minimized.

Unless specifically noted otherwise, the guidance in this regulatory guide is applicable to the FPP for new reactor plants. DG-1145, “Combined License Applications for Nuclear Power Plants (LWR Edition),” provides guidance regarding the scope and content of the COL application for new reactors.

8.2 Enhanced Fire Protection Criteria

New reactor designs should ensure that safe-shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire and that reentry into the fire area for repairs and operator actions is not possible. Because of its physical configuration, the control room is excluded from this approach, provided the design includes an independent alternative shutdown capability that is physically and electrically independent of the control room. The control room should be evaluated to ensure that the effects of fire do not adversely affect the ability to achieve and maintain safe shutdown. New reactors should provide fire protection for redundant shutdown systems in the reactor containment building that will ensure, to the extent practicable, that one shutdown division will be free of fire damage. Additionally, new reactor designs should ensure that smoke, hot gases, or the fire suppressant will not migrate into other fire areas to the extent that they could adversely affect safe-shutdown capabilities, including operator actions.

8.3 Passive Plant Safe-Shutdown Condition

As discussed in SECY-94-084, the definitions of safe shutdown contained in the Commission's regulations and guidelines do not address the inherent limitations of passive RHR systems.

In GDC 34, "Residual Heat Removal," of Appendix A to 10 CFR Part 50, the NRC regulations require that the design include an RHR system to remove residual heat from the reactor core so that specified acceptable fuel design limits are not exceeded. GDC 34 further requires suitable redundancy of the components and features of the RHR system to ensure that the system safety functions can be accomplished, assuming a loss of offsite power or onsite power, coincident with a single failure.

Passive reactor designs are limited by the inherent ability of the passive heat removal processes and cannot reduce the temperature of the reactor coolant system below the boiling point of water for heat transfer to occur between the reactor coolant and the heat sink. The plant designs include cooling systems to bring the reactor to cold shutdown or refueling condition; however, these systems are not safety grade. These nonsafety-grade systems (i.e., makeup water to the heat sink and cool-down capability) are necessary to maintain long-term cooling (i.e., beyond 72 hours) and must be capable of accomplishing their respective functions without damage to the fuel as demonstrated by design and analysis.

Based on the discussion and recommendations of SECY-94-084, the passive decay heat removal systems must be capable of achieving and maintaining 215.6 °C (420 °F) or below for non-LOCA events. This safe-shutdown condition is predicated on demonstration of acceptable passive safety system performance.

8.4 Applicable Industry Codes and Standards

In general, the FPP for new light-water reactor designs should comply with the provisions specified in NFPA 804, "Standard for Fire Protection for Advanced Light-Water Reactor Electric Generating Plants," as they relate to the protection of post-fire safe-shutdown capability and the mitigation of a radiological release resulting from a fire. However, the NRC has not formally endorsed NFPA 804 and some of the guidance in the NFPA standard conflicts with regulatory requirements. When conflicts occur, the applicable regulatory requirements and guidance, including the guidance in this regulatory guide, will govern. The standards of record related to the design and installation of fire protection systems and features required to satisfy NRC requirements in all new reactor designs are those NFPA codes and standards in effect 180 days before the submittal of the application under 10 CFR Part 50 or 10 CFR Part 52.

8.5 Other New Reactor Designs

Fire protection programs for proposed new non-light-water reactor designs should meet the overall fire protection objectives and guidance provided in the applicable regulations and this regulatory guide as they relate to safe shutdown and radiological release, as well as the specific fire protection requirements, as applicable. Fire hazards should be identified, evaluated, and an appropriate level of protection provided to meet these objectives. Design reviews and testing programs should confirm the safe-shutdown capability. SSCs important to safe shutdown should be protected in accordance with the enhanced criteria described above for light-water reactors.

8.6 Fire Protection Program Implementation Schedule

SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria," identifies fire protection as an "operation program." However, only those elements of the FPP that will not be implemented fully until the completion of the plant should be addressed as an operational program. This may include, but is not be limited to, the fire brigade, combustible and ignition source control program, procedures and prefire plans, and portable extinguishing equipment. The COL application should identify the operational program aspects of the FPP and the implementation schedule for each. In lieu of the implementation schedule, the applicant may propose inspections, tests, analyses, and acceptance criteria for these aspects of the program.

8.7 Fire Protection for Nonpower Operation

NRC regulations and guidance do not specifically address fire protection during nonpower modes of plant operation (e.g., during shutdown for maintenance and/or refueling) except for existing plants that adopt an NFPA 805 FPP. However, the requirements for fire prevention in Regulatory Position ~~7.5 is based on CMEB 9.5-1 and GL 93-06.~~

~~D. IMPLEMENTATION~~

2 of this guide apply to all modes of plant operation, including shutdown. License applications for new reactors should also address any special provisions to ensure that, in the event of a fire during a nonpower mode of operation, the plant can be maintained in safe shutdown.

9. Fire Protection for License Renewal

Licensees may apply for a license renewal to permit continued plant operation beyond the original operating license period of operation, in accordance with the provisions of 10 CFR Part 54. The fire protection licensing and design basis under license renewal should not differ significantly from that in effect before renewal with the exception that fire protection SSCs must be included in an aging management program as appropriate.

As stated in 10 CFR Part 54.21, "Contents of Application—Technical Information," those components with intended functions that are identified within the scope of license renewal, those components which are passive (i.e., they do not perform their functions with moving parts) and long-lived (i.e., they are not subject to replacement based on qualified life or routine replacement) are subject to an aging management review (AMR). Examples of fire protection components that are passive and long-lived and, therefore, would be subject to an AMR, include fire barrier assemblies (e.g., ceilings, damper housing, doors, floors, penetration seals walls), sprinkler heads, fire suppression system piping and valves casings, and fire protection tanks and pump casings, and fire hydrant casings. Active components are defined as components which perform an intended function as described in 10 CFR 54.4, "Scope," with moving parts or with a change in configuration or properties; as such, they are excluded from the AMR. For example, smoke/heat detectors are considered active components.

