# Regulatory Analysis of Proposed Generic Letter 2006-XX: Post-Fire Safe-Shutdown Circuit Analysis Spurious Actuations

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**U.S. Nuclear Regulatory Commission**
Office of Nuclear Reactor Regulation

July 11, 2006

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# 1. INTRODUCTION

This document presents the draft regulatory analysis for the proposed Generic Letter (GL) 2006-XX: Post-Fire Safe-Shutdown Circuit Analysis Spurious Actuations. This introduction is divided into two sections. Section 1.1 states the problem and the reason for the proposed GL, and Section 1.2 provides background information relative to the pertinent regulatory requirements in 10 CFR Part 50.

## 1.1 Statement of the Problem and Reason for the Generic Letter

Sufficient evidence currently exists to suggest that the fire protection programs (FPPs) for many nuclear power plants (NPPs) may not account for the credible threat of circuit failures resulting from multiple spurious actuations (e.g., fire induced signals from a hot short in a circuit that could cause a valve to close instead of remain open) occurring simultaneously or in rapid succession (precluding any mitigating or compensating actions prior to the next one) during or after a fire event. Given (1) the number of licensee event reports (LERs) identifying plant problems related to fire-induced electrical circuit failures and (2) cable fire testing data suggesting a high probability for multiple simultaneous (or occurring closely in succession) dependent hot shorts that may result from fire events, NRC is proposing licensee action in proposed GL 2006-XX.

This proposed GL provides required measures to ensure that each license holder of an operating NPP is maintaining a compliant FPP mandated by 10 CFR 50.48(a) and detailed in 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 3, "Fire Protection." These regulations require that each FPP provide post-fire safe-shutdown capability such that one of the redundant trains (structures, systems, and components (SSCs)) for safe shutdown is protected from fire damage.

The goal of this proposed GL is to ensure that for each NPP, the FPP provides reasonable assurance that during a fire event, one train of systems necessary to achieve and maintain hot shutdown (including circuits where fire-induced failure could prevent the operation or cause the maloperation of equipment) remains free of fire damage.

## 1.2 Background

10 CFR 50.48(a) specifies that each license holder of an operating NPP must have a FPP that satisfies 10 CFR 50, Appendix A, GDC 3. In addition, all NPPs licensed to operate before January 1, 1979, must comply with 10 CFR Part 50, Appendix R, Section III.G, "Fire Protection of Safe Shutdown Capability," which specifies the fire protection features to be provided for SSCs important to reactor safe shutdown. Plants licensed to operate since January 1, 1979, were evaluated for compliance using NUREG-0800, Standard Review Plan (SRP), Section 9.5.1, "Fire Protection Program." All NPP licensees are required to implement their approved FPP, considering multiple spurious actuations, in accordance with the applicable regulatory requirements.

**The objective of the fire protection requirements and guidance is to provide reasonable assurance that one train of systems necessary to achieve and maintain hot shutdown remains free of fire damage. This includes protecting circuits where fire-induced failure could prevent the operation, or cause maloperation, of equipment necessary to achieve and maintain post-fire safe-shutdown. As part of the FPP, each NPP license holder must consider the effects of spurious actuations in the circuits analysis to identify circuits at risk** and then provide adequate protection against fire-induced circuit failures. However, the number and occurrence rate (simultaneously or sequentially) of spurious actuations considered in the circuits analyses for fire events have not been defined in 10 CFR Part 50 nor in NRC guidance on fire protection.

Both NRC and industry have used the phrase “one-at-a time” to evaluate spurious actuations caused by hot shorts during a fire event, but the phrase is not defined in 10 CFR Part 50. Licensees have interpreted the phrase “one-at-a-time” to mean either that no more than one spurious actuation will occur per fire event, or that multiple spurious actuations can occur during a fire event but with sufficient time between actuations to allow for mitigation (e.g., manual action to open a valve that has closed due to a spurious signal). NRC has issued Safety Evaluation Reports (SERs) that have accepted both interpretations.

In 1997, NRC began receiving LERs identifying plant-specific problems related to potential fire-induced electrical circuit failures that could prevent operation or cause maloperaton of equipment necessary to achieve and maintain hot shutdown. NRC documented these problems in Information Notice 99-17, “Problems Associated With Post-Fire Safe-Shutdown Circuit Analysis.” In 1998, NRC staff began to interact with stakeholders to evaluate the problem and attempt to develop an effective risk-informed solution. While the issues were being clarified, NRC issued guidance on inspection findings in Enforcement Guidance Memorandum (EGM) 98-002, “Disposition of Violations of Sections III.G and III.L of Appendix R to 10 CFR Part 50 Involving Circuit Failures,” Revision 2 (ADAMS Accession No. ML003710123). Given the different stakeholder interpretations on spurious actuations, NRC temporarily suspended the associated circuits portion of the fire protection inspections.[1] The decision is documented in an NRC memorandum from John N. Hannon to Gary H. Holahan dated November 29, 2000 (ML003773142).

In 2001, the Electric Power Research Institute (EPRI) and the Nuclear Energy Institute (NEI) conducted cable fire tests that demonstrated a relatively high probability of multiple spurious actuations occurring simultaneously or in rapid succession during or after a fire (see EPRI Report No. 1006961, “Spurious Actuation of Electrical Circuits Due to Cable Fires: Results of an Expert Elicitation,” and NUREG/CR-6776, “Cable Insulation Resistance Measurements Made During Cable Fire Tests”). The testing covered the most common types of cable insulation, jacketing materials, and raceways used in nuclear power plants.

[1] Associated circuits are distinct from the circuits directly required for operation of post-fire safe-shutdown trains of equipment. Associated circuits are not required for post-fire safe shutdown, but could interfere with post-fire safe shutdown if damaged by fire.

The EPRI/NEI cable fire test results clearly demonstrated that the two interpretations of the phrase “one-at-time” used by licensees to evaluate spurious actuations are no longer credible representations of the potential number and frequency of spontaneous actuations that can be caused by hot shorts during a fire event. If a licensee has not considered in the post-fire safe-shutdown circuits analysis that multiple spurious actuations may occur simultaneously or in rapid succession during or after a fire event, the licensee may not be in compliance with 10 CFR 50.48 and 10 CFR Part 50, Appendix A, GDC 3.

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# 2. IDENTIFICATION AND PRELIMINARY ANALYSIS OF ALTERNATIVE APPROACHES

This analysis considers three options. The following subsections describe each option.

## 2.1 Option 1: No Action

Under Option 1, the no-action alternative, NRC would not require NPP license holders to evaluate the licensing basis regarding multiple spurious post-fire safe-shutdown circuit analyses.

By definition, the no-action alternative has no incremental benefits or costs because it does not change the status quo. This option is inconsistent with NRC's goal for this action as discussed in Section 1.1.

## 2.2 Option 2: Issue Generic Letter Requiring Licensee Action

Under Option 2, NRC would issue a GL that would require each NPP license holder[2] to evaluate its FPP for compliance with existing requirements in 10 CFR 50.48 and 10 CFR 50, Appendix A, GDC 3, given the recent information on the frequency of spurious actuations that may result from hot shorts occurring during fire events.

Option 2 would require the license holder for each NPP to:

- Evaluate the licensing basis regarding multiple spurious post-fire safe-shutdown circuit analysis. The evaluation must compare the plant licensing basis to the requirement in 10 CFR Part 50 to protect redundant safe-shutdown trains from multiple simultaneous spurious actuations and maintaining one train free of damage

- Submit within 90 days of the date of the GL, a written response to NRC in compliance with 10 CFR 50.54(f).[3]

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[2] The proposed GL requirements do not apply to any license holder of a nuclear power reactor that has permanently ceased operations, with certification that fuel has been permanently removed from the reactor vessel.

[3] 10 CFR 50.54(f) states: "The licensee shall at any time before expiration of the license, upon request of the Commission, submit, as specified in §50.4, written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. Except for information sought to verify licensee compliance with the current licensing basis for that facility, the NRC must prepare the reason or reasons for each information request prior to issuance to ensure that the burden to be imposed on respondents is justified in view of the potential safety significance of the issue to be addressed in the requested information. . . ."

- For each NPP where the license holder determines that the existing post-fire safe-shutdown circuits analysis is compliant with the GL information on spurious actuations, submit a response that specifies the basis for the conclusion.

- The response must compare the plant licensing basis to the regulatory requirement for protecting redundant safe-shutdown trains from multiple spurious actuations and maintaining one train free of fire damage and the information in the proposed GL.

- For each NPP where the license holder determines that the existing post-fire safe-shutdown circuits analysis is non-compliant with the GL information on spurious actuations, submit a response that includes:

  - The license holder's conclusion regarding compliance with 10 CFR Part 50 regulatory requirements and information in the proposed GL. The response must compare the plant licensing basis to the regulatory requirement for protecting redundant safe-shutdown trains from multiple spurious actuations and maintaining one train free of fire damage and the information in the proposed GL.

C Submit within 30 days of the date of the GL a written response that addresses any alternative course of action proposed and the basis for its acceptability if a license holder is unable to meet the 90-day response deadline.

For NPPs with non-compliant FPPs:

C Select one of two methods to evaluate the affected SSCs of the reactor identified in the functionality assessment:

Method 1a: Perform a post-fire safe-shutdown circuits analysis using a risk-informed evaluation that considers defense-in-depth and safety margins (use RG-1.174; NEI 00-01, Rev. 1; and RG 1.205)[4]; or

Method 1b: Perform a deterministic evaluation (use NEI 00-01, Rev. 1); or

Method 2: Adopt a performance-based FPP permitted by 10 CFR 50.48(c) - National Fire Protection Association (NFPA) 805 standard

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[4] Regulatory Guide - 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing **Basis," November 2002.**

NEI 00-01, Rev. 1, "Guidance for Post-Fire Safe Shutdown Circuit Analysis," January 2005.

Regulatory Guide - 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," May 2006 (ADAMS Accession No. ML061100174).

(use RG 1.205; NEI 04-02, Rev. 1).[5] Use the methodology prescribed by these references to assess the ability of the FPP to meet the performance criteria defined in the references.

C Devise corrective actions necessary to return the FPP to compliance with 10 CFR Part 50 requirements and the information in the proposed GL.

C Submit within 6 months of the date of the GL, a written response detailing the plans for plant modifications, license amendments, exemption requests, and/or other means to meet the 10 CFR Part 50 requirements and the plant's licensing basis.

