U.S. NUCLEAR REGULATORY COMMISSION

DRAFT REGULATORY GUIDE DG-1360

Proposed Revision 2 to Regulatory Guide 1.205

Issue Date: November 2020
Technical Leads: Charles Moulton and Shivani Mehta

RISK-INFORMED, PERFORMANCE-BASED FIRE PROTECTION FOR EXISTING LIGHT-WATER NUCLEAR POWER PLANTS

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes an approach that is acceptable to the staff of the U.S. Nuclear Regulatory Commission (NRC) to meet the regulatory requirements of Title 10, "Energy," of the *Code of Federal Regulations* (10 CFR) section 50.48(c) (Ref. 1) and National Fire Protection Association (NFPA) Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition (Ref. 2), which is incorporated by reference in 10 CFR 50.48(c).

Applicability

This RG applies to reactor licensees subject to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," that voluntarily adopt a new fire protection licensing basis that complies with the requirements in 10 CFR 50.48(a) and 10 CFR 50.48(c). The RG could also apply to holders of combined licenses under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." However, because large sections of NFPA 805 would not be applicable to a 10 CFR Part 52 licensee, no combined license holder is expected to adopt 10 CFR 50.48(c) as its licensing basis. Therefore, the NRC is not expanding the RG's applicability to combined license holders at this time.

Applicable Regulations

- 10 CFR Part 50 provides regulations for licensing production and utilization facilities, including the fire protection regulations listed below.
    - 10 CFR 50.48(a) requires applicants and licensees to have a fire protection plan that satisfies General Design Criterion (GDC) 3, "Fire protection," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50.

- 10 CFR 50.48(c) establishes the requirements for using NFPA 805 as an alternative to the requirements associated with 10 CFR 50.48(b) and Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," or the fire protection license conditions for plants licensed after January 1, 1979. This regulation incorporates by reference NFPA 805, 2001 Edition, with certain exceptions.

- 10 CFR Part 50, Appendix A, GDC 3, requires operating reactor licensees to design structures, systems, and components important to safety to minimize the probability and effect of fires and explosions.

Related Guidance

- RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (Ref. 3), describes an approach that is acceptable to the staff for developing risk-informed applications for a licensing basis change that considers engineering issues and applies risk insights. It provides general guidance concerning analysis of the risk associated with proposed changes in plant design and operation.

- RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities" (Ref. 4), describes one acceptable approach for determining whether the technical adequacy of a probabilistic risk assessment (PRA) is sufficient to provide confidence in the results, such that the PRA can be used in regulatory decision-making for light-water reactors.

- RG 1.189, "Fire Protection for Nuclear Power Plants" (Ref. 5), describes an approach that is acceptable to staff for licensees to meet the regulatory requirements of 10 CFR 50.48(a) and (b), and 10 CFR Part 50, Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979." These regulations state the requirements governing a nuclear power plant's fire protection program (FPP).

- RG 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves" (Ref. 6), describes a method acceptable to the staff for complying with the regulatory criteria with regard to the application of thermal overload protection devices that are integral with the motor starter for electric motors on motor-operated valves. This method would ensure that the thermal overload protection devices will not needlessly prevent the motor from performing its safety-related function.

- NUREG-0800, SRP Section 9.5.1.2, "Risk-Informed, Performance-Based Fire Protection Program" (Ref. 7), provides guidance on risk-informed, performance-based FPP licensing actions submitted pursuant to 10 CFR 50.48(c).

- NUREG/CR-6850/EPRI 1011989, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities," Volume 1, "Summary and Overview," and Volume 2, "Detailed Methodology," September 2005 (Ref. 8), and NUREG/CR-6850/EPRI 1019259, Supplement 1, "Fire Probabilistic Risk Assessment Method Enhancements," September 2010 (Ref. 9), provide guidance from the NRC and EPRI on a methodology for conducting a fire PRA.

Purpose of Regulatory Guides

The NRC issues RGs to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific issues or postulated events, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This RG provides guidance for implementing the mandatory information collections in 10 CFR Part 50 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). These information collections were approved by the Office of Management and Budget (OMB), under control number 3150-0011. Send comments regarding this information collection to the Information Services Branch (T6-A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the OMB reviewer at: OMB Office of Information and Regulatory Affairs (3150-0011), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street, NW, Washington, DC 20503; e-mail: oira_submission@omb.eop.gov.

Public Protection Notification

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

B. DISCUSSION

Reason for Revision

This revision of the RG (Revision 2) addresses new information identified since the guide was revised in 2009 and updates previous staff positions and endorsements. This RG endorses Nuclear Energy Institute (NEI) guidance documents, NEI 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)," Revision 3, issued 2019 (Ref. 10), and portions of NEI 00-01, "Guidance for Post Fire Safe Shutdown Circuit Analysis," Revision 4, issued 2019 (Ref. 11). This revision also includes guidance concerning fire-induced circuit failures, which is located in Section C.3.3, "Circuit Analysis."

Background

In accordance with 10 CFR 50.48(a), each operating nuclear power plant must have a fire protection plan that satisfies GDC 3. In addition, plants licensed to operate before January 1, 1979, must meet the requirements of Appendix R to 10 CFR Part 50, except to the extent provided for in 10 CFR 50.48(b). The NRC requires plants licensed to operate after January 1, 1979, to comply with 10 CFR 50.48(a), as well as any plant-specific fire protection license conditions and technical specifications.

The fire protection requirements of 10 CFR 50.48(b) and Appendix R to 10 CFR Part 50, and the associated regulatory guidance, are prescriptive in that they identify specific methods for ensuring nuclear safety in the event of a fire. The industry and some members of the public have characterized these requirements as creating an unnecessary regulatory burden to achieve an acceptable level of fire safety and comply with the general, performance-based requirements of GDC 3.

On March 26, 1998, in SECY-98-058, "Development of a Risk-Informed, Performance-Based Regulation for Fire Protection at Nuclear Power Plants" (Ref. 12), the staff proposed to work with NFPA and the industry to develop a risk-informed, performance-based consensus standard for nuclear power plant fire protection. The SECY noted that the NRC could endorse this consensus standard in a future rulemaking as an alternative set of fire protection requirements to the existing regulations in 10 CFR 50.48, "Fire Protection." In SECY-00-0009, "Rulemaking Plan, Reactor Fire Protection Risk-Informed, Performance-Based Rulemaking," dated January 13, 2000 (Ref. 13), the NRC staff requested and received Commission approval to proceed with a rulemaking to permit power reactor licensees to adopt NFPA 805 as an alternative to existing fire protection requirements. On February 9, 2001, the NFPA Standards Council approved the 2001 Edition of NFPA 805 as an American National Standard for performance-based fire protection for light-water nuclear power plants.

Effective July 16, 2004 (Ref. 14), the Commission amended its fire protection requirements in 10 CFR 50.48 to add 10 CFR 50.48(c), which incorporates by reference the 2001 Edition of NFPA 805, with certain exceptions, and allows licensees to apply for a license amendment to comply with the 2001 Edition of NFPA 805.

In parallel with the Commission's efforts to issue a rule incorporating the risk-informed, performance-based fire protection provisions of NFPA 805, NEI published implementing guidance for the specific provisions of NFPA 805 and 10 CFR 50.48(c) in NEI 04-02. RG 1.205, Revision 1, endorsed, with clarifications and exceptions, NEI 04-02, Revision 2. This revision of the RG (Revision 2) updates the previous staff positions in RG 1.205, Revision 1, and endorses NEI 04-02, Revision 3. This RG also offers additional information and guidance to supplement the NEI document and assist licensees in

meeting the NRC's regulations in 10 CFR 50.48(c) related to adopting a risk-informed, performance-based FPP.

NEI 04-02, Revision 3, provides detailed guidance applicable to many of the regulatory requirements of 10 CFR 50.48(c) and NFPA 805. This guide sets forth regulatory positions, emphasizes certain issues, clarifies the requirements of 10 CFR 50.48(c) and NFPA 805, clarifies the guidance in NEI 04-02, and modifies the NEI 04-02 guidance where required. Should a conflict occur between NEI 04-02 and this RG, the regulatory positions in this guide govern.

References to NEI 04-02 in this regulatory guide refer to Revision 3 of that NEI document. References to NEI 00-01 in this regulatory guide refer to Revision 4 of that NEI document.

Fire Protection Program Changes

Before the issuance of 10 CFR 50.48(c), plants typically adopted a standard fire protection license condition. Under this condition, the licensee could make changes to the approved FPP without prior NRC approval only if the changes would not adversely affect the plant's ability to achieve and maintain safe shutdown in the event of a fire. In 10 CFR 50.48(c), the NRC requires licensees choosing to adopt NFPA 805 to identify license conditions to be revised or superseded. Licensees should request a new fire protection license condition that will define the revised bases for making changes to the approved NFPA 805 FPP without prior NRC approval. Regulatory Position 3.1 in Section C provides an example license condition.

Appendices to NFPA 805

As discussed in the Statement of Considerations (titled "Approval of Incorporation by Reference" in the *Federal Register* notice for the final 10 CFR 50.48(c) rulemaking), the appendices to NFPA 805 are not considered part of the rule.

Fire Probabilistic Risk Assessment

Although a licensee may transition to an FPP based on NFPA 805 without a fire probabilistic risk assessment (PRA)[1] model, licensees should develop a plant-specific fire PRA to fully realize the safety and cost benefits of making the transition to NFPA 805. This is because a fire PRA forms the basis for risk-informed changes to the FPP that can be made without prior NRC review and approval under a revised plant license condition, as described in Regulatory Position 3.1 in Section C.