Certain passive and long-lived components are considered consumables and, therefore, are not subject to an AMR. System filters, fire extinguishers, fire hoses, and air packs (within the scope of license renewal) may be excluded, on a plant-specific basis, from an AMR under 10 CFR 54.21(a)(1)(ii). These components are considered within the scope of license renewal and are typically replaced based on specific performance and condition monitoring activities that clearly establish a routine replacement practice based on a qualified life of the component. An AMR may exclude these components based on specific performance and condition monitoring activities provided that the applicant (1) identifies and lists in the license renewal application each component type subject to such replacement, and (2) identifies the applicable monitoring and replacement programs that conform to appropriate standards (e.g., NFPA standards).

For all components identified within the scope of license renewal and subject to an AMR, programs must be in place to maintain each component's intended function throughout the period of extended operation. For example, the intended function of fire suppression piping or the fire pump casing is to provide a pressure boundary. Programs to manage the aging effects of the pressure boundary can be existing plant programs, modified (or enhanced) programs, or new programs specifically created to address aging concerns. The development of modified or newly created programs is dependent upon (1) the aging effect that needs to be managed, and (2) the ability of the current program to manage the aging effect throughout the period of extended operation.

Plants that have installed Halon 1301 extinguishing systems that will be credited during the extended life of the plant should have a plan for continued access to an adequate supply of replacement Halon or a plan to replace the system.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this draft regulatory guide. No backfitting is intended or approved in connection with the issuance of this guide.

Except inits issuance.

The NRC has issued this draft guide to encourage public participation in its development. Except in those cases in which aan applicant or licensee proposes or has previously established an acceptable alternative method for complying with specified portions of the NRC's regulations, the methods to be described in thisthe active guide willwill reflect public comments and will be used in the evaluation of licenseein evaluating compliance with the requirements of 10 CFR 50.48. This guide will also be usedCFR 50.48 for license applications, license amendment applications, and exemption requests. The staff will also use this guide to evaluate submittals from operating reactor licensees who initiate proposed changes to their fire protection programs that are initiated by the licenseeFPPs if there is a clear nexus between the proposed change and this guidance.

GLOSSARY

REGULATORY ANALYSIS

The NRC published a regulatory analysis with the draft of this guide when it was originally issued for public comment as Draft Regulatory Guide DG-1097, in June 2000. No changes were necessary, so the NRC staff has not prepared a separate regulatory analysis for this draft revision of Regulatory Guide 1.189. A copy of the regulatory analysis is available for inspection or copying for a fee in the NRC's Public Document Room at 11555 Rockville Pike, Rockville, Maryland.

BACKFIT ANALYSIS

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This draft regulatory guide does not require a backfit analysis as described in 10 CFR 50.109(c) because it does not impose a new or amended provision in the NRC's rules or a regulatory staff position interpreting the Commission rules that is either new or different from a previous applicable staff position. In addition, this draft regulatory guide does not require the modification or addition to systems, structures, components,SSCs or design of a facility, or the procedures or organization required to design, construct, or operate a facility. Rather, a licensee can select a preferred method for achieving compliance with a license or the rules or the orders of the Commission as described in 10 CFR 50.109(a)(7). This draft regulatory guide provides an opportunity to use the standards described herein if ~~that is a licensee's preferred method.~~the licensee chooses to do so.

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GLOSSARY

Administrative Controls—Policies, procedures, and other elements that relate to the FPP. Administrative controls include but are not limited to inspection, testing, and maintenance of fire protection systems and features; compensatory measures for fire protection impairments; review of the impact of plant modifications on the FPP; fire prevention activities; fire protection staffing; control of combustible/flammable materials; and control of ignition sources.

Alternative ~~**Shutdown — The**~~**Shutdown**—The capability to ~~safely~~ shut down the reactor ~~in the event of a fire using existing systems that have been~~that is required when it is not feasible to provide the required protection for redundant safe-shutdown trains in one or more fire areas or where fire suppression activities, including inadvertent operation or rupture of a water suppression system, could prevent safe shutdown. Appendix R to 10 CFR Part 50 allows an existing plant system to be rerouted, relocated, or modified~~.~~

~~**Approved** — Tested~~ (at the time the need for an alternative means of shutdown is identified but not during or after the fire) such that it can perform the required safe-shutdown function that the fire- or water-damaged redundant system would normally perform. (See also **Dedicated Shutdown** and **Success Path**.)

Any-and-All—The scope of potential fire-induced circuit failures or spurious operations in a fire area. The post-fire safe-shutdown circuit analysis should address any-and-all possible failures and spurious operations caused by the failures, including combinations of multiple failures/operations, that could prevent safe shutdown. (See RIS 2005-30 for a discussion of the scope of spurious operation analysis.)

Approved—Tested and accepted for a specific purpose or application by a recognized testing laboratory~~.~~

~~**Associated Circuits** — Circuits that do not meet the separation requirements for safe shutdown systems and components and are associated with safe shutdown systems and components by common power supply, common enclosure, or the potential to cause spurious operations that could prevent or adversely affect the capability to safely shut down the reactor as a result of fire-induced failures (hot shorts, open circuits, and short to ground).~~

~~**Automatic** — Self-acting~~ or reviewed and specifically approved by the NRC in accordance with the appropriate regulatory process (e.g., 10 CFR 50.12).

Automatic—Self-acting, operating by its own mechanism when actuated by some monitored parameter such as a change in current, pressure, temperature, or mechanical configuration.

Combustible ~~**Material — Any**~~**Material**—Any material that will burn or sustain the combustion process when ignited or otherwise exposed to fire conditions.

Common ~~**Enclosure — An**~~**Enclosure**—An enclosure (e.g., cable tray, conduit, junction box) that contains circuits required for the operation of safe~~-~~-shutdown components and circuits for ~~non-safe shutdown~~nonsafe-shutdown components.

