NUREG-0800

~~NUREG-0800~~

~~(Formerly NUREG-75/087)~~

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

~~OFFICE OF NUCLEAR REACTOR REGULATION~~

9.5.1 FIRE PROTECTION PROGRAM

REVIEW RESPONSIBILITIES

Primary - ~~Plant Systems Branch (SPLB)~~

~~Secondary - None~~ Organization responsible for the review of fire protection

Secondary - None

I. AREAS OF REVIEW

The purpose of the fire protection program (FPP) is to provide assurance, through a defense-in-depth philosophy, that the Commission's fire protection objectives are satisfied. These objectives are: 1) minimize the potential for fires and explosions to occur; 2) rapidly detect, control, and extinguish fires that do occur; and 3) ensure that fire will not prevent the performance of necessary safe--shutdown functions and will not significantly increase the risk of radioactive releases to the environment. In addition, fire protection systems must be designed such that their failure or inadvertent operation does not adversely impact the ability of the structures, systems and components (SSCs) important to safety to perform their safety functions. ~~A fire protection program~~The FPP for a nuclear power plant licensed to operate generally consists of the following elements:

- comprehensive identification and analysis of fire and explosion hazards
- organization and staff positions responsible for management and implementation of the ~~fire protection program~~FPP
- fire prevention program consisting of administrative policy, procedures, and practices for training of general plant personnel; control of fire hazards; inspection, testing and maintenance of fire protection systems and features; control of plant design and modification; control of fire system outages and impairments; and ~~fire protection program~~FPP quality assurance
- automatic fire detection, alarm, and suppression systems, including fire water supply and distribution systems
- manual suppression capability including~~; standpipe design~~ portable fire extinguishers, standpipes, hydrants, hose stations, fire department connections, fire brigade organization, training, qualification, equipment, and drills~~,~~; emergency plans and procedures~~;~~; and, if applicable, offsite mutual aid capabilities~~.~~,

~~ATTACHMENT~~

- building design for fire protection including layout of fire areas, fire barrier design and qualification testing, interior finish, electrical system design, ventilation system design, drainage systems, and other systems and features for minimizing the threat of fire
- post-fire safe~~-~~-shutdown analysis and procedures that demonstrate that the plant can achieve and maintain safe shutdown in the event of a fire
- probabilistic ~~risk/safety analysis~~risk assessment (PRA) that identifies relative fire risks and vulnerabilities~~.~~

The specific areas of the ~~fire protection program~~FPP to be reviewed will vary depending on the type and scope of the applicant's or licensee's submittal. This Standard Review Plan (SRP) can be applied in the review of ~~changes to fire protection programs for operating reactors, including those subject to license renewal; fire protection programs for shutdown/decommissioned reactors;~~ the FPP for the following submittals:

- applications for new ~~designs, and other related~~reactor design certifications
- applications for new reactor combined operating licenses (COLs)
- applications to shut down and decommission a licensed plant
- applications for license renewal
- license amendment requests for power uprates
- licensee requests for exemptions and other license amendments that impact FPPs
- other FPP-related submittals, such as fire PRAs~~.~~

~~For operating reactors, SPLB reviews the overall fire protection program as described in the licensee's Safety Analysis Report (SAR), including the fire hazards analysis, the description of the fire prevention and protection features, and the safe shutdown analysis. Changes to the approved fire protection program, such as exemptions or deviations that require NRC approval, are reviewed to ensure that fire protection objectives will continue to be met. The cumulative effect of previously approved changes on the effectiveness of the fire protection program will be evaluated as part of the review for new submittals.~~

SPLB will review changes to the plant fire protection program associated with requests for power uprates to ensure that there is no adverse effect on the capability to achieve and maintain safe shutdown following a fire.

SPLB will review proposed changes to the plant fire protection program for shutdown and decommissioned reactors as described in the licensee's decommissioning plans and submittals.

SPLB will review

SRP Section 9.5.1 focuses on deterministic FPPs. This SRP section is not intended to be the primary review guidance document for plants that have adopted a risk-informed, performance-based FPP in accordance with 10 CFR 50.48(c) and National Fire Protection Association (NFPA) Standard NFPA 805. The primary review guidance document for NFPA 805 plants will be developed in the future. In the interim, this SRP will be used as appropriate for applications for advanced reactor designs to ensure the Commission's enhanced fire protection criteria for these reactors is satisfied.

SPLB reviews the overall fire protection programplants that adopt a performance-based FPP in accordance with 10 CFR 50.48(c).

Unless specifically noted otherwise, the review guidance in this SRP section is applicable to the FPP for new reactor plants.

The staff reviews the FPP described in the licensee's or applicant's submittal (typically the SAR), with respectreference to the Acceptance Criteria in this SRP and the criteria contained in BTP SPLB 9.5.1, attached to this SRP section. Specifically, SPLBthe staff reviews the following:

1. Overall fire protection program requirements, including to the extent appropriate for the type and scope of the licensee submittals:

1. FPP administration with respect to fire protection organization,; administrative policies,; fire prevention controls,; applicable administrative, operations, maintenance and emergency procedures; quality assurance; access to and egress from fire areas,; fire brigade capability; and emergency response capability.

2. Evaluation of the potential fire hazards for areas containing equipment important to safety throughout the plant and, for the effect of postulated fires and explosions relative to maintaining the ability to perform safe--shutdown functions, and for minimizing radioactive releases to the environment.

3. Plant layout, egress routes,Plant layout, access and egress routes with respect to 1) firefighting and local operator manual actions, 2) facility arrangements, and 3) structural design features whichthat provide separation or insolation of redundant systems important to safety.

4. Selection and design of fire detection, alarm, control and suppression systems on the basis of the fire hazards analysis; of design, testing, qualification, and maintenance of fire barriers, including penetration seals; of use of noncombustible materials; and of design of floor drains, ventilation, emergency lighting and communication systems.

5. The fire protection system piping and instrumentation diagrams (P&IDs)~~;~~, including with respect to redundancy of equipment~~;~~ and with respect to the fire protection design criteria and failure modes and effects analysis, including the potential effects of inadvertent discharge or failure of fire protection systems on ~~structure, systems, and components~~SSCs important to safety.

6. On multiple unit sites, fire protection and control provisions during construction, shutdown or decommissioning of the adjacent units~~ will be reviewed~~, in order to verify that the integrity and operability of the shared fire protection systems are maintained and that fire hazards associated with one unit will not have an adverse affect on the adjacent unit.

7. For operating plants and new design applications, ~~SPLB reviews the~~ post-fire safe-shutdown analysis, including~~;~~ the list of systems and components needed to provide post-fire safe~~-~~-shutdown capability~~,~~; the arrangement of the systems and components within the plant fire areas~~,~~; the separation between redundant safe~~-~~-shutdown systems and components~~,~~; the fire protection for safe~~-~~-shutdown systems and components~~,~~; and potential interactions between non-safety systems, fire protection systems, and systems important to safety for potential adverse effects on the safe~~-~~-shutdown capability. ~~Advanced~~New reactor designs must also meet the Commission's enhanced fire protection criteria as described in ~~the attached BTP. Applications submitted in accordance with the provisions specified in 10 CFR Part 52 must submit a design specific fire risk assessment in accordance with §52.47(a)(v).~~

~~8. SPLB reviews the fire protection program~~Appendix A to this SRP section.

8. FPP for shutdown and decommissioned reactors as part of the overall review of the decommissioning plans and activities under 10 CFR ~~Part 50, §50~~50.82. The ~~SPLB~~staff reviews the fire hazards analysis, fire protection systems and features, and other measures necessary to protect against the release of radioactive material as a result of fire adversely impacting spent fuel storage or radioactive wastes from plant decommissioning, dismantlement, or demolition.

~~9. SPLB reviews, in conjunction with the Probabilistic Safety Assessment Branch (SPSB), fire PRAs~~ The Office of Nuclear Reactor Regulation (NRR) has review responsibility during the initial stages of decommissioning. The Office of Nuclear Material Safety and Safeguards (NMSS), Division of Waste Management and Environmental Protection, Decommissioning Directorate, oversees the decommissioning program after the fuel has been removed from the plant spent fuel pool, including approval of license termination when decommissioning activities are successfully completed.

9. Inspection, Test, Analysis, and Acceptance Criteria (ITAAC). For design certification and combined license (COL) reviews, the applicant's proposed information on the ITAAC associated with the systems, structures, and components (SSCs) related to this SRP section is reviewed in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria - Design Certification." The staff recognizes that the review of ITAAC is performed after review of the rest of this portion of the application against acceptance criteria contained in this SRP section. Furthermore, the ITAAC are reviewed to assure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

10. COL Action Items and Certification Requirements and Restrictions. COL action items may be identified in the NRC staff's final safety evaluation report (FSER) for each certified design to identify information that COL applicants must address in the application. Additionally, DCs contain requirements and restrictions (e.g., interface requirements) that COL applicants must address in the application. For COL applications referencing a DC, the review performed under this SRP section includes information provided in response to COL action items and certification requirements and restrictions pertaining to this SRP section, as identified in the FSER for the referenced certified design.

11. Operational Program Description and Implementation. For a COL application, the staff reviews the final safety analysis report (FSAR) Table 13.x to ensure the fire protection program is included. The staff reviews the operational program description and the proposed implementation milestones. Specific to this SRP section are the fire protection program based on the requirements of 10 CFR 50.48.

Review Interfaces

The listed SRP sections interface with this section as follows:

1. Fire PRAs are reviewed as part of SRP Section 19.0, Probabilistic Risk Assessment. The organization responsible for review of the PRA may consult the organization responsible for fire protection.

2. Guidance for review of plant features that ensure safe shutdown in the event of an intentional attempt to damage plant SSCs (e.g., terrorist attack) is provided in SRP Section 13.6.

3. For COL reviews of operational programs, the review of the applicant's implementation plan is performed under SRP Section 13.4, "Operational Review."

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

The ~~application~~applicability of the following requirements and acceptance criteria in the conduct of the review is dependent on the type and scope of the submittal ~~being reviewed under this SRP Section~~. For operating reactors, power uprates and license renewals, the existing plant licensing basis, and specifically the fire protection license condition, establishes the applicability of the acceptance criteria listed below. For shut-down and decommissioned reactors, only a portion of the criteria is applicable, and the specific criteria of Regulatory Guide ~~1.191 should be followed as described in the BTP to this SRP section~~(RG) 1.191, “Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown,” should provide the basis for the review. For new applications, the criteria in paragraphs 1-6 below are applicable as modified by ~~the specific~~other relevant criteria, including the enhanced fire protection criteria of SECY ~~Papers; SECY~~ 90-016~~,~~ and SECY 93-087, as well as the passive plant safe-~~-~~shutdown criteria of SECY 94-084. ~~Submittals related to fire PRA are reviewed relative to the applicable specific criteria discussed below.~~

~~The applicant or licensee's fire protection program will generally be considered acceptable if it meets the applicable criteria established in the following:~~

~~1. 10 CFR Part 50, §50~~

The acceptance criteria included in previous revisions of this SRP section as Branch Technical Position SPLB 9.5-1 have been removed and have been incorporated in Revision 1 of RG 1.189, "Fire Protection for Nuclear Power Plants."

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. 10 CFR 50.48, "Fire protection," which ~~establishes~~requires that operating nuclear power plants have a fire protection plan that ~~meets~~satisfies General Design Criterion (GDC) 3 and also provides general requirements regarding the content of the fire protection plan and the applicability of 10 CFR Part 50, Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979."

2. 10 CFR ~~Part 50, §50~~50.48(f) establishes the criteria for a fire protection plan for those plants that have submitted the certifications required for license termination under §50.82(a)(1).

3. 10 CFR Part 50, Appendix A, GDC 3, "Fire Protection," establishes the criteria for the fire and explosion protection of ~~structures, systems, and components~~SSCs important to safety. GDC 3 also establishes the criteria for fire detection and ~~fire fighting~~firefighting systems and for the use of noncombustible and heat~~-~~-resistant materials throughout the unit.

~~4.~~ 4. 10 CFR Part 50, Appendix A, GDC 5, "Sharing of Structures, Systems, and Components," as it applies to shared fire protection systems and potential fire impacts on shared ~~structures, systems and components~~SSCs important to safety.

~~5.~~ 5. 10 CFR Part 50, Appendix A, GDC 19, "Control Room," as it applies to providing the capability both inside and outside the control room to operate plant systems necessary to achieve and maintain safe~~-~~-shutdown conditions.

~~6.~~

6. 10 CFR Part 50, Appendix A, GDC 23, "Protection System Failure Modes," as it applies to safe~~-~~-failure states of the protection system when exposed to adverse conditions associated with fire events or inadvertent operation of fire protection systems.

~~7.~~

7. 10 CFR Part 50, Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," which establishes the ~~fire protection program~~FPP requirements for nuclear power plants operating prior to January 1, 1979, subject to the

provisions in ~~§50~~10 CFR 50.48(b). Appendix R establishes, along with other fire protection requirements, the requirement to demonstrate that one success path of ~~structures, systems, and components~~SSCs necessary to achieve and maintain safe shutdown of the reactor ~~are~~is protected from the effects of fire. The substantive provisions of Appendix R, or portions thereof, may apply to plants licensed to operate after January 1, 1979, ~~as~~to the extent incorporated in or provided for in the fire protection licensing basis for the individual plants.

~~The following specific~~

8. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," which establishes regulatory requirements applicable to new reactors.

9. 10 CFR 52.47(a)(1)(vi), as it relates to ITAAC (for design certification) sufficient to assure that the SSCs in this area of review will operate in accordance with the certification.

10. 10 CFR 52.97(b)(1), as it relates to ITAAC (for combined licenses) sufficient to assure that the SSCs in this area of review have been constructed and will be operated in conformity with the license and the Commission's regulations.

11. 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste," which establishes regulatory requirements applicable to spent nuclear fuel and waste storage.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for each review described in Subsection I of this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide ~~information, recommendations, and guidance and in general describe a basis~~ acceptable ~~to the staff that may be used to meet the Commission's fire protection requirements:~~

~~1. Regulatory Guide 1.174~~methods of compliance with the NRC regulations.

1. RG 1.174, Revision 1, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis," as it applies to the use of PRA in support of changes to the fire protection licensing basis for nuclear power plants.

~~2. Regulatory Guide 1.188~~ Appropriate techniques for performing a Fire PRA are presented in NUREG/CR-6850 (EPRI TR-1011989), "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities."

2. RG 1.188, Revision 1, "Standard Format and Content for Applications to Renew Nuclear Power Plant Operating Licenses," as it applies to fire protection programFPP considerations for license renewal such as equipment aging issues. This Regulatory GuideRG endorses the guidance in Nuclear Energy Institute (NEI) document, NEI 95-10, Revision 36, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54 - The License Renewal Rule."

3. Regulatory GuideProposed RG 1.189, Revision 1, "Fire Protection for Operating Nuclear Power Plants," which provides comprehensive staff positions and guidelines on fire protection for operating nuclear power plants.

4. Regulatory GuideRG 1.191, "Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown," which establishes the fire protection objectives and staff positions for implementing fire protection for those nuclear power plants that have submitted the necessary certifications for license termination under 10 CFR Part 50, §50.82(a).82(a).

5. Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," as it applies to the FPP of any new reactor COL application submitted in accordance with 10 CFR Part 52.

6. Enhanced fire protection criteria for advanced light waternew reactor designs as documented in SECY 90-016, SECY 93-087, and SECY 94-084. 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. SECY 90-016 and SECY 93-087 were approved by the Commission in staff requirements memoranda (SRM). SECY 94-084, in part, establishes criteria defining safe--shutdown conditions for passive light water reactor designs.

In addition to the criteria listed above, each of these documents may contain additional guidelines that provide criteria applicable to the review of applicant or licensee

7. For COL reviews, the description of the operational program and proposed implementation milestone(s) for the fire protection programs. BTP SPLB 9.5.1 attached to this SRP provides a more comprehensive discussion of the criteria listed above and its application toprogram are reviewed in accordance with 10 CFR 50.48. The operational program for fire protection program reviewsshould be fully implemented prior to fuel loading.

III. REVIEW PROCEDURE

The coordinated review branches will provide input for the areas of review stated in subsection I of this SRP section. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete for the scope of review. PROCEDURES

The reviewer will select and emphasize material from this SRP sectionthe procedures described below, as may be appropriate for a particular case, and using the applicable guidelines of the attached BTP.

~~1. Operating Nuclear Power Plants~~

~~The following procedures describe the reviews to be performed for operating nuclear power plants. Regulatory Guide 1.189 provides methods acceptable to the staff for fire protection of operating plants. The BTP attached to this SRP section provides detailed guidelines to aid in these reviews.~~

~~a. SPLB reviews the overall fire protection program and fire hazard analysis to evaluate the potential impacts of fires and explosions on structures, systems, and components important to safety. This evaluation shall determine if the proposed fire protection program is adequate to protect against the identified hazards and provides reasonable assurance that the fire protection objectives identified~~.

For each area of review specified in subsection I of this SRP section ~~are accomplished.~~

~~b. SPLB reviews the fire protection, plant design, and layout drawings and records to verify that the facility arrangement, equipment locations, building construction, structural, and compartmentation features that affect the control and mitigation of fire hazards are acceptable for the protection of equipment important to safety.~~

~~c. SPLB reviews the safe shutdown analysis, including equipment lists, circuit routing and analysis, layout and separation of redundant shutdown systems and components, and post-fire safe shutdown procedures to determine if reasonable assurance is provided that safe shutdown can be achieved and maintained for postulated fires.~~

~~d. SPLB determines that the design criteria and bases for the fire protection systems and features for detection, confinement, control, and mitigation of fires and explosions and the products of combustion are in accordance with the BTP guidelines and provide adequate protection for structures, systems, and components important to safety. The reviewer determines that fire protection support systems such as emergency lighting, communications, floor drains, and ventilation systems are adequately designed consistent with this objective. SPLB reviews fire protection system design to verify that failure or inadvertent operation will not adversely impact structures, systems, and components important to safety.~~

~~e. For multiple unit sites, SPLB determines if adequate protection is provided for shared structures, systems, and components in accordance with GDC 5. SPLB also determines if adequate protection is provided to operating units during concurrent construction, shutdown or decommissioning of other units. This includes an evaluation of the total fire protection program for each plant as well as the overall program for the site.~~

~~f. SPLB in conjunction with SPSB will review fire PRAs in support of risk informed changes to the fire protection licensing basis (i.e., per Regulatory Guide 1.174).~~

~~2. New Plant Applications~~

~~a. Review of new applications will generally follow the procedures in subsection III.1 above.~~ , the review procedure is identified below. These review procedures are based on the identified SRP acceptance criteria. For deviations from these specific acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to the SRP criteria provide an acceptable method of complying with the relevant NRC requirements identified in subsection II.