Consideration of International Standards

The International Atomic Energy Agency (IAEA) works with member states and other partners to promote the safe, secure, and peaceful use of nuclear technologies. The IAEA develops Safety Standards and Safety Guides for protecting people and the environment from harmful effects of ionizing radiation. This system of safety fundamentals, safety requirements, safety guides, and other relevant reports reflects an international perspective on what constitutes a high level of safety. To inform its development of this

[1] The NRC considers probabilistic safety analysis and PRA to be synonymous. This RG will use PRA. The term "fire PRA," as used in this RG, encompasses all levels and types of PRAs, including fire PRAs created before the issuance of NUREG/CR-6850/EPRI 1011989, the fire portions of individual plant examinations of external events, and enhanced PRAs for internal events.

RG, the NRC considered IAEA Safety Requirements and Safety Guides[2] pursuant to the Commission's International Policy Statement (Ref. 15) and Management Directive and Handbook 6.6 (Ref. 16).

In development of this RG, the following IAEA Safety Requirements and Guides were considered:

- NS-G-1.7, "Protection Against Internal Fires and Explosions in the Design of Nuclear Power Plants" (2004).

- NS-G-2.1, "Fire Safety in the Operation of Nuclear Power Plants" (2000).

Documents Discussed in Staff Regulatory Guidance

This RG endorses, in part, the use of one or more codes or standards developed by external organizations and other third party guidance documents. These codes, standards and third party guidance documents may contain references to other codes, standards or third party guidance documents ("secondary references"). If a secondary reference has itself been incorporated by reference into NRC regulations as a requirement, then licensees and applicants must comply with that standard as set forth in the regulation. If the secondary reference has been endorsed in a RG as an acceptable approach for meeting an NRC requirement, then the standard constitutes a method acceptable to the NRC staff for meeting that regulatory requirement as described in the specific RG. If the secondary reference has neither been incorporated by reference into NRC regulations nor endorsed in a RG, then the secondary reference is neither a legally-binding requirement nor a "generic" NRC approved acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified, consistent with current regulatory practice, and consistent with applicable NRC requirements.

[2] IAEA Safety Requirements and Guides may be found at WWW.IAEA.Org/ or by writing the International Atomic Energy Agency, P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria; telephone (+431) 2600-0; fax (+431) 2600-7; or e-mail Official.Mail@IAEA.Org. It should be noted that some of the international recommendations do not correspond to the requirements specified in the NRC's regulations, and the NRC's requirements take precedence over the international guidance.

C. STAFF REGULATORY GUIDANCE

1. Exceptions and Clarifications for NEI 04-02, Revision 3

All references to NEI 04-02 in these regulatory positions refer to Revision 3 of that NEI document.

a. As discussed in Section B of this RG in the paragraph titled **"**Documents Discussed in Staff Regulatory Guidance," the NRC's endorsement of NEI 04-02 does not imply the NRC's endorsement of the references cited in NEI 04-02. The NRC has not necessarily reviewed and approved the guidance provided in these references, except where specifically noted in this RG.

b. NEI 04-02 includes examples to supplement the guidance. These examples are illustrative only, and each licensee should ensure that an example is applicable to its particular circumstances before implementing its guidance.

c. NEI 04-02 often refers to requirements in NFPA 805 and 10 CFR 50.48(c). In some cases, NEI 04-02 suggests that the requirements are voluntary (e.g., "should" used in place of "shall"). Since the 2001 Edition of NFPA 805 has been incorporated by reference into 10 CFR 50.48(c), licensees and applicants must comply with that standard as set forth in the regulation, unless the NRC grants an exemption from the requirements of 10 CFR 50.48(c) in accordance with 10 CFR 50.12, "Specific Exemptions." If the licensee finds conflicts between NFPA 805 and NEI 04-02, licensees must follow the text of NFPA 805 because it is incorporated by reference in 10 CFR 50.48(c).

d. NEI 04-02, Section 4.3.2, states, "[P]art of an existing fire protection program may be transitioned to a new NFPA 805 licensing basis by performing a transition review and by addressing NFPA 805 topics not typically addressed in a previously approved fire protection program…" While this statement may be true for some licensees, it should not be interpreted to mean that the existing FPP, a priori, complies with the requirements of 10 CFR 50.48(c). Licensees should verify that portions of the existing FPP that are to be so "transitioned" do, in fact, comply with the requirements of NFPA 805.

e. NEI 04-02 states that, if operator manual actions that are not allowed under the current regulatory framework or do not have previous NRC approval become recovery actions, they should be evaluated using the change process. However, NFPA 805 states that the additional risk of recovery actions that are relied on to demonstrate the availability of a success path, as set forth in NFPA 805, Section 4.2.3.1, must be addressed using performance-based methods, as required by NFPA 805, Section 4.2.4 (see Regulatory Position 2.4).

f. NEI 04-02, Section 4.3.1, states that existing engineering equivalency evaluations (EEEEs) are an acceptable alternative to the deterministic requirements in NFPA 805, Section 4.2.3. The NRC endorses this guidance only if the conditions identified in Regulatory Position 2.3.2 are met.

g. NEI 04-02, Appendix O, provides a sample standard license condition, which the NRC does not endorse. Regulatory Position 3.1 provides an example license condition.

h. NEI 04-02, Section 4.6.2, provides a list of key items that a license amendment request should include. NEI 04-02, Appendix H, provides a license amendment template. The information provided may not be complete; for example, the list in NEI 04-02, Section 4.6.2, does not include submitting information to support the quality of the PRA models or the use of such models in

performing NFPA 805 risk assessments. The licensee should ensure that it submits sufficient information required by applicable regulations and needed for the NRC to make its safety finding on the application.

i. Subsequent to publication and endorsement of NEI 04-02, Revision 2, the industry developed and the NRC approved a number of NFPA 805 frequently asked questions (FAQs) related to fire PRA and fire PRA FAQs in RG 1.205, Revision 1, "Risk Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," issued December 2009 (Ref. 17). NEI 04-02, Revision 3, does not include the content of these FAQs, since they are related to fire PRAs. However, a table in NEI 04-02, Revision 3, Appendix M, lists their respective NRC-authored closure memoranda. Licensees should be aware that the information in this table may be incomplete or outdated. For example, subsequent NRC guidance may have modified or superseded an FAQ. This RG endorses neither the table nor the closure memoranda.

2. License Transition Process

2.1 Transition Schedule

In 10 CFR 50.48(c), the NRC does not mandate a specific schedule for implementing an FPP that meets the provisions of NFPA 805. However, the Statement of Considerations for 10 CFR 50.48(c) states that the NFPA 805 license amendment will include a license condition imposing the use of NFPA 805, together with an implementation schedule. Licensees should include an implementation schedule with their request to adopt an FPP based on NFPA 805.

2.2 License Amendment Request

2.2.1 *Uncertain Elements of Current Fire Protection Program*

The NRC may not have specifically approved certain aspects of the plant's current FPP (e.g., through an approved request under 10 CFR 50.12, "Specific Exemptions"). This has resulted in uncertainty in licensees' fire protection licensing bases. Licensees should submit elements of their plant's FPP, such as the crediting of recovery actions and circuit analysis methods, if they want explicit approval of these elements under 10 CFR 50.48(c). Any submittal addressing these FPP elements should include sufficient detail to allow the NRC to assess whether the licensee's treatment of these elements meets 10 CFR 50.48(c) requirements.

2.2.2 *Performance-Based Methods for Fundamental Fire Protection Program Elements and Minimum Design Requirements*

In accordance with 10 CFR 50.48(c)(2)(vii), a licensee may request NRC approval (by license amendment) to use NFPA 805 performance-based methods in determining the licensee's compliance with the FPP elements and minimum design requirements in Chapter 3 of NFPA 805. A licensee should provide sufficient information in the license amendment request to allow the NRC staff to determine that the performance-based approach does the following:

(1) satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release;

(2) maintains safety margins; and

(3) maintains fire protection defense in depth (fire prevention, fire detection, fire suppression, mitigation, and postfire safe-shutdown capability).

2.2.3 *Risk-Informed or Performance-Based Alternatives to Compliance with NFPA 805*

Under 10 CFR 50.48(c)(4), a licensee may request NRC approval (by license amendment) of the use of alternative risk-informed or performance-based methods (i.e., methods that differ from those prescribed by NFPA 805) to demonstrate compliance with 10 CFR 50.48(c). A licensee should provide sufficient information in the license amendment request to allow the NRC staff to determine that the proposed alternatives do the following:

(1) satisfy the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release;

(2) maintain safety margins; and

(3) maintain fire protection defense in depth (fire prevention, fire detection, fire suppression, mitigation, and postfire safe-shutdown capability).

The license amendment request should include complete and concise details for each of the proposed methods used to demonstrate that an alternative to compliance with NFPA 805 is acceptable. The license amendment request may reference generic methods (e.g., topical reports) that the NRC has previously approved and through which the licensee can demonstrate that the alternative is applicable for its intended use.

If the proposed methods have been adequately described in the license amendment request and accepted by the NRC, these methods may be applied to the licensee's FPP upon issuance of a license amendment approving the methods. A licensee may apply these approved methods within the limits specifically described in its licensing basis to implement plant changes that affect the FPP.