Common Power ~~**Supply — A**~~**Supply**—A power supply that feeds safe~~-~~-shutdown circuits and ~~non-safe shutdown~~nonsafe-shutdown circuits.

Control Room ~~**Complex — The**~~**Complex**—The zone served by the control room emergency ventilation system.

Dedicated ~~**Shutdown — The ability**~~**Shutdown**—The capability to shut down the reactor and maintain shutdown conditions ~~using structures, systems, or components dedicated to the purpose of accomplishing~~by adding new SSCs to an existing plant that are dedicated to performing post-fire safe~~-~~-shutdown functions. Like alternative shutdown, plant operators use dedicated shutdown when it is not feasible to provide the required protection for redundant safe-shutdown trains in one or more fire areas. (See also **Alternative Shutdown** and **Success Path**.)

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Electrical Raceway Fire Barrier~~— **Non-load-bearing**~~ **System**—Non-load-bearing partition type envelope system installed around electrical components and cabling that are rated by test laboratories in hours of fire resistance and are used to maintain safe~~-~~-shutdown functions free of fire damage.

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Emergency Control Station~~— Location~~—A location/device outside the main control room where ~~actions are taken by~~ operations personnel ~~to~~can manipulate plant systems and controls to achieve safe shutdown of the reactor. Emergency control stations can include control panels and individual devices such as valves, switches, and circuit breakers. III.G.1 protection for redundant safe-shutdown systems may not be claimed for redundant systems in a III.G.2 area by crediting an operator manual action at an emergency control station. Unless alternative or dedicated shutdown capability is provided, redundant circuits credited for post-fire safe-shutdown and located in the same fire area must be protected in accordance with III.G.2 without the use of emergency control stations of any kind.

Exposure ~~**Fire — A**~~**Fire**—A fire in a given area that involves either in situ or transient combustibles and is external to any ~~structures, systems, and components~~SSCs important to safety located in or adjacent to that same area. The effects of such fire (e.g.,~~ smoke~~ smoke, heat,~~ or~~ ignition) can adversely affect those ~~structures, systems, and components~~SSCs important to safety.

Thus, a fire involving one success path of safe~~-~~-shutdown equipment may constitute an exposure fire for the redundant success path located in the same area, and a fire involving combustibles other than those in either redundant success path may constitute an exposure fire to ~~both~~multiple redundant ~~trains~~success paths located in the same area.

Fire ~~Area — The~~Area—The portion of a building or plant that is separated from other areas by rated fire barriers adequate for the fire hazard.

Fire ~~Barrier — Components~~Barrier—Components of construction (walls, floors, and their supports), including beams, joists, columns, penetration seals or closures, fire doors, and fire dampers, that are rated by approving laboratories in hours of resistance to fire~~;~~ that are used to prevent the spread of fire.

Fire ~~Brigade — A~~Brigade—A team of on-site plant personnel that ~~have been~~is qualified and equipped to perform manual fire suppression activities.

Fire ~~Hazard — The existence of conditions~~Hazards—Conditions that involve the necessary elements to initiate and support combustion, including in situ or transient combustible materials, ignition sources (e.g., heat, sparks, open flames), and an oxygen environment.

Fire Hazard ~~Analysis — An~~Analysis—An analysis used to evaluate the capability of a nuclear power plant to perform safe~~-~~-shutdown functions and minimize radioactive releases to the environment in the event of a fire. The~~-~~ analysis includes the following features:

a. ~~I~~identification of fixed and transient fire hazards~~.~~

b. ~~I~~identification and evaluation of fire prevention and protection measures relative to the identified hazards~~.~~

c. ~~E~~evaluation of the impact of fire in any plant area on the ability to safely shut down the reactor and~~-~~ maintain shutdown conditions, as well as to minimize and control the release of radioactive material

Fire Protection Feature—Administrative controls, emergency lighting, fire barriers, fire detection and suppression systems, fire brigade personnel, and other features provided for fire protection purposes.

Fire Protection ~~Program — The~~Program—The integrated effort involving components, procedures, analyses, and personnel utilized in defining and carrying out all activities of fire protection. It includes system and facility design, fire prevention, fire detection, annunciation, confinement, suppression, administrative controls, fire brigade organization, inspection and maintenance, training, quality assurance, and testing.

Fire Protection System—Fire detection, notification, and suppression systems designed, installed, and maintained in accordance with the applicable nationally recognized codes and standards endorsed by the NRC.

Fire Resistance — —The ability of an element of building construction, component, or structure to fulfill, for a stated period of time, the required load-bearing functions, integrity, thermal insulation, or other expected duty specified in a standard fire-resistancefire resistance test.

Fire--Resistance Rating — TheRating—The time that materials or assemblies have withstood a fire exposure as- established in accordance with the test procedures of NFPA 251, "Standard Methods of Tests of Fire Endurance of Building Construction and Materials."

Fire Retardant Material — Means material—Material that has been coated or treated with chemicals, paints, or other materials that are designed to reduce the combustibility of the treated material.

Fire Risk — Refers to theRisk—The combination of the probability and consequences of a given fire event occurring and the estimated consequences of the event should it occur.

Fire Stop — Abased on consideration of (1) What can go wrong? (2) How likely is it? and (3) What are the consequences if it occurs?

Fire Stop—A feature of construction that prevents fire propagation along the length of cables or prevents fire from spreading of fire to nearby combustibles within a given fire area or fire zone.

Fire Suppression — ControlSuppression—Control and extinguishing of fires (firefighting). Manual fire suppression is the use of hoses, portable extinguishers, or manually actuated fixed systems by plant personnel. Automatic fire suppression is the use of automatically actuated fixed systems such as water, Halon, or carbon dioxideCO_2 systems.

Fire Watch — IndividualsWatch—Individuals responsible for providing additional (e.g., during hot work) or compensatory (e.g., for for system impairments) coverage of plant activities or areas for the purposes of detecting fires or for identifying activities and conditions that present a potential fire hazard. The individuals should be trained in identifying conditions or activities that present potential fire hazards, as well as the use of fire extinguishers and the proper fire notification procedures.