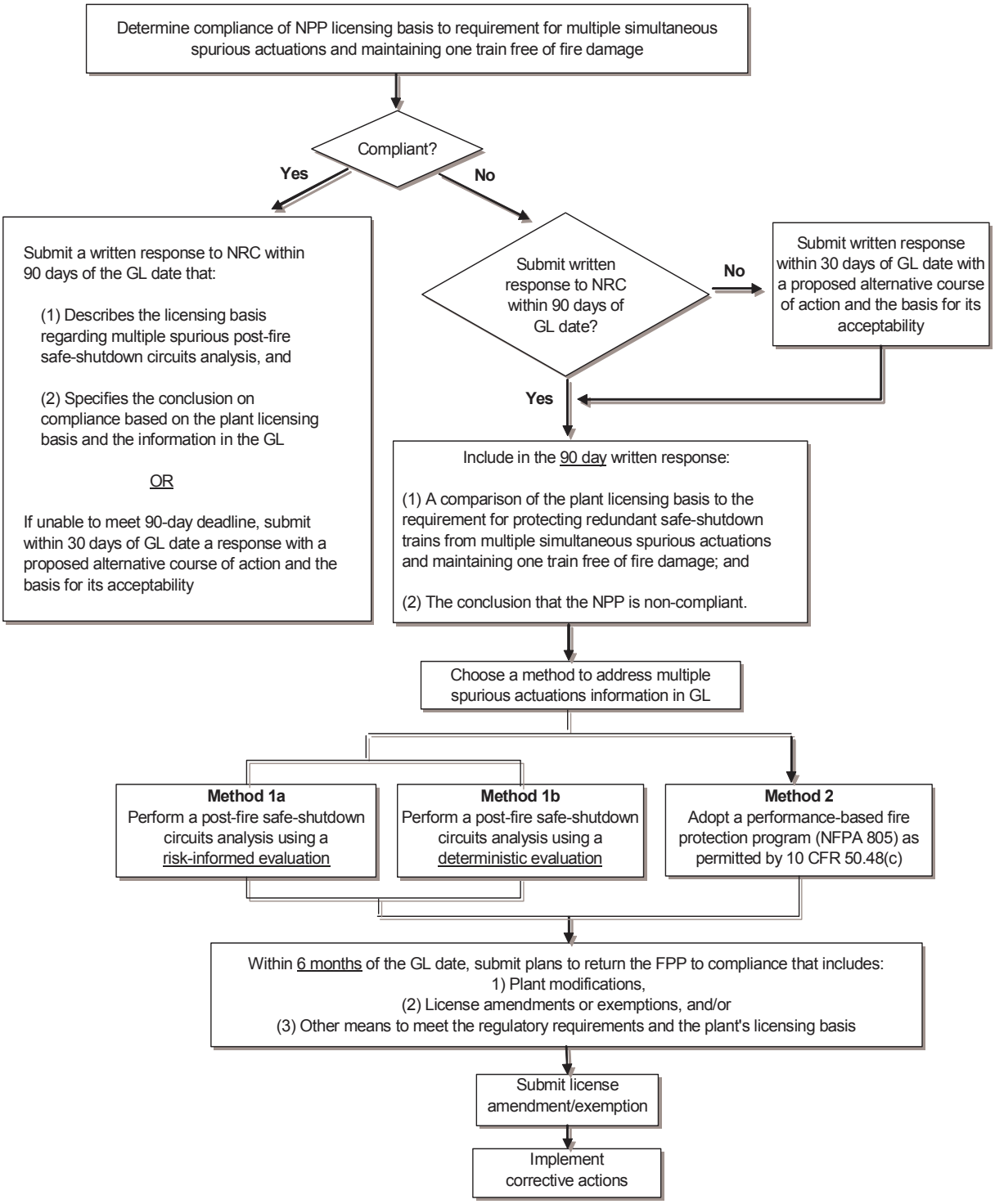
- **Submit an exemption or license amendment request.**

- **Implement corrective actions to return the FPP to compliance with 10 CFR Part 50 requirements and the information in the proposed GL.**

Exhibit 2-1 presents a flow chart of the potential license holder actions resulting from the proposed GL.

[5] NEI 04-02, Rev. 1, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)," September 2005 (ADAMS Accession No. ML052590476).

## Exhibit 2-1: Potential License Holder Actions, Option 2



## 2.3 Option 3: Inspection and Enforcement

Under Option 3, NRC would not issue a proposed GL and would instead rely on existing triennial fire protection inspections (IP 71111.05T) conducted through the Reactor Oversight Process (ROP) to identify NPPs with FPPs that do not comply with the requirements in 10 CFR 50.48 and 10 CFR 50, Appendix A, GDC 3. A component of each triennial fire protection inspection evaluates the circuit analyses and post-fire safe-shutdown analysis of an NPP related to spurious actuations that may result from hot shorts generated during a fire event.

If an inspection identifies any areas of non-compliance with respect to an NPP's FPP, NRC will issue an inspection report detailing each identified finding along with the severity of each finding. NRC will direct license holder action to resolve inspection findings.

Most license holder activities discussed under Option 2 also will be required under Option 3. However, one key difference is in the way licensee action to address the spurious actuations issue is directed. Under Option 2, each NPP will determine non-compliance based on the information specified in the proposed GL on spurious actuations. Under Option 3, NRC will determine through inspections whether the FPP's for NPPs comply with 10 CFR Part 50 requirements and require licensee action through resolution of inspection findings.

The activities listed below parallel most of the licensee actions described under Option 2. Option 3 would require each NPP license holder that received triennial fire protection inspection findings due to a non-compliant FPP to:

- Conduct an assessment of the functionality of affected SSCs of the reactor identified as non-compliant with respect to safe shutdown due to multiple spurious actuations caused by hot shorts generated during a fire.

- Implement compensatory measures in accordance with the NPP's FPP based on the affected SSCs identified during the triennial fire protection inspection and in the functionality assessment performed as a result of the inspection findings.

- Select one of two methods to evaluate the affected SSCs of the NPP identified in the functionality assessment:

  Method 1a: Perform a post-fire safe-shutdown circuits analysis using a risk-informed evaluation that considers defense-in-depth and safety margins (use RG-1.174; NEI 00-01, Rev. 1; and RG-1.205); or

  Method 1b: Perform a deterministic evaluation (use NEI 00-01, Rev. 1); or

  Method 2: Adopt a performance-based FPP permitted by 10 CFR 50.48(c) - National Fire Protection Association (NFPA) 805 standard (use RG-1.205; NEI 04-02, Rev. 1). Use the methodology prescribed by these references to assess the ability of the FPP to meet the performance criteria defined in the references.

C Devise corrective actions necessary to resolve the triennial fire protection inspection findings and return the FPP to compliance with 10 CFR Part 50 requirements.

C Submit written responses to the triennial fire protection inspection findings.

Participate in enforcement conferences and Safety Evaluation Review Panels (SERPs).

- **Submit an exemption or license amendment request.**
- **Implement corrective actions to return the FPP to compliance with 10 CFR Part 50 requirements.**

# 3. EVALUATION OF BENEFITS AND COSTS

This section describes the analysis conducted to identify and evaluate the benefits (values) and costs (impacts) of the proposed GL 2006-XX. Section 3.1 identifies the attributes that Options 2 and 3 are expected to affect. Section 3.2 describes the methodology used to analyze the benefits and costs associated with expected changes to the affected attributes.

## 3.1 Identification of Affected Attributes

This section identifies the factors within the public and private sectors that the proposed GL is expected to affect. These factors are classified as "attributes" using the list of potential attributes provided in Chapter 5 of the NRC's "Regulatory Analysis Technical Evaluation Handbook."[6] Affected attributes include the following:

- *Industry Implementation.* Option 2 (Issue Generic Letter) would require each NPP license holder to evaluate the post-fire safe-shutdown circuits analysis to assess compliance with 10 CFR 50.48, 10 CFR Part 50, Appendix A, GDC 3, and with the information in the proposed GL, and to provide a written response to comply with the requirements in 10 CFR 50.54(f). For reactors with FPPs that do not account for the multiple spurious actuations as defined in the proposed GL, the license holders must take corrective action. These license holders will incur costs associated with conducting assessments of affected SSCs, developing and implementing compensatory measures, conducting additional circuits analyses to identify at-risk circuits, conducting risk informed or deterministic analyses of the at-risk SSCs, designing and implementing physical plant modifications, and/or applying for license amendments or exemptions.

C *Industry Operation*. Option 3 (Inspections and Enforcement) would identify NPP license holders with non-compliant post-fire safe shutdown circuits analyses during triennial fire protection inspections and require licensee action. To return to compliance, license holders would resolve inspection findings by conducting similar activities to those described under Option 2 for the Industry Implementation attribute.

- ***Public Health (Accident).*** **Options 2 and 3 would reduce the risk that public health will be affected by accidents attributable to fire events creating hot shorts resulting in multiple spurious actuations preventing the safe-shutdown of a plant and possible core damage.**

- ***Occupational Health (Accident).*** **Options 2 and 3 would reduce the risk that occupational health will be affected by accidents attributable to fire events creating hot shorts resulting in multiple spurious actuations preventing safe-shutdown of a plant and possible core damage.**

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[6] NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook: Final Report," U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, January 1997.

- *Off-Site Property*. **Options 2 and 3 would** reduce the risk that off-site property will be affected by accidents attributable to fire events creating hot shorts resulting in multiple spurious actuations preventing the safe-shutdown of an NPP and possible core damage.

- *On-Site Property.* Options 2 and 3 would reduce the risk that on-site property will be affected by accidents attributable to fire events creating hot shorts resulting in multiple spurious actuations preventing the safe-shutdown of an NPP and possible core damage.

- *Improvements in Knowledge*. Option 2 would provide licensees and NRC with additional information on how the FPP for each NPP accounts for the frequency of spurious actuations that may result from hot shorts due to a fire event. The information requested in the proposed GL would provide NRC with information on the safety of the FPP for each NPP. Option 3 would provide NRC with additional information on the resolution of triennial fire protection inspection findings related to non-compliant FPPs.

- *Regulatory Efficiency*. Option 2 would provide new information to license holders on the frequency of spurious actuations that may result from hot shorts due to a fire event. The additional information will clarify existing industry interpretations on the frequency of spurious actuations, thus improving compliance with 10 CFR Part 50.

- *NRC Implementation.* For Option 2, NRC would expend staff resources to finalize the proposed GL. NRC also would review the 10 CFR 50.54(f) written responses for each NPP license holder, as well as review and approve license holder requests for license amendments and exemptions.

- *NRC Operation.*[7] For Option 3, NRC would expend staff resources to address triennial fire protection inspection findings and enforcement actions resulting from non-compliant FPPs of NPPs that do not adequately address spurious actuations, as well as review and approve license holder requests for license amendments and exemptions.

The proposed GL is *not* expected to affect the following attributes:

- Public Health (Routine);
- Occupational Health (Routine);
- Other Government;
- General Public;
- Antitrust Considerations;
- Safeguards and Security Considerations;
- Environmental Considerations; and
- Other Considerations.

[7] Under Option 2, all NRC inspections of NPPs to evaluate modifications to existing FPPs will be accomplished during triennial fire protection inspections (IP 71111.05T). Therefore, no incremental cost will result from staff inspections of the FPPs at NPPs.

## 3.2 Analytical Methodology

This section describes the methodology used to analyze the benefits and costs associated with Option 2 (Issue Generic Letter Requiring Licensee Action) and Option 3 (Inspection and Enforcement). The benefits of Options 2 and 3 include any desirable changes in affected attributes (e.g., improved safety, monetary savings) while the costs include any undesirable changes in affected attributes (e.g., monetary costs).

The analysis evaluates the following eight attributes affected by Options 2 and/or 3 on a quantitative basis:

- Public Health (Accident),
- Occupational Health (Accident),
- Offsite Property,
- Onsite Property,
- Industry Implementation,
- Industry Operation,
- NRC Implementation, and
- NRC Operation.

The evaluation for each affected attribute is presented in Section 3.2.3 for Option 2 and in Section 3.2.4 for Option 3.

The analysis evaluates the following two attributes affected by Option 2 and/or 3 on a qualitative basis:

- *Improvements in Knowledge*. Option 2 would require each NPP to provide information on the safety of each FPP, while Option 3 would require each NPP with triennial fire protection inspection findings to provide information to demonstrate the resolution of each FPP finding.