Licensee self-approval of FPP changes using approved alternative risk-informed or performance-based methods may be granted in the fire protection license condition, when appropriate. Subsequent changes to the approved alternative risk-informed or performance-based method must be submitted for NRC review and approval (through a license amendment request) before being applied to the licensee's FPP.

2.2.4 *Risk Evaluations*

In accordance with 10 CFR 50.48(c), licensees may evaluate fire areas using performance-based approaches. The performance-based approaches may be fire modeling or other engineering analyses (i.e., NFPA 805, Section 4.2.4.1), a fire risk evaluation (i.e., NFPA 805, Section 4.2.4.2), or a risk-informed or performance-based alternative to compliance with NFPA 805 (i.e., 10 CFR 50.48(c)(4)). These methods are applied to aspects of a fire area that are used as an alternative to the NFPA 805 deterministic criteria,[3] whether these alternatives involve hardware (equipment and systems) functions or

[3] The "deterministically compliant plant" has been referred to as "an ideal plant" that may not exist or be feasible in practice. Based on experience with the two NFPA 805 pilot plants, the risk of most variances from the deterministic requirements can readily be evaluated by postulating modifications, such as moving or protecting cables, which would meet the deterministic requirements. This provides the base case against which the added risk of the proposed alternative is evaluated. Because of the great similarity between the deterministic criteria of NFPA 805 and the requirements in Appendix R to 10 CFR Part 50, the compliant configuration should be clear, in most cases. An exception might occur for fire scenarios in which evacuation of the main control room is necessary. The RG addresses this by defining the term "primary control station," which is used in the NFPA 805 definition of recovery action; see Regulatory Position 2.4.

human actions. (Note that EEEEs, as set forth in NFPA 805, Section 2.2.7, can be used to demonstrate compliance with the deterministic criteria; refer to Regulatory Position 2.3.2.)

A license amendment request should clearly demonstrate that the requirements of 10 CFR 50.48(c) and NFPA 805 will be met, including any required risk assessments. The quality of the risk assessments should be consistent with Regulatory Position 4.3.

One type of risk assessment, the plant change evaluation, provides risk information as described in NFPA 805, Sections 2.2.9 and 2.4.4. Regulatory Position 3.2 discusses plant change evaluations, which apply to a plant that has made the transition to NFPA 805. Another type of risk assessment provides risk information on the performance-based alternatives to the deterministic approach in the fire risk evaluation, which includes, as necessary, the evaluation of the additional risk of certain recovery actions in accordance with NFPA 805, Section 4.2.4 (refer to Regulatory Position 2.4). Fire risk evaluations are used to make the transition to NFPA 805.

For each fire area for which the licensee has used a fire risk evaluation to demonstrate compliance with NFPA 805, any increase in risk should be acceptable, as described in Regulatory Position 2.2.4.1. The total increase in risk from these fire areas should also be acceptable, as described in Regulatory Position 2.2.4.2.

2.2.4.1 Fire Risk Evaluations (Including Recovery Actions) by Fire Area

Fire risk evaluations may be performed as a performance-based approach to demonstrate that an alternative to the NFPA 805 deterministic criteria is acceptable. Any increase or decrease in risk (both in terms of core damage frequency (CDF) and large early release frequency (LERF)) should be evaluated and provided for each fire area that uses a fire risk evaluation.

In some cases, the NRC has previously approved recovery actions that are proposed in lieu of deterministic requirements.[4] For these actions, the additional risk should be submitted with the transition license amendment request and can be deemed acceptable[5] because of the previous approval. These previously approved alternatives to the deterministic requirements can be "carried over" into the NFPA 805 licensing basis. However, the additional risk of previously approved recovery actions is considered during transition when evaluating the acceptability of other risk increases resulting from the use of the fire risk evaluation approach. Regulatory Position 2.2.4.3 provides guidance on the base risk.

Figure 1 provides a convenient framework to focus the discussion of this concept. The flowchart in Figure 1 starts with a given fire area to which the performance-based approach of NFPA 805, Section 4.2.4.2, is applied (block [1]). The licensee must estimate additional risk of the previously approved recovery actions, compared to the NFPA 805 deterministic criteria, and include it in the transition license amendment request. If that additional risk (block [2]) is greater than the acceptance guidelines in RG 1.174 (i.e., in Region I of either Figure 4 or Figure 5 of RG 1.174), then the NRC staff will not normally approve any net increase in risk in that fire area (block [3]) from other variances from the deterministic requirements (VFDRs). Note that the acceptance guidelines of RG 1.174 may require the total CDF or LERF (or both) to evaluate changes for which the risk impact exceeds specific guidelines. If additional VFDRs are associated with that fire area (e.g., equipment or cables that do not meet the requirements; recovery actions not previously approved by the NRC), then those VFDRs would either

[4] "Previously approved" means that it has been submitted to the NRC Office of Nuclear Reactor Regulation and approved by the NRC (e.g., in a safety evaluation report or in an exemption).

[5] The additional risk could be deemed acceptable unless circumstances indicate that a forward fit under MD 8.4 (as referenced in Section D below) is warranted.

have to be brought into deterministic compliance, or any additional risk associated with those VFDRs would have to be offset by an equal or greater reduction in risk for that fire area. The NRC staff will not normally approve net risk increases in fire areas for which the previously approved recovery actions represent an additional risk above the acceptance guidelines in RG 1.174 (block [5]).

Block [4] represents the case in which the additional risk of previously approved recovery actions, compared to the NFPA 805 deterministic criteria, is less than the acceptance guidelines in RG 1.174. In this case, the NRC will normally approve risk increases in that fire area resulting from other alternatives to deterministic compliance, not previously approved, provided that the total risk increase for that fire area (i.e., from previously approved recovery actions and the other alternatives) meets the acceptance guidelines in RG 1.174. If this total risk increase exceeds the acceptance guidelines in RG 1.174, the NRC staff will not normally approve the proposed alternatives.

If there is no net risk increase in a fire area (block [3]), or if the total additional risk from alternatives to deterministic criteria, both previously approved and not previously approved, is within the acceptance guidelines in RG 1.174 (block [4]), then the NRC staff will normally find that the additional risk associated with that fire area is acceptable for making the transition to NFPA 805 (block [6]).

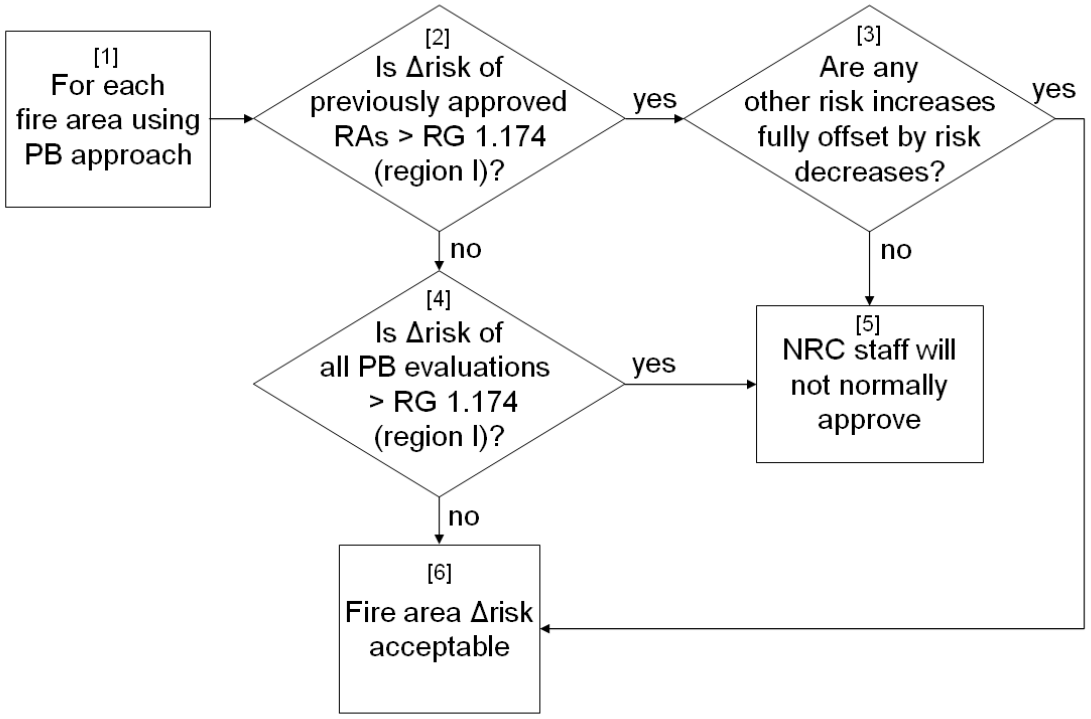

Figure 1. Framework for Fire Risk Evaluations during Transition When Crediting Previously Approved Recovery Actions (RAs)
[Δrisk = change in risk; PB = performance based]

2.2.4.2 Total Plant Delta Risk of Implementing NFPA 805

The total increase or decrease in risk associated with the implementation of NFPA 805 for the overall plant should be calculated by summing the risk increases and decreases for each fire area (including any risk increases resulting from previously approved recovery actions). The total risk increase should be consistent with the acceptance guidelines in RG 1.174. Note that the acceptance guidelines of RG 1.174 may require the total CDF, LERF, or both to evaluate changes for which the risk impact exceeds specific guidelines. If the additional risk associated with previously approved recovery actions is greater than the acceptance guidelines in RG 1.174, then the net change in total plant risk incurred by any proposed alternatives to the deterministic criteria in NFPA 805, Chapter 4 (other than the previously approved recovery actions), should be risk-neutral or represent a risk decrease.

