



Southern Company

Technology Inclusive Content of Application Project
For Non-Light Water Reactors

**Follow-on RIPB Implementation Guidance Needed
for Advanced Non-Light Water Reactors**

Prepared by:
Southern Company Services, Inc.
42 Inverness Center Parkway
Birmingham, AL 35242-4809

August 2021

Purpose

This paper, “Follow-on RIPB Implementation Guidance Needed for Advanced Non-Light Water Reactors,” identifies complementary regulatory guidance documents needed for modernizing the current risk-informed and performance-based (RIPB) regulatory framework to enable support of advanced non-light water reactors (ANLWRs). Such modernization is critical for establishing a more complete regulatory framework that supports the deployment of commercially viable ANLWRs and for maximizing the benefits of the required investment by all ANLWRs and the U.S. government. It is particularly important for those developers/applicants that use the NEI 18-04, “Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development,” methodology for developing and establishing RIPB licensing and design bases.

This paper also recommends the development of a limited number of key RIPB program implementation guidance documents that can be used as examples of the elements needed to complete the development of an RIPB regulatory framework for ANLWRs. Such guidance documents should be formulated to facilitate use by Part 50/52 applicants as well as by future Part 53 applicants.

Introduction

The current framework of regulations and supporting guidance for commercial reactors, developed for large light water reactors (LWRs), does not adequately consider the variety of ANLWRs that are being designed and considered for deployment. Therefore, it is important to modernize the framework to fully address the needs of such reactors. Additionally, the modernized framework must apply the lessons learned from the operating fleet as well as meet the Commission’s long-standing objectives for risk informing regulations. These actions support a more efficient and effective regulatory framework and a reduction in regulatory burden on applicants and licensees. This necessitates that such a modernized regulatory framework be holistic and integrated at relevant levels, as well as risk-informed and performance-based. In systematically approaching this modernization, one of the first steps is to examine the framework that is used to regulate the commercial nuclear fleet (independent of the type of technology).

Figure 1 describes the five main components of NRC’s regulatory framework and the relationships of these components.

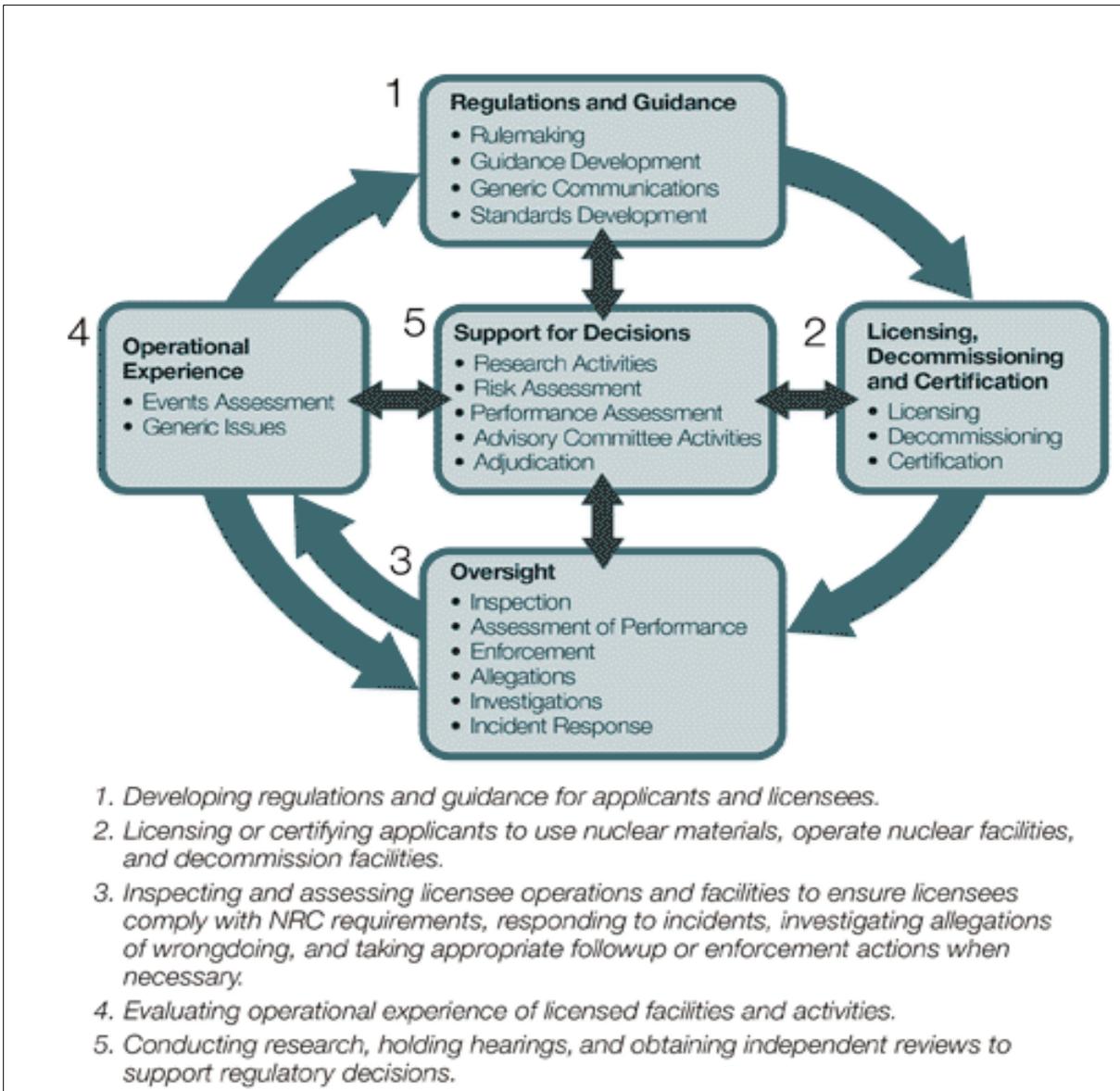


Figure 1. Components of the NRC Regulatory Framework

(Source: [How We Regulate | NRC.gov](https://www.nrc.gov/inspections-and-licensing/how-we-regulate))

Each of the first four components of the regulatory framework has a number of elements/provisions (e.g., requirements or regulatory guides) that delineate either the expectations, how the expectations are to be met, how the expectations will be measured, or how the expectations will be enforced. The fifth component, “Support for Decisions,” primarily supports the needs of the first four components. Examples of such elements/provisions for the first four components include requirements for technical specifications, quality assurance, reporting, inspection programs, and event assessments.