- *Regulatory Efficiency*. Option 2 would provide in the proposed GL additional information to clarify existing industry interpretations on spurious actuations during fire events.

A qualitative evaluation was performed for each attribute due to the difficulty and uncertainty involved in quantifying the benefits and impacts. The qualitative benefits discussion is presented in Section 4.3.

### 3.2.1 Baseline for the Analysis

This regulatory analysis measures the incremental impacts of Option 2 and Option 3 relative to a baseline (Option 1, the No Action alternative).

### 3.2.2 Affected Universe

This analysis considers 104 operating NPPs, as verified in NUREG-1350, NRC Information Digest, 2005-2006 Edition.[8]

### 3.2.3 Analysis of the Incremental Requirements, Option 2

The NRC evaluated every provision contained in Option 2 relative to the applicable baseline (Option 1, the No Action alternative). Based on this analysis, the NRC developed equations to estimate costs (impacts) using available data, augmented by assumptions when necessary, and guidance contained in NUREG/BR-0184.

General assumptions applying to all benefits calculations:

*Remaining reactor life*. The benefits calculations for affected attributes (Public Health (Accident); Occupational Health (Accident); Offsite Property; and Onsite Property) rely upon a key data input, the remaining operating life of the reactor. Benefits do not begin to accrue until an NPP returns to compliance with 10 CFR Part 50 requirements and the information in the proposed GL. The quantified benefits for the aforementioned attributes result from averted accident costs.

- In 2006, the average remaining reactor life for all NPPs with an operating license is 34 years, assuming that each NPP receives a 20 year operating license extension.

  Assumptions:

  - All NPPs with non-compliant FPPs will return to compliance in 2007 or 2008.
  - Percentage of non-compliant NPPs that will return to compliance in 2007: 50 percent.
    - Average remaining reactor life: 33 years.
  - Percentage of non-compliant NPPs that will return to compliance in 2008: 50 percent.
    - Average remaining reactor life: 32 years.

[8] The analysis includes Browns Ferry 1, a plant that has been inactive since 1985. The license holder for Browns Ferry 1, the Tennessee Valley Authority (TVA), projects that the reactor will return to operations in 2007. This information is not included in the 2005-2006 version of the NRC Information Digest.

#### 3.2.3.1 Public Health (Accident)

Assumptions:
- Decrease in core damage frequency (CDF): 1E-5/year[9]
- Population dose: 199,000 person-rem
- Monetary value per person-rem averted: $2,000/person-rem
- Average remaining reactor life:
  - NPPs returning to compliance in 2007: 33 years
  - NPPs returning to compliance in 2008: 32 years
- Annual discount rates: 7% and 3%

One time benefit per reactor from averted accident costs (over the remaining life of the reactor):
(1E-5/year decrease in CDF) x (199,000 person-rem) x ($2,000/person-rem) x
[1 - exp ( - (discount rate) x (remaining reactor life))] / (discount rate)

For additional information on these assumptions and calculations, refer to Section 5.7.1 in NUREG/BR-0184, January 1997.

#### 3.2.3.2 Occupational Health (Accident)

Assumptions:
- Decrease in CDF: 1E-5/year
- Monetary value per person-rem averted: $2,000/person-rem
- Avoided occupational "immediate" dose per facility-year : 3,300 person-rem
- Avoided occupational long-term dose per facility-year: 20,000 person-rem
- Return to pre-accident state (cleanup period): 10 years
- Average remaining reactor life:
  - NPPs returning to compliance in 2007: 33 years
  - NPPs returning to compliance in 2008: 32 years
- Annual discount rates: 7% and 3%

One time benefit per reactor from averted accident costs (over the remaining life of the reactor): (immediate dose) + (long-term doses)

[9] See Appendix 2 for additional information on a core damage frequency bounding analysis. In the appendix, a bounding analysis estimates that the increase in CDF for a typical "older" plant could be as high as ~1E-4/yr. However, this is considered a worst case, not appropriately applied as an average value across all NPPs. A more representative "average" would be ~1E-5/yr, considering one might expect a spread in delta-CDF values of two orders of magnitude between typical "older" and "newer" NPPs, with 1E-5/yr as the geometric mean between the extremes (1E-4/yr and 1E-6/yr). Actual values would have to be calculated on a plant-specific basis, beyond the scope of this regulatory analysis, for which an average value is deemed appropriate.

Immediate dose
(1E-5/year decrease in CDF) x (3,300 person-rem immediate dose) x ($2,000/person-rem) x [1 - exp ( - (discount rate) x (remaining reactor life))] / (discount rate)

Long-term doses
(1E-5/year decrease in CDF) x (20,000 person-rem long-term dose) x ($2,000/person-rem) / [(10 years long-term doses accrue) x (discount rate)$^2$] x
[1 - exp ( - (discount rate) x (remaining reactor life))] x
[1 - exp ( - (discount rate) x (10 years long-term doses))]

For additional information on these assumptions and calculations, refer to Section 5.7.3 in NUREG/BR-0184, January 1997.

#### 3.2.3.3 Offsite Property

Assumptions:
- Decrease in CDF: 1E-5/year
- Offsite property damage from an accident: $338 million[10]
- Average remaining reactor life:
  - NPPs returning to compliance in 2007: 33 years
  - NPPs returning to compliance in 2008: 32 years
- Annual discount rates: 7% and 3%

One time benefit per reactor from averted accident costs (over the remaining life of the reactor):
(1E-5/year decrease in CDF) x ($338 million offsite property damage) x
[1 - exp ( - (discount rate) x (remaining reactor life))] / (discount rate)

For additional information on these assumptions and calculations, refer to Section 5.7.5 in NUREG/BR-0184, January 1997.

[10] The $246 million offsite property damage estimate in 1990 dollars presented in NUREG/BR-0184 has been adjusted to 2005 dollars using the implicit price deflators for GDP as presented in the Survey of Current Business, March 2006 (U.S. Department of Commerce, Bureau of Economic Analysis).

#### 3.2.3.4 Onsite Property

Assumptions:

- Decrease in CDF: 1E-5/year
- Onsite property cleanup and decontamination for a single accident: $1.9 billion[11]
- Net Present Value (NPV) of Replacement Power for a single event[12]:
  - Use with 7 % discount rate:
    - $1.62E+9 (remaining life of reactor = 33 years)
    - $1.60E+9 (remaining life of reactor = 32 years)
  - Use with 3% discount rate:
    - $2.45E+9 (remaining life of reactor = 33 years)
    - $2.36E+9 (remaining life of reactor = 32 years)
- Return to pre-accident state: 10 years
- Average remaining reactor life:
  - NPPs returning to compliance in 2007: 33 years
  - NPPs returning to compliance in 2008: 32 years

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[11] The $1.5 billion onsite cleanup cost estimate in 1993 dollars presented in NUREG/BR-0184 has been adjusted to 2005 dollars using the implicit price deflators for GDP as presented in the Survey of Current Business, March 2006 (U.S. Department of Commerce, Bureau of Economic Analysis).

[12] The analysis used the equation presented in NUREG/BR-0184 (page 5.44), to derive the net present value (NPV) of replacement power for a single event at an NPP, using a 7 percent discount rate. The NPV calculation is based on remaining reactor life and therefore, a different NPV result for a single event was derived for each year that an NPP returned to compliance in the analysis (note: benefits do not accrue until NPP compliance is achieved). However, the NPV for replacement power using a 3 percent discount rate required additional calculations.

NUREG/BR-0184 states that the NPV equation for replacement power is not accurate at lower discount rates (less than 5 percent) and recommends linear interpolation of NPV results at these lower discount rates (note: a 1 percent NPV replacement power value is provided to conduct linear interpolations). However, the 1 percent NPV replacement power value provided to conduct linear interpolations is only for a reactor with a remaining life of 24 years. Because the regulatory analysis evaluates reactors with greater remaining lives than the one modeled in NUREG/BR-0184, it was necessary to derive a 1 percent NPV for replacement power to use in linear interpolations for NPV results for NPPs with remaining reactor lives exceeding 24 years. This was accomplished by dividing the NPV replacement power equation result for the 1 percent net present value (reactor remaining life = 24 years) by the net present value (1 percent discount rate) provided in NUREG/BR-0184 for use in linear interpolations. The ratio result presents the percentage deviation in accuracy from the equation result to the NPV value provided for interpolation. The analysis then used the ratio result to adjust the NPV equation results for a discount rate of 1 percent for reactors with remaining lives exceeding 24 years (e.g., under Option 2, NPPs return to compliance with 32 and 33 years of remaining reactor life).

Also, NUREG/BR-0184 presents the NPV replacement power results in 1993 dollars. The regulatory analysis adjusted these results to 2005 dollars using the Producer Price Index (PPI) for Commodities (Group: Fuels and related products, Item: Electric Power, Series ID: WPU954) U.S. Department of Labor, Bureau of Labor Statistics, April 2006.

- Annual discount rates: 7% and 3%

One time benefit per reactor from averted accident costs (over the remaining life of the reactor): (Cleanup and decontamination cost) + (Long term replacement power cost)

Cleanup and decontamination cost:
(1E-5/year decrease in CDF) x ($1.9 billion cleanup and decontamination) / [(10 years to return to pre-accident state) x (discount rate)$^2$)] x [1 - exp ( - (discount rate) x (remaining reactor life))] x [1 - exp ( - (discount rate) x (10 years to return to pre-accident state))]

Long term replacement power cost:
(1E-5/year decrease in CDF) x [(NPV replacement power single event) / (discount rate)] x [1 - exp ( - (discount rate) x (remaining reactor life))]$^2$

For additional information on these assumptions and calculations, refer to Section 5.7.6 in NUREG/BR-0184, January 1997.

#### 3.2.3.5 Industry Implementation

Option 2 requires that for each NPP, the license holder conduct the following activities as detailed below. For each activity, the analysis lists the assumptions and equations used to estimate the value/impact per reactor.