2.2.4.3 Baseline Risk for Plant Change Evaluations

Upon completing the transition to an NFPA 805 licensing basis, the post-transition baseline risk for use in evaluating the effect of subsequent plant changes on cumulative risk will be the risk of the plant at the point of full implementation of NFPA 805 (i.e., after completing all plant modifications and changes that the licensee has committed to make during the transition).

2.2.5 *Nonpower Operational Modes*

The scope of NFPA 805 requires licensees to address the impacts of fires during all phases of plant operation, including shutdown, degraded conditions, and decommissioning. Section 4.3.3 and Appendix F to NEI 04-02 provide detailed guidance on one acceptable approach to addressing fires during nonpower operational modes.

2.2.6 *Radioactive Release Transition*

A licensee's FPP must comply with the radioactive release performance criteria in NFPA 805, Section 1.5.2. The license amendment request should clearly demonstrate that this requirement will be met once the transition is complete. The licensee should address methods for achieving the performance criteria for both smoke and fire suppression agents, on a fire-area-by-fire-area basis, during all modes of operation; address the potential for cross-contamination (water runoff and smoke from a contaminated area being directed through an uncontaminated area); and include the following:

(1) the method used to identify which systems, components, and flow paths are used to meet the release criteria;

(2) the identification of FPP elements, including measures, systems, procedural control actions, and flow paths, credited to meet the criteria;

(3) a description of plant programs, such as fire brigade training and equipment maintenance, that are relied upon to sustain equipment reliability and fire brigade performance; and

(4) a bounding analysis, qualitative risk analysis, or quantitative risk analysis that demonstrates that the release criteria have been met.

Section 4.3.4 and Appendix G to NEI 04-02 provide additional information and guidance related to this topic.

2.2.7 *Monitoring Program*

NFPA 805 requires licensees to establish a monitoring program to ensure the availability and reliability of the fire protection systems and features, assess the performance of the FPP in meeting the performance criteria, and ensure the assumptions in the engineering analyses remain valid. Section 5.2 and Appendix G of NEI 04-02 provide detailed guidance on one acceptable approach to establishing an appropriate monitoring program.

2.3 Carryover of Current Fire Protection Programs into NFPA 805

In certain cases, the NRC may have granted exemptions or deviations that are reflected in the licensee's current FPP that would be acceptable alternatives to the NFPA 805 requirements. If the NRC has previously approved such alternatives, licensees should reference documentation of that approval. Elements of a licensee's pre-transition fire protection licensing bases that can be shown to meet NFPA 805 requirements, including approved exemptions, deviations, and safety evaluation reports, are not "changes to a previously approved FPP" and would not be included in the NFPA 805, Section 2.4.4, plant change evaluation. However, certain recovery actions, whether part of the pre-transition fire protection licensing basis or not, require the use of performance-based methods, as discussed in Regulatory Position 2.4.

2.3.1 *Previously NRC-Approved Alternatives to NFPA 805, Chapter 3, Fundamental Fire Protection Program and Design Elements*

NFPA 805 states that previously approved alternatives to the fundamental FPP attributes identified in Chapter 3 take precedence over the requirements in NFPA 805, Chapter 3.

The provisions of Appendix R to 10 CFR Part 50 do not apply to nuclear power plants licensed to operate before January 1, 1979, to the extent that the NRC staff accepted fire protection features in comprehensive fire protection safety evaluation reports issued before August 1976, when the NRC published Appendix A to Branch Technical Position (BTP) Auxiliary and Power Conversion Systems Branch (APCSB) 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976" (Ref. 18), or they were accepted by the NRC staff as satisfying the provisions of the BTP reflected in the NRC's fire protection safety evaluation reports issued before the effective date of February 19, 1981. The fire protection license condition for these facilities references these safety evaluation reports for the regulatory basis for a major portion of their FPPs.

The documentation that demonstrates prior NRC approval of an alternative to the requirements in NFPA 805, Chapter 3, as well as approval of non-compliances with existing license regulatory requirements, includes NRC approvals of exemption or deviation requests and fire protection safety evaluation reports related to plant-specific licensing actions. Inspection reports, meeting minutes, and letters from licensees without a corresponding written NRC approval are examples of documents that do not represent NRC approval for this purpose.

Existing exemptions or deviations from these attributes of NFPA 805, Chapter 3, are previously approved alternatives to the fundamental FPP attributes and, therefore, take precedence over the requirements in NFPA 805, Chapter 3, provided the NRC staff determines that the licensee has acceptably addressed the continued validity of any exemption or deviation in effect at the time of application. The term "valid," used in this context, means that the technical basis for approval of the original exemption or deviation still applies (e.g., plant modifications or other changes have not invalidated the assumptions or analysis that formed the basis for the exemption or deviation; new information has not surfaced that would invalidate the original finding).

In the case of exemptions, the NRC will rescind, if appropriate, the original exemption in the NFPA 805 license amendment, since, in many cases, the NRC's approval to use 10 CFR 50.48(c) and NFPA 805 will negate the licensee's need for the exemption.

2.3.2 *Previously NRC-Approved Alternatives to Deterministic Requirements in NFPA 805, Section 4.2.3*

NFPA 805, Section 2.2.7, defines EEEEs and states that, when applying a deterministic approach, licensees may use EEEEs to demonstrate compliance with the specific deterministic fire protection design requirements in NFPA 805, Chapter 4, for existing plant configurations. These EEEEs must clearly demonstrate an equivalent level of fire protection compared to the deterministic requirements.

In the past, licensees have requested and received exemptions or deviations from the specific requirements in pretransition fire protection regulations (i.e., 10 CFR Part 50, Appendix R). Licensees may use existing exemptions or deviations to demonstrate compliance with the specific deterministic fire protection design requirements in Chapter 4 of NFPA 805, provided the NRC staff determines that the licensee has acceptably addressed the continued validity of any exemption or deviation in effect at the time of the NFPA 805 license amendment application and that the exemption or deviation does not involve a recovery action, as defined in NFPA 805, Section 1.6.52, that is used to demonstrate the availability of a success path for the nuclear safety performance criteria (see also Regulatory Position 2.4). The term "valid," used in this context, means that the technical basis for approval of the original exemption or deviation still applies (e.g., plant modifications or other changes have not invalidated the assumptions or analysis that formed the basis for the exemption or deviation; new information has not surfaced that would invalidate the original finding).

The NRC's approval of the licensee's request to implement an FPP based on NFPA 805 should reference the valid exemption or deviation as the basis for demonstrating an equivalent level of fire protection, as permitted under Section 2.2.7 of NFPA 805. The NRC will rescind, as appropriate, the original exemption in the license amendment, since, in many cases, the NRC's approval to use 10 CFR 50.48(c) and NFPA 805 will negate the licensee's need for the exemption.

A licensee may use EEEEs as described in Section 2.2.7 of NFPA 805 to demonstrate equivalency to the deterministic requirements, in cases where an exemption or deviation was not granted, provided the following are true:

a. The EEEE clearly demonstrates an equivalent level of fire protection compared to the deterministic requirements in NFPA 805, Chapter 4.

b. The EEEE is not based on a risk calculation.

c. The EEEE does not include any recovery actions, as defined in NFPA 805, Section 1.6.52, to demonstrate the availability of a success path for the nuclear safety performance criteria.

One type of EEEE is commonly referred to as a "Generic Letter (GL) 86-10 evaluation." These evaluations, which are conducted consistent with GL 86-10, "Implementation of Fire Protection Requirements," dated April 24, 1986 (Ref. 19), permit licensees that have adopted the GL 86-10 standard fire protection license condition to make changes to their approved FPPs without prior NRC approval, if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire. The NRC may not have reviewed and approved these changes, and they may not necessarily demonstrate an equivalent level of fire protection compared to the deterministic requirements in

Section 2.2.7 of NFPA 805. The licensee should verify that any EEEEs relied upon to meet the deterministic requirements of NFPA 805, Section 4.2.3, including GL 86-10 evaluations, meet the three conditions above.

NEI 04-02, Section 4.1.1, notes that the licensee should review EEEEs during the NFPA 805 transition process to ensure that the quality level and basis for acceptability are still valid. Appendix B-3 to NEI 04-02 provides detailed guidance on the review of EEEEs. Except as noted above, satisfactory results from this review should provide an adequate basis to show that the EEEEs meet the deterministic requirements of Chapter 4 of NFPA 805. Guidance for acceptable EEEEs appears in the most recent revision of RG 1.189.

NEI 04-02, Section B.3.2, states that licensees should summarize EEEEs that demonstrate that a fire protection system or feature is "adequate for the hazard" in documentation for their license amendment request. If a licensee is not requesting specific approval for an "adequate for the hazard" EEEE, then the license amendment request should state that the licensee has used an EEEE to demonstrate compliance and should briefly describe the evaluated condition. Licensees requesting specific NRC approval for "adequate for the hazard" EEEEs, as discussed in Regulatory Position 2.2.1, should state that they have used the EEEE to demonstrate compliance and submit a detailed summary, including sufficient detail to allow the NRC staff to evaluate the EEEE. The level of detail should include (1) a summary of each condition, (2) a summary of the evaluation of each condition, and (3) a summary of the resolution of each condition.

