

Risk-Informed/Performance-Based Fire Protection Regulation for U.S. Nuclear Power Plants

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Abstract - *The U.S. Nuclear Regulatory Commission (NRC) is considering to allow changes to the fire protection programs at existing U.S. light water nuclear power plants through the use of risk-informed/performance-based evaluations. The current deterministic requirements seek to assure the capability for post-fire safe shutdown margin through the engineered survival of safe shutdown systems. These requirements were developed before the benefits of probabilistic risk assessment techniques and performance-based methods such as fire modeling. The proposed regulation is based on a consensus standard, the National Fire Protection Association's National Fire Code, NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2001 Edition. The revised regulation would be voluntary and is expected to reduce the need for exemptions and regulatory burden associated with the existing deterministic approach. This paper discusses the overall rulemaking and the status of NRC's plans for implementation of a final regulation.*

Key Words: Fire Protection, NFPA 805, Risk-Informed, Performance-Based Regulation, Appendix R

I. BACKGROUND

In 1971, the US Atomic Energy Commission (now the U.S. Nuclear Regulatory Commission) promulgated General Design Criterion Number 3 relating to fire protection. Subsequently, as a result of a fire at the Browns Ferry Nuclear Power Plant in 1975, the NRC developed specific guidance for implementing these criteria. In the late 1970s, the NRC worked with licensees to establish configurations that would meet this guidance and reached closure on most issues. To resolve the remaining contested issues, the NRC published a new mandatory regulation 10 CFR 50.48, *Fire Protection*, and its associated Appendix R in

1980. For the most part, these requirements are considered deterministic in nature.

The NRC has issued approximately 900 exemptions from the fire protection regulations. Most of these exemptions were granted to licensees that submitted a deterministic technical evaluation demonstrating that their plant-specific alternative approach satisfied the underlying purpose of the rule. The processing and tracking of these exemption and deviation requests have become a significant burden on the resources of the NRC and the nuclear industry.

In 1995, the NRC published in the Federal Register a final policy statement on the use of probabilistic risk assessment methods in nuclear activities (60 FR 42622). In 1998, the Commission provided guidance for identifying and assessing performance-based approaches to the regulations (SECY 98-058). This augmented the guidance in the NRC's Regulatory Guide 1.174, *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*, dated July 1998. In the late 1990s, the Staff cooperatively participated in the NFPA consensus process which ultimately resulted in the NFPA 805 standard. In 2000, the Staff received approval for proceeding with rulemaking to permit licensees to voluntarily adopt NFPA 805 as an alternative to existing fire protection requirements. In 2001, the NFPA Standards Council approved NFPA 805 as a performance-based standard for fire protection at light water nuclear power plants. In November 2002, the proposed rule was published in the Federal Register for public comment (67 FR 66578). The Nuclear Energy Institute (NEI) expressed support for the NFPA 805 rulemaking and is, in parallel developing implementation guidance for the final regulation.

II. NFPA 805 OVERVIEW

The NFPA develops fire codes and standards through a consensus process approved by the American National Standards Institute. The NFPA Technical Committee on Fire Protection for Nuclear Facilities is responsible for the development and maintenance of three standards: NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, NFPA 804, *Standard for Fire Protection for Advanced Light*

Water Reactor Electric Generating Plants, and NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*. The committee members are volunteers from various public and private organizations, including federal agencies, national laboratories, the power industry, insurance companies, consultants, and nuclear reactor vendors (Westinghouse, General Electric, etc.). NFPA 805 replaced the existing standard, NFPA 803, *Standard for Fire Protection for Light Water Nuclear Power Plants*.

NFPA 805 provides the following: fundamental fire protection program elements, minimum design requirements, a methodology for determining fire protection systems and features, a methodology for applying performance-based fire protection requirements, and the fire protection requirements for decommissioned nuclear power plants. The standard specifies requirements for all phases of operation and is concerned with nuclear safety, radioactive release, life safety, and plant damage and business interruption caused by a fire. Besides low to full power, all phases of plant operation includes: shutdown, degraded conditions, and decommissioned plants.