C **Assess plant licensing basis regarding multiple spurious post-fire safe-shutdown circuits analysis for compliance with 10 CFR Part 50 requirements given the information in the proposed GL.**

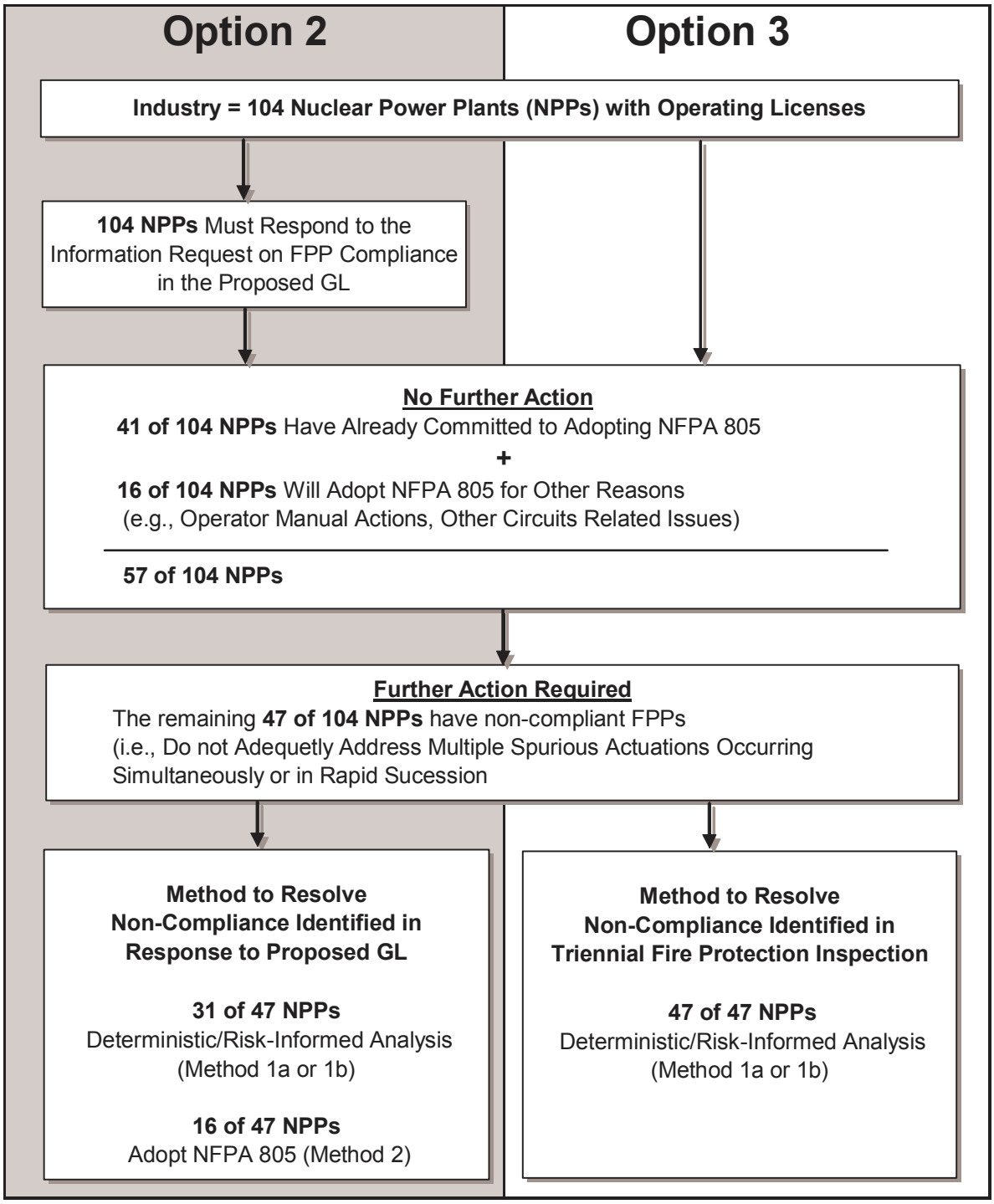
Assumptions:

- Licensee staff time per reactor to review the assumptions in the existing FPP on spurious actuations: 80 hours.
- Industry wage rate: $100.00/hour.[13]
- Number of NPPs affected: 104 (see Exhibit 3-1).

One-time cost per reactor:
(80 hours) x (industry wage rate)

[13] This NRC staff assumption is used throughout the analysis, but is not listed under the assumptions section for any subsequent calculations in the analysis.

**Exhibit 3-1: Number of Affected Entities by Option**



C **For each NPP where the license holder determines that the existing post-fire safe-shutdown circuits analysis is non-compliant with 10 CFR Part 50 requirements, the license holder should:**

Conduct an assessment of the functionality of the SSCs to identify potentially at-risk circuits that may affect the ability of the NPP to achieve and maintain safe shutdown in light of multiple spurious actuations caused by hot shorts generated during a fire event.

Assumptions:

- 47 of 104 NPPs will conclude that the existing post-fire safe-shutdown circuits analysis is non-compliant with 10 CFR Part 50 requirements and information in the proposed GL.
    - The analysis does not account for the costs and benefits to 57 NPPs that have already committed to adopting NFPA 805 standard[14] or NRC estimates will adopt the NFPA 805 standard to resolve issues unrelated to this NRC action on spurious actuations (e.g., operator manual actions, resolve other circuits related issues). See Exhibit 3-1 for additional information on the number of affected entities.
- A functionality assessment for an NPP consists of performing an analysis of the SSCs to identify potentially at-risk circuits affected by multiple spurious actuations occurring simultaneously or in rapid succession. Part of a functionality assessment consists of selecting and tracing the circuits and cables of the NPP.
- Another component of a functionality assessment is to analyze the traced circuits and cables information contained in a cable routing tracking system to identify potentially at-risk circuits. The analysis includes the costs for some NPPs to utilize cable routing tracking systems to analyze SSCs and identify potentially at-risk circuits.[15]
- An acceptable functionality assessment is consistent with an evaluation performed for RIS 2005-020.[16]

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[14] NRC has received or expects to receive commitments from the license holders of 41 NPPs to adopt the NFPA 805 standard. NRC estimates that an additional 16 NPPs will adopt the NFPA 805 standard to resolve issues unrelated to this proposed action (e.g., operator manual actions, other circuits related issues). For these 57 plants (see Exhibit 3-1), the only cost included in the regulatory analysis is to respond to the required 90-day response to the proposed GL.

[15] The majority of NPPs already have conducted such an analysis (NEI 04-06, "Guidance for Self-Assessment of Circuit Failure Issues," March 2005) to determine SSCs potentially affected by multiple spurious actuations.

[16] RIS 2005-020, “Revision to Guidance Formally Contained in NRC Generic Letter 91-18, ‘Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability'," September 26, 2005.

- Percentage of NPPs that must identify SSCs potentially affected by multiple spurious actuation by analyzing a cable routing tracking system:10 percent.[17]

- Of the NPPs that must identify SSCs potentially affected by multiple spurious actuations, the percentage that:
  - have an electronic cable routing tracking system: 50 percent, or
  - have a paper cable routing tracking system: 50 percent.

- Licensee staff time per reactor to identify SSCs using an electronic cable routing tracking system: 200 hours.

- Licensee staff time per reactor to identify SSCs using a paper cable routing tracking system: 400 hours.

One-time cost for some reactors with electronic cable routing tracking systems:
(200 hours per reactor with electronic system) x (industry wage rate)

One-time cost for some reactors with paper cable routing tracking systems:
(400 hours per reactor with paper tracking systems) x (industry wage rate)

C **Implement compensatory measures in accordance with the plant FPP based on the affected SSCs identified by the functionality assessment.**

- At each non-compliant NPP, the license holder will implement two types of compensatory measures: (1) Hourly fire watches and (2) Manual actions.

- All compensatory measures will remain in place for 36 months until all plant upgrades and corrective actions have been completed.

Hourly fire watches:

- One contracted security guard will conduct an hourly fire watch per reactor.

- Security guard wage rate: $25.00/hour.

- Percentage of non-compliant NPPs that must use contracted security guards to conduct hourly fire watches: 50 percent.[18]

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[17] The regulatory analysis does not include the cost for any license holder to select and trace the circuits and cables for an NPP. This activity is necessary to comply with existing requirements in 10 CFR Part 50, Appendix R, and is also required for upgrading an FPP. However, the regulatory analysis accounts for the possibility of license holder non-compliance in a sensitivity analysis (see Appendix 1).

[18] Staff estimate that approximately 50 percent of the non-compliant NPPs will incur no incremental cost to conduct fire watches. This assumes that many NPPs only will need to conduct fire watches at a small number of locations that existing licensee staff will be able to evaluate as a part of

One-time cost for some non-compliant reactors:
(24 hours/day) x (365 days/year) x (3 years) x (security guard wage rate)

Manual actions:

- Licensee staff time per reactor to develop manual action procedures and training materials: 180 hours.

- Conduct initial operator training[19] on manual actions procedures per reactor:
  - Hours of training per operator: 8 hours.
  - Number of reactor operators per reactor: 50.

One-time cost per non-compliant reactor:
(180 hours for manual action procedures and training development) + [(8 hours of training per operator) x (50 operators per reactor)] x (industry wage rate)

C **Select one of two methods to evaluate the affected SSCs identified in the functionality assessment:**

- **Method 1a or 1b: Perform post-fire safe-shutdown circuits analysis using deterministic or risk-informed analysis based on guidance in the proposed GL; or**

- Method 2: Adopt a performance-based FPP permitted by 10 CFR 50.48(c) - National Fire Protection Association (NFPA) 805 standard.

C **Evaluate the affected SSCs identified in the functionality assessment using Method 1a or 1b.**

Assumptions:

- Number of NPPs choosing Method 1a or 1b: 31 reactors (see Exhibit 3-1).
  - C Percentage of NPPs choosing Method 1a: 50 percent.
  - C Percentage of NPPs choosing Method 1b: 50 percent.

normal daily activities.

[19] Ongoing training will be included in regular reactor operator training sessions already conducted on post-fire safe shutdown procedures and, therefore, no incremental cost will be incurred.

- Average licensee staff time to conduct deterministic analyses per reactor: 2,500 hours.[20]

- Average licensee staff time to conduct risk-informed analyses per reactor: 1,500 hours

One-time cost per non-compliant reactor choosing Method 1a:
(2,500 hours per reactor to perform deterministic analyses) x (industry wage rate)

One-time cost per non-compliant reactor choosing Method 1b:
(1,500 hours per reactor to perform risk-informed analyses) x (industry wage rate)

C **Evaluate the affected SSCs identified in the functionality assessment using Method 2.**

Assumptions:
- Number of NPPs choosing Method 2: 16 reactors (see Exhibit 3-1).

- Licensee staff labor per NPP choosing Method 2:

  - Licensee staff time per reactor to develop and perform a fire probabilistic risk assessment (PRA): 5,500 hours.[21]

  - Licensee staff time per reactor to perform risk-informed analyses consistent with NEI 04-02: 2,000 hours.

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[20] NEI 00-01, Rev. 1, states that "[t]he assumption of multiple spurious actuations may or may not be reflected in the plant licensing basis, but should be considered from the standpoint of potential risk significance." It provides risk-informed methods to determine this risk significance. RIS 2004-03, Rev. 1, directs NRC inspectors "[t]o focus on the most likely failure scenarios, including multiple concurrent spurious actuations, ... [by assuming] fire damage to no more than two separate cables for each scenario evaluated. This ... does not limit the number of cables that may be damaged by fire." The implications are that, from a deterministic perspective, there is no way a priori to limit the number of multiple spurious actuations that need to be considered as part of a the circuit analysis of the functionality assessment. Inspectors are directed to consider pairs, but this is not a limit. On the other hand, employing risk-informed insights involving the likelihood of spurious actuations provides a method to bound the number of multiple spurious actuations for analysis. Therefore, the difference in licensee staff time to perform deterministic and risk-informed analyses reflects the ability of the latter to limit the scope, while the former will not only have to draw somewhat on the latter, but also go beyond since purely risk-informed insights do not provide sufficient justification to limit the scope of a purely deterministic approach. The estimated difference to conduct deterministic analyses per NPP is 1,000 hours greater than to perform risk-informed analyses per NPP.

[21] **NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 1: Summary & Overview," September 2005. NUREG/CR-6850 provides an estimated range of 4,000 to 7,000 hours to conduct a fire PRA per reactor.**

One-time cost per non-compliant reactor choosing Method 2:
[(5,500 hours per reactor to perform fire PRA) + (2,000 hours per reactor to perform risk-informed analyses)] x (industry wage rate)

C **For each NPP where the license holder determines that the existing post-fire safe-shutdown circuits analysis compliant with the GL information on spurious actuations, submit a response that specifies the basis for the conclusion**.