For each type of submittal, the staff will conduct the review as follows:

1. New Reactor Applications

a. For applications submitted in accordance with 10 CFR Part 50, SPLBthe staff reviews the preliminary safety analysis report (PSAR) to determine if fire protection considerations are adequately incorporated in the proposed design. SPLB reviews the fire protection programand the FPP in the final safety analysis report (FSAR) to determine if fire hazards are appropriately identified and the fire protection program provides reasonable assurance that the fire protection objectives identified in subsection I of this SRP are accomplished. The BTP attached to this SRP section provides additional guidelines to support this review.

b. For standard. All applicable areas of review listed in Section I should be included in the review for a new reactor application. Reviews that cannot be performed adequately at the PSAR stage due to incomplete development of the FPP should be performed at the FSAR stage of the license application. See Appendix A for additional information.

b. For reviews of design certifications submitted in accordance withcertification and COL applications under 10 CFR Part 52, SPLB verifiesthe reviewer should follow the above procedures to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC)if applicable, site interface requirements, and combined license action items meet the acceptance criteria in subsection II. SPLB and SPSB will review the design specific fire risk assessment. The review of fire protection for standard. For design certifications will generally follow the procedures in subsection III.1 above with the exception that advanced reactor designs are reviewed to verify that the enhancedcertification applications, the reviewer should identify necessary COL action items. With respect to COL applications, the scope of the review is dependent on whether the COL applicant references a design certification, an ESP or other NRC-approved material, applications, and/or reports.

After this review, SRP Section 14.3 should be followed for the review of Tier I information for the design, including the postulated site parameters, interface criteria, and ITAAC.

c. For all submittals, the staff verifies that the fire protection criteria as described in subsection II of this SRP section and discussed in the attached BTP are also satisfied.

c. Review of standardprogram is fully described and that implementation milestones have been identified. The staff verifies that the program and implementation milestones are included in FSAR Table 13.x.

The staff will verify the satisfactory implementation of this program by inspection in accordance with NRC Inspection Manual Chapter IMC-2504, "Construction Inspection Program - Non-ITAAC Inspections."

The staff ensures that the program and associated implementation milestone(s) are included within the license condition on operational programs and implementation.

d. The staff provides any necessary support to the organization reviewing fire PRAs in support of new plant design certification applications will focus on identification of fire and explosion hazards inherent in the plant design, design of fire protection systems and features, fire protection provided for structures, systems, and components important to safety, including protection of systems and components necessary to achieve and maintain safe shutdown. The overall fire protection program, including such elements as organizational structure, administrative controls and procedures, quality assurance programs, and fire brigades are reviewed at the operating license stage.

3. Power Uprates

SPLB reviews applications for power uprates to ensure that the changes associated with the power uprate do not adversely affect the ability to achieve and maintain safe shutdown following a single fire. The BTP attached to this SRP provides guidance for this review.

4. License Renewal

SPLBand COL applications.

2. License Renewal

The staff reviews applications for license renewal to ensure that fire protection structures, systems, and componentsSSCs required for compliance with 10 CFR Part 50.48 are included within the scope of -license renewal as required underin accordance with 10 CFR Part 54.4(a). For those SSCs identified as being in scope SPLB then, the staff identifies those components whichthat are subject to an aging management review in accordance with 10 CFR Part CFR 54.21(a)(1). TheAppendix BTP attached to of this SRP provides guidelines for this review.

5. additional guidance for such a review. The staff provides any necessary support to the primary reviewing office for the review of fire PRAs in support of license amendment requests for plant life extension.

3. Power Uprates

The staff reviews license amendment requests for power uprate to ensure that the changes associated with the power uprate do not adversely affect the ability to achieve and maintain safe shutdown following a fire and that regulatory requirements for fire protection continue to be met. Changes to the plant's power level must be requested and approved via a license amendment, pursuant to 10 CFR 50.90, 50.91, and 50.92. Appendix D of this SRP provides additional guidance for such a review. The staff provides any necessary support to the primary reviewing office for the review of fire PRAs in support of power uprate license amendment requests.

4. License Termination

~~F~~The staff reviews the FPP for shutdown and decommissioning operations for those plants that have submitted the necessary certifications required by 10 CFR ~~Part 50, §50~~50.82(a)(1)~~, SPLB reviews the fire protection program for shutdown and decommissioning operations to verify that fire and explosion hazards are adequately identified and the fire protection program provides reasonable assurance that the hazards are controlled and the potential for release of radioactive material to the environment from fire or explosion is minimized in accordance with the acceptance criteria in subsection II. The BTP attached to this SRP section provides guidelines for review of fire protection programs~~. RG 1.191 provides additional guidance for review of FPPs for shutdown and decommissioning of nuclear power plants.

~~6~~5. Fire Protection Program ~~Changes, Deviations, and Exemptions~~

~~a. Program Changes and Amendments~~

~~If the licensee has adopted the standard license condition and incorporated the fire protection program in the FSAR, 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.~~

~~Regulatory Guide 1.189 defines "not adversely affect" as "maintaining sufficient safety margins" and references Regulatory Guide 1.174 for additional information. Regulatory Guide 1.174 defines maintaining sufficient safety margins as:~~

~~(1) codes and standards or their alternatives approved for use by the NRC are met ; or (2) safety analysis acceptance criteria in the licensing basis are met or proposed revisions provide sufficient margin to account for analysis and data uncertainty.~~

~~Amendment requests for changes that have the potential to affect the safety margin are reviewed to verify that the fire protection objectives continue to be met.~~

~~Relating item (1) above specifically to changes to the fire protection program under the standard license condition, changes that maintain compliance with the applicable National Fire Protection Association (NFPA) codes and standards that have been endorsed by the NRC, Appendix R to 10 CFR Part 50, Regulatory Guide 1.189, the applicable Branch Technical Positions, applicable NUREGs, other NRC approved or issued documents would be acceptable. Other documents approved or issued by the NRC 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., 50.48, Appendix R & GDC 3), and is consistent with the defense-in-depth philosophy for fire protection (see Section II.A of Appendix R). An assessment of the risk impact of the change would not be required to demonstrate compliance with item (1) of RG 1.174.~~

~~Relating to item (2) specifically to changes to the fire protection program to account for analysis and data uncertainty, the Standard Review Plan Chapter 19 provides the following general guidance: (a) It is shown that a phenomenon of concern cannot occur or is less likely to occur than originally thought; (b) It is shown that the amount of safety margin in the design is significantly greater than that which was assumed when the requirement or position was imposed and; (c) It is shown that the time available for operator actions is greater than originally assumed. Concerning item (a), due to the large uncertainty associated with its estimation, it is generally not acceptable for a licensee to base a change that results in a relaxation to the fire protection program solely on the predicted low likelihood of a fire occurring, unless the area impacted by the change is inerted (e.g. BWR drywell). Fire frequency is considered when assessing the significance of an inspection finding through the Significance Determination Process (See Inspection Manual Chapter 0609 Appendix F). Concerning item (b), if for example, in the original plant configuration and licensing basis a fire pump was originally credited~~

as rated for 3000 GPM at 120 psi, however the hydraulically most demanding plant area that is important to safety only requires 2500 GPM at 100 psi, the change to the lower flow and pressure rating would be acceptable, or if a barrier separating fire areas is credited in the licensing basis as having a rating of three hours, however consistent with the guidance provided in GL 86-10, the licensee has a valid analysis that provides reasonable assurance that a two hour rating is adequate to withstand the hazards in the area, it would be considered an acceptable change. Considering barriers that separate redundant shutdown trains in the same fire area a change in the rating from three hours to one hour would typically not be acceptable unless automatic suppression was provided in the area under consideration. Concerning item (c) replacement of fire protection systems or features with operator actions is typically not acceptable where redundant divisions required for safe shutdown are located in the same fire area unless alternative/dedicated shutdown capability is provided. The use of manual operator actions for alternative/dedicated shutdown capability should ensure that the additional burden placed on the operations personnel is small and the time period to perform the manual actions is not critical to plant safety. The substitution of repairs in lieu of installed fire protection systems and features for systems and components required to achieve and maintain cold shutdown would be acceptable provided the time to repair the cold shutdown capability did not exceed the limits prescribed in Appendix R. An assessment of the risk impact may or may not be necessary for satisfying the provisions under item (2) depending upon the nature of the change and the analysis used to justify the change.

It is the responsibility of the licensee to demonstrate that the change has not resulted in an adverse effect or a non-compliance with the applicable NRC requirements. In order to demonstrate that the change is acceptable, some sort of analysis is required. Failure to conduct the appropriate analysis by the licensee is a failure to meet the plant's fire protection license condition. The depth and scope of the analysis is dependent 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 is a failure to meet the plant's license condition.

b. Fire Protection Deviations

Plants licensed after January 1, 1979, that have adopted the standard fire protection license condition, do not need to request exemptions for alternative configurations. However, deviations from the applicable fire protection requirements or guidance should be identified and justified in the FSAR or FHA. The deviation may require a license amendment to change the license condition. Deviations submitted to the NRC for review and approval should include a technical justification for the proposed alternative approach. The technical justification should address the criteria described in Regulatory Guide 1.189, Positions 1.8.1 and 1.8.2. Only those deviations that adversely affect the ability to achieve and maintain safe shutdown in the event of a fire need prior approval by the NRC.

c. Fire Protection Program Exemptions

Plant-specific conditions may preclude compliance with one or more of the provisions specified in 10 CFR Part 50, 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 an adequate level of safety. The exemption request and attendant fire hazards analysis should provide a sound technical basis that clearly demonstrates that the fire protection defense-in-depth philosophy is appropriately maintained and that the exemption is technically justified. Regulatory GuideExemptions - Existing Plants

The staff reviews submitted requests for exemption from regulatory requirements applicable to the FPP in accordance with 10 CFR 50.12. The staff reviews the technical justification for the alternative approach and determines whether an exemption is appropriate under the 10 CFR 50.12 guidelines. RG 1.189 provides detailed criteria and guidelines for fire protection programreview of FPP exemption requests, including general conditions necessary for acceptance.

d. Changes to Design Certifications

Changes to fire protection program elements reviewed and approved

Where fire modeling or fire probabilistic risk assessment methodologies are used as a basis for an exemption request, the review of the exemption will consider the guidance and acceptance criteria for fire modeling provided in RG 1.189, as well as the guidance provided in this SRP, draft NUREG-1824/EPRI 1011999, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," and NUREG/CR-6850 (EPRI TR-1011989).

6. Fire Protection Program Exemptions - New Reactor Plants

The staff reviews exemptions to an approved certified design for a new reactor in accordance with the design certificationSection VIII of the appendix to 10 CFR 52 that is applicable to the specific certified reactor design. Exemptions from Tier 1 information are governed by the requirements of 10 CFR Part 52 must follow the change processes described in the regulation10 CFR 52.63(b)(1), which references the exemption approval process of 10 CFR 50.12.

7. Fire Protection Program License Amendments - New Reactors

The staff reviews license amendments for modifications to, additions to, or deletions from the terms of a new reactor COL, including the ITAAC, in accordance with 10 CFR 52.97(b)(2).

IV. EVALUATION FINDINGS

SPLBThe reviewer verifies that the applicant has provided sufficient information has been provided and that the review is adequate toand calculations (if applicable) support conclusions of the following type, to be included in the staff''s safety evaluation report:

a. Applications
. The reviewer also states the bases for those conclusions.

1. New Reactor Design Certifications and Combined Operating License Applications

The staff concludes that the fire protection program'sapplicant's FPP design criteria and basesassociated implementation are acceptable and meet the applicable requirements of 10 CFR CFR Part 50 and Part 50, §50.48 and52, and are consistent with Commission policy contained in SECY 90-016, SECY 93-087, and SECY 94-084 (plants with passive safe-shutdown), as well as other applicable acceptance criteria (staff should specify the applicable criteria depending on the type and scope of review). This conclusion is based onAs described above, the staff finds that the applicant meetinghas met the guidelines of the applicable Rregulatory Gguides and related industry standards. In meeting these guidelines the applicant has provided an acceptable basis for the design and location of structures, systems, and components

The applicant has demonstrated that safe shutdown can be achieved even assuming that all equipment in any one fire area (excluding the control room and reactor containment) will be rendered inoperable by fire and that re-entry into the fire area for repairs and operator actions is not possible. The applicant's design has provided an independent alternative shutdown capability that is physically and electrically independent of the control room. The applicant' design provides 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, the applicant's design ensures that smoke, hot gases, or the fire suppressant will not migrate into other fire areas to an extent that could adversely affect safe-shutdown capabilities, including operator actions.

The applicant has demonstrated that SSCs important to safety to minimize the probability and, including SSCs that are shared among multiple units, are adequately protected from the effects of fires and explosions;. The applicant's design has used noncombustible and heat resistant materials whenever practical; and has provided fire detection, suppression, and fire fightingfirefighting capabilities of appropriate capacity and capability to minimize the adverse effects of fire on structures, systems, and componentsSSCs important to safety. The applicant has demonstrated that structures, systems and components necessary to achieve post-fire safe shutdown are adequately protected from the effects of fires and explosions. In addition, the applicant has demonstrated that shared structures, systems, and components of the fire protection systems will not prevent their ability to perform their intended safety functions.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluations of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.

b. License Amendments

The staff concludes that the proposed change(s) (or amendments)ITAAC for the FPP provide reasonable assurance that the implementation of the FPP will be in accordance with the approved design and operational program descriptions (where applicable). The staff has included FPP and its implementation milestones within the license condition on operational program implementation.

The staff concludes that for differences between the licensee's FPP and the SRP acceptance criteria, the proposed alternatives provide an acceptable method of complying with the NRC regulations.

2. License Amendments and Exemption Requests

The staff concludes that the proposed exemption or amendment to the licensee's fire protection program areFPP is acceptable and that the fire protection programFPP continues to meet the applicable requirements of 10 CFR Part 50, 10 CFR Part 50, §50.48 and52, 10 CFR Part 54 and the enhanced fire protection requirements (new reactors), as well as other applicable acceptance criteria (staff should specify the applicable criteria depending on the type and scope of review). The staff has reviewed the licensee's analysis and justifications for the changes and concludes that the plant is still able to achieve and maintain safe--shutdown conditions orand to mitigate a radiological release following a fire.

c3. Shutdown/Decommissioning Fire Protection Programs

The staff concludes that the fire protection programFPP (or related changes) for shutdown and decommissioning of the plant is acceptable and meets the requirements of 10 CFR Part 50, §50 CFR 50.48(f) and other applicable acceptance criteria, including Regulatory Guide 1the guidance in RG 1.191. In meeting the acceptance criteria, the applicant for license termination has demonstrated that radioactive materials are adequately protected from the effects of fires and that potential radioactive hazards to the public, environment, and plant personnel are minimized.

For DC and COL reviews, the findings will also summarize (to the extent that the review is not discussed in other SER sections) the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable, and interface requirements and combined license action items relevant to this SRP section.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of exemption requests, license changes andamendments, license applications submitted, and other FPP-related submittals pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except in those cases in which the licensee or applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the methods described herein will be used by the staff in its evaluation of conformance with Commission regulations for fire protection.

The provision, 10 CFR Part 52, 10 CFR Part 54 and 10 CFR Part 72, as applicable. 10 CFR 50.34(h) requires that each application for a license docketed after May 17, 1982 should include an evaluation of the facility against the SRP of record, including identification and description of all differences between the design features, analytical techniques, and procedural measures proposed for a facility and those in the SRP acceptance criteria.

The provisions of this SRP section apply to reviews of applications docketed 180 dayssix months or more after the date of issuance of this SRP section.

Implementation schedules for conformance ~~to parts of~~with the ~~methods~~requirements or guidance discussed herein, if any, are contained in the referenced regulations~~ and~~, regulatory guides, and generic communications.

VI. REFERENCES

1. 10 CFR Part 50, ~~§50~~"Domestic Licensing of Production and Utilization Facilities."
   a. 50.12, "Specific exemptions"
   b. 50.34, "Contents of applications; technical information"
   c. 50.48, "Fire protection"

~~2. 10 CFR Part 50, §50~~ d. 50.82, "License ~~T~~termination"

   e. 50.90, "Application for amendment of license or construction permit"
   f. 50.91, "Notice for public comment; State consultation"
   g. 50.92, "Issuance of amendment"

2. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licences for Nuclear Power ~~Plants"~~ Plants."
   a. 52.47, "Contents of applications"
   b. 52.63, "Finality of standard design certifications"
   c. 52.79, "Contents of applications; technical information"
   d. 52.83, "Applicability of part 50 provisions"
   e. 52.97, "Issuance of combined licenses"

3. 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power ~~Plants"~~Plants."
   a. 54.4, "Scope"
   b. 54.21, "Contents of application - technical specifications"

4. 10 CFR Part 50, Appendix A, ~~General~~"General Design Criteria for Nuclear Power Plants."
   a. General Design Criterion 3, "Fire Protection"

~~6. 10 CFR Part 50, Appendix A,~~ b. General Design Criterion 5, "Sharing of Structures, Systems, and Components"

~~7. 10 CFR Part 50, Appendix A,~~ c. General Design Criterion 19, "Control Room"

~~8. 10 CFR Part 50, Appendix A,~~ d. General Design Criterion 23, "Protection System Failure Modes"

5. 10 CFR Part 50, Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979~~"~~"

~~10. Regulatory Guide 1.174~~."

6. 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste."

7. Branch Technical Position (BTP) SPLB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants." (Formerly BTP CMEB 9.5-1)

8. APCSB 9.5-1, Appendix A, "Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976."

9. ANS-58.23-200X, "Standard on Methodology for Fire PRA," American Nuclear Society (draft).

10. RG 1.139, "Guidance for Residual Heat Removal." (for Comment)

11. RG 1.174, Revision 1, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing ~~Basis"~~Basis."

12. ~~Regulatory Guide~~RG 1.188, Revision 1, "Standard Format and Content for Applications to Renew Nuclear Power Plant Operating ~~Licenses"~~Licenses."

13. ~~Regulatory Guide~~RG 1.189, Revision 1, "Fire Protection for ~~Operating~~ Nuclear Power ~~Plants"~~Plants."

14. ~~Regulatory Guide~~RG 1.191, "Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent ~~Shutdown"~~Shutdown."