In all cases, licensees that rely on EEEEs to demonstrate compliance with NFPA 805 requirements should document this usage in their license amendment request.

2.4 Recovery Actions

Use of recovery actions, as defined in NFPA 805, Section 1.6.52, to demonstrate the availability of a success path for the nuclear safety performance criteria does not meet the deterministic requirements in Section 4.2.3 of NFPA 805. Consequently, the licensee must address recovery actions, whether or not previously approved by the NRC, using the performance-based methods in Section 4.2.4, as required by NFPA 805, Section 4.2.3.1, and must evaluate the additional risk of their use according to NFPA 805, Section 4.2.4. Regulatory Position 2.2.4 provides guidance on calculating this additional risk of recovery actions. Appendix B.2.3 to NEI 04-02 provides detailed guidance on one acceptable approach for addressing recovery actions.

When using the performance-based methods in NFPA 805, Section 4.2.4, the licensee must demonstrate the feasibility and reliability of the recovery actions. NUREG-1852, "Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire," issued October 2007 (Ref. 20), provides information and discussion concerning demonstrating the feasibility and reliability of operator manual actions.

NFPA 805, Section 4.2.3.1, identifies recovery actions for which the additional risk must be evaluated, as required by NFPA 805, Section 4.2.4. These "success path" recovery actions are operator actions that, if not successful, would lead to the fire-induced failure of the "one success path of required cables and equipment to achieve and maintain the nuclear safety performance criteria." Other operator actions that do not involve the success path and may be credited in plant procedures or the fire PRA to overcome a combination of fire-induced and random failures or to maintain adequate fire protection defense in depth may also be recovery actions, but licensees do not need to evaluate the additional risk of their use.

The staff has identified two cases in which operator actions taken outside the main control room may be considered as taking place at a primary control station and are therefore not recovery actions based on the definition in NFPA 805, Section 1.6.52. These two cases involve dedicated shutdown or alternative shutdown controls that the NRC has reviewed and approved. In either case, the location or locations become primary when command and control is shifted from the main control room to these other locations.[6] For these two cases, the operator actions are not considered recovery actions, even if they are necessary to achieve the nuclear safety performance criteria. Activities to achieve the nuclear safety performance criteria that take place outside the main control room and are not covered by one of these two cases should be considered recovery actions as defined in NFPA 805:

(1) The first case involves the controls for a system or component specifically installed to meet the "dedicated shutdown" option in Section III.G.3 of Appendix R to 10 CFR Part 50. The NRC staff considers the operation of this equipment as taking place at a primary control station. A system or component that has been specifically installed under the dedicated shutdown concept is a system or component that is operated from a location outside the control room and is fully separated from the fire area where its use is credited. These systems or components cannot be operated from the control room. Operation of dedicated shutdown equipment would not be considered a recovery action, since this would be the primary control station.

(2) The second case involves controls for systems and components that have been modified to meet the "alternative shutdown" option in Section III.G.3 of Appendix R to 10 CFR Part 50, to provide independence and electrical separation from the control room to address a fire-induced control room evacuation. These alternative shutdown controls may be considered the primary control station, provided that, once enabled, the systems and equipment controlled from the panel are independent and electrically separated from the fire area, and the following additional criteria are met:

    a. The location should be considered the primary command and control center when the main control room can no longer be used. The control room team will evacuate to this location and use its alternative shutdown controls to safely shut down the plant.

    b. The location should have the requisite system and component controls, plant parameter indications, and communications so that the operator can adequately and safely monitor and control the plant using the alternative shutdown equipment.

    c. More than one component should be controlled from this location (a local control station provided to allow an individual component to be locally controlled, as in the local handwheel on a motor-operated valve, does not meet this definition).

    Figure 2 provides a summary illustration of a primary control station as described above.

[6] For example, use of a dedicated shutdown control would not be considered a recovery action following abandonment of the main control room, because that location may be considered a primary control station. Conversely, operation of dedicated or alternative shutdown controls while the main control room remains the command and control location would normally be considered a recovery action because, for such scenarios, the dedicated or alternative controls are not considered primary.

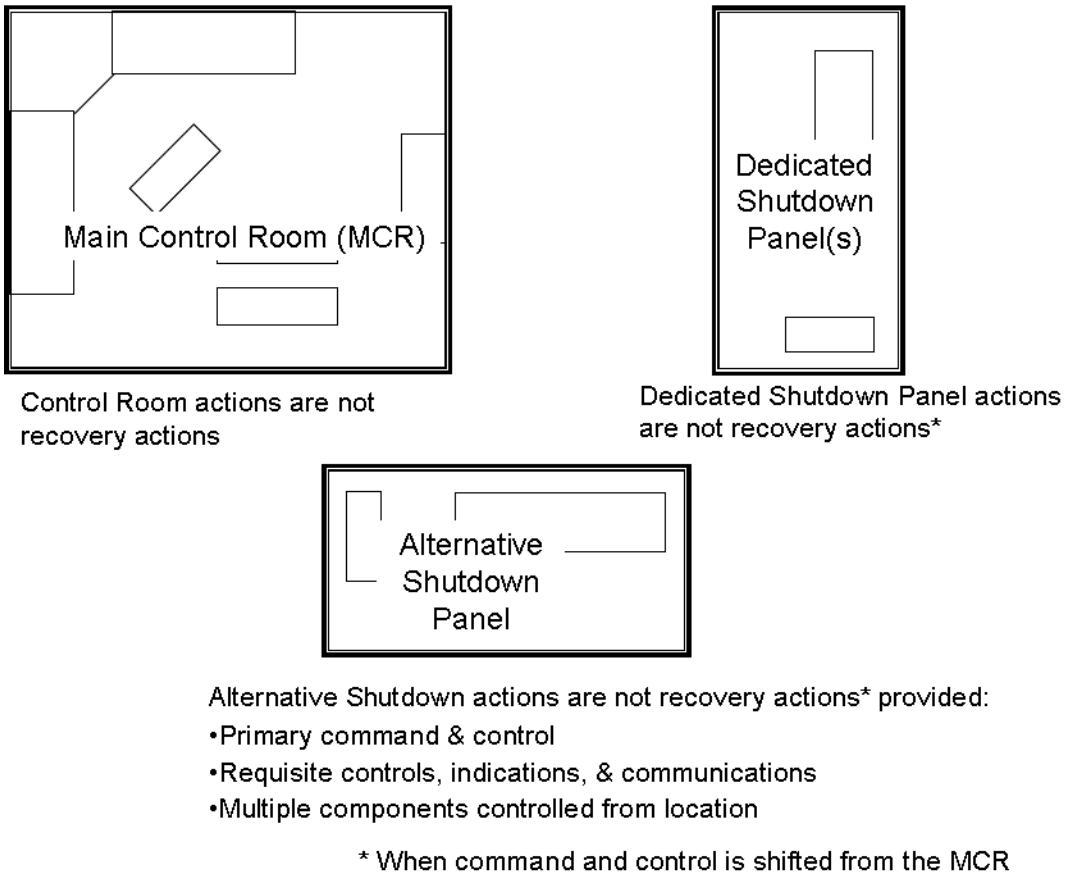

Figure 2. Illustration of Primary Control Station for Defining Recovery Actions

3. NFPA 805 Fire Protection Program

NFPA 805 refers to "the authority having jurisdiction." The NRC is the authority having jurisdiction for 10 CFR 50.48(c).

NFPA 805, Section 1.6, contains definitions applicable to the terminology used in the standard. RG 1.189 also contains a substantial list of definitions of fire protection terminology applicable to nuclear power generating stations. If potential differences or conflicts exist between definitions in NFPA 805 and other fire protection regulatory documents, and if these definitions are important to the licensing basis, licensees should use the NFPA 805 definitions.

3.1 Example License Condition

As specified in 10 CFR 50.48(c)(3)(i), the license amendment request must identify any license conditions to be revised or superseded. NFPA 805 and 10 CFR 50.48(c) identify aspects of a performance-based FPP that the NRC must specifically approve through a license amendment. The NRC intends 10 CFR 50.48(c) to allow certain changes to be made to the FPP without prior NRC review and approval, once the NRC approves the transition to a performance-based FPP.

The NRC intends to provide this flexibility to make certain changes without prior NRC review and approval in a license condition for licensees that make the transition to 10 CFR 50.48(c). An example

license condition, which includes acceptance criteria for making changes to the licensee's FPP without prior NRC review and approval, is shown below. The application of these risk acceptance criteria requires that the plant have an acceptable fire PRA that is in accordance with the guidance in Regulatory Position 4.3; refer also to Regulatory Position 3.2.4.

> (Name of Licensee) shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the licensee amendment request dated _____ (and supplements dated _____) and as approved in the safety evaluation report dated (and supplements dated _____). Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition, or requirement would require prior NRC approval, the licensee may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.
>
> Risk-Informed Changes that May Be Made Without Prior NRC Approval
>
> A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at the plant. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by the NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.
>
> (a) Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.
>
> (b) Prior NRC review and approval is not required for individual changes that result in a risk increase less than 1×10^{-7}/year (yr) for CDF and less than 1×10^{-8}/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.
>
> Other Changes that May Be Made Without Prior NRC Approval
>
> (1) Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program
>
> Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3, element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering

evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3, elements are acceptable because the alternative is "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

- "Fire Alarm and Detection Systems" (Section 3.8)
- "Automatic and Manual Water-Based Fire Suppression Systems" (Section 3.9)
- "Gaseous Fire Suppression Systems" (Section 3.10)
- "Passive Fire Protection Features" (Section 3.11)

(2) Fire Protection Program Changes that Have No More than Minimal Risk Impact

Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC safety evaluation report dated _____ to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense in depth and safety margins are maintained when changes are made to the fire protection program.