NFPA 805 has five main chapters. Chapter 1, *Introduction*, provides the defense-in-depth goals, performance objectives, and performance criteria. Chapter 2, *Methodology*, provides the general approach for establishing the fire protection requirements. Chapter 3, *Fundamental Fire Protection Program and Design Elements*, contains the core set of requirements and are mainly deterministic in nature. These requirements cover the fire protection plan, fire prevention, detection and

suppression systems, and passive features. Chapter 4, *Determination of Fire Protection Systems and Features*, establishes the deterministic and performance-based approaches to determine the systems and features required to achieve the performance criteria. Chapter 5, *Fire Protection During Decommissioning and Permanent Shutdown*, pertains mainly to the nuclear reactor plant areas and protection of spent fuel storage necessary to maintain the performance objectives.

III. NRC RULEMAKING OVERVIEW

The NRC is proposing to amend the fire protection requirements for nuclear power reactors in 10 CFR 50.48 to provide licensees with the option of voluntarily adopting an alternative set of fire protection requirements contained in NFPA 805, with NRC specified exceptions, as an alternative to the existing fire protection requirements. Existing requirements are deterministic and viewed by a number of reactor licensees as prescriptive in nature and unnecessarily inflexible. The objectives of the proposed change in NRC regulations are to:

- (1) provide an alternative, risk-informed/performance-based set of fire protection requirements for existing commercial nuclear power plants,
- (2) leverage the involvement of industry in the development of new requirements and implementation guidance, in accordance

with the Commission's Direction Setting Issue 13, *The Role of Industry*, and

- (3) achieve the technology transfer goal of Public Law 104-113, *National Technology Advancement and Transfer Act of 1995*, by endorsing a national consensus standard.

If a licensee meets all their current requirements, transitioning to NFPA 805 should be a modest effort since the corresponding deterministic requirements within NFPA 805 are similar to the existing regulation. Existing exemptions can remain in effect and if non-compliances are identified, the licensee may evaluate them with the new NFPA 805 performance-based approach. Operating facilities will have to address fire protection in all modes of operation, in comparison to existing requirements which address only full power operations. However, the licensee does not have to design the shutdown strategy to cold shutdown and the requirement for emergency lighting is relaxed. Under NFPA 805 nuclear safety goals, a fire should not prevent the plant from achieving and maintaining the fuel in a safe and stable condition, usually considered hot shutdown. Cold shutdown and emergency lighting may need to be addressed, but are not required within NFPA 805.

The draft rule has the following exceptions to NFPA 805:

- The life safety, plant damage and business interruption are not endorsed.
- The exception to establishing seismically qualified standpipes and hose stations in areas containing systems and components needed to perform the nuclear safety function is not endorsed.
- Uncertainty analysis is not required for the deterministic approach.
- Flame retardant coatings or automatic fixed fire suppression systems are considered equivalent protection in lieu of cables meeting the standard flame spread rating.
- Pressurized water reactor facilities cannot use the technique known as “feed-and-bleed” as the sole fire protection safe shutdown path for maintaining reactor coolant inventory, pressure control, and decay heat removal.

Implementation guidance is being developed by industry and it is the NRC’s plan to endorse this guidance in a Regulatory Guide. Once a licensee transitions to NFPA 805, changes to the fire protection program may be made with a risk-informed, performance-based evaluation, without prior NRC approval. This will reduce the regulatory burden of maintaining the existing exemptions, requesting new exemptions, and reduce the time to enact changes. The licensee must retain their supporting change evaluations and periodic

reviews will be conducted by the NRC inspection staff. The proposed rulemaking has been published for public comment and these comments will be addressed in the final rule. The final rule is scheduled to be published in the spring of 2004.