15. RG DG-1145, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

16. NUREG-0933, "A Prioritization of Generic Safety Issues."

17. NUREG-1800, Revision 1, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants~~,~~."

18. NUREG-1801, Revision 1, "Generic Aging Lessons Learned (GALL) Report~~,~~."

19. NUREG-1824/EPRI 1011999, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications." (Draft for Comment)

20. NUREG/CR-6850 (EPRI TR-1011989), "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities."

21. SECY-90-016, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory ~~Requirements"~~ Requirements." (ML#003707849)

22. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) ~~Designs"~~Designs." (ML#003707849)

23. SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant ~~Designs"~~

~~BRANCH TECHNICAL POSITION (BTP) SPLB 9.5-1~~
~~GUIDELINES FOR FIRE PROTECTION FOR NUCLEAR POWER PLANTS~~
~~(Formerly BTP CMEB 9.5-1)~~

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PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the draft Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

APPENDIX A

Supplemental Fire Protection Review Criteria for Shutdown and Decommissioned Reactors 44
APPENDIX B: SupplementalNew Reactors

Unless specifically noted otherwise, the review guidance in this SRP section is applicable to the FPP for new reactor plants. This appendix provides additional guidance applicable to new reactor FPPs.

Many of the current fire protection requirements and guidelines for operating reactors were issued after the construction permits and/or operating licenses were approved by the Commission. The backfit of these requirements and guidelines to existing plant designs created the need for considerable flexibility in the application of the regulations on plant-by-plant basis. For new reactor designs, fire protection requirements, including the protection of safe-shutdown capability and the prevention of radiological release, can be readily integrated in the planning and design phase for the plant.

For applications submitted in accordance with 10 CFR Part 52, design elements of the FPP are addressed in the design certification process. During the design certification process, action items are identified that should be addressed by the combined license applicant. These commitments include action items to establish the FPP for protection of SSCs important to safety as well as the procedures, equipment, and personnel necessary to implement the program. These commitments include, but are not limited to, updating the fire hazards analysis to address final plant design and administrative program elements (e.g., licensee fire protection staffing and organization, quality assurance, procedures, fire prevention programs, and training); fire brigade and emergency response capability; the final design of fire protection systems and features; and the design and analysis of post-fire safe-shutdown capability.

The review of COL applications should also consider the guidance to applicants provided in DG-1145, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

1. Enhanced Fire Protection Review Criteria for Advanced Reactors 51
APPENDIX C:

Based on operational experience with existing reactors and insights from examination of internal fire events, the staff determined that fire protection for safe-shutdown capability should be enhanced for new reactor designs. The enhanced fire protection criteria were initially proposed to the Commission in SECY-90-016. This criteria was extended to the review of passive LWR designs in SECY-93-087. These criteria are as follows:

> Evolutionary advanced light water reactor (ALWR) designers must ensure that safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire and that re-entry 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 an independent alternative shutdown capability that is physically and electrically independent of the control room is included in the design. Evolutionary ALWRs must 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, the evolutionary ALWR designers must 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.

2. Passive Plant Safe-Shutdown Condition

As discussed in SECY-94-084, the definitions of safe shutdown as contained in the Commission's regulations and guidelines do not address the inherent limitations of passive residual heat removal systems.

In General Design Criterion (GDC) 34 of Appendix A to 10 CFR Part 50, the NRC regulations require that the design include a residual heat removal (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. The NRC promulgated these requirements to ensure that the RHR system is available for long-term cooling to ensure a safe-shutdown state.

Post-fire safe shutdown for currently operating LWRs is defined in RG 1.189 as those conditions specified in the Technical Specifications for Hot Standby [Pressurized Water Reactors (PWRs)], Hot Shutdown [Boiling Water Reactors (BWRs)], and Cold Shutdown. RG 1.139 specifies Cold Shutdown as 93.3 °C (200 °F) for PWRs and 100 °C (212 °F) for BWRs.

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 non-safety-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 should 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 should be capable of achieving and maintaining 215.6 °C (420 °F) or below for non-loss-of-coolant-accidents (non-LOCA) events. This safe-shutdown condition is predicated on demonstration of acceptable passive safety system performance and the acceptable resolution of regulatory treatment of non-safety systems that are necessary for long-term shutdown.

3. Applicable Industry Codes and Standards

In general, the FPP for new light water reactor designs should comply with the provisions specified in NFPA 804, "Fire Protection for Advanced Light Water Reactors," related 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. Where conflicts occur, the applicable regulatory requirements and guidance will govern. The standards of record related to the design and installation of fire protection systems and features sufficient 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.

4. Other New Reactor Designs

FPPs for proposed new non-light water reactor designs should meet the overall fire protection objectives outlined in RG 1.189 related to safe shutdown and radiological release, as well as the specific fire protection requirements where applicable. Fire hazards should be identified by the applicant, 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 safety should be protected in accordance with the enhanced criteria described above for light water reactors. Fire protection systems and features should be consistent with the RG 1.189 criteria to the extent a fire hazards analysis conducted by the applicant shows it to be necessary.

5. Fire Protection Program Implementation Schedule

Fire protection has been identified as an “operational program” in SECY-05-0197, “Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria.” However, only those elements of the FPP that will not be fully implemented until the completion of the plant should be addressed as an operational program. These elements may include, but are not limited to, the fire brigade capability, combustible and ignition source control program, procedures and pre-fire plans, and portable extinguishing equipment. The COL application should identify the operational program aspects of the FPP and the implementation schedule for each. The staff should develop a license condition with respect to the implementation milestones. In lieu of the implementation schedule, the applicant may propose inspections, tests, analyses, and acceptance criteria for these aspects of the program.

6. Risk-Informed Review of New Reactors

Review of existing reactors’ license applications included an assessment of the plants’ FPPs without guidance as to the relative risk significance of one aspect of the program over another. While the current fire protection regulations and guidance are risk-informed to a certain extent, they do not provide a basis for focusing staff resources on the most risk-significant areas of fire protection. The experience gained from regulating and inspecting existing plants has identified aspects of the plant FPPs that warrant more extensive review. In addition, while a risk-informed approach to new reactor design review should reflect the experience gained in connection with existing plants, the new reactors include significant design improvements that impact the FPP. These design improvements should also be considered when reviewing a license application for a new reactor plant. Finally, in addition to the Browns Ferry fire, there have been other notable plant fires that have provided insight with respect to specific nuclear plant fire risks and how to protect against them (see e.g., IN 2002-27, “Recent Fires at Commercial Nuclear Power Plants in the United States”). The following discussion of the relative risk significance of the various aspects of a plant FPP applies to all new reactors, whether or not they adopt a risk-informed, performance-based FPP.

6.1 Primary Focus of Staff Review

Since the new reactor approach to protection of post-fire safe-shutdown capability is to provide installed passive separation of redundant trains, the staff review should focus on the licensee's approach to train separation. The staff should review the detailed definition of train separation; the method of identifying which systems, components and circuits need to be separated; the assumptions upon which adequate separation is determined; the design and testing of the separation barriers; the approach when full separation is not feasible; the method of verifying that the separation barrier is installed and maintained properly; and the method of verifying that the as-built cable routing provides the separation necessitated by the design.

6.2 Aspects of New Reactor Fire Protection Programs that Reduce Fire Risk

The overall maturity of fire protection regulation, nuclear plant operation, and analysis methods and the opportunity to incorporate the benefits in the original plant design will greatly enhance new reactor plant safety. The following aspects of the new reactor FPPs will also enhance post-fire plant safety and should be considered by the staff when reviewing license applications:

a. The enhanced fire protection concept and fully-separated 4-train design reduce the safety significance of fire detection/suppression systems, fire brigade response, and other aspects of the FPP for the areas of the plant where the enhanced level of fire protection is provided.

b. Where the plant's design includes an additional safe-shutdown train to ensure safe-shutdown capability when one train is out for maintenance (i.e., there are at least three 100%-capacity redundant trains) and one train fails due to fire, the maintenance downtime for any one train is likely to be a small percentage of total operating time. Consequently, there may be a high probability that even with loss of one train from fire, an extra train beyond the minimum required for safe shutdown will be available.

c. Since the fire protection regulations are being incorporated in the original design rather than being backfitted to existing plants, use of the plant change process should be greatly reduced, which should reduce the potential risk increases due to changes.

d. Post-fire, safe-shutdown circuit analysis should be greatly simplified, reducing the potential for errors.

e. Full train separation should significantly reduce security concerns associated with a fire by reducing access needs.

f. Extensive use of fiber optics should greatly reduce the likelihood of hot shorts and spurious actuations - this development is particularly significant in the control room where full separation of trains is not possible.

g. Use of fiber optics also reduces the fire area combustible loadings and thus the challenge to fire barriers.

h. The enhanced fire protection approach should greatly reduce the importance and scope of previously contentious fire protection issues such as operator manual actions and multiple spurious actuations.

i. The concept of alternative/dedicated shutdown systems, widely used in current reactors, should be virtually eliminated for new reactors (except for a control room or containment fire).

j. Enhanced fire protection attention to smoke migration and smoke damage should reduce the contribution of these phenomena to overall fire risk.

k. The increased level of passive protection necessary for new reactor designs reduces the potential contribution to overall fire risk from delay in applying water to electrical fires.

l. Use of digital control systems greatly reduces the number and size of electrical cabinets in the control room, reducing (likely to a significant extent) the fire ignition frequency in this critical area.

m. Where used, gel-type batteries virtually eliminate the hydrogen gas explosion hazard in plant battery rooms.

n. Reactors with passive shutdown systems have reduced combustible loading, reduced ignition sources, and reduced potential for fire-induced equipment failure.

o. Use of PVC and other non-IEEE 383 rated cable jacketing and insulation should be minimized.

p. The Advanced Boiling Water Reactor (ABWR) and the Economic Simplified Boiling Water Reactor (ESBWR) design plants have no external reactor coolant pumps, eliminating a major fire hazard inside containment. In addition, the containment atmosphere during operation of the ABWR and ESBWR is inerted as with the existing BWR plants.

6.3 Risk-Informed Post-Fire Safe-Shutdown Circuit Analyses

RIS 2004-03, Rev. 1, "Risk-Informed Approach for Post-Fire Safe-Shutdown Circuit Inspection," was issued to provide NRC inspectors with guidance in performing risk-informed inspections of existing plant post-fire safe-shutdown circuit protection. This guidance may also be considered in the review of new reactor circuit analyses; however, it is important to note that the guidance in this RIS is not a basis for regulatory compliance. The guidance optimizes inspector resources by identifying the most risk-significant circuit configurations and cable materials. A plant (including a new reactor) that has not adopted a risk-informed, performance-based FPP may not apply the information included in this RIS to deviate from regulatory requirements without the review and approval of the NRC in accordance with the exemption process (10 CFR 52.63(b)(1) and 10 CFR Part 52.93, as applicable). NUREG/CR-6850 provides guidance with respect to fire PRA that may be applied to a risk-informed post-fire safe-shutdown circuit analysis. The staff may consider the information in RIS 2004-03, Rev. 1 and NUREG/CR-6850 when evaluating exemption and license amendment requests that are based on risk-informed methodologies.

6.4 Additional Risk Consideration for New Reactor Fire Protection Programs

Turbine buildings remain potentially high-fire-risk areas in new reactor plants. Consideration should be given to the potential risk to adjacent safety related buildings and to ensuring control room or remote shutdown station habitability in the event of a major turbine fire.

7. Fire Protection for Non-Power Operation

NRC regulations and guidance do not specifically address fire protection during non-power 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 guidance for fire prevention in Regulatory Position 2 of RG 1.189 is applicable 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 non-power mode of operation, the plant can be maintained in a safe and stable condition.

8. Fire Protection System as Backup to Safety-Related Systems

Where a portion of the fire protection system provides required backup to a safe-shutdown system (e.g., makeup to a passive shutdown cooling system), it must meet the design basis requirements and other regulatory requirements of the safe-shutdown system for which it is providing backup. Although the fire protection system must be designed to perform both the required safe-shutdown function and the required fire protection function, the system need not be designed to perform both functions simultaneously.

9. Alternative Designs and Non-Applicable Acceptance Criteria

The new reactor designs that have been reviewed by the NRC have proposed FPP approaches for specific areas of the plant that are not in accordance with the acceptance criteria in RG 1.189. In addition, some of the acceptance criteria in RG 1.189 are not applicable to some reactor designs. The following are examples of alternative designs that have been accepted by the NRC and plant design features for which the acceptance criteria do not apply. These are examples and may not include all cases.

9.1 Alternative Designs

a. At least one new reactor design has been certified by the NRC without meeting the guidance in RG 1.189, Regulatory Position 6.1.2.2, to provide detection in control room cabinets and consoles. The acceptance of this approach was based on the low combustible loading in these cabinets and on the continuous occupancy of the control room, which allows rapid detection and response to a fire in the control room. Acceptance of a similar alternative design for other new reactor designs should be based on the fire hazards analysis.

b. At least one new reactor design has been certified by the NRC without meeting the guidance in RG 1.189, Regulatory Position 6.1.2.1, to provide area automatic fire suppression for control room under-floor areas and ceiling areas. The acceptance of this approach was based on the low combustible loading in these areas and on the continuous occupancy of the control room, which allows rapid detection and response to a fire in the control room. Acceptance of a similar alternative design for other new reactor designs should be based on the fire hazards analysis.

c. At least one new reactor design has been certified by the NRC without meeting the guidance in RG 1.189, Regulatory Position 6.1.2, to provide automatic water suppression in peripheral rooms in the control room complex. The acceptance of this approach was based on the low combustible loading in these areas and on the continuous occupancy of the control room, which allows rapid detection and response to a fire in the control room complex. Acceptance of a similar alternative design for other new reactor designs should be based on the fire hazards analysis.

d. The standpipes and hose stations serving the ESBWR containment are located outside of the containment (the acceptance criteria in RG 1.189, Regulatory Position 6.1.1.2, state that the standpipe and hose stations should be located outside of the drywell). The staff found this arrangement to be acceptable because it provided the capability to reach all areas inside the containment with at least one hose stream. The ESBWR containment is inerted during normal power operation and there are multiple access hatches around the perimeter of the containment. This arrangement may also be acceptable for other new reactor designs with inerted containments if the staff finds access and hose station capability is acceptable.

9.2 Non-Applicable Acceptance Criteria

a. In at least one new reactor design (ESBWR), the standby diesel generators are not required for safe shutdown. If these diesel generators are not important to safety, the guidance in RG 1.189 for diesel generator rooms is not applicable (unless the fire hazards analysis identifies an exposure hazard from the cable spreading room to adjacent areas containing equipment or cables important to safety). The staff should consider the diesel generators' importance to safety, as well as the potential impact on adjacent SSCs, when reviewing the fire protection provisions for these areas.

b. Cable spreading rooms typically include circuits that are important to safety and that, therefore, should be protected from fire in accordance with the acceptance criteria. The cable spreading rooms in at least one new reactor design (ESBWR) do not contain any electrical cables or equipment important to safety. The guidance in RG 1.189 for cable spreading rooms is not applicable to these cable spreading rooms (unless the fire hazards analysis identifies an exposure hazard from the cable spreading room to adjacent areas containing equipment or cables important to safety). The staff should consider the cable spreading rooms' importance to safety, as well as the potential impact on adjacent SSCs, when reviewing the fire protection provisions for these areas.

APPENDIX B

A. INTRODUCTION

The primary objective

The purpose of this appendix is to provide guidance on the review of the fire protection program at U.S. nuclear plants is to minimize both the probability of occurrence and the consequences of fire. To meet these objectives, the fire protection programs are designed to provide reasonable assurance, through defense-in-depth, that a fire will not prevent the performance of necessary safe shutdown functions and that radioactive releases to the environment in the event of a fire will be minimized.

The NRC's regulatory framework for nuclear plant fire protection programs is a number of regulations and supporting guidelines, including, but not limited to, 10 CFR Part 50, §50.48, 10 CFR Part 50, Appendix A, General Design Criterion 3 (GDC 3), 10 CFR Part 50, Appendix R, various regulatory guides, generic communications (e.g., Generic Letters, Bulletins, and Information Notices), NUREG reports, and industry standards. This BTP and the associated Standard Review Plan (SRP) Section 9.5.1, provide guidelines for staff review of applicant and licensee fire protection programs and related submittals. Since all the fire protection regulations promulgated by the NRC are not applicable to all plants, the review guidelines contained within this BTP are characterized as recommended practices and not as strict regulations or requirements. Reviews of fire protection programs for operating reactors, including those for license renewal, should be conducted in the context of the current licensing basis for the plant. Reviews for new plant applications, including standard design certifications should be reviewed to the guidelines in this BTP. For those reactors that are permanently shutdown and are subject to the requirementssystem in an application for renewal of a nuclear power plant operating license submitted in accordance with the provisions of 10 CFR Part 54, "Requirements for Renewal of Operating Licences for Nuclear Power Plants." RG 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 RG endorses the methods contained in NEI guideline, NEI 95-10, "Industry Guideline for Implementing the Requirements of 10 CFR Part 50, §50.82, "License Termination," the plants are assumed to be operating to an approved54 - The License Renewal Rule," Revision 6, June 2005. NUREG-1800, Revision 1, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" and NUREG-1801, Revision 1, "Generic Aging Lessons Learned (GALL) Report" also provide review guidance for license renewal applications.

10 CFR 54.4(a)(3), states, in part, that SSCs relied on in safety analyses or plant evaluations to perform a function that demonstrates compliance with the Commission's regulations for fire protection program at the time operations are ceased. The(10 CFR Part 50.48) are within the scope of the rule.

NUREG-1800 and NEI 95-10 provide the methodology for scoping and screening of fire protection objectives for these plants are modified from protection of structures, systems and components important to safety and necessary for safe shutdown, to minimizing the potential for fire inducedSSCs. When evaluating license renewal applications, it is important to note that the scope of SSCs included in 10 CFR Part 50.48 goes beyond the protection of only safety-related equipment. In accordance with General Design Criterion (GDC) 3, "Fire Protection," the scope of equipment required to comply with 10 CFR Part 50.48 is broad and also includes fire protection SSCs needed to minimize the effects of a fire and to prevent the release of radioactive materials that could result in a radiological hazard to the public, environment, or plant personnel. Guidelines for the review of fire protection for permanently shutdown plants are provided in Appendix A to this BTP.