Assumptions:
- Number of NPPs with post-fire safe-shutdown circuits that the license holder determines to be compliant with the GL information: 57 NPPs.[22]

- Licensee staff time per reactor to draft the 90-day response to the proposed GL detailing the basis for the compliance conclusion: 100 hours.

One-time cost per compliant reactor:
(100 hours per reactor) x (industry wage rate)

C **For each NPP where the license holder determines that the existing post-fire safe-shutdown circuits analysis non-compliant with 10 CFR Part 50 requirements based on the information in the proposed GL, the license holder must submit within 90 days of the date of the GL, a written response to NRC in compliance with 10 CFR 50.54(f).**

Assumptions:
- Number of NPPs with post-fire safe-shutdown circuits analyses that do not adequately account for the information on spurious actuations in the proposed GL: 47 NPPs.

- Licensee staff time per reactor to develop and draft the 90-day response: 200 hours.

- Any license holder that cannot submit a response within 90 days of the GL date will supply the information at a later date, and will also provide NRC with a written response within 30 days of the proposed GL response as discussed below.

One-time cost per non-compliant reactor:
(200 hours per reactor) x (industry wage rate)

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[22] NRC has received or expects to receive commitments from the license holders of 41 NPPs to adopt the NFPA 805 standard. NRC estimates that an additional 16 NPPs will adopt the NFPA 805 standard to resolve issues unrelated to this proposed action (e.g., operator manual actions, other circuits related issues). Adopting the NFPA 805 standard is an acceptable method to resolve non-compliance; and, for this regulatory analysis, such adoption is assumed to be the chosen method of compliance.

C **If a license holder is unable to meet the 90-day response deadline, submit within 30 days of the date of the GL a written response that addresses any alternative course of action proposed and the basis for its acceptability.**

Assumptions:
- Licensee staff time to develop and draft the 30-day response per reactor: 60 hours.
- Percentage of non-compliant NPPs unable to meet the 90-day response deadline (due to workforce or expertise limitations): 35 percent.
    - All NPPs with compliant FPPs will submit a response to NRC within 90 days of the date of the proposed GL.

One-time cost for some non-compliant reactors:
(60 hours per reactor) x (industry wage rate)

C **Submit within 6 months of the date of the GL, a written response detailing the plans for plant modifications, license amendments, exemption requests, or other means to meet the 10 CFR Part 50 requirements and the plant's licensing basis.**

Assumptions:
- Number of NPPs with non-compliant FPPs that must submit a 6 month response: 47 NPPs.
- Licensee staff time per reactor to develop and draft the 6 month response: 400 hours.

One-time cost per non-compliant reactor:
(400 hours per reactor) x (industry wage rate)

C **Request an exemption or license amendment.**

Assumptions:
- Number of NPPs with non-compliant FPPs that must submit either an exemption or license amendment request to NRC: 47 NPPs.
- Licensee staff time per reactor to prepare and submit an exemption or license amendment request: 400 hours.[23]

[23] Hours estimate to complete a license exemption/amendment request obtained from "Final Supporting Statement For Application For Construction Permit or Operating License (And Other Miscellaneous Sections of 10 CFR Part 50) - 10 CFR 50.12, 50.30, 50.33(a), 50.34, 50.34(g), 50.54(bb), 50.55(b), 50.55(d), 50.59(c), 50.74, 50.80, 50.90, 50.91(a) and (b)."

- Time line for preparing and submitting license exemption and amendment requests:
  - 50 percent of NPPs will submit requests in 2007.
  - 50 percent of NPPs will submit requests in 2008.

One-time cost per reactor
(400 hours per reactor) x (industry wage rate)

C **Design and implement corrective actions necessary to return the FPP to compliance with 10 CFR Part 50 requirements and the information in the proposed GL.**

Assumptions:
- Corrective actions consist of implementing physical modifications to the reactor after receiving approval from NRC through a license amendment.
  - Number of NPPs with non-compliant FPPs that must make physical plant modifications to the reactor: 47 NPPs.
  - Average cost per reactor to design and implement physical modifications: $1,000,000.
  - Average time per reactor to complete corrective actions: 2.5 years.
  - All plant modifications will be performed during normal reactor operation and outage periods. Therefore, no incremental downtime or replacement energy costs will result from physical modifications to a reactor.

One-time cost per non-compliant reactor:
$1 million dollars to design and implement physical modifications

See Appendix 3 for a summary of the assumptions and impacts described in Section 3.2.3.4.

#### 3.2.3.5 NRC Implementation

C **Finalize proposed GL 2006-XX.**

Assumptions:
- NRC staff time to finalize proposed GL 2006-XX: 1,750 hours.
- NRC staff wage rate: $88.00/hour.

One time NRC cost:
(1,750 hours staff time) x (NRC staff wage rate)

C **Review 90-day response to proposed GL consistent with 10 CFR 50.48(f) and issue a response.**

Assumptions:
- NRC staff time per reactor to review 90-day response to proposed GL and issue a response: 30 hours.

- NRC stall will review a 90-day response for each of the 104 NPPs with operating licenses.

One-time NRC cost:
(104 reactors) x (30 hours per reactor) x (NRC staff wage rate)

C **Review 30-day response to proposed GL consistent with 10 CFR 50.48(f) submitted by license holders unable to meet the 90-day GL response requirement and issue a response.**

Assumptions:
- NRC staff time per reactor to review 30-day response and issue a response: 10 hours.

- Percentage of license holders unable to meet the 90-day response deadline (due to workforce or expertise limitations): 35 percent.

One time NRC cost:
(47 non-compliant reactors) x (percent submitting 30-day response) x
(10 hours per reactor) x (NRC staff wage rate)

C **Review 6-month responses to proposed GL submitted by license holders**.

Assumptions:
- NRC staff time per reactor to review 6-month response and issue a response: 80 hours.

One time NRC cost:
(47 non-compliant reactors) x (80 hours per reactor) x (NRC staff wage rate)

C **Review license amendment and exemption requests from license holders.**

Assumptions:
- NRC staff time per reactor to review and respond to a license amendment or exemption request: 200 hours.

- Number of NPPs with non-compliant FPPs that must submit either a license exemption or amendment request to NRC: 47 NPPs (see Exhibit 3-1).

- Time line for receiving license exemption and amendment requests:
  - 50 percent of NPPs will submit requests in 2007.

- 50 percent of NPPs will submit requests in 2008.

One time NRC cost:
(47 non-compliant reactors) x (200 hours per reactor) x (NRC staff wage rate)

See Appendix 3 for a summary of the assumptions and impacts described in Section 3.2.3.5.

### 3.2.4 Analysis of the Incremental Requirements, Option 3

The NRC evaluated each provision contained in Option 3 relative to the applicable baseline (Option 1, the No Action alternative). Based on this analysis, the NRC developed equations to estimate benefits (values) and costs (impacts) using available data, augmented by assumptions when necessary.

#### 3.2.4.1 Public Health (Accident); Occupational Health (Accident); Offsite Property; Onsite Property

See Sections 3.2.3.2 through 3.2.3.5 for the discussion on the affected attributes Public Health (Accident), Occupational Health (Accident); Offsite Property, and Onsite Property. The assumptions, data, and equations used to calculate the impacts for these affected attributes are the same as those used in Option 2 with the exception of the following:

Assumptions:

- Average remaining reactor life:
  - In 2006, the average remaining plant life for all operating NPPs is 34 years, assuming that each NPP receives a 20 year operating license extension. Benefits resulting from Option 3 will not begin to accrue until an NPP returns to compliance.

  - Under Option 3, each NPP, on average, will return to full compliance after resolving triennial fire protection inspection findings from two consecutive inspections (i.e., within 6 years of the initial inspection findings).
    - 7 NPPs will return to compliance in 2011: 29 years
    - 16 NPPs will return to compliance in 2012: 28 years
    - 16 NPPs will return to compliance in 2013: 27 years
    - 8 NPPs will return to compliance in 2014: 26 years

- Net Present Value of Replacement Power[24] for a single event:
  - Use with 7% discount rate:
    - $1.51 E+9 (remaining life of reactor = 29 years)
    - $1.48 E+9 (remaining life of reactor = 28 years)
    - $1.44 E+9 (remaining life of reactor = 27 years)
    - $1.41 E+9 (remaining life of reactor = 26 years)

[24] See discussion in Section 3.2.3.4 for additional information on NPV replacement power calculations.

- Use with 3% discount rate:
  - $2.09 E+9 (remaining life of reactor = 29 years)
  - $2.00 E+9 (remaining life of reactor = 28 years)
  - $1.91 E+9 (remaining life of reactor = 27 years)
  - $1.82 E+9 (remaining life of reactor = 26 years)

#### 3.2.4.2 Industry Operation

Most license holder activities discussed under Option 2 also will be required under Option 3. However, one key difference is in the way licensee action to address the spurious actuations issue is directed. Under Option 2, each NPP will determine non-compliance based on the information specified in the proposed GL on spurious actuations. Under Option 3, NRC will determine through inspections whether the FPPs for NPPs comply with 10 CFR Part 50 requirements and require licensee action through resolution of inspection findings.

Under the current triennial fire protection inspection process within the ROP, one-third of all reactor sites receive an inspection each year. Therefore, of the 65 reactor sites (i.e., locations of the 104 NPPs licensed to operate), approximately 22 reactor sites (35 NPPs) will be evaluated each year.

Assumptions:

- Number of NPPs that will receive triennial fire protection inspection findings for non-compliant FPP's based on spurious actuations: 47 NPPs.

- Each NPP, on average, will receive two triennial fire protection inspections that identify deficiencies in the FPPs for spurious actuations prior to returning to full compliance with 10 CFR Part 50.48 and 10 CFR 50, Appendix A, GDC 3.

Time line for conducting triennial fire protection inspections:

- With an August 2006 effective date for the commencement of triennial fire protection inspections with revised multiple spurious actuations evaluations, only half of the reactor sites to be inspected in 2006 will be subject to the revised inspections for multiple spurious actuations. That is, half of the reactor sites to receive a triennial audit (11 sites) would have already received a triennial fire protection inspection in 2006 by the time NRC begins conducting the revised inspections. As a result, only 11 of the 22 reactor sites inspected in 2006 will be evaluated based on the revised inspections for multiple spurious actuations.

- In 2006, NRC will conduct initial triennial fire protection inspections using the revised inspection process for multiple spurious actuations at 11 reactor sites (17 NPPs).

- In 2007, NRC will conduct initial triennial fire protection inspections using the revised inspection process for multiple spurious actuations at 22 reactor sites (35 NPPs).

- In 2008, NRC will conduct initial triennial fire protection inspections using the revised inspection process for multiple spurious actuations at 22 reactor sites (35 NPPs).

- In 2009, NRC will conduct initial triennial fire protection inspections using the revised inspection process for multiple spurious actuations at the 10 remaining reactor sites (17 NPPs) that were not evaluated based on the revised inspection process for multiple spurious actuations initiated in August 2006.

    - The remaining 12 reactor sites inspected in 2009 will receive a second triennial fire protection inspection based on the revised inspection process for multiple spurious actuations.

- Exhibit 3-2 presents, by year, the total number of NPPs receiving initial (and second) triennial fire protection inspection findings reports for non-compliant FPPs due to spurious actuations issues..