Fire Zones — SubdivisionsZones—Subdivisions of fire areas.

Free of Fire Damage — The structure, system, or componentDamage—The SSCs (including electrical circuits) under consideration isare capable of performing its intendedtheir required post-fire safe-shutdown functions during and after the postulated fire, as needed, without repair. The crediting of operator actions to restore damaged SSCs or to mitigate the consequences of the fire-induced damage should be in accordance with Regulatory Position 5.3.3 of this guide.

Hazardous ~~Material — A~~Material—A substance that, upon release, has the potential ~~of causing~~to cause harm to people, property, or the environment.

High-Impedance ~~Fault — A~~Fault—A circuit fault condition resulting in a short-to-ground, or conductor-to-conductor hot short, where residual resistance in the faulted connection maintains the fault current level below the component's circuit breaker long-term setpoint.

Hot ~~Short — Individual~~Short—Individual conductors of the same or different cables come in contact with each other and may result in an impressed voltage or current on the circuit being analyzed.

Hot ~~Work — Activities~~Work—Activities that involve the use of heat, sparks, or open flame such as cutting, welding, and grinding.

~~Impairment — The~~Impairment—The degradation of a fire protection system or feature that adversely affects the ability of the system or feature to perform its intended function.

Important to ~~Safety — Nuclear~~Safety—Nuclear power plant ~~structures, systems, and components~~SSCs "important to safety" are those required to provide reasonable assurance that the facility can be operated without undue risk to the health and safety ~~of the public.~~of the public. In Appendix R to Part 50, "important to safety" and "safety related" apply to all safety functions.

Interrupting ~~Device — A~~Device—A breaker, fuse, or similar device installed in an electrical circuit to isolate the circuit (or a portion of the circuit) from the remainder of the system in the event of an overcurrent or fault downstream of the interrupting device.

In situ ~~Combustibles — Combustible~~Combustibles—Combustible materials that constitute part of the construction, fabrication, or installation of plant ~~structures, systems, and components~~SSCs and as such are fixed in place.

Isolation ~~Device — A~~Device—A device in a circuit that prevents malfunctions in one section of a circuit from causing unacceptable influences in other sections of the circuit or other circuits.

~~Listed — Equipment~~Listed—Equipment or materials included on a list published by a recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states that certain specific equipment or materials meet nationally recognized standards and have been tested and found suitable for use in a specified manner.

Mitigate—Performance of an action that stops the progression of or reduces the severity of an unwanted condition. With respect to nuclear plant fire protection, mitigation generally refers to operator actions inside or outside the main control room to restore the capability to achieve and maintain safe shutdown where a fire has degraded that capability.

New Reactors—Those reactors that are significantly different in operation from the current generation light-water reactors and provide enhanced margins of safety or utilize simplified, inherent, or other innovative means to accomplish their safety functions.

Noncombustible ~~Material —~~Material—(a) Material that, in the form in which it is used and under conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat, or (b) material having a structural base of noncombustible material, with a surfacing not over ~~1/8 inch~~3 mm (⅛ inch) thick that has a flame spread rating not higher than 50 when measured in accordance with ASTM E~~-~~-84, ~~"Standard~~“Standard Test Method for Surface Burning Characteristics of Building Materials.~~"~~”

One-at-a-Time—An approach to post-fire safe-shutdown circuit analysis that assumes only one spurious operation can occur in any single fire or that multiple spurious operations will occur only one-at-a-time, permitting any required mitigation to achieve and maintain safe shutdown to be performed on an individual basis without consideration of possible simultaneous spurious operations. This approach does not comply with fire protection regulatory requirements.

Open ~~Circuit — A~~Circuit—A failure condition that results when a circuit (either a cable or individual conductor within a cable) loses electrical continuity.

Operator Action—A normal action taken by an operator inside the main control room to achieve and maintain post-fire safe-shutdown, not including repairs.

Operator Manual Action—Actions performed by operators to manipulate components and equipment from outside the main control room to achieve and maintain post-fire hot shutdown, not including “repairs.” Operator manual actions comprise an integrated set of actions needed to ensure that hot shutdown can be accomplished for a fire in a specific plant area. Manual operation of valves, switches, and circuit breakers is allowed to operate equipment and isolate systems in accordance with Regulatory Position 5.3.3 and is not considered a repair.

Post-Fire Safe-Shutdown Analysis—A process or method of identifying and evaluating the capability of SSCs necessary to accomplish and maintain safe-shutdown conditions in the event of a fire.

Post-Fire Safe-Shutdown Circuits—Electrical circuits whose fire-induced failure (e.g., short circuit, short to ground) could prevent safe shutdown, either directly (e.g., loss of power to a safe-shutdown pump) or indirectly (e.g., spurious opening of a flow diversion path because of one or more control circuit hot shorts; failure of a motor-operated valve to perform an active post-fire safe-shutdown function caused by fire-induced failure of a valve protective circuit).

Post-Fire Safe-Shutdown System/Equipment—Systems and equipment that perform functions needed to achieve and maintain safe shutdown during and following a fire (regardless of whether the system or equipment is part of the success path for safe shutdown). This includes systems and equipment of which fire-induced spurious operation could prevent safe shutdown.

Pre-Fire ~~**Plans — Documentation**~~**Plans**—Documentation that describes the facility layout, access, contents, construction, hazards, hazardous materials, types and locations of fire protection systems, and other information important to the formulation and planning of emergency fire response.

~~**Raceway — An**~~**Raceway**—An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted by code. Raceways include, but are not limited to, rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquid-tight flexible conduit, flexible metallic tubing, flexible metal conduit, electrical nonmetallic tubing, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways.

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Radiant Energy (Heat) ~~**Shield — A**~~**Shield**—A noncombustible or fire-resistive barrier installed to provide separation protection of redundant cables, equipment, and associated non-safety circuits within containment~~.~~
or in the main control room.