Section B, Background, 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, Firematerial to the environment - i.e., equipment "important to safety." If applicable, the scoping methods used by an applicant should include review of any commitments made for compliance with Appendix A to Branch Technical Position APCSB 9.5-1, "Guidelines for fire Protection for Nuclear Plants Docketed Prior to July 1, 1976," or 10 CFR Part 50, Appendix R, "Fire Protection Program Review Guidelines, provides guidance for review of fire protection programs, and the elements thereof, that are considered to provide an acceptable level of fire protection for nuclear power plants. The guidance provided is a compilation of the fire protection requirements and guidelines from the existing regulations and staff guidance and not all of these guidelines may be applicable to the type or scope of review (e.g., operating reactor, license renewal, new application, plant shutdown and/or decommissioning). The guidelines in Section C follow closely the content of Regulatory Guide 1.189 for operating nuclear power plants, which provides comprehensive guidance for nuclear plant fire protection programs. Not all of the information, criteria and guidance will apply to a given review and therefore, it is the reviewer's responsibility to select the information applicable to the scope of review. The appendices to this BTP provide additional review guidance for specific, unique, or expanded fire protection program criteria.

Section D, Glossary, contains terms and definitions used in this BTP.

This BTP has been developed to provide comprehensive review guidance for nuclear power plant fire protection programs. This guidance identifies the scope and depth of fire protection that the Commission considers acceptable for nuclear power plants. This guidance may be used for review of existing fire protection programs and program elements, proposed changes to existing programs that are subject to NRC review, new applications, fire vulnerability analyses [e.g., fire probabilistic risk assessments (PRA)], and programs for plant shutdown and decommissioning. Risk-informed and performance-based alternatives to the guidance presented in this regulatory guide may be acceptable and are evaluated on a case-by-case basis.

B. BACKGROUND

1. Fire Protection Regulatory History

During the initial implementation of the U.S. nuclear reactor program, regulatory acceptance of fire protection programs 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 important to safety. GDC 3 addresses fire protection requirements and specifies, in part, that (1) structures, systems, and components important to safety must be designed and located to minimize the probability and effects of fires and explosions, (2) noncombustible and heat-resistant materials be used wherever practical, and (3) fire detection and suppression systems be provided to minimize the adverse effects of fires on structures, systems, and components important to safety. However, during this early stage of nuclear power regulation, given the lack of detailed implementation guidance for this general design criterion, the level of fire protection was generally found to be 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 (i.e., a candle) 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 extinguished using 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 (40 feet) by 6.1 m (20 feet). More than 1600 cables, routed in 117 conduits and 26 cable trays, were 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, both in the design of fire protection features and in licensee 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”), the NRC Browns Ferry special review team recommended that the NRC (1) develop detailed guidance for implementing the general design criterion for fire protection and (2) conduct a detailed review of the fire protection program at each operating nuclear power plant, comparing it to the guidance developed.

In May 1976, the NRC issued Branch Technical Position (BTP) APCSB 9.5-1, 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. As part of this action, the staff requested each licensee to provide an analysis that divided the plant into distinct fire areas and demonstrated 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, 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 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 evaluation that included a fire hazard analysis. These analyses were reviewed by the staff using the guidelines of Appendix A to APCSB 9.5-1. The staff also conducted inspections of operating reactors to examine the relationship of structures, systems, and components important to safety with the fire hazards, potential consequences of fires, and the fire protection features. After reviewing licensee responses to the BTP, the staff determined that additional guidance on the management and administration of fire protection programs was necessary, and in mid-1977, issued Generic Letter 77-002, which provided criteria used by the staff in review of specific elements of a licensee's fire protection program, including organization, training, combustible and ignition source controls, firefighting procedures and quality assurance. Many fire protection issues were resolved during the BTP review process, and agreements were included in the NRC-issued safety evaluation reports (SERs).

By the late 1970s to early 1980, the majority of operating plants had completed their analyses and implemented most of the fire protection program 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 adopt some of the 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 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 NRC fire protection requirements.

In November 1980, the NRC published the "Fire Protection" rule, 10 CFR Part 50.48, which specified broad performance requirements, as well as Appendix R, "Fire Protection Program fFor 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. 45, No. 1&5, May 22, 1980), Appendix R would have applied to all plants licensed prior to January 1, 1979, including those for which the staff had previously accepted the."

10 CFR Part 54.21 states that for those components with intended functions that are identified within the scope of license renewal, those components which are passive (do not perform their functions with moving parts) and long-lived (are not subject to replacement based on qualified life or routine replacement) are subject to an aging management review (AMR). Examples of 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 of the fifteen items in Appendix R were of such safety significance that they should apply to all plants (licensed prior to January 1, 1979), including those for which alternative fire protection actions had been approved previously by the staff. These items are fire protection of safe shutdown capability (including alternative, dedicated, or backup shutdown systems), emergency lighting,

and the reactor coolant pump 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. 45, Nov. 19, 1980)†. The remaining provisions of Appendix R did not apply provided that the fire protection features proposed or implemented by the licensee for those provisions had been accepted by the NRC staff in a safety evaluation. In addition, the rule provided for an exemption process that could be used by a licensee provided that a requiredcomponents which are passive and long-lived, and that, therefore, would be subject to an AMR, include fire barrier assemblies (e.g. ceilings, damper housing, doors, floors, penetration seals and walls), sprinkler heads, fire suppression system piping and valve bodies, and 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 Part 50.48(c)(6)). Under this process, if the Director, Office of Nuclear Reactor Regulation, determined that a licensee has made a prima facie showing of a sound technical basis for such an assertion, then the implementation dates of the rule were delayed until final Commission action on the exemption request. Appendix R to 10 CFR Part 50 and 10 CFR Part 50.48 became effective on February 17, 1981.

During the initial backfit of the fire protection regulations, the NRC approved a large number of 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 became 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, 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, the detailed implementing guidance, the plant-by-plant review, and finally the issuance and backfit of the fire protection regulations 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 1979, and have 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. These plants were typically reviewed to the guidelines of Standard Review Plan (NUREG-0800) Section 9.5.1, which subsumed the criteria specified in Appendix R. In July 1981, the NRC issued a major revision to NUREG-0800 for use in review of new license applications. This 1981 revision included Standard Review Plan (SRP) Section 9.5.1 with Branch Technical Position CMEB 9.5-1 as an update to the earlier fire protection BTPs. This document is a revision to the 1981 version of the SRP.

Following promulgation of 10 CFR Part 50.48 and Appendix R, the staff issued Generic Letter 81-12 (February 20, 1981) and later its associated clarification letter (March 22, 1982). In these letters, the staff identified the information necessary to perform their 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 81-12 also requested that technical specifications be developed for safe shutdown equipment that was not already included in the existing plant technical specifications.

~~Most licensees requested and were granted additional time to perform their re-analysis, 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 differences were identified in the staff's draft SERs and were discussed on several occasions with the cognizant licensees. These discussions culminated in the issuance of Generic Letter 83-33 (October 19, 1983).~~

~~Certain licensees disagreed with, or found it difficult to implement, the interpretations provided in Generic Letter 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, and disagreements in the implementation of interpretations provided in Generic Letter 83-33, the Nuclear Utility Fire Protection Group requested interpretations of certain Appendix R requirements and provided a list of questions to be discussed with the industry. The NRC responded by holding workshops in each Region to assist the industry in understanding the NRC's requirements and to improve the staff's understanding of the industry's concerns. The results of these workshops and the Steering Committee's findings and recommendations for addressing ongoing fire protection issues were documented in Generic Letter 85-01. Generic Letter 85-01 included a proposed Generic 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 revised and later issued as Generic Letter 86-10, "Implementation of Fire Protection Requirements," on April 24, 1986.~~

~~Also included in Generic Letter 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 without prior notification to the NRC in accordance with the provisions of 10 CFR Part 50.59, provided the changes did not adversely affect the plant's ability to achieve and maintain post-fire safe shutdown. The licensee, upon modification of the license to adopt the standard condition, could also amend the license to remove the fire protection technical specifications. Generic Letter 88-12, "Removal of Fire Protection Requirements from Technical Specifications" (August 2, 1988), gave licensees additional guidance for implementation of the standard license condition and removal of the technical specifications associated with fire detection and suppression, fire barriers, and fire brigade staffing. 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.~~

~~Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities - 10 CFR Part 50.54(f)," was issued to licenses on November 23, 1988 requesting that licensees perform individual plant examinations to identify plant-specific vulnerabilities to severe accidents and appropriate corrective actions, if any. Based on knowledge gained in the IPE process and concerns associated with the risk of external events, Supplement 4 to Generic Letter 88-20 was issued in June of 1991 requesting, in part, that IPE for external events, or IPEEE, be performed for internal fires. The primary objectives of the IPEEE were for licensees to (1) develop an appreciation of severe accident behavior, (2) understand the most likely severe accident sequences that could occur at the plant under full power operating conditions, (3) gain a~~

qualitative understanding of the overall likelihood of core damage and radioactive material release, and (4) if necessary, reduce the overall likelihood of core damage and radioactive material releases by modifying hardware and procedures that would help prevent or mitigate severe accidents.

As plants approach the end of their operating license, licensees are determining that license extension is a viable economic alternative to permanent plant shutdown. 10 CFR Part 54 provides the Commissions regulations with regard to license renewal. License renewal, in part, requires the licensee to address potential aging issues for certain equipment important to safety as identified in the rule. Fire protection related equipment necessary to meet the Commission's fire protection regulations are included within the scope of the rule. Regulatory Guide 1.188, industry guideline NEI 95-10, NUREGs 1800 and 1801 provide guidance for meeting the license renewal requirements including those applicable to fire protection.

During the late 1980s and early-mid 1990s, the NRC staff reviewed several design certification applications for advanced reactor designs. During these reviews, it became evident that revised or updated fire protection criteria was necessary and appropriate to address past generic issues and the new design concepts. The staff's recommendations to the Commission for revised or enhanced fire protection are documented in several SECY papers including, SECY-90-16, SECY-93-087, and SECY-94-084.

In August of 1996, the NRC amended its rules applicable to decommissioning and subsequent termination of licenses for nuclear power plants. Included in the amendment were changes to the fire protection rule, 10 CFR Part 50.48, to establish the fire protection requirements for nuclear power plants that have permanently terminated operations. Regulatory Guide 1.191 was subsequently issued in May 2001 providing additional guidance for implementation of the fire protection regulations for permanently shutdown reactors.

In April 2001, the Commission issued Regulatory Guide 1.189, which was developed to consolidate the fire protection requirements and guidance for operating nuclear power plants that had been developed over the years. The Regulatory Guide addresses the requirements specific to fire protection for operating plants, and thus, does not address the IPEEE, license renewal, decommissioning, or enhanced fire protection requirements discussed above.

As illustrated in the preceding discussion, the Commission's fire protection requirements and guidelines consist of a multitude of rules, regulatory guides, generic communications, staff guidance, and other related documents. This BTP is intended to compile the Commission's requirements and guidelines into comprehensive review guidance that directly, or via reference, will support the reviewer in determining the adequacy of fire protection programs or related submittals for new designs, operating plants, license renewal, or permanently shutdown nuclear power plants.

2. Fire Protection Program Goals and Objectives

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 or result in release of radioactive materials to the environment.

3. Fire Protection Program Performance Goals

3.1 Safety-Related Structures, Systems, and Components

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.

3.2 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.

For advanced reactor designs, safe shutdown must be achieved assuming all equipment in any one fire area will be rendered inoperable by fire and post-fire re-entry for repairs or operator actions is not possible.

For passive light water reactor designs that rely on natural circulation and heat transfer to remove reactor decay heat, safe shutdown is defined in SECY 94-084 and Appendix B of this BTP.

3.3 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 as defined in Appendix A to 10 CFR Part 50. Requirements for protection against radiation during normal operations are specified in 10 CFR Part 20. Anticipated operational occurrences should not result in radiological consequences, and the exposure criteria of 10 CFR Part 20 apply. Prevention of 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 fire protection program.

4. Regulatory Requirements

There are a number of regulatory requirements with applicability to the development and implementation of fire protection programs for nuclear power plants. These requirements are identified in the Acceptance Criteria, Subsection II, of SRP 9.5.1. The criteria applicable to a particular review is dependent on the type and scope of the review being performed and the plant specific licensing basis. Section C and the appendices to this BTP provide additional discussion on the application of specific requirements and criteria to a particular type of review (e.g., operating reactor, license renewal, license termination, or new designs).

5. Fire Protection 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, operating status, or applications.

Regulatory Guide 1.189, Section B, provides considerable discussion on the fire protection licensing and design basis for operating nuclear power plants. As discussed in B.1 above, Regulatory Guide 1.189 was developed to provide comprehensive guidelines identifying current staff positions on fire protection of operating nuclear power plants. Reviews of operating reactors are conducted in the context of the current licensing basis with this BTP and the Regulatory Guide as tools to assist in evaluating the adequacy of the licensee's program.

The fire protection licensing and design basis under license renewal should not differ significantly from that in effect prior to renewal with the exception that fire protection structures, systems and components must be included in an aging management program as appropriate. Appendix C to this BTP provides review guidelines for license renewal.

The fire protection licensing and design basis for plants requesting power uprates should not differ significantly from the basis in effect prior to the uprate request. The review of changes resulting from the power uprate must insure that safe shutdown capability is ensured. Appendix E to this BTP provides review guidelines for license renewal.

For those plants which are permanently shutdown and/or are undergoing decommissioning, the licensing basis is modified in accordance with the requirements in 10 CFR Part 50, §50.82. Fire protection for permanently shutdown reactors is governed by 10 CFR Part 50, 50.48(f) and the guidelines in Regulatory Guide 1.191. The fire protection objectives as listed in 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.

The design certification and combined license application requirements for advanced reactor designs are provided in 10 CFR Part 52. Fire protection for these designs must meet the requirements of 10 CFR Part 50.48(a) and 10 CFR Part 50, Appendix A, General Design Criterion 3, to provide an enhanced level of fire protection beyond that provided for currently operating reactors, and is reviewed to the applicable guidelines in this BTP.

6. Assumptions of Fire Occurrence

6.1 Postulated Fire and Fire Damage

Fire damage to safe shutdown equipment or fires with the potential to result in release of radioactive materials to the environment are 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 or 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 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.

Damage limits for hot shutdown and cold shutdown systems and components are described in the safe shutdown review guidelines in this BTP. 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. 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 systems and features cannot be provided to ensure that safe shutdown capability will be preserved.

6.2 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 with severe natural phenomena 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, unrelated fires in two or more units need not be postulated to occur simultaneously. Fires involving facilities shared between units and fires caused by natural or man-made events that have a reasonable probability of occurring and affecting more than one reactor unit should be considered.

6.3 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.

As described in Position 5.6.1 of Regulatory Guide 1.189, alternative shutdown capability should accommodate post-fire conditions where offsite power is available and where offsite power is not available for 72 hours. 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.

Reliance on station blackout to accomplish safe shutdown objectives is discussed in Section C.2.6.

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

Fire damage to structures, systems, and components can result from heat, smoke, ignition, or suppression activities. When using a performance-based or risk-informed approach, the fragility of structures, systems, and components to fire damage, including the ability to recover affected structures, systems, and components, should be considered.

C. FIRE PROTECTION PROGRAM REVIEW GUIDELINES

This section of the BTP provides review guidelines that address the various elements of a fire protection program for nuclear power plants. These guidelines are written to cover elements that are generally required of programs for plants that have been licensed to operate, although fire hazard analysis, safe shutdown analysis, and fire protection design elements described herein are applicable to new applications as well. Although new license applications or applications for certifications of new designs will not likely include details of organizational fire protection responsibilities and fire protection related administrative procedures, the applications should include appropriate commitments to these elements.

As stated above, this section is structured to address review of fire protection for operating plants and new designs. Reviews to address special cases such as license renewal applications, shutdown/decommissioning plans (i.e., license termination), and fire PRA submittals should follow the guidelines in the attached appendices.

1. Fire hazards analysis

A fire hazards analysis should demonstrate that the fire protection objectives are accomplished.

1.1 The fire hazards analysis objectives

a. Identifies potential in situ and transient fire hazards;

b. Specifies measures for fire prevention, detection, suppression, and confinement for fire areas containing structures, systems, and components important to safety; and;

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

1.2 Fire hazard analysis scope and content

The fire hazards analysis verifies that the NRC fire protection program guidelines have been met. The analysis should identify and justify any deviations from regulatory guidelines. Justification for deviations from the regulatory guidelines should show that an equivalent level of protection will be achieved. 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.

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

a. The NRC fire protection requirements and guidance that apply.

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

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 structures, systems, and components important to safety to damage from the effects (e.g., heat, flame, smoke) of fires. Wildfire hazards should be addressed if there is the potential for a wildfire to damage SSCs important to safety.

c. The design, installation, operation, testing, and maintenance of automatic fire detection and suppression capability. The fire hazard analysis should describe the level of automatic protection provided relative to the specific fire hazards that have been identified.

d. Manual suppression capability, including systems (e.g., hydrants, standpipes, extinguishers), fire brigades, manual firefighting equipment, plans and procedures, mutual aid, and accessibility of plant areas for manual fire fighting.

e. 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).

f. Fire area layout and identification of fire barriers. Fire barrier design (e.g., materials, configuration, components, and qualification testing), installation, inspection, maintenance, and testing.

Fire area construction (walls, floor, ceiling, dimensions, volume, ventilation, and congestion). The fire hazard analysis should provide sufficient information to determine that fire areas have been properly selected based on the hazards present and the need for separation of structures, systems, and components important to safety.

g. Layout and configurations of structures, systems, and components important to safety. The protection for safe shutdown systems within a fire area should be determined on the basis of the worst case fire 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 components important to safety. Fire development should consider the potential for involvement of other combustibles, both fixed and transient, in the fire area. The extent of such damage should be evaluated in the fire hazards analysis and should consider exposure to fire, heat, smoke, or water. The analysis should consider the degree of spatial separation between redundant shutdown systems, the combustibles present, 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 effects of the postulated fire should be evaluated with and without actuation of the automatic suppression system.

h. Potential fire impacts on operations, including:

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

2. Fire conditions that may necessitate evacuation from areas that are required to be attended for safe shutdown,

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

i. 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-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."

j. Availability of oxygen (e.g., inerted containment).

k. Alternative, dedicated, or backup shutdown capability for those fire areas where adequate separation of redundant safe shutdown systems cannot be achieved.

2. Safe Shutdown Capability

The fire protection program, and specifically the fire hazard analysis or safety analysis report, must describe the protection of structures, systems, and components important to safety such that post-fire safe shutdown of the plant can be achieved and maintained. Safe shutdown objectives and guidelines for operating reactors are described in detail in Regulatory Guide 1.189. For advanced reactor designs, the fire protection and safe shutdown design must also meet the enhanced fire protection criteria described in Appendix B. Licensees that submit applications for license renewal are expected to continue to meet the current plant fire protection licensing basis with the added provision that aging issues, as they apply to fire protection related structures, systems, and components, must be addressed.