Transition License Conditions

(1) Before achieving full compliance with 10 CFR 50.48(c), as specified by (2) below, risk-informed changes to the licensee's fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in (2) above.

(2) The licensee shall implement the following modifications to its facility to complete the transition to full compliance with 10 CFR 50.48(c) by {date}.

{Reference the plant-specific list of modifications identified by the licensee as necessary to complete the transition to its new fire protection license basis.}

The licensee shall maintain appropriate compensatory measures in place until completion of the modifications delineated above.

(3) The licensee shall implement the following implementation items by {date}:

{Reference the plant-specific list of implementation items identified by the licensee as necessary to complete the transition to its new fire protection license basis}.

3.2 NFPA 805 Plant Change Evaluation Process

3.2.1 *Definition of a Change*

NFPA 805 includes provisions for licensees to make changes to their approved FPPs, once the transition to a 10 CFR 50.48(c) license is complete. Sections 2.2.9 and 2.4.4 of NFPA 805 require a "plant change evaluation" for any change to a previously approved FPP element. In the context of an NFPA 805 FPP that complies with 10 CFR 50.48(c), a change may be any of the following:

(1) a physical plant modification that affects the FPP,

(2) a programmatic change (e.g., change to a procedure, assumption, or analysis) that affects the FPP, or

(3) an in situ condition (physical or programmatic) that is not in compliance with the plant's FPP.

For changes that involve acceptance of an existing unapproved condition (i.e., a noncompliance), appropriate compensatory measures should be established and should remain in place until either the plant is modified to achieve compliance or the condition is found acceptable. Acceptance of the as-found condition may be the result of either the NRC's review and approval or the self-approval process, according to the licensee's fire protection license condition.

3.2.2 *Plant Change Evaluations*

The licensee should perform an engineering evaluation to demonstrate acceptability of the change in terms of the plant change evaluation criteria and compliance with the fire protection requirements of 10 CFR 50.48(a). The plant change evaluation process includes an integrated assessment of the acceptability of the change in risk, defense in depth, and safety margins, regardless of the methods or approaches used to evaluate the change. RG 1.174 provides acceptance guidance applicable to NFPA 805 plant change evaluations.

NFPA 805, Section 2.4.4.2, states that the defense-in-depth concept should be maintained as it relates to fire protection and nuclear safety. Under NFPA 805, Section 1.2, fire protection defense in depth is achieved when an adequate balance of each of the following elements is provided:

(1) preventing fires from starting;

(2) rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage; and

(3) providing an adequate level of fire protection for structures, systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.

The philosophy of nuclear safety defense in depth is maintained when a reasonable balance is preserved among prevention of core damage, prevention of containment failure, and mitigation of consequences. RG 1.174 provides guidance on maintaining the philosophy of nuclear safety defense in depth that is acceptable for NFPA 805 plant change evaluations.

3.2.3 *NRC Approval of Fire Protection Program Changes*

The following are examples of FPP changes that licensees must submit for NRC review and approval through a license amendment request before implementation:

(1) changes that do not meet the acceptance criteria of the approved license condition;

(2) changes to the fundamental FPP elements and design requirements of Chapter 3 of NFPA 805, which use performance-based methods, unless specified in the fire protection license condition for the plant;

(3) changes that have been evaluated using risk-informed or performance-based alternatives to compliance with NFPA 805, where the alternatives have not been approved for use by a license amendment, as required by 10 CFR 50.48(c)(4); and

(4) combined changes where any individual change would not meet the risk acceptance criteria of the approved license condition.

Licensees may request, in accordance with 10 CFR 50.48(c)(2)(vii), NRC approval of a method, with a bounding analysis approach, to use when evaluating minor changes to elements in NFPA 805, Chapter 3. Upon NRC approval of the bounding method, the licensee may make subsequent minor changes to Chapter 3 elements by performing an engineering analysis to demonstrate that the proposed change is within the scope of the approved method and complies with the bounding conditions. The licensee's fire protection license condition will reference the approval to make these changes.

3.2.4 *Plant Changes Without Prior NRC Approval*

The example license condition in Regulatory Position 3.1 sets forth criteria for making changes to the approved NFPA 805 FPP without prior NRC approval. The risk acceptance criteria for plant changes provided in this example license condition are acceptable to the NRC.

Where permitted by the approved fire protection license condition, licensees of plants that have a fire PRA that is in accordance with Regulatory Position 4.3 may make risk-informed changes without prior NRC review and approval. The types of plant changes that may be implemented without prior NRC review and approval will be limited to those for which the risk assessment methods are adequate to demonstrate that any increase in risk will continue to meet the risk acceptance criteria.

Licensees must also maintain appropriate levels of defense in depth and adequate safety margins.

The licensee should document each plant change evaluation consistent with Section 4 of RG 1.200 and retain the documentation in accordance with the requirements of NFPA 805, Section 2.7.

3.2.5 *Combined Changes and Cumulative Risk of Changes*

Section 2.4.4.1 of NFPA 805 requires licensees to evaluate the cumulative effect of plant changes (including all previous changes that have increased risk) on overall risk. Licensees should evaluate the cumulative risk in accordance with Section 6.3.2 of RG 1.174.

After the transition to NFPA 805, the cumulative risk of subsequent FPP changes is the change in risk compared to the post-transition baseline risk (see Regulatory Position 2.2.4). Also, after the transition to NFPA 805, licensees should only include changes associated with the FPP in cumulative

risk evaluations. In the example license condition in Regulatory Position 3.1, the NRC chose risk acceptance criteria low enough to provide reasonable assurance that the effect of self-approved changes on cumulative risk would be acceptable. However, when licensees request FPP changes that they may not self-approve after the transition to NFPA 805, their license amendment requests should address the cumulative impact of all previous FPP changes since adopting NFPA 805.

Section 2.4.4.1 of NFPA 805 further states that, if more than one plant change is combined into a group for the purpose of evaluating acceptable risk, each individual change shall be evaluated, along with the evaluation of the combined change. Any risk increases may be combined with risk decreases when estimating the total risk change. Licensees should address combined changes in accordance with the guidance in Regulatory Positions 1.1 and 1.2 of RG 1.174.

3.3 Circuit Analysis

Chapter 3 of industry guidance document NEI 00-01, Revision 4, when used in conjunction with NFPA 805 and this RG, provides one acceptable approach to circuit analysis for a plant implementing an FPP under 10 CFR 50.48(c). All references to NEI 00-01 in these regulatory positions refer to Revision 4 of that NEI document. Where the deterministic requirements in Chapter 4 of NFPA 805 are not met for the protection of required circuits, circuit analysis assumptions about the number of spurious actuations, the manner in which they occur (e.g., sequentially or simultaneously), and the time between spurious actuations should be supported by engineering analysis or test results (or both) that are accepted by the NRC. Aspects of circuit protection that do not conform to the deterministic requirements in Chapter 4 of NFPA 805 and were not previously approved by the NRC in accordance with Regulatory Position 2.3.2 may be evaluated using the fire risk evaluation (transition) or the plant change evaluation (post-transition) in NFPA 805.

The NRC developed NUREG/CR-7150, "Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE)," Volumes 1, 2, and 3 (Refs. 21, 22, and 23) as a consensus report on technical issues related to multiple spurious operations (MSOs) by technical experts based on the current best available evidence and represents the current state of the art. Based on NUREG/CR-7150, and industry guidance document NEI-00-01, the following should be considered when performing a circuit analysis:

(1) The spurious operation of a three-phase alternating current (AC) motor due to proper polarity hot shorts on three-phase power cabling, and the spurious operation of a direct current (DC) compound-wound motor due to proper polarity hot shorts in the motive/power cabling, are considered "incredible." Therefore, these failure modes no longer need to be evaluated for any safe-shutdown components, including high-/low-pressure interface components.

(2) Based in part on current transformer (CT) testing performed at Brookhaven National Laboratory (Ref. 24), the phenomenon involving ignition of a secondary fire from an open-circuited CT secondary circuit is not a concern for a CT used in any low- and medium-voltage applications (i.e., up to and including 15kV primary circuit voltage).

(3) A multiple high-impedance faults (MHIFs) analysis is not required when protective devices for the affected circuits are properly coordinated and have been appropriately tested and maintained. IEEE Standard 242, "IEEE Recommended Practices for Protection and Coordination of Industrial and Commercial Power Systems" (Ref. 25), provides detailed guidance on achieving proper coordination. NEI 00-01, Appendix B.1, justifies the elimination of the need to evaluate MHIFs.