Redundant Train/System—One of two or more similar trains of equivalent capacity in the same system powered by separate electrical divisions or one of two or more separate systems that each perform the same post-fire safe-shutdown function as its design function. With respect to fire protection regulatory requirements and guidance, a redundant train or system is distinct from an alternative or dedicated shutdown train or system. (See also **Success Path**.)

Remote ~~**Shutdown — The**~~**Shutdown**—The capability, including necessary instrumentation and controls, to safely shut down the reactor and maintain shutdown conditions from outside the main control room. (~~See GDC 19.)~~
See GDC 19, "Control Room.")

Repair—An action that may be credited with achieving and maintaining cold shutdown, including the replacement of fuses and cabling. Selected equipment replacement is also allowed if practical. Repairs not permitted include the use of clip leads in control panels (i.e., hard-wired terminal lugs should be used) and the use of jumper cables other than those fastened with terminal lugs.

Restricted ~~**Area — Any**~~**Area**—Any area to which ~~access is controlled by~~ the licensee controls access for purposes of protecting individuals from exposure to radiation and radioactive materials.

Safe ~~**Shutdown — For**~~**Shutdown**—For fire events, those plant conditions specified in the plant ~~T~~technical ~~S~~specifications as ~~Hot S~~ hot standby, ~~H~~hot ~~S~~shutdown, or ~~C~~cold ~~S~~shutdown.

Safe--Shutdown ~~Analysis — A~~Analysis—A process or method of identifying and evaluating the capability of ~~structures, systems, and components~~SSCs necessary to accomplish and maintain safe--shutdown conditions in the event of a fire.

Safe--Shutdown System/Safe--Shutdown ~~Equipment — Systems~~Equipment—Systems and equipment that perform functions needed to achieve and maintain safe shutdown (regardless of whether ~~or not~~ the system or equipment is part of the success path for safe shutdown).

Safety-Related Systems and ~~Components — Systems~~Components—Systems and components required to mitigate the- consequences of postulated design--basis accidents.

Secondary ~~Containment — The~~Containment—The combination of physical boundary and ventilation systems designed to- limit the release of radioactive material.

Short ~~Circuit — A failure condition that results when a circuit (either a cable or individual conductor within a cable) comes into electrical contact with another circuit.~~

Circuit—An abnormal connection (including an arc) of relatively low impedance, whether made accidentally or intentionally, between two points of different potential.

~~**Short-to-Ground** — A failure condition that results when a circuit (either a cable or individual conductor within a cable) comes into electrical contact with a~~**Short-to-Ground**—A short circuit between a conductor and a grounded reference point (e.g., grounded ~~conducting device such as a cable tray, conduit, grounded equipment, or other grounded component.~~

conductor, conduit or other raceway, metal enclosure, shield wrap, or drain wire within a cable).

Spurious ~~Operation — The~~Operation—The undesired operation of equipment resulting from a fire that could affect the- capability to achieve and maintain safe shutdown.

Standards (Code) of ~~Record — The~~Record—The specific editions of the nationally recognized codes and standards endorsed by the NRC that constitute the licensing ~~or~~and design basis for the plant.

Success ~~Path — The~~Path—The minimum set of structures, systems (including power, instrument, and control circuits and instrument-sensing lines), and components ~~necessary~~that must remain free of fire damage in order to achieve and maintain safe shutdown in the event of a fire.

Success path is synonymous with the safe-shutdown “train free of fire damage” and includes electrical circuits whose fire-induced failure could prevent safe shutdown. In the context of Appendix R, Section III.G, redundant train (Section III.G.2) and alternative/dedicated system (Section III.G.3) are both success paths and this definition is applicable.

Temporary ~~Structures — Buildings~~Structures—Buildings, tents, shelters, platforms, trailers, or other structures that are erected ~~for the purpose of supporting~~to support plant operations and maintenance~~,~~ but are not permanent site facilities.

Turnout ~~Gear — Personnel~~Gear—Personnel protective clothing for ~~fire fighting~~firefighting such as coats, pants, boots, helmets, gloves, and self-contained breathing ~~apparatus (SCBA)~~apparatuses.

Transient ~~Combustibles — Combustible~~Combustibles—Combustible materials that are not fixed in place or not an integral part of an operating system or component.

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- **10 CFR 50.12**, “Specific Exemptions.”
- **10 CFR 50.48**, “Fire Protection.”
- **10 CFR 50.59**, “Changes, Tests and Experiments.”
- **10 CFR 50.72**, “Immediate Notification Requirements for Operating Nuclear Power Reactors.”
- **10 CFR 50.73**, “Licensee Event Report System.”

11 All NRC regulations listed herein are available electronically through the Public Electronic Reading Room on the NRC’s public Web site, at http://www.nrc.gov/reading-rm/doc-collections/cfr/. Copies are also available for inspection or copying for a fee from the NRC’s Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR’s mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; email PDR@nrc.gov.

GDC 3, "Fire Protection," of Appendix A 10 CFR 50.82, "License Termination."

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~~+See the inside front cover of this guide for information on obtaining copies of NRC documents, printed copies or online electronic versions.~~5, June 2005. (ADAMS Accession Number ML050730286)

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12 All regulatory guides listed herein were published by the U.S. Nuclear Regulatory Commission. Where an ADAMS accession number is identified, the specified regulatory guide is available electronically through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html. All other regulatory guides are available electronically through the Public Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/reg-guides/. Single copies of regulatory guides may also be obtained free of charge by writing the Reproduction and Distribution Services Section, ADM, USNRC, Washington, DC 20555-0001, or by fax to (301) 415-2289, or by email to DISTRIBUTION@nrc.gov. Active guides may also be purchased from the National Technical Information Service (NTIS) on a standing order basis. Details on this service may be obtained by contacting NTIS at 5285 Port Royal Road, Springfield, Virginia 22161, online at http://www.ntis.gov, or by telephone at (703) 487-4650. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room (PDR), which is located at 11555 Rockville Pike, Rockville, Maryland; the PDR's mailing address is USNRC PDR, Washington, DC 20555-0001. The PDR can also be reached by telephone at (301) 415-4737 or (800) 397-4205, by fax at (301) 415-3548, and by email to PDR@nrc.gov.