Requirements for safe shutdown do not apply to permanently shutdown or decommissioned reactors. Fire protection objectives for shutdown plants are addressed in Appendix A of this BTP

2.1 Safe Shutdown Objectives

Safe shutdown goals and objectives for operating reactors are described in Regulatory Guide 1.189, Regulatory Position 5. The primary safe shutdown objective is to provide assurance that fuel integrity is maintained (i.e., fuel design limits are not exceeded). For alternative or dedicated shutdown, reactor coolant system process variables should be maintained within those predicted for a loss of normal ac power, and fission product boundary integrity should not be affected.

Safe shutdown goals and objectives for advanced reactor designs are essentially the same as those for operating reactors except as modified in Appendix B of this BTP.

2.2 Safe Shutdown Systems

For operating reactors, systems and components necessary for safe shutdown are identified in Regulatory Guide 1.189. Structures, systems, and components necessary for safe shutdown of advanced reactor designs may differ somewhat in their design and operation; however, the basic shutdown functions are the same.

The applicant or licensee fire protection program should be reviewed to determine if the structures, systems, and components identified in the safe shutdown analysis are adequate to accomplish the safe shutdown objectives. Specific capabilities to be evaluated include reactivity control, control of reactor coolant level and pressure, and decay heat removal. Inherent in this capability is the necessary supporting systems (e.g., cooling water, makeup water, and electrical power) as well as the instrumentation and monitoring capability to verify proper system operation and to verify that shutdown conditions are achieved and maintained.

2.3 Safe Shutdown Analysis

The fire protection program should include an analysis that demonstrates the structures, systems and components identified in Section C.2.2 above can accomplish their respective post-fire safe shutdown function. The safe shutdown analysis should demonstrate that redundant safe shutdown systems and components are adequately separated such that one success path of safe shutdown capability will be available post-fire. Fire barriers or automatic suppression, or both, may be used to protect redundant systems or components necessary for safe shutdown. In addition to identifying the protection provided for redundant safe shutdown systems, the analysis must also include an evaluation of associated circuits and the potential impacts these circuits might have on the safe shutdown capability.

Associated circuits are those circuits within a fire area that 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 do not meet fire separation requirements and have 1) a common power source with the safe shutdown equipment, 2) a connection to circuits for equipment whose spurious operation could adversely affect safe shutdown, or 3) a common enclosure with safe shutdown circuits. The analysis must demonstrate that potentially disabling conditions caused by associated circuits are prevented or otherwise mitigated and the potentially impacted safe shutdown equipment will function as designed.

The safe shutdown analysis should describe the methodology necessary to accomplish safe shutdown, including mitigation of spurious operations or other faulted conditions related to associated circuits. Manual actions may not be credited in lieu of providing the required separation of redundant systems or associated circuits located in the same fire area unless alternate, dedicated, or backup shutdown capability is provided. The analysis should also demonstrate that plant areas where operator actions are necessary are accessible and habitable under fire/post-fire conditions, and without traversing the affected fire area. Procedures should also be described for those actions necessary to repair those safe shutdown systems and components necessary for cold shutdown. The analysis must demonstrate that these procedures can be implemented within the appropriate time limitations and with equipment, personnel, and tools available on-site. Regulatory Guide 1.189, Regulatory Position 5.7 provides additional guidance for safe shutdown procedures for operating reactors. For advanced reactor designs, all equipment in the affected fire area is assumed lost and the area cannot be re-entered to operate or repair systems required to achieve and maintain safe shutdown (see Appendix B).

2.4 Alternate and Dedicated Shutdown

Alternative, dedicated, or backup shutdown capability should be identified in the safe shutdown analysis for those fire areas where the analysis identifies redundant safe shutdown paths located in the same fire area that are not protected as described in Regulatory Guide 1.189, Position 5.5, from potential damage from a single fire, fire suppression activities, or inadvertent rupture of fire suppression systems. For those fire areas where alternative or dedicated shutdown capability is required, fixed fire suppression and detection as described in Regulatory Guide 1.189, Position 5.6 should be provided.

The safe shutdown analysis must demonstrate that alternate or dedicated shutdown systems, components, and any associated circuits necessary achieve and maintain hot shutdown are free of fire damage and capable of performing the necessary safe shutdown function. The alternate or dedicated shutdown systems and components may be unique for each fire area or zone requiring alternate or dedicated shutdown capability. As noted in Section 2.3, alternate or dedicated shutdown may require manual operator actions to be taken from remote operating stations, local panels, and/or individual equipment locations. The analysis must demonstrate that the manual actions are sufficient to achieve the safe shutdown functions and can be performed within the time constraints necessary to ensure that safe shutdown performance objectives are met. Procedures describing the necessary operator actions to accomplish alternate or dedicated shutdown should be described in the analysis.

2.5 Cold Shutdown

For operating reactors, safe shutdown systems and components necessary to achieve and maintain cold shutdown conditions need not be protected from fire damage; however, the capability to make repairs to cold shutdown systems and to achieve cold shutdown within established time constraints must be demonstrated (see Regulatory Guide 1.189, Regulatory Position 5.4). Tools and equipment for repair of cold shutdown systems and components must be available on-site. Procedures must be established as necessary to accomplish the repairs. When repairs are necessary in the fire area, the licensee or applicant 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.

2.6 Station Blackout for Safe Shutdown

Several operating plant 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 acceptability of safe shutdown procedures that voluntarily enter, or otherwise create, an SBO condition is determined on a case-by-case basis.

The ability to cope with SBO as part of the post-fire safe shutdown methodology is dependent 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 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.

Applications for advanced reactor designs may not rely on SBO to mitigate potential fire damage to safe shutdown systems or associated circuits.

2.7 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 conditions can change 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 fire protection program 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 release of radioactive materials, under the differing conditions that may be present during shutdown operations.

3. Organization

For operating plants (including those applicants for license renewal), permanently shutdown plants, or decommissioning activities, the fire protection program should describe the organizational structure and responsibilities for establishing and implementing the fire protection program. These responsibilities include, fire protection program policy; program management (including program development, maintenance, updating and compliance verification); fire protection staffing and qualifications; engineering and modification; inspection, testing, and maintenance of fire protection systems and features and equipment; fire prevention, emergency response (e.g., fire brigades and offsite mutual aid); general employee, operator, and fire brigade training. Regulatory Guide 1.189, Regulatory Position 1.1, and Regulatory Guide 1.191, Regulatory Position 3.1 provide additional guidelines for fire protection organizations.

Design certifications of advanced reactor designs primarily address the design, and location of fire protection systems and features, that protect structures, systems and components important to safety, and ensure safe shutdown capability. Administrative elements of the fire protection program, including the fire protection organization, are the responsibility of the operating license applicant. Staff review of future plant design certifications should identify commitments for the operating license applicant to provide organizational information during the licensing process as part of the overall fire protection program development. Licensing reviews of new plants must verify the commitments have been satisfied.

4. Quality Assurance

The quality assurance (QA) program for fire protection should be part of the overall plant QA program. The licensee for an operating plant should have and maintain a QA program that provides assurance that the fire protection structures, systems, and components are designed, fabricated, erected, tested, maintained, and operated so that they will function as intended. Fire protection systems are not "safety-related" and are therefore not within the scope of

Appendix B to 10 CFR Part 50, unless the licensee has committed to include these systems under the Appendix B program for the plant.

Detailed guidelines for fire protection quality assurance for operating reactors are contained in Regulatory Position 1.7 of Regulatory Guide 1.189.

5. 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 and 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.

For plants that have submitted applications for license renewal or for which renewal has been approved, fire protection structures, systems, and components subject to aging considerations (see Appendix C) should be addressed, as appropriate, in fire prevention attributes applicable to inspection, testing, and maintenance of fire protection structures, systems, and components.

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.

For design certification reviews of advanced reactors, the fire prevention elements of the program are generally not part of the design certification material and are identified as action items for the license applicant.

5.1 Plant design and modification practices

Plant design and modification procedures should include fire protection considerations. The procedures should contain provisions that evaluate the impacts of modifications on installed fire protection systems and features, safe shutdown capability, potential for fire induced release of radioactive materials, and the potential to increase or modify, in a potentially adverse manner, the plant fire hazards. Procedures and practices related to the physical modification of the plant should contain provisions that provide reasonable assurance the modification process will not have adverse affects on the fire protection of the plant structures, systems, and components important to safety.

For plant decommissioning, procedures should provide similar assurances that adequate fire protection is provided for decommissioning and demolition activities and these activities will not adversely impact stored spent fuel or radioactive materials. Fire protection systems and features should not be disabled or removed until the need for protection is eliminated (i.e., radioactive materials are not at risk from fire in the area of consideration and fires occurring in these areas will not expose radioactive materials in adjacent areas).

The design certification process for advanced reactors as governed by 10 CFR Part 52, establishes certain limitations and requirements on the modification of certified designs.

5.2 Combustible control practices

The reviewer should evaluate administrative procedures that control the handling, use, and storage of flammable and combustible materials. Procedures should strictly control the use of flammable and combustible materials in plant areas important to safety, and storage of flammable and combustible materials in these areas should be prohibited, unless these materials are stored in designated areas with appropriate fire protection systems and features provided.

Flammable and combustible liquids and gases are potentially significant fire hazards and procedures should clearly define the use, handling, and storage of these hazards. Flammable and combustible liquids should be stored in accordance with the guidelines of NFPA 30, "Flammable and Combustible Liquids Code." Compressed and liquefied flammable gases should be stored in accordance with the appropriate NFPA codes. In some cases where flammable and combustible liquids and gases cannot be separated from structures, systems, and components important to safety (e.g., diesel generator day tanks, lubricating oil systems for mechanical equipment, and flammable gas distribution), the design and layout of the structures, systems, and components important to safety, and that of the system containing the flammable or combustible liquid or gas, should be reviewed to verify appropriate fire protection systems and features are provided. See Regulatory Guide 1.189, Position 2.1.3 for additional guidance.

During maintenance and modification activities, the staging and use combustible materials may be necessary. Procedures should establish strict controls on transient fire hazards such as wood, plastic, chemicals, filters, ion exchange resins, and other materials that are necessary to support plant operations, maintenance, modification, and refueling activities. Regulatory Guide 1.189, Position C.2.1.1 provides guidelines on controls of specific transient hazards.

Temporary power cables used during maintenance outages are transient combustibles as well as potential ignition sources. Reviewers should verify that procedures adequately address fire protection for temporary electrical power supply and distribution.

5.3 Ignition source control practices

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. Considerations include the following:

a. Hot work involving open flame or spark producing activities should be controlled by a permitting process that provides assurance that the work activity is adequately reviewed by fire protection staff, the work area is adequately protected, and personnel trained to perform fire watch and suppress incipient fires are present during and after the work.

b. 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.

c. Use of temporary electrical services is routine, particularly during maintenance and modification outages. Procedures and practices should provide assurance that temporary power sources connected to plant systems have documented engineering review and evaluation, including determinations that the temporary service will not adversely impact SSCs important to safety.

d. 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.

Regulatory Guide 1.189, Regulatory Position 2.2 provides additional guidelines and criteria for control of ignition sources for operating reactors. Regulatory Guide 1.191, Position 3.5 contains similar guidelines for those plants that have permanently ceased operation.

5.4 Housekeeping practices

The fire protection program should describe administrative procedures and practices that govern routine housekeeping. Housekeeping involves plant cleanliness and routine inspection to provide assurance that plant conditions do not present unnecessary fire hazards or hazards to the safe access to and egress from areas containing equipment important to safety. Operational and maintenance practices should include provisions for timely response and cleanup to spills of chemicals or flammable and combustible liquids; removal of waste, refuse, scrap and other combustibles resulting from daily operations and maintenance; and inspection of plant areas to verify that fire protection requirements are properly implemented.

5.5 Inspections, testing and surveillance

The fire protection program should address the inspection, testing and maintenance of fire protection systems and features. Outages of fire protection systems and features should be controlled by a permit system. The procedures and practices for outages should establish appropriate compensatory actions for the fire protection system or feature that is out-of-service.

Test plans should be established that provide for routine functional testing of fire protection systems and components. Fire barriers and installed assemblies and penetrations should be periodically inspected. Active fire barrier components such as fire dampers and doors should be functionally tested.

The fire protection program should identify that fire protection system inspection, testing, and maintenance is performed by qualified personnel.

Additional guidelines and criteria on the inspection, testing and maintenance of fire protection systems and features is provided in Regulatory Guide 1.189, Regulatory Position 2.4.

5.6 Compensatory measures and corrective actions for program deficiencies.

The fire protection program should describe procedures and practices governing compensatory measures and corrective actions for fire protection systems and features that are out-of-service for maintenance, modification, or repair. The fire protection program should also address deficiencies in design of fire protection systems and features; deficiencies in procedures; and other degraded or nonconforming conditions that have a potentially adverse impact on plant fire protection or the ability to achieve and maintain post-fire safe shutdown. See Regulatory Guide 1.189, Regulatory Positions, 1.5, 1.7.8, and 1.8.1.4 for additional guidance and criteria.

6. Fire Detection and Suppression

The design of fire detection, alarm and suppression systems should be reviewed relative to the fire hazards and applicable codes and standards to determine if the systems provide adequate fire protection of structures, systems and components important to safety. The potential adverse impacts of system operation, including inadvertent operation or failure, on the operation of structures, systems, and components important to safety should also be evaluated.

Where automatic fire detection and suppression is installed, it should provide complete protection throughout the fire area. For those areas where only partial coverage is installed, the fire hazard analysis should demonstrate the adequacy of the design to provide the necessary protection.

6.1 Fire detection

Fire detection should be provided in areas that contain equipment important to safety and should alarm locally and in the control room. The design, operation and testing of fire detection and alarm systems should meet the guidelines in Regulatory Guide 1.189, Position 3.1 and those of NFPA 72, "National Fire Alarm Code."

6.2 Water supply and mains

6.2.1 Fire Protection Water Supply

Fire protection water supplies should be of adequate quality, redundancy, and volume. The water supply requirements should be based on the largest calculated demand, including system demand and hose stream flow. Regulatory Guide 1.189, Position 3.2.1, NFPA 22, "Standard for Water Tanks for Private Fire Protection," and NFPA 24, "Standard for the Installation of Private Fire Service Mains and Their Appurtenances," provide additional guidance for fire protection water supplies.

Common water supplies that serve multiple plants or multiple systems including fire, sanitary water, service water, and/or the ultimate heat sink, must be capable of meeting fire demands under all expected conditions without negative impact on safety functions.

6.2.2 Fire Pumps

Fire pumps should have suitable redundancy and capacity (at least two 100% capacity pumps) to meet the fire flow demands calculated for the system. Specific design criteria are provided in Regulatory Guide 1.189, Position 3.2.2. NFPA 20, "Standard for the Installation of Centrifugal Fire Pumps," provides additional guidelines for fire pump installations.

6.2.3 Fire Mains

An underground yard fire main loop should be installed to furnish calculated fire water flow demands, including those for manual suppression. Sectionalizing capability and other design considerations should be provided as described in Regulatory Guide 1.189, Position 3.2.3. NFPA 24 provides additional guidance and references other applicable design codes

~~and standards developed by such organizations as the American National Standards Institute (ANSI) and the American Water Works Association (AWWA).~~

~~6.3 Automatic Fire suppression~~

~~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 . Automatic fire suppression systems should be selected on the basis of the hazard. Automatic systems should be designed and installed in accordance with appropriate NFPA standards as follows:~~

- ~~Sprinkler systems - NFPA 13~~
- ~~Water spray systems - NFPA 15~~
- ~~Water mist systems - NFPA 750~~
- ~~Foam water systems - NFPA 11, NFPA 11A, NFPA 16, and NFPA 16A, as appropriate for the application.~~

~~Automatic gaseous fire extinguishing systems may be also be specified depending on the fire hazard. Gaseous systems should also be evaluated for potential impacts on the habitability of areas containing equipment important to safety where operations personnel perform safe shutdown actions. Automatic gaseous extinguishing systems should be designed and installed in accordance with appropriate NFPA standards as follows:~~

- ~~Carbon dioxide systems - NFPA 12~~
- ~~Halon 1301 systems - NFPA 12A~~
- ~~Clean agent systems - NFPA 2001~~

~~Where automatic gaseous fire extinguishing systems are used, they should meet the guidelines in Regulatory Guide 1.189, Position 3.3 in addition to the standards listed above.~~

~~6.4 Manual fire suppression~~

~~This section addresses review of plant equipment to support manual firefighting. Plant design should include standpipes, hydrants, hose stations, and portable fire fighting equipment such as hoses, nozzles, and extinguishers for use by properly trained firefighting personnel. Fire brigades, including firefighting personal protective equipment, are addressed in Section 6.5 below.~~

~~6.4.1 Standpipes and Hose Stations~~

~~Plant design should include provisions for use of interior fire hose in areas containing equipment important to safety. Standpipes should be designed to withstand seismic events as specified in Regulatory Guide 1.189. Standpipes and hose stations should be located as dictated by the fire hazard analysis to facilitate access and use for firefighting operations. Standpipe and hose stations should meet the provisions of Regulatory Guide 1.189 and NFPA 14 for Class III standpipes. Water supply calculations should demonstrate that the water supply system can meet standpipe pressure and flow demands per NFPA 14.~~

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

6.4.2 Hydrants and Hose Houses

Plant fire mains should have hydrants installed to provide full exterior coverage and sufficient flow for required manual hose streams demands. Manual firefighting equipment such as hose, nozzles, fittings and tools should be provided in hose houses or on mobile carts or trucks. Hydrant and manual suppression equipment should be provided as specified in Regulatory Guide 1.189 and NFPA 24.

6.4.3 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.

6.4.4 Fire Extinguishers

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

6.5 Manual Firefighting Capabilities

6.5.1 Fire Brigade

The fire protection program should describe the onsite firefighting capability. Minimum fire brigade staffing should be established. Personnel assigned to the fire brigade should be qualified, trained and equipped for firefighting in accordance with the guidelines in Regulatory Guide 1.189 for operating nuclear power plants, or Regulatory Guide 1.191 for permanently shutdown plants.