**Exhibit 3-2: Estimated Number of NPPs Receiving Inspection Findings for Non-Compliant FPPs Due to Revised Inspection Procedures for Spurious Actuations**

| Year | Initial Triennial Fire Protection Inspection | | Second Triennial Fire Protection Inspection | |
|---|---|---|---|---|
| | NPPs Inspected | Non-Compliant NPPs | NPPs Inspected | Non-Compliant NPPs |
| 2006 | 17 | 8 | | |
| 2007 | 35 | 15 | | |
| 2008 | 35 | 15 | | |
| 2009 | 17 | 9 | 17 | 8 |
| 2010 | | | 35 | 15 |
| 2011 | | | 35 | 15 |
| 2012 | | | 17 | 9 |
| **Total** | **104** | **47** | **104** | **47** |

- All NPPs will return to compliance with 10 CFR 50.48 and 10 CFR 50, Appendix A, by 2014.

**For each NPP at a site receiving an initial triennial fire protection inspection finding that the existing post-fire safe-shutdown circuits analysis is non-compliant with 10 CFR Part 50 requirements because of inadequate consideration of multiple spurious actuations, the license holder must:**

C Conduct an assessment of the functionality of the SSCs to identify potentially at-risk circuits that may affect the ability of the NPP to achieve and maintain safe shutdown in light of multiple spurious actuations caused by hot shorts generated during a fire event.

Assumptions:

- 47 of 104 NPPs will receive triennial fire protection findings for non-compliant FPPs.
    - The analysis does not account for the costs and benefits to 57 NPPs that have already committed to adopting NFPA 805 standard[25] or NRC estimates will adopt the NFPA 805 standard to resolve issues unrelated to this NRC action on spurious actuations (e.g., operator manual actions, resolve other circuits related issues). See Exhibit 3-1 for additional information on the number of affected entities.
- A functionality assessment for an NPP consists of performing an analysis of the SSCs to identify potentially at-risk circuits affected by multiple spurious actuations occurring simultaneously or in rapid succession. Part of a functionality assessment consists of selecting and tracing the circuits and cables of the NPP.
- Another component of a functionality assessment is to analyze the traced circuits and cables information contained in a cable routing tracking system to identify potentially at-risk circuits. The analysis includes the costs for some NPPs to utilize cable routing tracking systems to analyze SSCs and identify potentially at-risk circuits.[26]
    - Percentage of NPPs that must identify SSCs potentially affected by multiple spurious actuation by analyzing a cable routing tracking system: 10 percent.[27]
    - Of the NPPs that must identify SSCs potentially affected by multiple spurious actuations, the percentage that:
        - have an electronic cable routing tracking system: 50 percent, or
        - have a paper cable routing tracking system: 50 percent.

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[25] NRC has received or expects to receive commitments from the license holders of 41 NPPs to adopt the NFPA 805 standard.

[26] The majority of NPPs already have conducted such an analysis (NEI 04-06, "Guidance for Self-Assessment of Circuit Failure Issues," March 2005) to determine SSCs potentially affected by multiple spurious actuations.

[27] The regulatory analysis does not include the cost for any license holder to select and trace the circuits and cables for an NPP. This activity is necessary to comply with existing requirements in 10 CFR Part 50, Appendix R, and is also required for upgrading an FPP. However, the regulatory analysis accounts for the possibility of license holder non-compliance in a sensitivity analysis (see Appendix 1).

- Licensee staff time per reactor to identify SSCs using an electronic cable routing tracking system: 200 hours

- Licensee staff time per reactor to identify SSCs using a paper cable routing tracking system: 400 hours.

- The cost of conducting a functionality assessment is incurred in the first 12 months after an NPP receives a triennial fire protection inspection finding.

- An acceptable functionality assessment is consistent with an evaluation performed for RIS 2005-020.

One-time cost for some reactors with electronic cable routing tracking systems: (200 hours per reactor with electronic system) x (industry wage rate)

One-time cost for some reactors with paper cable routing tracking systems: (400 hours per reactor with paper tracking systems) x (industry wage rate)

C **Implement compensatory measures in accordance with the plant FPP for the affected SSCs identified by the functionality assessment.**

Assumptions:

- Upon receiving triennial fire protection inspection findings for a non-compliant FPP, the license holder of the NPP will implement two types of compensatory measures: (1) Hourly fire watches and (2) Manual actions.

- All compensatory measures will remain in place for an average of 72 months (6 years) per reactor, until all plant upgrades and corrective actions have been completed.

- The analysis equally divides the total cost incurred by industry to conduct fire watches from 2006 through 2014. This cost distribution provides a simplified manner to account for different NPPs receiving triennial fire protection findings in 2006, 2007, 2008, or 2009, and therefore, initiating compensatory measures in different years.

Hourly fire watches:

- One contracted security guard will conduct an hourly fire watch per reactor.

- Security guard wage rate: $25.00/hour.

- Percentage of non-compliant NPPs that must contract staff to conduct hourly fire watches: 50 percent.[28]

One-time cost for some non-compliant reactors:
(24 hours/day) x (365 days/year) x (6 years) x (security guard wage rate)

Manual actions:

C Licensee staff time per reactor to develop manual action procedures and training materials: 180 hours.

- Conduct initial operator training[29] on manual actions procedures per reactor:
  - Hours of training per operator: 8 hours.
  - Number of reactor operators per reactor: 50.

- The costs associated with developing manual action procedures and training materials and conducting initial operating training will be incurred by each reactor within 12-months of a site receiving an initial triennial fire protection findings report.

One-time cost per non-compliant reactor:
(180 hours for manual action procedures and training development) + [(8 hours of training per operator) x (50 operators per reactor)] x (industry wage rate)

C **Select one of two methods to evaluate the affected SSCs identified in the functionality assessment:**

- **Method 1a or 1b: Perform post-fire safe-shutdown circuits analysis using deterministic or risk-informed analysis based on guidance in the proposed GL; or**

- Method 2: Adopt a performance-based FPP permitted by 10 CFR 50.48(c) - National Fire Protection Association (NFPA) 805 standard.

[28] Staff estimate that approximately 50 percent of NPPs will incur no incremental cost to conduct fire watches. This assumes that many NPPs will need to conduct fire watches on only a small portion of each plant and therefore existing licensee staff will be able to conduct this activity as a part of normal daily activities.

[29] Ongoing training will be included in regular reactor operator training sessions already conducted on post-fire safe shutdown procedures and, therefore, no incremental cost will be incurred beyond the one-time operator training.

C **Evaluate the affected SSCs identified in the functionality assessment using Method 1a or 1b.**

Assumptions:

- Number of NPPs choosing Method 1a or 1b: 47 reactors (see Exhibit 3-1).
  - C Percentage of NPPs choosing Method 1a: 50 percent.
  - C Percentage of NPPs choosing Method 1b: 50 percent.

- Average licensee staff time to conduct deterministic analysis per reactor: 2,500 hours.[30]

- Average licensee staff time to conduct a risk-informed analysis per reactor: 1,500 hours

- The costs associated with evaluating affected SSCs using Method 1a or 1b will be incurred by an NPP within 12 months of the license holder receiving a triennial fire protection inspection findings report for a non-compliant FPP.

One-time cost per reactor choosing Method 1a:
(2,500 hours per reactor to perform deterministic analyses) x (industry wage rate)

One-time cost per reactor choosing Method 1b:
(1,500 hours per reactor to perform risk-informed analyses) x (industry wage rate)

C **Evaluate the affected SSCs identified in the functionality assessment using Method 2.**

Assumptions:

- No NPP will choose to adopt NFPA 805 (Method 2) to resolve triennial fire protection inspection findings for a non-compliant FPP due to spurious actuations.

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[30] NEI 00-01, Rev. 1, states that "[t]he assumption of multiple spurious actuations may or may not be reflected in the plant licensing basis, but should be considered from the standpoint of potential risk significance." It provides risk-informed methods to determine this risk significance. RIS 2004-03, Rev. 1, directs NRC inspectors “[t]o focus on the most likely failure scenarios, including multiple concurrent spurious actuations, ... [by assuming] fire damage to no more than two separate cables for each scenario evaluated. This ... does not limit the number of cables that may be damaged by fire." The implications are that, from a deterministic perspective, there is no way a priori to limit the number of multiple spurious actuations that need to be considered as part of a the circuit analysis of the functionality assessment. Inspectors are directed to consider pairs, but this is not a limit. On the other hand, employing risk-informed insights involving the likelihood of spurious actuations provides a method to bound the number of multiple spurious actuations for analysis. Therefore, the difference in licensee staff time to perform deterministic and risk-informed analyses reflects the ability of the latter to limit the scope, while the former will not only have to draw somewhat on the latter, but also go beyond since purely risk-informed insights do not provide sufficient justification to limit the scope of a purely deterministic approach. The estimated difference to conduct deterministic analyses per NPP is 1,000 hours greater than to perform risk-informed analyses per NPP.

C **Submit to NRC written responses to resolve inspection findings that include:**

- **A detailed description of compensatory measures implemented; and**
- **A description and proposed schedule for any plant modifications and license amendment/exemption requests to return the plant to compliance with 10 CFR Part 50 regulations and the plant's licensing basis.**

Assumptions:

- 47 of 104 NPPs will receive triennial fire protection findings for non-compliant FPPs.
- Licensee holder staff time per reactor to develop and draft responses to each triennial fire protection inspection findings report: 550 hours.
- Number of triennial fire protection inspection findings reports per reactor: 2.
- The total cost to industry to respond to triennial fire protection inspection findings reports is equally divided over the time period covered by the analysis (2006 through 2014).

One-time cost per non-compliant reactor:
(550 hours per reactor per inspection report) x (2 inspection reports per reactor) x (industry wage rate)

• **Participate in resolving the triennial fire protection inspection findings through enforcement conferences, meetings, and Safety Evaluation Review Panels.**

Assumptions:

- 47 of 104 NPPs will receive triennial fire protection findings for non-compliant FPPs.
- Licensee holder staff time per reactor per triennial fire protection inspection report: 150 hours.
- Number of triennial fire protection inspection findings reports per reactor: 2.
- **The total cost to industry to participate in enforcement conferences, meetings, and Safety Evaluation Review Panels with NRC is equally divided over the time period covered by the analysis (2006 through 2014).**

**One-time cost per non-compliant reactor:**
**(150 hours per reactor) x (2 inspections per reactor) x (industry wage rate)**

C **Request an exemption or license amendment.**

Assumptions:

- 47 of 104 NPPs will receive triennial fire protection findings for non-compliant FPPs.
- Each license holder will triennial fire protection findings will submit either a license exemption or license amendment request(s) for each NPP at a reactor site.
- Licensee staff time per reactor to prepare and submit a license amendment or exemption request: 400 hours.[31]
- Average number of license exemption or amendment requests submitted per NPP with a non-compliant FPP: 1.5.[32]
- The analysis equally divides the total cost incurred by industry to submit license exemption and license amendment requests from 2007 through 2013.

One-time cost per non-compliant reactor:
(400 hours per reactor) x (1.5 license amendments/exemptions per NPP) x (industry wage rate)

C **Design and implement corrective actions necessary to return the FPP to compliance with 10 CFR Part 50 requirements.**

Assumptions:

- Corrective actions consist of implementing physical modifications to the reactor after receiving approval from NRC through a license amendment.
  - Number of NPPs with non-compliant FPPs that must make physical plant modifications to the reactor: 47 NPPs.
  - Average cost per reactor to design and implement physical modifications: $1,000,000.