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[13] All NUREG-series reports listed herein were published by the U.S. Nuclear Regulatory Commission. Most are available electronically through the Public Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/nuregs/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; email PDR@nrc.gov. In addition, copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328, telephone (202) 512-1800; or from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, http://www.ntis.gov, telephone (703) 487-4650.

NUREG-1022, "Event Reporting Guidelines: 10 CFR 50.72 and 50.73," Revision ~~1, January 1998.~~

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SECY-90-016, "Evolutionary Light-Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," January 12, 1990. (ADAMS Accession Number ML003707849)

[14] Generic Letter 86-10, "Implementation of Fire Protection Requirements," USNRC, April 24, 1986.eAll Commission papers (SECYs) listed herein were published by the U.S. Nuclear Regulatory Commission. Where an ADAMS accession number is identified, the specified paper is available electronically through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html. All other listed Commission papers are available electronically through the Public Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/commission/secys/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; email PDR@nrc.gov.

SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," April 2, 1993. (ADAMS Accession Number ML003707849)

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15 All generic letters (GLs) listed herein were published by the U.S. Nuclear Regulatory Commission and are available electronically through the Public Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/gen-comm/gen-letters/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; email PDR@nrc.gov.

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16 All information notices (INs) listed herein were published by the U.S. Nuclear Regulatory Commission and are available electronically through the Public Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; email PDR@nrc.gov.

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17 All regulatory issue summaries (RISs) listed herein were published by the U.S. Nuclear Regulatory Commission and are available electronically through the Public Electronic Reading Room on the NRC’s public Web site, at http://www.nrc.gov/reading-rm/doc-collections/gen-comm/reg-issues/. Copies are also available for inspection or copying for a fee from the NRC’s Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR’s mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; and email PDR@nrc.gov.

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~~**IP 64100,** "Postfire Safe Shutdown~~ (Available at http://www.nrc.gov/reading-rm/doc-collections/insp-manual/technical-guidance/tgsts10.pdf.)

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National Fire Protection Association Codes and Standards
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The following listed NFPA code names and titles are based on the current editions of the codes. The "code of record" for an existing plant will typically be an earlier edition and/or may be an edition with a different title and/or number that addresses the same subject. The code of record for fire protection system modifications and for new reactors should be in accordance with the "Code of Record" subsection in Section B of this Regulatory Guide.

NFPA 1, "Uniform Fire Code."

NFPA 10, "Standard for Portable Fire Extinguishers."

~~**NFPA 11,** "Standard for Low-Expansion Foam."~~

NFPA ~~11A-1970~~11, "Standard for Low-, Medium-, and High-Expansion Foam~~ Systems."~~

~~**NFPA 11C,** "Standard for Mobile Foam Apparatus~~."

NFPA 12, "Standard on Carbon Dioxide Extinguishing Systems."

NFPA 12A, "Standard on Halon 1301 Fire Extinguishing Systems."

NFPA 13, "Standard for the Installation of Sprinkler Systems."

NFPA 14, "Standard for the Installation of Standpipe and Hose Systems."

NFPA 15, "Standard for Water Spray Fixed Systems for Fire Protection."

NFPA 16, "Standard for the Installation of ~~Deluge~~ Foam-Water Sprinkler and Foam-Water Spray Systems."

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NFPA 20, "Standard for the Installation of ~~Centrifugal~~Stationary Pumps for Fire ~~Pumps~~Protection."

NFPA 22, "Standard for Water Tanks for Private Fire Protection."

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18 Copies may be purchased from the NFPA, 1 Batterymarch Park, Quincy, MA [phone: (800) 344-3555; fax: (800) 593-NFPA (6372)]. Purchase information is available through the NFPA's Web-based store at http://www.nfpa.org/Catalog/.

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NFPA 54, "National Fuel Gas Code."

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NFPA 58, "Liquefied Petroleum Gas Code."

NFPA 69, ~~"Explosion~~"Standard on Explosion Prevention Systems."

NFPA 70, "National Electrical Code."

NFPA 72, "National Fire Alarm Code."

NFPA 75, "Standard for the Protection of ~~Electronic Computer/Data Processing~~Information Technology Equipment."

NFPA 78, "Lightning Protection Code"

NFPA 80, "Standard for Fire Doors and ~~Windows~~Other Opening Protectives."

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NFPA 90A, "Standard for the Installation of Air~~-~~-Conditioning and Ventilating Systems."

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NFPA 204, "Standard for Smoke and Heat Venting."

NFPA 220, "Standard on Types of Building Construction."

NFPA 221, "Standard for High-Challenge Fire Walls and Fire Barrier Walls."

NFPA 251, "Standard Methods of Tests of Fire Endurance of Building Construction and Materials."

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

NFPA 259, "Standard Test Method for Potential Heat of Building Material."

~~**NFPA 299,** "Standard for Protection of Life and Property from Wildfire~~."

NFPA 600, "Standard on Industrial Fire Brigades."

NFPA 701, "Standard Methods of Fire Tests for ~~Flame-Resistant~~Flame Propagation of Textiles and Films."

NFPA 703, "Standard for Fire-Retardant ~~Impregnated~~Treated Wood and Fire-Retardant Coatings for Building Materials."

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

NFPA 1144, "Standard for Protection of Life and Property from Wildfire."

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NFPA 1410, "Standard on Training for Initial ~~Fire Attack."~~ Emergency Scene Operations."

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The following list of industry standards and guides is based on the current editions of the codes. The "code of record" for an existing plant will typically be an earlier edition and/or may be an edition with a different title and/or number that addresses the same subject. The code of record for fire protection system modifications for existing plants and for new reactor fire protection systems should be determined in accordance with the "Code of Record" subsection of Section B of this Regulatory Guide.