6.5.2 Procedures and Pre-fire Plans

The fire protection program should include procedures that control actions by the plant operating staff and fire brigade upon notification of a fire and pre-fire plans that define fire hazards, equipment important to safety, and firefighting strategies in all plant areas. Additional guidelines and criteria are described in Regulatory Guide 1.189. Additional guidance on pre-fire planning is provided in NFPA 1620, "Recommended Practice for Pre-Incident Planning."

6.5.3 Performance Assessment/Drill Criteria

The fire protection program should establish fire brigade drills and drill frequencies to maintain and assess fire brigade capabilities and performance. Drills should involve offsite emergency response organizations that provide mutual aid. Additional criteria and guidelines are provided in Regulatory Guide 1.189.

6.5.4 Offsite Manual Fire-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. The fire hazard analysis, procedures, and pre-fire plans should identify mutual aid requirements in response to fires. The capabilities (e.g., equipment compatibility, training, drills, and command control) of offsite responders should be described in the fire protection program. Additional guidelines on mutual aid response are provided in Regulatory Guide 1.189 for operating nuclear power plants and Regulatory Guide 1.191 for permanently shutdown plants.

7. Building Design

7.1 General Building and Building System Design

This section provides guidance on review of 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. Guidance for passive fire barrier design is provided in Section 7.2.

7.1.1 Building Layout - Fire Areas and Zones

In accordance with GDC 3, structures, systems, and components important to safety must be designed and located to minimize the probability and effect of fires and explosions. The requirements of GDC 3 are met, in part, by compartmentalizing the facilities into fire areas and fire zones using passive fire barriers. These fire areas and 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 components important to safety. Fire areas are typically defined by fire rated separations. 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. Evaluations by some licensees made prior to 10 CFR Part 50, Appendix R, were based on fire zones that do not meet the strict definition of fire areas. In some cases, the separation of redundant safe shutdown 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. Fire zone concepts should not be applied in protecting redundant systems in advanced reactor designs.

The fire hazards analysis should identify the individual fire areas and zones in the plant, the design of the fire separations, and the underlying purpose of the separation (e.g., separation of redundant safe shutdown systems). Additional guidelines for fire areas/zones and the design of fire barrier separations is provided in Regulatory Guide 1.189.

7.1.2 Access and Egress Design

The plant layout should include adequate means of access to all plant areas for manual fire suppression. 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 structures, systems, and components, and potential restrictions or delays to safe shutdown area access potentially caused by (security) locking systems.

7.1.3 Combustibility of Building Components and Features

Materials used in construction or fabrication of nuclear power plant structures, systems, and components should be noncombustible or heat resistant to the extent practical in accordance with requirements in GDC 3. Walls, floors, roofs, including structural materials, suspended ceilings, thermal insulation, radiation shielding materials, and soundproofing and interior finishes should be noncombustible. Materials and interior finishes should meet the criteria in Regulatory Guide 1.189 for non-combustibility, including qualification and testing requirements. In situ combustible materials used in plant structures systems and components should be identified in the fire hazard analysis and suitable fire protection should be specified.

7.1.4 Electrical System Fire Protection Design

Electrical cables are a significant source of combustible material in nuclear power plants. Cable trays and open raceways provide means by which fire can ignite and propagate exposing redundant cable systems and other equipment important to safety to fire-induced failure.

Electrical cables should meet flame test criteria of IEEE 383 or 1202, or be provided with alternative protection as allowed by the specific plant licensing and/or design basis (See Regulatory Guide 1.189). Cable tray and raceway construction should be metal. Fire detection and suppression capability should be provided for electrical cable systems and described in the fire hazards analysis. Considerations in determining the level of protection should include the adequacy of separation of redundant cable systems by rated fire barriers. Fire detection should be installed in all areas containing cables systems important to safety and fire suppression capability should be available in areas containing redundant cables and cable trays important to safety, or areas containing non-safety structures, systems, and components that could expose redundant safe shutdown systems. Cable separation, manual and/or automatic suppression should be specified in accordance with the guidelines of Regulatory Guide 1.189.

The potential for cable systems to cause ignition of adjacent cables or other combustible materials that could impact equipment important to safety should be considered in the cable system design and associated fire protection features.

In addition to electrical cables, transformers and electrical cabinets also present a fire hazard to equipment important to safety. Transformers and electrical cabinets should be protected as described in Regulatory Guide 1.189.

7.1.5 HVAC Design

Means to ventilate, exhaust, or isolate the fire area should be provided as determined by the fire hazards analysis. The analysis should also consider the consequences of ventilation system failure caused by the fire and the effects on structures, systems and components important to safety from the loss of capability to ventilate, exhaust, or isolate a given fire area. Considerations in evaluating ventilation systems and components under fire conditions include:

a. Routing of ventilation power and control cables relative to the fire areas served by the system.

b. Control of the potential release of radioactive materials entrained in products of combustion (e.g., smoke and gases), including consequences of ventilation system and component failures.

c. Separation of supply air intakes for equipment important to safety from exhaust and smoke vents or outlets, and from exterior fire exposure hazards.

d. Effects of ventilation on fire suppression systems (e.g., total flooding gaseous systems).

e. Combustibility of filter media and potential for fire damage to filters and consequential impacts on radioactive material control.

f. Smoke and heat removal and/or control to support firefighting and safe shutdown operations.

g. Capability to maintain habitability of areas occupied or traversed by plant operations staff in performing safe shutdown operations, including the control room and post-fire safe shutdown system and component locations (and egress/access thereto) where local operator actions may be necessary.

Additional guidelines and standards applicable to the review of ventilation systems are provided or identified in Regulatory Guide 1.189.

7.1.6 Drainage

The design of plant floor drains should be reviewed to assess the capability to protect equipment important to safety from flooding associated with automatic and manual fire suppression, including inadvertent operation or failure of fire suppression systems. Drains may also impact concentrations of gaseous suppression agents in total flooding systems. Drainage in areas containing flammable or combustible liquids should be designed to minimize the potential to propagate fire to other areas via the drainage system. The drainage system capability to control and contain potentially contaminated water should also be described in the fire hazards analysis and/or fire response procedures. Additional guidelines are provided in Regulatory Guide 1.189.

7.1.7 Emergency Lighting

Emergency lighting should be provided throughout the plant as necessary to support fire suppression actions and safe shutdown operations, including access and egress pathways to safe shutdown areas during a fire event. Detailed guidance on the acceptable design, testing and maintenance of emergency lighting is addressed in Regulatory Guide l.189.

7.1.8 Communications

Plant communication systems, including hardwired and radio systems should be designed to provide adequate communication during fire events and should be protected from fire damage. The communication system design should provide effective communication between plant personnel performing safe shutdown, fire brigade personnel involved in firefighting activities, and other plant emergency response activities (See Regulatory Guide 1.189 and SRP Section 9.5.2)

7.1.9 Explosion Prevention

The fire hazards analysis should identify and evaluate potential explosion hazards. Large quantities of gaseous and/or liquefied hydrogen are used for water treatment and generator cooling at nuclear power plants and present a significant fire and explosion hazard. Other flammable gases may also be present on the plant site (e.g., welding/cutting gases and fuel for gas powered turbine generators). Plant battery rooms can also be a source of hydrogen accumulation (see Section C.8.1.7). Hydrogen and flammable gas systems should be designed with appropriate explosion prevention to protect areas containing equipment important to safety. Some high voltage electrical equipment (e.g. switchgear and transformers) have the potential for an energetic electrical fault that can damage structures, systems or components important to safety. Transient explosive hazards include hydrogen delivery vehicles, and gases used for hot work (welding, brazing, cutting). Preventative and protective measures should be defined in the fire protection program to address these hazards. Additional guidelines, including applicable NFPA standards are identified and discussed in Regulatory Guide 1.189. Guidelines governing hot work and flammable gases are also provided in Sections C.5 and C.9 of this BTP as well as Regulatory Guides 1.189 and 1.191.

7.2 Passive Fire Resistive Features

The fire hazard analysis should discuss the application, layout and design of passive fire resistive features used in the power plant. Fire resistive features such as structural fire barriers and electrical raceway fire barrier systems provide the necessary separation of systems and components important to safety. These fire resistive features must meet appropriate design, testing, qualification, and maintenance standards.

7.2.1 Structural Fire Barriers

Structural fire barriers described in the fire protection program documentation should be designed, fabricated, installed, and/or constructed in accordance with designs that have been tested and qualified by approving laboratories. Specific fire barrier applications should be compared to testing and qualification reports to validate the specified barrier resistance is consistent with the fire hazards present and the fire protection and equipment separation objectives and requirements. In reviewing fire barrier design, the reviewer should evaluate the components of construction (walls, floors, and their supports), including beams, joists, columns, penetration seals or closures, fire doors, and fire dampers that are part of the fire barrier assembly to ensure the assembly meets the specified resistance.

In some cases, exact replication of a tested configuration cannot be achieved. In these cases additional review is necessary and should verify the design is adequate for the hazards present. The fire hazards analysis should document the acceptability of those applications that deviate from tested and qualified configurations. Specific criteria applicable to these reviews is provided in Regulatory Guide 1.189.

The fire protection program should describe the fire barrier testing and qualification methods and results. The program should also describe the inspection, testing and maintenance program to maintain the barriers, including doors, dampers, and penetration seals in their qualified configuration.

Specific criteria, guidelines, and applicable codes standards for design, testing, and maintenance of structural fire barriers and barrier components are provided in Regulatory Guide 1.189.

7.2.2 Electrical Raceway Fire Barrier Systems

Fire resistive protection may be applied to redundant safe shutdown electrical circuits and cable systems located in the same fire area where separation by structural fire barriers or re-routing of redundant circuits or cables is not practical. For fire areas where separation of electrical circuits important to safe shutdown cannot be accomplished via rated structural fire barriers, electrical raceway fire barrier assemblies have been installed on air drops, conduits, cable trays and junction boxes to meet 1-hour and 3-hour separation requirements. Where 1-hour fire resistive barriers are applied, automatic fire detection and suppression should also be installed.

Electrical raceway fire barrier systems should be tested and qualified in accordance with applicable standards. The assemblies should be installed and maintained in accordance with the tested configuration. Regulatory Guide l.189 provides extensive criteria and discussion on the testing and qualification of electrical raceway fire barrier systems.

Fire stops may also be applied to limit fire propagation along horizontal and vertical cable routing. The specific criteria for horizontal and vertical fire stop application is provided in Regulatory Guide 1.189.

Licensees or applicants that rely on fire rated cables to meet NRC requirements for protection of safe shutdown systems or components from the effects of fire should request an exemption or deviation as appropriate.

8. Fire Protection of Areas Important to Safety

Several areas within a nuclear power plant present unique hazards or design issues relative to fire protection and safe shutdown. This section provides guidelines for the review of fire protection in these areas. More detailed guidelines are provided in Regulatory Guide 1.189.

8.1 Areas Related to Power Operation

8.1.1 Containment

Regulatory Guide 1.189 provides specific guidelines on the protection of fire hazards and equipment important to safety in containment. Specific considerations include:

a. Separation and other fire protection features of redundant systems in close proximity (e.g., electrical penetration areas and reactor coolant system instrumentation locations).

b. Fire protection of containment hazards including lube oils, hydraulic oils, cables, electrical cabinets, and combustible filter media. Refueling and maintenance activities introduce additional transient hazards (e.g., contamination control materials, chemicals, hot work, and scaffolds) that should be evaluated and protected.

c. Automatic fire detection and suppression capability inside containment should be described and evaluated in the fire hazard analysis. Manual suppression capability (e.g., standpipes and hose stations) should also be provided and designed to appropriate standards. The design should allow fire suppression attack internal to containment while maintaining containment integrity. Operation of the fire protection systems should not compromise the integrity of the containment or other systems important to safety. Fire protection actions in containment area should function in conjunction with total containment requirements such as ventilation and control of contaminated liquid and gaseous release

d. Due to potential limits on containment accessibility during and post-fire, the fire hazards analysis should evaluate the effects of postulated fires on the integrity of containment, the primary coolant system, and safe shutdown systems assuming no action is taken to suppress the fire.

8.1.2 Control Room Complex

Redundant systems important to safety are in close proximity in the control room areas and there is a significant hazard present from cables and other electrical equipment in the area. Therefore, fire protection in the control room is extremely important to the protection of these systems. Specific consideration in reviewing control room fire protection include:

a. Separation by fire barriers from the effects of fires in adjacent areas.

b. Interior finishes (e.g., carpeting) should be non-combustible or of limited combustibility as established by testing (see Section C.7.1.3).

c. Fire detection as well as manual and automatic suppression capability should be provided as described in Regulatory Guide 1.189, including protection of equipment important to safety from inadvertent operation or failure of the suppression systems. Cable raceways under raised floors should be reviewed to determine if adequate fire detection and suppression are provided for potential fires in these areas.

d. Ventilation systems should provide for smoke control and removal and habitability of the control room under fire and post-fire conditions should be addressed in the fire protection.

8.1.3 Cable Spreading Room

Cable spreading rooms should provide for adequate separation of redundant systems. If adequate separation is not possible, an alternative, dedicated, or backup shutdown capability should be provided. The layout and protection of cable spreading rooms should, at a minimum, meet the criteria in Regulatory Guide 1.189.

8.1.4 Plant Computer Rooms

Computer rooms should be protected with fire barriers and fire protection systems as described in Regulatory Guide 1.189.

8.1.5 Switchgear Rooms

Specific fire protection considerations for review of switchgear rooms include:

a. Fire separation of switchgear rooms containing equipment important to safety from the remainder of the plant, including redundant switchgear.

b. Fire protection systems including detection and suppression should be installed. Automatic fire suppression systems and/or manual suppression capability should be designed with appropriate consideration for the fire and operational hazards present, including consideration of the effects of inadvertent system operation or failure.

8.1.6 Remote Shutdown Areas

Areas providing remote shutdown capability should be separated from the control room complex by barriers having a minimum fire rating of 3 hours. 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.

Locations containing remote shutdown panels must be habitable for 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.

8.1.7 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. Switchgear, inverters, and battery chargers should not be located in these battery rooms. Redundant battery chargers may be located with the battery switchgear and should be protected in a manner consistent with that for redundant switchgear (see Section 8.1.5). Automatic fire detection should be provided to alarm and annunciate in the control room and alarm locally. Ventilation systems in the battery rooms should be capable of maintaining the hydrogen concentration below 2%. Loss of ventilation should be alarmed in the control room. Standpipes, hose stations, and portable extinguishers should be readily available outside the room.

8.1.8 Diesel Generator Rooms

Specific fire protection considerations for review of diesel generator rooms include:

a. Fire barrier separations should be provided between redundant systems and from other areas of the plant.

b. Day tank fuel supplies should be designed and located in accordance with the guidelines in Regulatory Guide 1.189.

c. Automatic fire suppression should be installed to suppress or control any diesel generator fuel oil or lubricating oil fires. Impacts of suppression systems on operating generators should be addressed in the fire hazard analysis. Automatic fire detection and manual suppression capability should be provided.

d. Drainage for firefighting water including the potential for propagation of combustible liquid fires to other interconnected areas via drainage systems.

8.1.9 Pump Rooms

Structures and rooms housing redundant pumping systems 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. Fire suppression and detection should be provided as determined by the fire hazards analysis. If automatic fire suppression capability is provided, consideration of suppression effects on pump operation should be evaluated in the fire hazards analysis.

8.2 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(s).

8.2.1 New Fuel Areas

Fire protection of new fuel areas should be described in the fire hazards analysis. The use of automatic and manual fire suppression, as well as the storage configuration of new fuel, should preclude criticality for any water density that might occur during fire water application.

8.2.2 Spent Fuel Areas

The fire hazards analysis should describe the level of protection for the spent fuel pool and related systems (e.g., cooling and makeup) that is necessary to minimize the potential fire induced release of radioactive material.

Regulatory Guide 1.191 provides additional guidelines relative to fire protection of spent fuel areas for permanently shutdown reactors that have not completed removal of the spent fuel to an independently licensed storage facility.

8.2.3 Radwaste Building/Storage Areas and Decontamination Areas

Fires in radioactive waste storage areas have the potential to adversely affect plant operations and release radioactive materials to the environment. Specific considerations in review of radioactive waste areas include:

a. Separation of radioactive waste buildings, storage areas, and decontamination areas from other areas of the plant.

b. Fire detection and suppression capability including containment/confinement of suppression water.

c. Ventilation system capability to control release of radioactive materials for fires in these areas.

d. Packaging and protection from fire of contaminated materials such as ion exchange resins, charcoal filters, HEPA filters, and other contaminated combustible materials.

8.2.4 Dry Cask Spent Fuel Storage Areas

Fire protection of dry cask storage is addressed by the requirements of 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, 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.

8.2.5 Water Tanks

Storage tanks that supply water for safe shutdown should be protected from the effects of an exposure fire.

8.2.6 Cooling Towers

Cooling towers should be of noncombustible construction or so located and protected 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.

9. Special Hazards

Special hazards are plant systems, components, or other equipment that present potentially significant fire exposure or explosion hazards to equipment important to safety and thus require special consideration in the review of the fire protection program.

9.1 Reactor Coolant Pump Oil Collection

Reactor coolant pumps (RCPs) contain a significant quantity of lubricating oil in proximity to extremely hot surfaces. A large combustible liquid fire inside containment could significantly threaten safe shutdown capability and would be extremely difficult to suppress. For these reasons, oil collection systems should be installed to safely contain oil leakage or discharge from ruptures. The specific design of oil collection systems should meet the guidelines in Regulatory Guide 1.189.

9.2 Turbine/Generator Building

Turbine buildings contain large quantities of lubricating and hydraulic oil reservoirs and piping, electrical cables, and hydrogen cooling systems for the generator. The fire hazards analysis should describe how plant areas important to safety are protected from the potentially severe fire and explosion hazards in the turbine/generator building. Fire barrier design and other fire protection systems and features should be demonstrated to be adequate for the hazards present.

9.3 Station Transformers

Transformers can be a significant source of combustible material and ignition energy. Transformers installed in fire areas containing systems important to safety should be of the dry type or insulated and cooled with noncombustible liquid. Oil-filled transformers should be provided with appropriate enclosures, fixed fire suppression, oil confinement capability and separated from areas important to safety as described in Regulatory Guide 1.189.

9.4 Diesel Fuel Oil Storage Areas

Diesel fuel oil storage presents a potentially significant fire hazard and should be separated from areas important to safety as described in Regulatory Guide 1.189.

9.5 Flammable Gas Storage and Distribution

Large quantities of flammable gases are used for generator cooling and reactor coolant system water chemistry. Flammable gas storage and piping systems should be evaluated in the fire hazards analysis for potential impacts on structures, systems, and components important to safety. Specific guidelines as to design and location of bulk gas storage and distribution systems is provided in Regulatory Guide 1.189, which also references applicable NFPA standards.