[31] Hours estimate to complete a license exemption/amendment request obtained from "Final Supporting Statement For Application For Construction Permit or Operating License (And Other Miscellaneous Sections of 10 CFR Part 50) - 10 CFR 50.12, 50.30, 50.33(a), 50.34, 50.34(g), 50.54(bb), 50.55(b), 50.55(d), 50.59(c), 50.74, 50.80, 50.90, 50.91(a) and (b)."

[32] Half of the non-compliant NPPs with submit 1 license amendment or exemption request and the remaining half of the non-compliant NPPs will submit 2 license amendment or exemption requests.

- All plant modifications will be performed during normal reactor operation and outage periods. Therefore, no incremental downtime or replacement energy costs will result from physical modifications to a reactor.

- The analysis equally divides the total cost incurred by industry to design and implement corrective actions from 2006 through 2014.

One-time cost per non-compliant reactor:
$1 million dollars to design and implement physical modifications

See Appendix 3 for a summary of the assumptions and impacts described in Section 3.2.4.2.

#### 3.2.4.3 NRC Operation

C **Triennial fire protection inspections findings and enforcement actions**

- No incremental change will result in preparing for or in conducting the triennial fire protection inspections given that the normal inspection process evaluates the circuits analysis and post-fire safe shutdown analysis for each NPP.

C **NRC headquarters staff support to NRC regions**

Assumptions:
- NRC headquarter staff time per year to support NRC regions in resolving triennial fire protection inspection findings and enforcement actions: 1,000 hours.

One time NRC cost:
(1,000 hours per year) x (9 years to return all NPPs to compliance) x
(NRC staff wage rate)

C **Review inspection findings, and participate in enforcement conferences and Safety Evaluation Review Panels (SERPs)**

Assumptions:
- Staff labor per triennial fire protection inspection per reactor to review license holder responses to inspection findings and to participate in enforcement conferences and SERPs: 200 hours per reactor.

- Number of triennial fire protection inspection findings reports per reactor: 2.

- The total cost to NRC to conduct these activities is equally divided over the years of the analysis from 2006 through 2014.

One time NRC cost:
(47 non-compliant reactors) x (200 hours per reactor) x (2 inspections per reactor) x
(NRC staff wage rate)

C **Conduct Fire Protection Significance Determination Process Phase 3 analyses**

Assumptions:

- Staff labor per reactor per triennial fire protection inspection to conduct a phase 3 analysis: 340 hours.
- Number of triennial fire protection inspection findings reports per reactor: 2.
    - The total cost to NRC to conduct these activities is equally divided over the years of the analysis from 2006 through 2013.

One time NRC cost:
(47 non-compliant reactors) x (340 hours per reactor) x (2 inspections per reactor) x (NRC staff wage rate)

C **Review license amendment or exemption requests**

As a result of triennial fire protection inspections findings, each NPP will submit either a license amendment or exemption request(s) to resolve inspection findings.

Assumptions:

- NRC staff time per reactor to review and respond to a license amendment or exemption request: 200 hours.
- Number of license exemption or amendment requests submitted by the license holder per NPP: 1.5.
- The total cost to NRC to review license amendment and exemption requests is equally divided over the years of the analysis from 2007 through 2013.

One time NRC cost:
(47 non-compliant reactors) x (200 hours per reactor) x (1.5 license amendments/ exemptions per NPP) x (NRC staff wage rate)

See Appendix 3 for a summary of the assumptions and values/impacts described in Section 3.2.4.

# 4. RESULTS

This section presents the analytical results and is organized into four sections. Section 4.1 presents findings on the overall benefits and costs of Option 2 and 3. Section 4.2 presents the quantitative results for each affected attribute, and Section 4.3 presents the qualitative results for each affected attribute. Section 4.4 discusses the backfit.

## 4.1 Benefits and Costs

This section summarizes the benefits (values) and costs (impacts) estimated for Options 2 and 3. For Options 2 and 3, five attributes have been analyzed quantitatively. For Option 2, three attributes have been analyzed qualitatively, while for Option 3, two attributes have been analyzed qualitatively. The *net* benefits and costs calculated for each option are presented below. Some benefits resulting from Options 2 and 3 could be evaluated only on a qualitative basis (as noted in Section 3.2).

*Option 2 (Issue Generic Letter Requiring Licensee Action)*
Relative to the no-action alternative, Option 2 would result in estimated net one time quantitative costs to:

- Industry of $85.4 million (total present value), assuming a 7-percent discount rate, or $87.8 million, assuming a 3-percent discount rate.
    - For reactors with FPPs that do not account for the spurious actuations as defined in the proposed GL, license holders will incur costs associated with developing and implementing compensatory measures; conducting additional circuits analyses to identify at-risk circuits; conducting risk informed or deterministic analyses of the at risk SSCs; designing and implementing physical plant modifications; and/or applying for license amendments or exemptions.
- NRC of $1.5 million (total present value), assuming a 7-percent discount rate, or $1.6 million, assuming a 3-percent discount rate.
    - NRC will incur one time implementation costs to finalize the generic letter; review and respond to the 90-day written response submitted by each license holder of an operating NPP; review and respond to 30-day written responses submitted by some license holders of operating NPPs; and review and respond to license amendment and exemption requests.

Offsetting the net costs to industry and NRC, Option 2 would result in benefits related to safety. Benefits would result from the reduced risk of accidents resulting from the inability to safely shutdown an NPP because of spurious actuations generated from hot-shorts occurring during a fire event.

Option 2 would result in estimated net one time quantitative benefits to:

- Public health (accident) of $2.2 million (total present value), assuming a 7-percent discount rate, or $3.7 million, assuming a 3-percent discount rate;

- Occupational health (accident) of $192,000 (total present value, assuming a 7-percent discount rate, or $384,000, assuming a 3-percent discount rate;

- Offsite property of $1.8 million (total present value), assuming a 7-percent discount rate, or, $3.2 million, assuming a 3-percent discount rate; and

- Onsite property of $15.3 million (total present value), assuming a 7-percent discount rate, or $29.3 million, assuming a 3-percent discount rate.

Note: additional benefits may result from the reduced number of license exemptions and amendment requests that the 16 NPPs adopting NFPA 805 submit to NRC. The analysis does not attempt to quantify these additional benefits because of the uncertainty in the number of fewer exemption and amendment requests that may be submitted by the 16 NPPs.

Net quantitative result - Option 2:

- Cost of $67.4 million (total present value,7-percent discount rate), or $52.8 million (total present value, 3-percent discount rate).

*Option 3 (Inspection and Enforcement)*
Relative to the no-action alternative, Option 3 would result in estimated net one time quantitative costs to:

- Industry of $78.7 million (total present value), assuming a 7-percent discount rate, or $89.5 million, assuming a 3-percent discount rate.

    - License holders for NPPs receiving triennial fire protection inspection findings for non-compliant post-fire safe shutdown circuits analyses would incur costs to resolve inspection findings. The activities conducted would be similar to those described for industry under Option 2.

- NRC of $5.1 million (total present value), assuming a 7-percent discount rate, or $5.8 million, assuming a 3-percent discount rate.

    - NRC would incur one time operations costs to review and respond to triennial fire protection inspection findings reports; to participate in enforcement actions and Safety Evaluation Review Panels; to conduct Fire Protection Significance Determination Process Phase 3 Analyses; to support NRC regional staff in resolving inspection and enforcement activities; and to review and respond to license amendment and exemption requests.

Offsetting the net costs to industry and NRC, Option 3 would result in benefits related to safety. Option 3 would result in estimated net one time quantitative benefits to:

- Public health (accident) of $1.5 million (total present value), assuming a 7-percent discount rate, or $2.9 million, assuming a 3-percent discount rate;
- Occupational health (accident) of $131,000 (total present value, assuming a 7-percent discount rate, or $299,000, assuming a 3-percent discount rate;
- Offsite property of $1.2 million (total present value), assuming a 7-percent discount rate or, $2.5 million, assuming a 3-percent discount rate; and
- Onsite property of $9.7 million (total present value), assuming a 7-percent discount rate or, $19.9 million, assuming a 3-percent discount rate.

Benefits would result from the reduced risk of accidents that could result from the inability to safely shutdown NPPs because of spurious actuations generated from hot-shorts occurring during fire events.

Net quantitative result - Option 3:

- Cost of $71.3 million (total present value,7-percent discount rate), or $69.8 million (total present value, assuming a 3-percent discount rate).

Exhibit 4-1 presents a summary of the qualitative and quantitative benefits and costs for Options 2 and 3.

**Exhibit 4-1: Summary of Benefits and Costs**

| Net Monetary Savings (+) or Costs (-) | Non-Monetary Benefits/Costs |
|---|---|
| **Option 2: Issue Generic Letter Requiring Licensee Action** | |
| ***Quantitative Benefits:***<br>**Public Health (Accident)**<br>$2.2 million - 7% discount rate<br>$3.7 million - 3% discount rate<br><br>**Occupational Health (Accident)**<br>$192,000 - 7% discount rate<br>$384,000 - 3% discount rate<br><br>**Offsite Property**<br>$1.8 million - 7% discount rate<br>$3.2 million - 3% discount rate<br><br>**Onsite Property**<br>$15.3 million - 7% discount rate<br>$29.3 million - 3% discount rate<br><br>***Quantitative Costs:***<br>**Industry**:<br>($85.4 million) 7% discount rate<br>($87.8 million) 3% discount rate<br><br>**NRC:**<br>($1.5 million) 7% discount rate<br>($1.6 million) 3% discount rate | ***Qualitative Benefits:***<br>*Improvements in Knowledge*. The license holder responses to the proposed GL will provide NRC with information on the FPP for each operating NPP to evaluate compliance with 10 CFR Part 50.<br><br>*Regulatory Efficiency*. The proposed GL will clarify existing industry interpretations on frequency and timing of spurious actuations during fire events, thus improving compliance with 10 CFR Part 50.<br><br>***Qualitative Costs:***<br>*None.* |

| Net Monetary Savings (+) or Costs (-) | Non-Monetary Benefits/Costs |
|---|---|
| **Option 3: Inspection and Enforcement** | |
| ***Quantitative Benefits:***<br>**Public Health (Accident)**<br>$1.5 million - 7% discount rate<br>$2.9 million - 3% discount rate<br><br>**Occupational Health (Accident)**<br>$131,000 - 7% discount rate<br>$299,000 - 3% discount rate<br><br>**Offsite Property**<br>$1.2 million - 7% discount rate<br>$2.5 million - 3% discount rate<br><br>**Onsite Property**<br>$ 9.7 million - 7% discount rate<br>$19.9 million - 3% discount rate<br><br>***Quantitative Costs:***<br>**Industry**:<br>($78.7 million) 7% discount rate<br>($89.5 million) 3% discount rate<br><br>**NRC:**<br>($5.1 million) 7% discount rate<br>($5.8 million) 3 % discount rate | ***Qualitative Benefits:***<br>*Improvements in Knowledge.* The license holder responses to the triennial fire protection inspection reports will provide NRC with information on the resolution of inspection findings and compliance with 10 CFR Part 50.<br><br>***Qualitative Costs***:<br>*None.* |

Exhibits 4-2 and 4-3 present the breakdown of total benefit and cost for each affected attribute.

## 4.2 Quantitative Benefits and Costs

Exhibits 4-2 and 4-3 provide the results of the quantitative analyses for each attribute affected under Option 2 and 3.