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ANSI/IEEE C.2, "National Electrical Safety Code~~" (On CD-ROM. Contact IEEE Customer Service at 1-800-678-IEEE or email to customer.service@ieee.org to order.)~~

~~**ASME/ANSI**~~."[20]

ASME B31.1, American Society of Mechanical ~~Engineers/American National Standards Institute~~Engineers, ~~ASME/ANSI~~ASME Standard B31.1, ~~"Power Piping."~~"Power Piping" American Society of Mechanical Engineers, New York New York.[21]

ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities," American Society of Mechanical Engineers~~Standard NQA-1~~, New York New York.

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19 Copies may be obtained from the American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Illinois 60526; telephone (708) 352-6611; fax (708) 352-0499. Purchase information is available through the ANS Web-based store at http://www.ans.org/store/vi-240198.

20 This standard is available on CD-ROM. Contact IEEE Customer Service at 1-800-678-IEEE or by email to customer.service@ieee.org to order.

21 Copies of ASME standards may be purchased from the American Society of Mechanical Engineers, Three Park Avenue, New York, New York 10016-5990; phone (800) 843-2763. Purchase information is available through the ASME Web-based store at http://www.asme.org/Codes/Publications/.

ASTM D-2859, ~~"Standard~~"Standard Test Method for Flammability of Finished Textile Floor Covering Materials,~~"~~" American Society for Testing and Materials, West Conshohocken, Pennsylvania.[22]

ASTM D-3286, "Standard Test Method for Gross Calorific Value of Coal and Coke by the Isoperibol Bomb Calorimeter," *Annual Book of ASTM Standards,* American Society for Testing and Materials, ~~Annual Book of ASTM Standards~~West Conshohocken, Pennsylvania.

ASTM E-84, "Standard Test Method for Surface Burning Characteristics of Building Materials," *Annual Book of ASTM Standards,* American Society for Testing and Materials, ~~Annual Book of ASTM Standards~~West Conshohocken, Pennsylvania.

ASTM E-119, "Standard Test Methods for Fire Tests of Building Construction and Materials," *Annual Book of ASTM Standards,* American Society for Testing and Materials, ~~Annual Book of ASTM Standards~~West Conshohocken, Pennsylvania.

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22 Copies of ASTM standards may be purchased from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, Pennsylvania 19428-2959; phone (610) 832-9585. Purchase information is available through the ASTM Web site at http://www.astm.org.

23 Copies of the listed EPRI standards may be purchased from the Electric Power Research Institute (EPRI), 3420 Hillview Ave., Palo Alto, California 94304; telephone (800) 313-3774; fax (925) 609-1310.

24 Copies are available from Factory Mutual Research Corporation, 1301 Atwood Avenue, P.O. Box 7500, Johnston, Rhode Island 02919; phone (401) 275-3000; fax (401) 275-3029. Purchase information is available through the Web-based FM Global Resource Catalog at http://www.fmglobalcatalog.com/ProductInfo.aspx?productid=P7825CD.

IEEE 242, ~~"IEEE~~"IEEE Recommended Practices for Protection and Coordination of Industrial and Commercial Power Systems,~~"~~" Institute of Electrical and Electronics Engineers, ~~ANSI/IEEE Standard 242~~Piscataway, New Jersey.[25]

IEEE 383, ~~"IEEE~~"IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, ~~IEEE Standard 383~~Piscataway, New Jersey.

IEEE 634, "IEEE Standard Cable Penetration Fire Stop Qualification Test," Institute of Electrical and Electronics Engineers, ~~IEEE Standard 634~~Piscataway, New Jersey.

IEEE 690-1984, "IEEE Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations," ~~IEEE Standard 690~~Institute of Electrical and Electronics Engineers, Piscataway, New Jersey.

IEEE 835, "Standard Power Cable Ampacity Tables," Institute of Electrical and Electronics Engineers, ~~IEEE Standard 835~~Piscataway, New Jersey.

IEEE 1202, "IEEE Standard for Flame Testing of Cables for Use in Cable Trays in Industrial and Commercial Occupancies," Institute of Electrical and Electronics Engineers, ~~IEEE Standard 1202.~~ Piscataway, New Jersey.

NEI 00-01, "Guidance for Post-Fire Safe-Shutdown Circuit Analysis," Revision 1, Nuclear Energy Institute, Washington, DC, January 2005. (ADAMS Accession Number ML050310295)

NEI 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)," Revision 1, Nuclear Energy Institute, Washington, DC, September 2005. (ADAMS Accession Number ML052590476)

UL 555, "Fire Dampers," Underwriters Laboratories, Inc., Northbrook, Illinois (see http://www.ul.com/info/standard.htm).

UL Directory, "Building Materials Directory," Underwriters Laboratories, Inc., Northbrook, Illinois (see http://www.comm-2000.com/).

UL Subject 1724, Appendix B, "Qualification Test for Circuit Integrity of Insulated Electrical Wires and Cables in Electrical Circuit Protection Systems" (Paragraph B3.16), to "Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems," Issue No. 2, August 1991 (see http://www.comm-2000.com/).

[25] Copies of the listed IEEE standards may be obtained from the Institute of Electrical and Electronics Engineers, Inc., IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, New Jersey 08855.

APPENDIX A~~:~~

EQUIVALENCY

This appendix provides information and previously accepted examples from Generic Letter ~~86-10[(1)]~~86-10, “Implementation of Fire Protection Requirements,” with regard to the use of equivalency in evaluating fire protection and safe~~-~~-shutdown features.