9.6 Nearby Facilities

Plant support facilities (e.g., offices, maintenance shops, warehouses, temporary structures, and equipment storage yards), co-located power generating units (e.g., nuclear, coal, natural gas), nearby industrial facilities (e.g., chemical plants, refineries, manufacturing facilities) should be addressed in the fire protection program 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 exposure fires from nearby facilities.

D. GLOSSARY

Administrative Controls - Policies, procedures and other elements that relate to the fire protection program. 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 plant modifications impact on the fire protection program, fire prevention activities, fire protection staffing, control of combustible/flammable materials, and control of ignition sources.

Advanced 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.

Alternative Shutdown — The capability to safely shut down the reactor in the event of a fire using existing systems that have been rerouted, relocated, or modified.

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 (i.e. hot shorts, open circuits, and short to ground).

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.

Backup Shutdown — See Alternative Shutdown.

Combustible Material — Any material that will burn or sustain the combustion process when ignited or otherwise exposed to fire conditions.

Common 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 components.

Common Power Supply — A power supply that feeds safe shutdown circuits and non-safe shutdown circuits.

Control Room Complex — The compartments served by the control room emergency ventilation system.

Dedicated Shutdown — The ability to shut down the reactor and maintain shutdown conditions using structures, systems, or components dedicated to the purpose of accomplishing post-fire safe shutdown functions.

Emergency Control Station — A location outside the main control room where actions are taken by operations personnel to manipulate plant systems and controls to achieve safe shutdown of the reactor.

Exposure Fire — A fire in a given area that involves either in situ or transient combustibles and is external to any structures, systems, and components 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 trains located in the same area.

Fire 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 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 team of on-site plant personnel that have been qualified and equipped to perform manual fire suppression activities.

Fire Hazard — The existence of 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 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:

- Identification of fixed and transient fire hazards.
- Identification and evaluation of fire prevention and protection measures relative to the identified hazards.
- 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 brigade personnel, and other features provided for fire protection purposes.

Fire Protection Program — The integrated effort involving components, procedures, and personnel utilized in 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-resistance test.~~

~~**Fire Resistance Rating** — The time that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251.~~

~~**Fire Retardant Material** — Means 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 the combination of the probability of a given fire event occurring and the estimated consequences of the event should it occur.~~

~~**Fire Stop** — A feature of construction that prevents fire propagation along the length of cables or prevents spreading of fire to nearby combustibles within a given fire area or fire zone.~~

~~**Fire Suppression** — 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 dioxide systems.~~

~~**Fire Watch** — Individuals responsible for providing additional (e.g., during hot work) or compensatory (e.g., 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** — Subdivisions of fire areas.~~

~~**Free of Fire Damage** — The structure, system, or component under consideration is capable of performing its intended function during and after the postulated fire, as needed, without repair.~~

~~**Hazardous Material** — A substance that, upon release, has the potential of causing harm to people, property, or the environment.~~

~~**High Impedance 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 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 that involve the use of heat, sparks, or open flame such as cutting, welding, and grinding.~~

~~**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 power plant structures, systems, and components “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.

Interrupting 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 materials that constitute part of the construction, fabrication, or installation of plant structures, systems, and components and as such are fixed in place.

Isolation 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 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.

Noncombustible 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 thick that has a flame spread rating not higher than 50 when measured in accordance with ASTM E-84, "Standard Test Method for Surface Burning Characteristics of Building Materials."

Open Circuit — A failure condition that results when a circuit (either a cable or individual conductor within a cable) loses electrical continuity.

Pre-Fire 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 — A 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: cable trays, junction boxes, conduit, tubing, raceways, wireways, and busways.

Raceway Fire Barrier — 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.

Radiant Energy (Heat) Shield — A noncombustible or fire resistive barrier installed to provide separation protection of redundant cables, equipment, and associated non-safety circuits within containment.

Remote 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.)

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

Safe Shutdown — For fire events, those plant conditions specified in the plant Technical Specifications as Hot Standby or Hot Shutdown, and Cold Shutdown.

Safe Shutdown Analysis — A process or method of identifying and evaluating the capability of structures, systems, and components necessary to accomplish and maintain safe shutdown conditions in the event of a fire.

Safe Shutdown System/Safe Shutdown 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 and components required to mitigate the consequences of postulated design basis accidents.

Secondary 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.

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 grounded conducting device such as a cable tray, conduit, grounded equipment, or other grounded component.

Spurious 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 specific editions of the nationally recognized codes and standards endorsed by the NRC that constitute the licensing and design basis for the plant.

Success Path — The minimum set of structures, systems, and components necessary to achieve and maintain safe shutdown in the event of a fire.

Temporary Structures — Buildings, tents, shelters, platforms, trailers, or other structures that are erected for the purpose of supporting plant operations and maintenance, but are not permanent site facilities.

Turnout Gear — Personnel protective clothing for fire fighting such as coats, pants, boots, helmets, gloves, and self-contained breathing apparatus (SCBA).

Transient Combustibles — Combustible materials that are not fixed in place or an integral part of an operating system or component.

E. REFERENCES

~~A list of references applicable to review of fire protection programs is provided in SRP Section 9.5.1 and Regulatory Guide 1.189.~~

APPENDIX A: Supplemental Fire Protection Review Criteria for Shutdown and Decommissioned Reactors

A. INTRODUCTION

This appendix provides addition guidelines for review of fire protection programs and related submittals for nuclear power plants that have ceased operations and processed the necessary certifications under 10 CFR Part 50, §50.82(a)(1) and is based on the information and guidelines provided in Regulatory Guide 1.191.

B. DISCUSSION

The primary objective of the fire protection program for operating reactors is to limit fire damage to structures, systems, and components (SSCs) important to safety, to ensure the capability to safely shut down the reactor and maintain it in a safe shutdown condition. For those plants that have permanently ceased operations and removed fuel from the reactor vessel, the safe shutdown requirements of 10 CFR Part 50.48(a)(2)(iii), and Appendix R to 10 CFR Part 50, are no longer applicable. The primary fire protection concern for permanently shut down plants is protecting the integrity of the spent fuel and preventing, or minimizing, the release of radioactive materials resulting from fires involving contaminated plant SSCs or radioactive wastes. The radiation dose limits specified in 10 CFR Part 20, "Standards for Protection Against Radiation," apply for plant personnel and members of the public for fire incidents at permanently shutdown nuclear power plants. Licensees should make every effort to maintain exposures to radiation resulting from a fire as low as reasonably achievable.

The fire protection program for the operating reactor provides the baseline for the decommissioning phase. Licensees that have permanently shut down their nuclear power plant(s), and have made the necessary decommissioning submittals to the NRC as required by 10 CFR Part 50.82, have the option of beginning immediate decommissioning and dismantlement of the facility or may choose to place the facility in a monitored storage condition for some period of time prior to commencing with final decommissioning and dismantlement activities. The fire protection requirements may be considerably different depending on the licensee's selected approach to decommissioning.

In general, the processes and activities associated with nuclear plant decommissioning can be dynamic with plant conditions and configurations continuously changing. Decommissioning activities may increase plant fire hazards through mechanisms that include, but are not limited to, increased hot work, increases in combustible loading, erection of temporary structures to support decommissioning or dismantlement of the plant, and deactivation or abandonment of plant systems. In addition to the physical changes to the plant, the licensee's organizational structure and responsibilities are expected to be different for decommissioning, with staffing levels significantly less than during plant operations. Because of the dynamics of the decommissioning process, the licensee's fire protection program should be re-evaluated and revised as necessary to reflect the facility condition through the various stages of decommissioning in accordance with the following guidance.

C. Permanent Shutdown/Decommissioning Fire Protection Program

General guidelines are provided below relative to review of fire protection program scope and content for shutdown/decommissioning of nuclear power plants. Specific criteria and

~~guidelines for shutdown/decommissioning fire protection programs are provided in Regulatory Guide 1.191.~~

~~1. General~~

~~1.1 Fire Protection Objectives~~

~~The fire protection program objectives for shutdown and decommissioning are similar to, but not exactly the same as those for operating reactors. The primary difference is the safe shutdown objective for operating reactors is replaced by an objective to minimize radiological hazards from fire. The specific objectives are:~~

- ~~Reasonably prevent fires from occurring;~~
- ~~Rapidly detect, control, and extinguish those fires which do occur and which could result in a radiological hazard; and~~
- ~~Ensure that the risk of fire-induced radiological hazards to the public, environment and plant personnel is minimized.~~

~~1.2 Fire Protection Program Standards~~

~~The fire protection program for decommissioning should be founded on sound engineering practices and established industry standards such as those provided by the National Fire Protection Association (NFPA). The standards-of-record for an individual plant are generally established in the operating plant fire protection program and will also be considered as applicable to the decommissioning fire protection program as appropriate.~~

~~1.4 Fire Protection Program Scope~~

~~1.4.1 Operating Plant Program Transition~~

~~Operating plants are required to have a fire protection program in accordance with the requirements of GDC 3 and 10 CFR Part 50.48. The primary objective of the operating plant fire protection program is to provide defense-in-depth protection of the capability to shutdown the reactor and maintain it in a safe shutdown condition. The safe shutdown objective is not applicable under decommissioning, with the reactor permanently shutdown and fuel removed from the reactor vessel. However, many of the elements of the operating plant fire protection program continue to be applicable under plant decommissioning. The operating plant fire protection program provides the baseline analysis and description of plant fire hazards, administrative controls, physical protection features and emergency response capabilities. Many of these elements will be carried over to the decommissioning fire protection program.~~

~~1.4.2 Decommissioning Fire Protection Program~~

~~The fire protection program is expected to change throughout the various phases of decommissioning. Initially, with spent fuel removed from the reactor and stored in the spent fuel pool, the development and maintenance of a comprehensive decommissioning fire protection program is appropriate to provide assurance that the probability of fires affecting the spent fuel or other radiological hazards is minimized, and the consequences of fires, should they occur, are adequately mitigated. As decommissioning progresses, and the spent fuel is moved to an independent storage facility or permanent repository, the fire protection requirements for the plant may be scaled down in accordance with the diminishing radiological hazard. However, even in the absence of spent fuel, a fire protection program should be~~

maintained that ensures adequate protection from the fire-induced release of radioactive material from contaminated plant areas, and combustible wastes.

The scope of the decommissioning fire protection program as described in this guidance is limited to those decommissioning activities associated with the radiological hazards present in the plant, or ancillary facilities (e.g., on-site waste storage) that directly support the decommissioning process. Fire protection requirements for independent spent fuel storage installations (ISFSIs) that are licensed in accordance with the requirements of 10 CFR Part 72 are not within the scope of this guidance. For plant areas that are considered property loss concerns only, the fire protection requirements applicable to these areas are determined solely by the licensee.

The licensee should maintain a fire protection program as long as there are radiological hazards on site, or until termination of the license and release of the site for unrestricted use.

2. Fire Hazards Analysis

The fire hazards analysis for shutdown/decommissioning should provide a comprehensive evaluation of the facility fire hazards, the fire protection capability relative to the identified hazards, and the ability to protect spent fuel and other radioactive materials from potential fire-induced releases. The fire hazards analysis in place at the time of plant operation may be used as the baseline, but should be re-evaluated and revised as necessary to reflect the unique or different fire protection issues and strategies associated with decommissioning. Specific considerations that should be addressed in the revised fire hazards analysis include:

a. Changes to fire hazards including, but not limited to, combustible loading from sources such as equipment lay-down areas, waste accumulation and storage areas, and materials necessary to support decontamination and dismantlement activities; increases in hazards from hot work during dismantlement of facility structures, systems, and components; and installation of temporary structures and support systems (e.g., electrical, heating, and ventilation) that may impact plant fire hazards.

b. Changes to plant fire protection administrative controls, systems, and features as facilities are modified, decommissioned, and dismantled.

c. Identification, evaluation and protection of radiological hazards including, spent fuel, contaminated plant areas and waste storage. Structures, systems, and components important to minimizing the release of radioactive materials under fire and post-fire conditions should be evaluated and appropriate protection provided.

d. The fire hazards analysis should evaluate the risks to exposure from fires at co-located or near-by facilities. Consideration should be given to the effects of a fire on shared systems for multi-unit sites, and the potential for fires to propagate from one facility to the other.

3. Administrative Controls

The shutdown/decommissioning fire protection program should identify those administrative controls (e.g., policies, procedures, and practices) that govern the performance or execution of fire protection program activities necessary to ensure that the fire protection objectives are met. These administrative controls should not differ considerably from those in place when the plant was operating with the exception that they address the revised hazard conditions.

3.1 Organization

Consistent with the requirements for operating plants, the licensee fire protection program should identify and clearly establish the organizational responsibilities for management and implementation of the fire protection program. The fire protection responsibilities of licensee decommissioning contractors should also be established.

3.2 Fire Protection Procedures

The shutdown/decommissioning fire protection program should describe emergency procedures and pre-fire plans that describe emergency response actions, including the necessary operational actions, (e.g., ventilation system line-ups and operational requirements) that are necessary to mitigate the consequences of fires. Coordination with off-site responders and the fire response leadership and command structure for both the on-site fire brigade and off-site responder(s) should be defined.

3.3 Training

Training is necessary to ensure that licensee employees, contractors, and emergency responders have the necessary knowledge and skills to properly execute their responsibilities relative to the fire protection program. Training should address general employee, fire watch, and fire brigade training requirements.

3.4 Control of Combustible Materials

Combustible materials including flammable and combustible liquids, compressed gases, construction materials, and refuse, should be used, stored or disposed of in a manner that minimizes the occurrence of fire. Transient fire hazards associated with decommissioning activities should be minimized to the extent possible, and should be promptly removed upon completion of the activities. Regulatory Guide 1.191 contains specific guidelines regarding control of transient combustible materials

3.5 Control of Ignition Sources

The fire protection program should describe procedures for protection against potential fires from cutting, welding, grinding and work involving open flame. Decommissioning activities may also rely on temporary and portable heat producing equipment and electrical systems.

3.6 Control of Fire Protection Systems and Equipment

The fire protection program should contain provisions for ensuring the necessary fire fighting capability as described in the fire hazard analysis is maintained. Specific considerations include:

a. Inspection, testing, and maintenance of manual fire fighting equipment, including fire brigade turnout gear and breathing apparatus, extinguishers, hoses, nozzles, tools, fittings, portable lighting, communications, and ventilation devices.

b. Inspection, testing and maintenance of installed fire protection systems. Fire protection systems include passive fire protection systems such as fire barrier components and fire barrier seals; and active fire protection systems such as fire alarm systems, fire suppression systems, and fire water supply systems.

c. Controls for identification, prioritization and timely correction of fire protection impairments, informing fire protection staff of the impairment, and establishing compensatory measures for the duration of the impairment, including control of hazardous work activities (e.g., hot work) during system impairments.

d. Control of fire area boundaries/barriers, including the maintenance of these structures as the facility is modified or dismantled during decommissioning.

3.7 Control of Structures, Enclosures, and External Areas

The fire protection program should address fire hazards created by the construction and location of temporary enclosures and structures. Temporary structures should not present a fire exposure hazard to plant structures containing radioactive materials, radioactive contamination, or contaminated waste material accumulation or storage areas. The fire protection program should identify controls to protect structures containing radioactive materials from an exposure fire. The fire hazard presented by transient combustibles, including stored materials, debris, vegetation, and near-by or co-located structures, should be considered.

4. Physical Fire Protection Features

Physical fire protection features (e.g., barriers, detection, and suppression) will change with changing hazards as a plant is permanently shut down and decommissioned. The fire hazards analysis should specify the physical fire protection features necessary to minimize the potential for a fire to result in the release or spread of radioactive materials.

4.1 Fire Detection and Alarms Systems

Detection systems in operating reactor facilities are generally placed in locations where fire hazards present an exposure threat to safety related equipment. Under decommissioning, the fire hazards and the associated detection and alarm requirements may change significantly. The change in priority from protecting safety related equipment required for safe shutdown, to protecting against the release or spread of radioactive material, may require re-evaluation of the detection and alarm system design to ensure that decommissioning fire hazards are adequately protected.

4.2 Fire Barriers

For operating reactors, fire area boundaries are generally established based on the need to separate and protect safe shutdown systems. Based on a fire hazards analysis, fire areas may be re-designated to address the unique hazards and protection requirements of the decommissioning process. Fire areas should be designated based on consideration of the hazards present, the potential for a fire in a given area to result in release of radioactive materials, the ability to effectively contain, fight, and control the fire using manual suppression, and the ability of personnel to safely evacuate the plant. Fire areas should be separated by fire rated barriers. The fire resistance rating of a fire barrier should be commensurate with the potential fire severity in each fire area.

4.3 Fire Suppression Systems

Fire suppression capability should be maintained during shutdown/decommissioning based on the fire hazards analysis, including water supplies and distribution systems, automatic suppression systems, and manual fire fighting systems (e.g., hydrants and standpipes). Specific considerations include:

a. ~~Maintaining adequate and reliable fire water supply and distribution to meet flow demands based on fire hazards analysis. Decommissioning activities may result in the isolation, removal, or abandonment of portions of the distribution system. Any system changes should be reviewed to ensure that adequate flow and coverage is provided to the remaining plant areas. For fire water supplies and distribution systems that are shared by multi-unit sites, decommissioning activities should not affect the water supply to the operating unit(s).~~

b. ~~Automatic fire suppression systems, existing at the time a plant enters the decommissioning phase, should be maintained operable as necessary based on the fire hazards analysis. The need for automatic fire suppression systems in plant areas during decommissioning activities may change depending on the type of operations being performed in an area, the addition or removal of combustible materials, and/or the removal of radioactive materials and contamination.~~

c. ~~Manual fire suppression systems should be provided in the plant to supplement automatic fire protection systems and to provide suppression coverage to areas not protected by automatic systems, including areas where systems have been deactivated. Decommissioning activities may change the plant configuration and fire hazards; may require the construction of temporary enclosures or structures; and may necessitate the abandonment or removal of automatic systems as facilities are dismantled or modified and radiological hazards are removed. Manual fire suppression capability should be maintained throughout shutdown/decommissioning to ensure protection against fire-induced radioactive material releases.~~

d. ~~The shutdown/decommissioning fire protection program should describe the manual fire fighting capability for the plant. Manual firefighting capability should be provided by an on-site fire brigade and/or off-site emergency services. A fire emergency plan should be developed detailing the response to fire alarms and the responsibilities assigned to emergency response personnel. For operating reactors, early detection and application of manual suppression can be critical in minimizing the fire damage to safe shutdown systems that are necessary to prevent damage to the reactor core and subsequent releases of radioactive material. In comparison, the threat of fuel damage is reduced during decommissioning with the fuel stored in the spent fuel pool or other approved storage facility. Under these conditions of spent fuel storage, fire suppression response times may not be as critical. The necessary fire emergency response capability should be determined based on the fire hazards and the potential for those hazards to involve radioactive material.~~

APPENDIX B: Supplemental Fire Protection Review Criteria for Advanced Reactors

Many of the current fire protection requirements and guidelines for operating reactors were issued after the construction permits and/or operating licenses were approved by the Commission. The backfit of these requirements and guidelines to existing plant designs created the need for considerable flexibility in the application of the regulations on plant-by-plant basis. For advanced reactor designs, 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 for the plant.