(4) When evaluating fire-induced hot shorts and MSOs, the following guidance applies to the number and duration of hot shorts to be considered:

a. Number of Hot Shorts for Transient Inrush Considerations – If the MSO scenario involves the potential failure of a safe-shutdown power supply resulting from a temporary overload condition caused by multiple, concurrent inrush currents (i.e., an overlapping inrush transient current from multiple separate loads) due to the spurious operation of multiple loads as a result of hot shorts on the control cable for each load, then the MSO does not need to be considered. This is provided that (1) a normal transient inrush current duration exists, (2) the spurious operations are caused by fire damage to control cables for the loads from the power supply of concern, and the loads are otherwise operating correctly and have no potential for power cable fire damage, (3) the load sequencer for the associated power supply is not damaged by the fire such that it may cause multiple loads to simultaneously spuriously start, and (4) target conductors that could spuriously start or energize loads powered from the same power supply are in separate cables.

b. Number of Inter-Cable Hot Shorts Regardless of Latching Characteristics or Coping Time – If the MSO requires four or more separate target cables with inter-cable hot shorts, excluding a ground fault equivalent hot short (GFEHS), then the MSO does not need to be considered, regardless of whether the circuits are latching or non-latching. For ungrounded power supplies, a credible GFEHS is significantly more likely than inter-cable hot shorts and as such, is not included in this guidance. Spurious operation(s) for the MSO scenario that can be caused by a GFEHS should be considered unless otherwise limited. Inter-cable failures that can result in a GFEHS cannot be counted as part of this limit of four or more separate inter-cable hot shorts. There is no sustained duration consideration required for this case.

c. Number of Non-Latching Hot Shorts with 10-Minute Coping Time Regardless of Circuit Failure Mode – If the MSO requires (1) three or more concurrent fire-induced hot shorts on separate target cables in non-latching circuits and (2) the hot shorts must be sustained for more than 10 minutes to cause a condition that cannot be tolerated (refer to NEI 00-01, Appendix H), then the MSO does not need to be considered, regardless of the conductor hot short failure mode (i.e., intra-cable, inter-cable, or GFEHS). For MSO scenarios that result in conditions that cannot be tolerated for 10 minutes or less, any number of non-latching intra-cable circuit failures should be considered, unless otherwise limited. In addition, for latching fire-induced hot shorts, any number of intra-cable circuit failures should be considered unless otherwise limited.

d. Sequentially Selected Fire-Induced Circuit Failures – If the MSO requires a selective sequence of five or more separate target cables, each with specific fire-induced cable failures, and the adverse condition will not occur if the sequence is not produced by the fire-induced circuit failures (e.g., hot short, short to ground, open circuit) with at least two of these failures being hot shorts, then the MSO does not need to be considered, regardless of fire-induced failure durations, circuit configurations, or fire-induced failure types. To be beyond what needs to be considered for MSOs, the total number of sequential failures must exceed the threshold established above without including (1) the more probable failures of conductor grounding of grounded AC circuits in armored cable or (2) for ungrounded DC circuits, the more probable failures of intra-cable short or GFEHS in armored cable as one of the sequential failures. The metal armor of armored cable is assumed to always be grounded in accordance with NFPA 70, “National Electrical Code” (Ref. 26).

e. In general, the duration of a hot short may be assumed to be limited to 20 minutes in AC circuits and 40 minutes in DC circuits.

In response to fire-induced MSO concerns, several licensees proposed the use of shorting switches as a design feature to protect against MSOs. The shorting switch is a circuit design that places a short across a coil in the circuit of concern when the circuit is in its "standby" state to prevent spurious energization of the coil. When operation of the component is desired, the motion of the hand switch removes the short before energizing the coil to actuate the component. Any circuit using a shorting switch should have this feature of removing the short provided by the shorting switch before energizing the coil (i.e., break before make). The JACQUE-FIRE Phenomena Identification and Ranking Table (PIRT) Panel reviewed the proposed design and provided supplemental technical information to form a comprehensive set of design considerations and recommendations for the reliable use and application of shorting switches in NUREG/CR-7150. Appendix I to NEI 00-01, which outlines these design considerations and recommendations, provides one acceptable methodology for shorting switch applications.

NEI 04-02, Section B.2.1, provides one acceptable approach for identifying and screening MSOs when analyzing the postfire safe-shutdown circuits. Licensees should use the fire risk evaluation or plant change evaluation (as applicable) described in Regulatory Positions 2.2.4 and 3.2.2, respectively, for unscreened spurious actuations.

The nuclear safety capability circuit analysis should address both the possible equipment damage caused by spurious actuation and the inability to restore equipment operability, including the types of failures described in the NRC's Information Notice (IN) 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire," dated February 28, 1992 (Ref. 27). In addressing the types of failures described in IN 92-18, some licensees have credited thermal overload protection installed in the electrical circuits for the associated motor-operated valves. Licensees that use thermal overload protection to prevent damage to motor-operated valves should use the guidance in RG 1.106. The types of failures described in IN 92-18 are an example of a failure mechanism that may not have been considered during the postfire safe-shutdown analysis. Protecting against this one type of failure does not preclude the requirement to address other possible fire-induced failure mechanisms.

4. NFPA 805 Analytical Methods and Tools

4.1 General

NFPA 805, Section 2.7.3, has requirements for the quality of engineering analyses and associated methods that the licensee applies to demonstrate compliance with the performance criteria for nuclear safety and radioactive release.

4.2 Fire Models

NEI 04-02, Section 5.1.2, provides guidance on the fire models that licensees may use in an NFPA 805 transition, compliance with the NFPA 805 fire modeling requirements, and fire model verification and validation (V&V).

The NRC staff and the Electric Power Research Institute (EPRI) have documented the V&V for five fire models in NUREG-1824 (EPRI 1011999), "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," issued May 2007 (Ref. 28). The specific fire models are (1) NUREG-1805, "Fire Dynamics Tools (FDT^s) Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program," issued December 2004 (Ref. 29),

(2) Fire-Induced Vulnerability Evaluation (FIVE), Revision 1, which is part of NUREG-1824, (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) NIST's Fire Dynamics Simulator (FDS).[7] The NRC accepts the use of these models to perform the performance-based evaluations in NFPA 805, Section 4.2.4, if each model is shown to have been appropriately applied within the range of its applicability and V&V.

Licensees may also propose the use of other fire models; however, licensees are responsible for providing evidence of the acceptable V&V of these fire models. Licensees should submit the V&V documents for licensee-proposed fire models with their license amendment requests for NRC review. A license amendment request may use other fire models, documented in generic reports (e.g., topical reports), which the NRC has previously reviewed and found acceptable, if the licensee can demonstrate that the model has been used within the range of its applicability and V&V.

The NRC provides further discussion of V&V in NUREG-1824, Supplement 1 (EPRI 3002002182), issued November 2016 (Ref. 30), and NUREG-1934 (EPRI 1023259), "Nuclear Power Plant Fire Modeling Analysis Guidelines (NPP FIRE MAG)," issued November 2012 (Ref. 31).

Licenses may find the discussion in Appendix C to NFPA 805 useful in determining which fire models to use and applying those fire models within their limitations; however, the NRC only endorses the fire models, methods, data, and examples in those appendices to the extent that they have been (or can be) adequately verified and validated or to the extent that they are demonstrated as appropriate for the specific application.

4.3 Fire Probabilistic Risk Assessment

The fire PRA used to perform the risk assessments in NFPA 805, Section 2.4.4 (plant change evaluation), and Section 4.2.4.2 (fire risk evaluation), must be of sufficient technical adequacy to support the application. In accordance with Section 2.4.3.3 of NFPA 805, the NRC must find the PRA approach, methods, and data acceptable. There are two aspects to assessing the technical adequacy of the PRA results. First, the underlying PRA (i.e., the baseline model) should be technically adequate. Second, the analyses, assumptions, and approximations to map the cause-effect relationship associated with the application must be technically adequate.

The licensee may address the first aspect for risk-informed applications by conforming to the peer review and self-assessment processes in RG 1.200. This RG provides one approach acceptable to the NRC for determining the technical adequacy of the baseline PRA model. RG 1.200 endorses, with certain clarifications and qualifications, Addendum A to the American Society of Mechanical Engineers/American Nuclear Society (ASME/ANS) RA-Sa 2009, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications" ("PRA Standard") (Ref. 32).

The licensee should address the second aspect by describing the specific modeling of each cause and effect relationship associated with the application. The NRC staff will review the engineering analyses, assumptions, and approximations made in developing and using the PRA model to determine whether they are appropriate, focusing on the key assumptions (i.e., those that are significant to the application), as outlined in NUREG-0800, Section 19.1, "Determining the Technical Adequacy of

[7] For more information on these codes, the user is encouraged to contact the National Institute of Standards and Technology at 100 Bureau Drive, Gaithersburg, MD 20899; phone: 301-975-2000; website: https://www.nist.gov/ and the Electricité de France at phone: +33 (0) 1 4042 4637, website: https://www.edf.fr/en/the-edf-group.

Probabilistic Risk Assessment for Risk-Informed License Amendment Requests after Initial Fuel Load" (Ref. 33).

The licensee should submit the documentation described in Section 4.2 of RG 1.200 to address the baseline PRA and application-specific analyses. For PRA Standard "supporting requirements" important to the NFPA 805 risk assessments, the NRC position is that Capability Category II is generally acceptable. Licensees should justify use of Capability Category I for specific supporting requirements in their NFPA 805 risk assessments, if they contend that it is adequate for the application. Licensees should also evaluate whether portions of the PRA need to meet Capability Category III, as described in the PRA Standard.