A-1. Process Monitoring Instrumentation

~~Section~~ Paragraph III.L.2.d of Appendix R~~ to 10 CFR Part 50 states that "The~~, “Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979,” to Title 10, Part 50, “Domestic Licensing of Production and Utilization Facilities,” of the *Code of Federal Regulations* (10 CFR Part 50) states, “The process monitoring function shall be capable of providing direct readings of the process variables necessary to perform and control~~"~~” the reactivity control function.~~ Regulatory Positions 5.3 and 5.4 of this guide provide a list of instrumentation acceptable to and preferred by the staff to demonstrate compliance with this provision.~~ While this guidance provides an acceptable method for ~~compliance~~complying with the regulation, it does not exclude other alternative methods of compliance. ~~A~~The licensee should justify alternative instrumentation to comply with the regulation (e.g., boron concentration indication) ~~should be justified~~ based on a~~-~~ technical evaluation.

A-2. Fire Area Boundaries

The term ~~"fire~~“fire area~~"~~” as used in Appendix R means an area sufficiently bounded to withstand the~~-~~ hazards associated with the area and, as necessary, to protect important equipment within the area from~~-~~ a fire outside the area. ~~In order t~~To meet the regulation, fire area boundaries need not be completely sealed floor-to-ceiling, wall-to-wall boundaries. However, the licensee should identify and consider all unsealed openings~~ should be identified and considered~~ in evaluating the effectiveness of the overall barrier. Where fire area boundaries are not wall-to-wall, floor-to-ceiling boundaries with all penetrations sealed to the fire rating required of the boundaries, licensees should perform an evaluation to assess the adequacy of fire boundaries in their plants to determine whether the boundaries will withstand the hazards associated with the area. ~~This analysis should be performed by at least a~~A fire protection engineer and, if required, a systems engineer should perform this analysis. However, if the safety evaluation report had identified certain cable penetrations ~~were identified~~ as open~~ SER~~ items at the time Appendix R became~~-~~ effective, Section III.M of the rule applies ~~(~~[see 10 CFR 50.48(b)~~)~~], and any variation from the~~-~~ requirements of Section III.M requires an exemption. In any event, ~~these analyses~~licensees should ~~be retained by the licensees~~retain these analyses for subsequent ~~NRC~~ audits by the NRC.

A-3. Automatic Detection and Suppression

Sections III.G.2.b and III.G.2.c of Appendix R state~~ that "In~~, “In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area.~~"~~” Other provisions of

Appendix R (e.g., Section III.G.2.e) also use the phrase ~~"fire~~"fire detectors and an automatic fire suppression system in the fire area.~~"~~"

~~In order to~~ To comply with these provisions, the licensee should install suppression and detection sufficient to protect against the hazards of the area ~~should be installed~~. In this regard, detection and suppression providing less than full area coverage may be adequate to comply with the regulation. Where full area suppression and detection ~~is~~are not installed, licensees should ~~perform an evaluation to assess~~evaluate the adequacy of partial suppression and detection to protect against the hazards in the area. ~~The evaluation should be performed by a~~A fire protection engineer and, if required, a systems engineer should perform this evaluation. The licensee should retain evaluations ~~should be retained~~ for subsequent NRC audits. If a licensee is providing no suppression or detection, the licensee should request an exemption or license amendment ~~should be requested.~~

~~REGULATORY ANALYSIS~~

~~A regulatory analysis was published with the draft of this guide when it was issued for public comment (Task DG-1097, June 2000). No changes were necessary, so a separate regulatory analysis for~~.

APPENDIX B

FIRE PROBABILISTIC RISK ASSESSMENTS

In addition to an existing plant that has not adopted a risk-informed, performance-based fire protection program (FPP) in accordance with Title 10, Section 50.48(c), of the *Code of Federal Regulations* [10 CFR 50.48(c)], licensees that have not adopted 10 CFR 50.48(c) and licensees preparing new reactor FPPs may apply risk-informed methodologies, including fire probabilistic risk assessment (PRA), to the evaluation of an FPP change. However, the U.S. Nuclear Regulatory Commission (NRC) must review and approve the proposed methodologies, including the acceptance criteria, before the implementation of the plant change.

According to 10 CFR 52.47(a)(v), new reactor applications submitted under 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," must include a design-specific PRA. A detailed fire PRA is not necessarily required for a new reactor FPP. However, if an applicant for a combined operating license (COL) references a certified design and if that certified design developed a fire PRA, then the COL applicant, per proposed 10 CFR 52.80(a), should use that PRA and update it to reflect site- and plant-specific information that may not have been available at the design stage. In addition, a licensee that has a risk-informed, performance-based FPP [similar to a National Fire Protection Association (NFPA) 805 program] or that plans to evaluate plant changes using a risk-informed approach must have a detailed fire PRA.

The term “fire PRA” encompasses all levels and types of PRAs, ranging from a simplified bounding analysis to a detailed analysis in accordance with NUREG/CR-6850, “EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities,” and the draft American Nuclear Society Fire PRA Standard. NUREG/CR-6850 should be the basis for the review of the proposed methodologies. Chapter 19, “Probabilistic Risk Assessment,” of the Standard Review Plan (SRP) (NUREG-1800) contains additional guidance on the review of nuclear power plant PRAs.

A fire PRA should receive a peer review to the extent that adequate industry guidance is available. The NRC will review and accept the industry guidance before its application to specific fire PRAs. The NRC should also review the results of the plant-specific peer reviews. All types and levels of fire PRAs should be subject to a peer review. If adequate industry guidance is not available for conducting a fire PRA peer review, the NRC should review the fire PRA for acceptability.

Licensees may use PRA and/or risk insights gained from other methods in support of proposed changes to the plant licensing basis, such as license amendment requests per 10 CFR 50.90, “Application for Amendment of License or Construction Permit,” and 10 CFR 50.92, “Issuance of Amendment.” Regulatory Guide 1.189 has not been prepared. A copy of the regulatory analysis is available for inspection or copying for a fee in the NRC’s Public Document Room at 11555 Rockville Pike, Rockville, Maryland.

BACKFIT ANALYSIS

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74, “An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” provides guidelines for the use of PRA in support of plant changes that require NRC approval. Plant changes that are not subject to NRC approval are not within the scope of Regulatory Guide 1.174. Where licensees use PRA in support of submittals to change the plant licensing basis, they should follow the guidelines of SRP Chapter 19.