For applications submitted in accordance with 10 CFR Part 52, design elements of the fire protection program are addressed in the design certification process. In addition a design specific fire risk assessment in accordance with §52.47(a)(v) shall be submitted. During the design certification process, action items are identified that must be addressed by the combined license applicant. These commitments include action items to establish the fire protection program for protection of structures, systems, and components important to safety and the procedures, equipment, and personnel required to implement the program. These commitments include, but are not limited to, updating the fire hazards analysis to address final plant design and those administrative program elements (e.g., licensee fire protection staffing and organization, quality assurance, procedures, fire prevention programs, and training); fire brigade and emergency response capability; the final design of fire protection systems and features; and the design and analysis of post-fire safe shutdown capability.

1. Enhanced Fire Protection Criteria

Based on operational experience with existing reactors and insights from examination of internal fire events, the staff determined that fire protection for safe shutdown capability should be enhanced for advanced reactor designs. The enhanced fire protection criteria was initially proposed to the Commission in SECY-90-016. This criteria was extended to review of passive LWR design in SECY-93-087. This criteria is as follows:

> Evolutionary advanced light water reactor (ALWR) designers must ensure that safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire and that re-entry 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 an independent alternative shutdown capability that is physically and electrically independent of the control room is included in the design. Evolutionary ALWRs must 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, the evolutionary ALWR designers must 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.

2. Passive Plant Safe Shutdown Condition

As discussed in SECY-94-084, the definitions of safe shutdown as contained in the Commission's regulations and guidelines do not address the inherent limitations of passive residual heat removal systems.

In General Design Criterion (GDC) 34 of Appendix A to 10 CFR Part 50, the NRC regulations require that the design include a residual heat removal (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. The NRC promulgated these requirements to ensure that the RHR system is available for long-term cooling to ensure a safe shutdown state.

Post-fire safe shutdown (for currently operating LWRs) is defined (in Regulatory Guide 1.189) as those conditions specified in the Technical Specifications for Hot Standby [Pressurized Water Reactors (PWRs)], Hot Shutdown [Boiling Water Reactors (BWRs)], and Cold Shutdown. Regulatory Guide 1.139 and Branch Technical Position (BTP) RSB 5-1 specify Cold Shutdown as 93.3 °C (200 °F) for PWRs and 100 °C (212 °F) for BWRs.

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 non-safety 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 demonstrated by design and analysis to be capable of accomplishing their respective functions without damage to the fuel.

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-loss-of-coolant-accidents (non-LOCA) events. This safe shutdown condition is predicated on demonstration of acceptable passive safety system performance and the acceptable resolution of regulatory treatment of non-safety systems that are necessary for long term shutdown.

3. Passive Plant Safe Shutdown Spurious Operations

The safe shutdown analysis for passive reactor designs should be evaluated for adverse impacts caused by spurious operations of non-safety interfacing systems. These spurious operations may be caused by associated circuits (see BTP Section C.2.3) located within the fire area of concern, which may cause an adverse effect on the ability of the passive systems to perform the safe shutdown function.

4. Applicable Industry Codes and Standards

The fire protection program for advanced light water reactor designs should comply with the provisions specified in NFPA 804, "Fire Protection for Advanced Light Water Reactors" related to the protection of post-fire safe shutdown capability and the mitigation of a radiological release resulting from a fire. The standards of record related to the design and installation of fire protection systems and features required to satisfy NRC requirements in all advanced 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.

5. Other New Reactor Designs

Fire protection programs for proposed new non-light water reactor designs should meet the overall fire protection objectives outlined in the BTP related to safe shutdown and radiological release. 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. Structures, systems, and components important to safe shutdown should be protected in accordance with the enhanced criteria described below. Fire protection systems and features should be consistent with the BTP criteria as determined necessary by a fire hazards analysis.

Similar to the enhanced fire protection criteria previously discussed in Section 1 of this appendix for ALWRs, the following performance criteria applies to the review of other new reactor designs:

New reactor designs must ensure that safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire and that re-entry 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 an independent alternative shutdown capability that is physically and electrically independent of the control room is included in the design. New reactor designs must provide fire protection for redundant shutdown systems in the reactor building that will ensure that one shutdown division will be free of fire damage. Additionally, the new reactor designs must ensure that smoke, hot gases, or fire suppressants will not migrate into other fire areas to the extent that they could adversely affect safe shutdown capabilities, including operator actions.

APPENDIX C: Supplemental Fire Protection Review Criteria for License Renewal

The purpose of this appendix is to provide guidance on the fire protection system information to be provided in an application for renewal of a nuclear power plant operating license submitted in accordance with the provisions of 10 CFR Part 54, "Requirements for Renewal of Operating Licences 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 Nuclear Energy Institute (NEI) guideline, NEI 95-10, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54 - The License Renewal Rule," Revision 3, March 2001.

10 CFR Part 54, §54.4(a)(3), states, in part, that structures, systems, and components (SSCs) relied on in safety analyses or plant evaluations to perform a function that demonstrates compliance with the Commission's regulations for fire protection (10 CFR Part 50.48) are within the scope of the rule.

NEI 95-10 provides the methodology for screening of fire protection SSCs. When evaluating license renewal applications, it is important to note that the scope of SSCs included in 10 CFR Part 50.48 goes beyond the protection of only safety-related equipment. In accordance with General Design Criterion (GDC) 3, "Fire Protection," equipment required to comply with 10 CFR Part 50.48 is broad and includes fire protection SSCs needed to also minimize the effects of a fire and to prevent the release of radioactive material to the environment. If applicable, the scoping methods used by an applicant should include review of any commitments made for compliance with Appendix A to Branch Technical Position APCSB 9.5-1, "Guidelines for fire Protection for Nuclear Plants Docketed Prior to July 1, 1976," or 10 CFR Part 50, Appendix R, "Fire Protection Program For Nuclear Power Facilities Operating Prior to January 1, 1979."

10 CFR Part 54.21 states that for those components with intended functions that are identified within the scope of license renewal, those components which are passive (do not perform their functions with moving parts) and long-lived (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 which 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 and walls), sprinkler heads, fire suppression system piping and valves, and fire protection tanks and pump casings, and fire hydrant casings.

tanks and pump casings, and fire hydrant casings. Active components are defined as components that perform an intended function as described in 10 CFR 54.4 with moving parts or with a change in configuration or properties, and 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 inclusion in the 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 aging management reviewAMR under 10 CFR Part 54.21(a)(1)(ii). These components are considered to be 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. These components may be excluded from an AMR 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., National Fire Protection Association (NFPA) standards).

It is required that tThe applicant should state in the license renewal application that the components are included within scope but excluded from an AMR on the basis of the consumables position. Furthermore, steps (1) and (2) shown above must be addressed in theIn addition, the application should identify those fire protection system components that the licensee considers to be outside of the scope of equipment required for 10 CFR 50.48 compliance as well as the basis for that determination. The license renewal application to ensure that proper technical justification is provided for the exclusion of the system filters, fire extinguishers, fire hoses, and air packs.

should include an up-to-date piping and instrumentation diagram for the fire protection system that clearly indicates the in-scope portions of the system.

For all components identified within the scope of license renewal and subject to an aging management reviewAMR, programs are creditedmust be in place to maintain aeach component's intended function throughout the period of extended operation. NUREG-1801 identifies aging management programs that were determined to be acceptable to manage aging effects of SSCs in the scope of the license renewal as required by 10 CFR 54. For example, the intended function of fire suppression piping or the fire pump casing is to provide a pressure boundary. Therefore, pPrograms credited to manage the aging effects forof the pressure boundary can be in the form of 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 either a plan for continued access to an adequate supply of replacement Halon or a plan to replace the system.

Due to the uniqueness of each existing nuclear power plant and to the variations in plant licensing bases, the staff should consider that requirements imposed on one plant are not necessarily applicable to another plant and, similarly, exceptions approved for one plant may not apply to another plant. Each plant should be evaluated based on the site-specific design and licensing basis.

APPENDIX ~~D:~~ C
Supplemental Fire Protection Review Criteria for Fire-Probabilistic Risk Assessments (PRA)

~~1.0 Fire Risk Assessment~~

~~Generic Letter 88-20, Supplement 4, requested licensees to perform individual plant examinations of external events (IPEEE), to assess severe accident vulnerabilities, including vulnerabilities to internal fire events.~~

The purpose of this appendix is to provide guidance for the review of the fire protection information to be provided in an application for PRA. An existing plant that has not adopted a risk-informed, performance-based FPP in accordance with 10 CFR 50.48(c) may apply risk-informed methodologies, including fire PRA, to the evaluation of a FPP change. However, the proposed methodologies, including the acceptance criteria, must be reviewed and approved by the NRC prior to the implementation of the plant change.

10 CFR Part 52.47(a)(v) requires that new reactor applications submitted under Part 52 include a design specific ~~fire risk assessment. The specific objectives of the fire risk assessment are to:~~

1. ~~develop an appreciation of severe accident behavior;~~
2. ~~understand the most likely severe accident sequences that could occur at the plant under full power operating conditions;~~
3. ~~gain a qualitative understanding of the overall likelihood of core damage and radioactive material release; and~~
4. ~~reduce the overall likelihood of core damage and radioactive material releases by modifying hardware and procedures that would help prevent or mitigate severe accidents, if necessary.~~

~~Methods previously determined acceptable to the staff for performing a fire risk assessment are a level 1 fire PRA as described in NUREG/CR-2300, a simplified fire PRA as described in NUREG/CR-4840, or the Electric Power Research Institute's Fire Vulnerability Evaluation (FIVE) methodology.~~

~~The licensee may use the COMPBRN code to model fire propagation, provided that the shortcomings identified in NUREG/CR-5088, "Fire Risk Scoping Study," developed by Sandia National Laboratory, are addressed. When the licensee assesses the effectiveness of manual fire fighting, it should use plant-specific data from fire brigade training to determine the response time of the fire fighters. The effectiveness of fire barriers should be assessed, and the use of separation in determining fire zones critically examined. The walkdown procedures should be specifically tailored to assess the remaining issues identified in the NUREG/CR-5088: (1) seismic/fire interactions, (2) effects of fire suppressants on safety equipment, and (3) control system interactions for severe accident vulnerabilities. Containment performance should be assessed to determine if vulnerabilities stemming from sequences that involve containment failure modes distinctly different from those obtained in the internal event analyses are predicted.~~

~~Fire risk assessment submittals should contain the following information:~~

- A description of the methodology and key assumptions used in performing the fireprobabilistic risk assessment.

- A discussion of the criteria used to identify critical fire areas and a list of critical areas, including (a) single areas in which equipment failures represent a serious erosion of safety margin, and (b) same as (a), but for double or multiple areas sharing common barriers, penetration seals, HVAC ducting, etc.

- A discussion of the criteria used for fire size and duration and the treatment of cross-zone fire spread and associated major assumptions.

- A discussion of the fire initiation data base, including the plant-specific data base used. Describe the data handling method, including major assumptions, the role of expert judgment, and the identification and evaluation of sources of data uncertainties. A discussion of each case where the plant-specific data used is less conservative than the data base used in the approved fire vulnerability methodologies.

- A discussion of the effects of fire growth and propagation, the transport and effects of hot gases and smoke, and the analysis of detection and suppression systems and their associated assumptions, including the treatment of suppression-induced damage to equipment.

- A discussion of fire damage modeling, including the definition of fire-induced failures related to fire barriers and control systems and fire-induced damage to cabinets. A discussion of how human intervention is treated and how fire-induced and non-fire-induced failures are combined. Identify recovery actions and types of fire mitigating actions taken credit for in these sequences.

- Discuss the treatment of detection and suppression, including fire fighting procedures, fire brigade training and adequacy of existing fire brigade equipment, and treatment of access routes versus existing barriers.

- All functional/systemic event trees associated with fire initiated sequences.

- A description of dominant functional/systemic sequences leading to core damage along with their frequencies and percentage contribution to overall fire core damage frequencies. Sequence selection criteria are provided in GL 88-20 and NUREG-1335. The description of the sequences should include a discussion of specific assumptions and human recovery action.

- The estimated core damage frequency, the timing of the associated core damage, a list of analytical assumptions including their bases, and the sources of uncertainties.

- Any fire induced containment failures.

A detailed fire PRA is not necessarily required for a new reactor FPP. However, if a COL applicant references a certified design and if that certified design developed a fire PRA, then the COL applicant, per proposed 10 CFR 52.80(a), is to 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 an 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 and the draft American Nuclear Society Fire PRA Standard. NUREG/CR-6850 should provide the basis for the review of the proposed methodologies. Refer to SRP Chapter 19, “Probabilistic Risk Assessment,” for additional guidance on the review of nuclear power plant PRAs.

A fire PRA should be subjected to a peer review to the extent that adequate industry guidance is available. The industry guidance will be reviewed and, if appropriate, accepted by the NRC prior to its application to specific fire PRAs. The results of the plant-specific peer reviews should also be reviewed by the NRC. A peer review should be conducted for all types and levels of fire PRAs. In the event that 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~~pursuant to 10 CFR ~~Part 50, §50~~50.90 and ~~§50~~50.92. ~~Regulatory Guide~~RG 1.174, “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~~RG 1.174. Where PRA is used by licensees in support of submittals to change the plant licensing basis, the guidelines of SRP Chapter 19 should be followed.

Licensees may apply fire modeling methodologies to a performance-based evaluation of the FPP and to changes to the program. Fire modeling results can provide input to a change evaluation, but the change should also be evaluated for the impact on plant risk, defense-in-depth, and safety margin. Licensees should document that the fire models and methods used meet NRC requirements. The licensee should also document that the models and methods used in performance-based analyses are 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.

The NRC’s Office of Nuclear Regulatory Research (RES) and the Electric Power Research Institute (EPRI) have documented the verification and validation (V&V) 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 (FDT^{s}),” (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 been specifically V&V’d by the NRC; however, licensees are responsible for providing acceptable V&V of these fire models. The V&V documents for licensee-proposed fire models are subject to NRC review and approval.

APPENDIX ~~E:~~ D
Supplemental Fire Protection Review Criteria for Power Uprates

The purpose of this appendix is to provide guidance for the review of the fire protection information ~~to be provided~~ in an application for a power uprate. Power uprates typically result in an increase in decay heat generation following a plant trip; however, this change usually does not affect the elements of a ~~fire protection program~~FPP related to administrative controls, fire suppression and detection systems, fire barriers, the fire protection responsibilities of plant personnel, the procedures and resources necessary for the repair of systems required to achieve and maintain cold shutdown, ~~or~~nor does it usually result in an increase in the potential for a radiological release resulting from a fire. The licensee's submittal should confirm that the power uprate results in no changes to these elements, and this finding should be reflected in the staff's safety evaluation. If the licensee indicates that there is an impact on these elements, the staff should review the impact against the acceptance criteria in the applicable sections of this ~~BTP~~SRP to ensure that the Commission's fire protection goals are satisfied.

The systems relied upon to achieve and maintain safe shutdown following a fire may be affected by the power uprate due to the increase in decay heat generation following a plant trip. For fire events where the licensee is relying on one full train of the redundant systems normally used for safe shutdown, the licensee's analysis of the impact of the power uprate on the important plant process parameters performed for other plant transients, such as a loss of off-site power or a loss of main feedwater, will typically bound the impact for a fire event such that a specific analysis for fire events is not ~~required~~necessary. However, where a licensee~~s rely~~ relies on less than full capability systems for fire events, such as partial ~~ADS~~automatic depressurization or a reduced capability makeup pump, the licensee should provide a specific analysis for fire events ~~should be provided~~ that demonstrates that the fuel design limits are not exceeded ~~such~~, that fuel integrity is maintained and that there are no adverse consequences on the reactor pressure vessel integrity or the attached piping. ~~Plants~~Licensees that rely on alternative/dedicated or backup shutdown capability for post-fire safe shutdown should analyze the impact of the power uprate on the alternative/dedicated or backup shutdown capability. The staff should verify that ~~the capability of~~ the alternative/dedicated or backup systems relied upon for post-fire safe shutdown are capable of achieving and maintaining safe shutdown considering the impact of the power uprate.

The plant's post-fire safe~~-~~-shutdown procedures may also be impacted by the power uprate. For example, the allowable time to perform necessary operator actions may decrease as a result of the power uprate and the ~~required~~necessary flow rates for systems required to achieve and maintain safe shutdown may need to be increased. The licensee should identify the impact of the power uprate on the plant's post-fire safe~~-~~-shutdown procedures.

RIS-001, Revision 0, "Review Standard for Extended Power Uprates," provides additional guidance for the review of applications for power uprate.

SRP Section 9.5.1
Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in (Draft) Revision 4, dated October 2003 of this SRP. See ADAMS accession number ML052070563.

In addition, this SRP section was administratively updated in accordance with NRR Office Instruction, LIC-200, Revision 1, "Standard Review Plan (SRP) Process." The revision also adds standard paragraphs to extend application of the updated SRP section to prospective applications submitted pursuant to 10 CFR Part 52.

The technical changes are incorporated in Revision 5, dated 200X:

1. Removed Branch Technical Position SPLB 9.5-1 (the BTP guidance has been incorporated in draft Revision 1 of Regulatory Guide 1.189, "Fire Protection for Nuclear Power Plants," (DG-1170))

2. Expanded the review guidance for new reactors

3. Added references to applicable regulatory documents issued subsequent to Revision 4

4. Deleted Appendix A: "Supplemental Fire Protection Review Criteria for Shutdown and Decommissioned Reactors" (this guidance is provided in RG 1.191)

5. Updated guidance on the use of fire modeling and probabilistic methodologies for non-NFPA 805 plants (a new separate SRP section is being prepared for NFPA 805 plants)