The staff will rely on the guidance in RG 1.200 to review all facility changes associated with implementing NFPA 805 that are submitted for prior staff review and approval. The staff will rely on this guidance to provide confidence that self-approved changes meet the acceptance guidelines. The licensee's self-approval process should include an evaluation of all unresolved peer review issues to assess the potential impact of the unresolved issue on the application-specific evaluation. Any unresolved issue that could have a substantive impact on the results must be resolved. The licensee's self-approval process should also include the methods for modeling the cause and effect relationship described in Regulatory Position 3.2.4.

The NRC and EPRI have documented a methodology for conducting a fire PRA in NUREG/CR-6850/EPRI 1011989, enhanced by Supplement 1 to that document. However, recognizing that merely using the methods explicitly documented in NUREG/CR-6850/EPRI 1011989 may result in a conservative assessment of fire risk, licensees may choose to perform more detailed plant-specific analyses to provide greater realism in the fire PRA model. Additionally, progress in fire PRA realism was made through a now-concluded fire PRA FAQ program and will continue to be made through ongoing research.

Although a licensee may transition to an FPP based on NFPA 805 without a fire PRA model that encompasses all the areas in its facility, the licensee must develop a plant-specific fire PRA of sufficient scope and technical adequacy to demonstrate that the risk-informed requirements in the rule are met for all areas for which the licensee is using the risk-informed approach described in NFPA 805, Sections 2.4.3 and 4.2.4.2. If a licensee develops a fire PRA only for areas for which it uses the risk-informed approach, the licensee should develop, review, and maintain this limited-scope PRA in accordance with all applicable guidelines. The acceptance guidelines of RG 1.174 may require the total CDF or LERF (or both) to evaluate changes for which the risk impact exceeds specific guidelines. If no areas rely on the risk-informed approach, licensees may propose an alternative approach for making the transition to, and changing, an FPP based on 10 CFR 50.48(c).

D. IMPLEMENTATION

The NRC staff may use this regulatory guide as a reference in its regulatory processes, such as licensing, inspection, or enforcement. However, the NRC staff does not intend to use the guidance in this regulatory guide to support NRC staff actions in a manner that would constitute backfitting as that term is defined in 10 CFR 50.109, "Backfitting," and as described in NRC Management Directive 8.4, "Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests" (Ref. 34), nor does the NRC staff intend to use the guidance to affect the issue finality of an approval under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The staff also does not intend to use the guidance to support NRC staff actions in a manner that constitutes forward fitting as that term is defined and described in Management Directive 8.4. If a licensee believes that the NRC is using this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfitting or forward fitting appeal with the NRC in accordance with the process in Management Directive 8.4.

REFERENCES [8]

1. *U.S. Code of Federal Regulations*, "Domestic Licensing of Production and Utilization Facilities," Part 50, Chapter I, Title 10, "Energy."

2. National Fire Protection Association (NFPA), NFPA Standard 805, "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants," Quincy, MA, 2001 Edition. [9]

3. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Washington, DC.

4. NRC, RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Washington, DC

5. NRC, RG 1.189, "Fire Protection for Nuclear Power Plants," Washington, DC.

6. NRC, RG 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves," Washington, DC.

7. NRC, NUREG-0800, Chapter 9, SRP Section 9.5.1.2, "Risk-Informed (RI), Performance-Based (PB) Fire Protection Program (FPP)," Washington, DC.

8. NRC, NUREG/CR-6850/EPRI 1011989, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 1: Summary and Overview; Volume 2: Detailed Methodology," Washington, DC, September 2005. (ADAMS Accession Nos. ML052580075 and ML052580118)

9. NRC, NUREG/CR-6850/EPRI 1019259, Supplement 1, "Fire Probabilistic Risk Assessment Methods Enhancements," Washington, DC, September 2010. (ADAMS Accession No. ML103090242)

10. Nuclear Energy Institute (NEI) 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)," Revision 3, 2020. (ADAMS Accession No. ML19351D277) [10]

---

[8] Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/ and through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html. The documents can also be viewed on line or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD. For problems with ADAMS, contact the PDR staff at (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail pdr.resource@nrc.gov.

[9] The National Fire Protection Association (NFPA) makes important safety codes and standards available for free online, and documents are available at http://www.nfpa.org/codes-and-standards/document-information-pages. They may also be purchased by calling NFPA Customer Sales (800) 344-3555 or writing NFPA, 1 Batterymarch Park, Quincy, MA 02169 7471.

[10] Publications from the Nuclear Energy Institute (NEI) are available at their Web site: http://www.nei.org or by contacting the headquarters at Nuclear Energy Institute, 1201 F St., NW, Suite 1100, Washington DC 20004-1218, Phone: 202-739-8000, Fax 202-785-4019.

11. NEI 00-01, "Guidance for Post Fire Safe Shutdown Circuit Analysis," Revision 4, December 2019. (ADAMS Accession No. ML19351D276)

12. NRC, SECY-98-058, "Development of a Risk-Informed, Performance-Based Regulation for Fire Protection at Nuclear Power Plants," Washington, DC, March 1998. (ADAMS Accession No. ML992910106)

13. NRC, SECY-00-0009, "Rulemaking Plan, Reactor Fire Protection Risk-Informed, Performance-Based Rulemaking," Washington, DC, January 13, 2000. (ADAMS Accession No. ML003671923)

14. NRC, "Voluntary Fire Protection Requirements for Light Water Reactors; Adoption of NFPA 805 as a Risk-Informed, Performance-Based Alternative," *Federal Register*, Vol. 69, No. 115: pp. 33536 (69 FR 33536), Washington, DC, June 16, 2004 (to be codified in 10 CFR 50.48(c)).

15. NRC, "Nuclear Regulatory Commission International Policy Statement," *Federal Register*, Vol. 79, No. 132, July 10, 2014, pp. 39415-39418.

16. NRC, Management Directive (MD) 6.6, "Regulatory Guides," Washington, DC, May 2, 2016 (ADAMS Accession No. ML18073A170).

17. NRC, RG 1.205, Revision 1, "Risk Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," Washington, DC, December 2009. (ADAMS Accession No. ML092730314)

18. NRC, Appendix A to Branch Technical Position APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976," Washington, DC, August 23, 1976. (ADAMS Accession No. ML070660458)

19. NRC, Generic Letter 86-10, "Implementation of Fire Protection Requirements," Washington, DC, April 24, 1986. (ADAMS Accession No. ML031150322)

20. NRC, NUREG-1852, "Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire," Washington, DC, October 2007. (ADAMS Accession No. ML073020676)

21. NRC, NUREG/CR-7150, Volume 3, "Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE): Technical Resolution to Open Issues On Nuclear Power Plant Fire-Induced Circuit Failure, Final Report (NUREG/CR-7150, Volume 3, BNL-NUREG-98204-2012, EPRI 3002009214)," Washington, DC, November 2017. (ADAMS Accession No. ML17331B098)

22. NRC, NUREG/CR-7150, Volume 2, "Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE): Final Report (NUREG/CR-7150, Volume 2, BNL-NUREG-98204-2012, EPRI 3002001989)," Washington, DC, May 2014. (ADAMS Accession No. ML14141A129)

23. NRC, NUREG/CR-7150, Volume 1, "Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE): Final Report, BNL-NUREG-98204-2012, EPRI 1026424," Washington, DC, October 2012. (ADAMS Accession No. ML12313A105)

24. NRC, NUREG/CR-7228, "Open Secondary Testing of Window-Type Current Transformers," Washington, DC, May, 2017. (ADAMS Accession No. ML ML17137A031)

25. Institute of Electrical and Electronics Engineers (IEEE), Standard 242, "IEEE Recommended Practices for Protection and Coordination of Industrial and Commercial Power Systems," Piscataway, NJ. [11]

26. NFPA, NFPA 70, "National Electrical Code," Quincy, MA.

27. NRC, Information Notice 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire," Washington, DC, February 28, 1992. (ADAMS Accession No. ML031200481)

28. NRC, NUREG-1824 (EPRI 1011999), "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," Washington, DC, May 2007. (ADAMS Accession Nos. ML071650546, ML071730305, ML071730493, ML071730499, ML071730527, ML071730504, ML071730543)

29. NRC, NUREG-1805, "Fire Dynamics Tools (FDTs) – Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program," Washington, DC. December 2004. (ADAMS Accession No. ML043290075)

30. NRC, NUREG-1824, Supplement 1 (EPRI 3002002182), "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," Washington, DC, November 2016. (ADAMS Accession Nos. ML16309A011, ML16062A288, ML16062A290, ML16062A351, ML16062A354)

31. NRC, NUREG-1934, "Nuclear Power Plant Fire Modeling Analysis Guidelines (NPP FIRE MAG)," Washington, DC, November 2012. (ADAMS Accession No. ML12314A165)

32. American Society of Mechanical Engineers (ASME) and American Nuclear Society (ANS), ASME/ANS RA-Sa 2009, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," New York NY; La Grange Park, IL, 2009.[12]

33. NRC, NUREG-0800, Section 19.1, "Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Washington, DC.

34. NRC, Management Directive 8.4, "Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests," Washington, DC, September 20, 2019. (ADAMS Accession No. ML18093B087)

---

[11] Copies of Institute of Electrical and Electronics Engineers (IEEE) documents may be purchased from the IEEE Services Center, 455 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855 or IEEE's Web site at http://www.ieee.org.publications_standards/index.

[12] Copies of American Society of Mechanical Engineers (ASME) standards may be purchased from ASME, Two Park Avenue, New York, NY 10016-5990; telephone (800) 843-2763. Purchase information is available through the ASME Web based store at https://www.asme.org/codes-standards.