**Exhibit 4-2**: **Quantitative Results (7-percent discount rate)**
Value (+) or Impact (-)

| **Attribute** | **Option 1: No Action** | **Option 2: Issue Generic Letter** | **Option 3: Inspection and Enforcement** |
|---|---|---|---|
| Public Health (Accident) | $0 | $2,165,834 | $1,470,071 |
| Occupational Health (Accident) | $0 | $192,458 | $130,632 |
| Offsite Property | $0 | $1,839,830 | $1,248,794 |
| Onsite Property | $0 | $15,312,180 | $9,663,516 |
| Industry Implementation | $0 | ($85,416,997) | $0 |
| Industry Operation | $0 | $0 | ($78,706,658) |
| NRC Implementation | $0 | ($1,500,066) | $0 |
| NRC Operation | $0 | $0 | ($5,096,462) |
| **Net Result** | **$0** | **($67,406,761)** | **($71,290,107)** |

Amounts may not sum to values shown because of rounding.

The results for Option 2 assume that the proposed GL will be finalized in August 2006 and that all reactors will return to compliance within 3 years, by 2008.

The results for Option 3 assume that NRC would begin conducting triennial fire protection inspections evaluating the FPPs for multiple spurious actuations at NPPs in August 2006, with all reactors returning to compliance within 9 years (by August 2014).

**Exhibit 4-3**: **Quantitative Results (3-percent discount rate)**
Value (+) or Impact (-)

| Attribute | Option 1: No Action | Option 2: Issue Generic Letter | Option 3: Inspection and Enforcement |
|---|---|---|---|
| Public Health (Accident) | $0 | $3,713,756 | $2,887,606 |
| Occupational Health (Accident) | $0 | $384,043 | $298,610 |
| Offsite Property | $0 | $3,154,756 | $2,452,959 |
| Onsite Property | $0 | $29,326,807 | $19,920,441 |
| Industry Implementation | $0 | ($87,779,135) | $0 |
| Industry Operation | $0 | $0 | ($89,517,677) |
| NRC Implementation | $0 | ($1,555,690) | $0 |
| NRC Operation | $0 | $0 | ($5,826,171) |
| **Net Result** | **$0** | **($52,755,463)** | **($69,784,232)** |

Amounts may not sum to values shown because of rounding.

## 4.3 Qualitative Benefits and Costs

The analysis evaluates two affected attributes on a qualitative basis (Improvements in Knowledge and Regulatory Efficiency). Options 2 and 3 would result in unquantifiable benefits due to knowledge gained by NRC on the safety of the fire protection program of each NPP. Option 2 also would result in improvements in regulatory efficiency because the proposed GL would clarify the existing industry interpretations on the frequency of spurious actuations that may result from hot shorts occurring during fire events. The analysis does not attempt to quantify the value of these attributes due to the difficulty and uncertainty involved in quantifying the benefits.

## 4.4 Backfit Analysis

Under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, 10 CFR 50.109(a)(4)(i), and 10 CFR 50.54(f), this GL requests addressees to evaluate their facilities to confirm compliance with the existing applicable regulatory requirements as discussed in this GL. The NRC position has been that all multiple spurious actuations caused by hot shorts have to be considered in a post-fire safe-shutdown circuits analysis. Also, the 2001 EPRI/NEI fire test program demonstrated that the previous assumptions regarding spurious actuations do not adequately address the potential risk to safe shutdown. The EPRI/NEI cable fire tests clearly showed, during and after a fire, a relatively high probability that multiple spurious actuations will occur simultaneously or in rapid succession. Fire-induced hot shorts that cause spurious actuations can prevent a train from performing its post-fire safe-shutdown function. The regulations require that spurious actuations must be considered.

Although both the NRC and the industry have used the phrase "one-at-a-time" in connection with post-fire spurious actuations caused by hot shorts, it is not defined in 10 CFR Part 50 regulations or fire protection guidance documents. The phrase has been used in at least two different senses. Some licensees have used "one-at-a-time" to mean that only one spurious actuation need be postulated for any single fire event. Other licensees have used the phrase to mean that multiple spurious actuations do not occur simultaneously and that there is sufficient time between spurious actuations for operators to take corrective actions. NRC has issued SERs that accepted both interpretations for specific situations in specific plants (e.g., NUREG-0876, Supplement No. 6, "Safety Evaluation Report Related to the Operation of Byron Station, Units 1 and 2," ADAMS Accession No. 8411200507). However, the NRC staff has interpreted the regulations to mean that these interpretations are only allowed with respect to the design of alternate shutdown capability. The EPRI/NEI cable fire testing conducted in 2001 demonstrated that neither interpretation conforms with the likely effects of a fire in an area containing safe-shutdown cables. Accordingly, the NRR staff's positions in this GL with respect to current fire protection requirements do not constitute backfitting as defined in 10 CFR 50.109(a)(1).

However, for Byron Station, Units 1 and 2 and Braidwood Station, Units 1 and 2, the staff positions with respect to one spurious actuation per fire represents a change in staff position, and if applied to the licensees of these plants, would constitute backfits under 10 CFR 50.109(a)(4)(i). As discussed in the GL, the imposition of the position with respect to multiple spurious actuations is necessary to comply with the (unchanged) staff interpretation of 10 CFR 50.48 and 10 CFR Part 50, Appendix A, GDC 3. Staff approval of the "single spurious actuation per fire event" for Byron Station, Units 1 and 2 and Braidwood Station, Units 1 and 2 constituted staff inconsistencies with respect to the necessary prerequisites for demonstrating compliance with 10 CFR 50.48 and 10 CFR Part 50, Appendix A, GDC 3, and the inconsistencies would be rectified by any backfitting imposed by the NRC in accordance with this GL.

The NRC staff has determined, in accordance with 10 CFR 50.54(f), that the information sought in this GL is necessary to verify licensee compliance with existing regulatory requirements in 10 CFR 50.48 and 10 CFR Part 50, Appendix A, GDC 3.

# 5. DECISION RATIONALE

## 5.1 Regulatory Analysis

Based on the assessment of the costs and benefits resulting from Options 2 and 3, the NRC has concluded that the proposed Option 2 would be justified.

Even though Option 2 has a higher net quantitative cost to industry of $85.4 million, as compared to $78.7 million for Option 3 (total present value, 7-percent discount rate), Option 2 provides a:

- Lower net quantitative cost of $67.4 million, as compared to $71.3 million for Option 3 (total present value, 7-percent discount rate);
- Greater net quantitative benefit of $19.5 million, as compared to $12.5 million for Option 3 (total present value, 7-percent discount rate);
- Lower net quantitative cost to NRC of $1.5 million, as compared to $5.1 million for Option 3 (total present value, 7-percent discount rate); and
- Quicker return to compliance for all NPPs by 2009, as compared to 2014 for Option 3.

# 6. IMPLEMENTATION

This section identifies how and when the proposed action would be implemented, the required NRC actions to ensure implementation, and the impact on NRC resources.

## 6.1 Schedule

The action (Option 2) would be enacted through a proposed Generic Letter, resolution of public comments, and a final Generic Letter. The staff has not identified any impediments to implementing the recommended alternatives.

Tentative Schedule:

| | | |
|---|---|---|
| C | Proposed GL Issued for Public Comment | October 19, 2005 |
| C | End of Public Comment Period | February 6, 2006 |
| C | Final GL Published | August 2006 |

## 6.2 Impact on Other Requirements

None.

# 7. OTHER PROCEDURAL REQUIREMENTS

This proposed GL would affect only licensees who are authorized to operate nuclear power plants. The companies that own these facilities do not fall within the definition of “small entities” set forth in the Regulatory Flexibility Act or the size standards adopted by the NRC on April 11, 1995 (60 FR 1834; 10 CFR 2.810). Therefore, this proposed GL would not have a significant economic impact on a substantial number of small entities, as applicable under the Regulatory Flexibility Act of 1980 [(5 U.S.C. 605(b))].

# APPENDICES

## APPENDIX 1: Sensitivity Analysis - Cable Tracing Non-Compliance

Appendix 1 provides a sensitivity analysis to account for the potential costs incurred by some NPPs that have not adequately selected, traced, and analyzed the circuits at each NPP. The analysis provides costs both for NPPs with advanced electronic (computerized) cable routing database systems and for NPPs with paper (non-electronic) cable routing systems.[33]

Assumptions

- Number of NPPs affected (i.e., NPP with non-compliant FPP) under both Options 2 and 3: 47 NPPs (see Exhibit 3-1 for additional information).
- Percentage of non-compliant NPPs with circuits and cable tracing analyses that do not comply with existing requirements in 10 CFR Part 50: 10 percent.
- An NPP will conduct circuits and cable tracing analyses as part of the functionality assessment described in Section 3.2.3.5 (Option 2) and Section 3.2.4.2 (Option 3).
    - For Option 2, the functionality assessment will be completed prior to submitting the 90 day written response to the GL.
    - For Option 3, the functionality assessment will be completed within 12 months of a license holder receiving an initial triennial fire protection findings report for a reactor site.
- Licensee staff time per reactor with an advanced electronic (computerized) cable routing database system: 1,500 hours.[34]
- Percentage of reactors with advanced computerized cable routing database tracking systems: 50 percent.
- Licensee staff time per reactor with a paper (non-electronic) cable routing system: 6,000 hours.

[33] NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 1: Summary & Overview," September 2005. NUREG/CR-6850 estimates that the level of effort to select, trace, and analyze circuits and cables per reactor is highly dependent on existing systems used to track cable and component routing. The estimate ranges from 600 hours for a reactor with advanced electronic cable routing databases to 6,000 hours for a reactor with paper cable routing tracking systems.

[34] NRC has chosen a higher estimate than provided in NUREG/CR-6850 to account for variability that may exist in the condition of advance cable routing database systems at some NPPs that may affect the low-end manpower estimate provided in the NUREG.

- Percentage of reactors with paper (non-electronic) cable routing tracking systems: 50 percent.

- Industry wage rate: $100.00/hour

One-time cost per reactor for some NPPs with advanced cable routing databases:
(1,500 hours per reactor) x ($100.00/hour industry wage rate)

One-time cost per reactor for some NPPs with paper cable routing systems:
(6,000 hours per reactor) x ($100.00/hour industry wage rate)

The total one-time cost to industry:
[(47 reactors) x (10 percent non-compliant) x (50 percent advanced database) x ($150,000 per reactor with advanced routing database)] +
[(47 reactors) x (10 percent non-compliant) x (50 percent paper tracking system) x ($600,000 per reactor with paper cable routing system)]

Option 2 results:
- Total present value to industry, 7% discount rate = ($1,875,000)
- Total present value to industry, 3% discount rate = ($1,875,000)

Note: activities conducted during first year of the analysis for all NPPs affected.

Option 3 results:
- Total present value to industry, 7% discount rate = ($1,586,546)
- Total present value to industry, 3% discount rate = ($1,742,136)

Note: activities conducted by each NPP are dependent on when the NPP receives the initial triennial fire protection inspection finding (varies by NPP from 2006 to 2009).

Option 2 and 3 results presented in 2005 dollars.

## APPENDIX 2: Core Damage Frequency Bounding Analysis

**[INSERT the final version of the bounding analysis "Bounding the Fire Risk from Circuit Spurious Actuations at Nuclear Power Plants," to Support Regulatory Analysis for GL 2006-xx, "Post-fire Safe-Shutdown Circuit Analysis Spurious Actuations. ADAMS Accession #: ML060870521]**

## APPENDIX 3: Summary of Assumptions and Results - Options 2 and 3