Based on operating experience, the regulator and industry recognize that in order to provide reasonable assurance of adequate protection of public health and safety while meeting the

principles of sound regulation and reducing unnecessary burden, it is best to use RIPB approaches to enhance these elements/provisions. Development and adoption of an RIPB approach will enhance the protection of public health and safety through increased focus on safety-significant matters and by more transparently demonstrating improved safety margins.

The application of RIPB approaches to enhance all components of the regulatory framework includes rulemakings, regulatory analyses, a generic issues program, event assessments, oversight processes (e.g., significance determination process), license amendments, and reviews.

For operating reactors, examples of successful applications of RIPB programs include 10 CFR 50.44 (combustible gas control), the reactor oversight process, licensee-initiated licensing changes such as the RIPB inservice inspection, 10 CFR 50.48(c) (fire protection), 10 CFR 50.36 (technical specifications), and 10 CFR 50.69 (special treatment requirements). Through these types of applications, RIPB approaches are an integral piece of NRC's and industry's voluntary programs (e.g., risk-informed applications), as well as NRC-required regulatory programs (e.g., Maintenance Rule).

For ANLWRs, an example of the successful application of the RIPB approach is the guidance in NEI 18-04 which addresses the Commission's SRM for SECY-03-0047 and "the related topic of improving how the agency uses risk-informed and performance-based approaches (e.g., the Commission's policy statement, "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities," dated August 16, 1995 (60 FR 42622)."

Specifically, NEI 18-04 supports the Commission's stated desire to achieve the following:

- "(1) Greater emphasis can be placed on the use of risk information by allowing the use of a probabilistic approach in the identification of events to be considered in the design, provided there is sufficient understanding of plant and fuel performance and deterministic engineering judgment is used to bound uncertainties.
- (2) A probabilistic approach for the safety classification of SSCs is allowed.
- (3) The single-failure criterion can be replaced with a probabilistic (reliability) criterion."

Since the initiation of probabilistic risk assessments for evaluating reactor designs and operations over 40 years ago, significantly enhanced tools and processes have been developed. Incorporating and modernizing these tools and processes into new systematic and transparent regulatory requirements or guidance in a technology-inclusive manner can provide flexibility and, at the same time, predictability.¹ The resulting regulatory framework will provide the

¹ The term *predictable* means that expected performance objectives are explicitly established. In a predictable regulatory framework, technology inclusive guidance to meet the expected objectives is provided.

needed agility² to innovate and promote the drive towards excellence while meeting regulatory requirements.

The LWR RIPB applications mentioned above have demonstrated increased regulatory effectiveness and reduced unnecessary burden. Staying consistent with the goal of establishing a RIPB regulatory framework and maintaining RIPB principles as an integral piece of the regulatory programs requires that all the elements/provisions of the first four components of the regulatory framework be modernized in way that allows all ANLWRs to benefit. This will also, at least, provide direction for the research element of the fifth component.

One option for such modernization is to continue to use the “bolt-on” and design-specific approach that has been used for the current fleet. The second option is to utilize a technology inclusive RIPB approach on the front end. This paper endorses the second option, using the NEI 18-04 approach for evaluating the safety case as the framework foundation. This will not only enhance the benefits of using an RIPB approach for those applicants that use the NEI 18-04 process for evaluating and demonstrating their design safety cases (which includes both Advanced Reactor Demonstration Program awardees), it also paves the way for incrementally advancing other non-LWR licensing activities more effectively.

As a reminder, NEI 18-04 uses risk insights, engineering analysis, and judgment to evaluate and demonstrate how a design meets the radiological release-related performance objectives of the regulation by providing evidence of a design’s margin to these performance objectives in a transparent manner. The approach also yields systematic inclusion of the principle of defense-in-depth. As a result, a design and licensing basis derived using the NEI 18-04 methodology provides demonstrable evidence that established performance objectives of the regulations are met while allowing flexibility to determine how these performance objectives are met. The approach allows for demonstrating design-specific evidence of margins to regulatory performance objectives in a more transparent manner. In turn, this enables a coherent approach for rightsizing requirements, assessing the impact of real and potential non-compliance, and evaluating temporary deviations from the baseline safety case. The visual representation of the RIPB safety case context is the Frequency-Consequence Target, which identifies Licensing Basis Event (LBE) margins to regulatory dose limits.

Potential Risk-Informed Programs

Currently, the industry, NRC, and DOE have initiated actions to develop a predictable, agile, and resilient³ regulatory framework for advanced reactors that establishes design, operational, and oversight requirements. The framework is part of “an integrated master plan” that should

² The term *agile* is herein applied to a regulatory framework that is flexible and efficiently (speedily) executable.

³ The term *resilient* describes the effective management of state-of-knowledge and state-of-the-art changes that excludes unnecessary burden and major disruptions.

establish the foundation “to help the agency achieve the Commission’s goal of a holistic, risk-informed and performance-based regulatory structure.”⁴

For perspective, Appendices A and B provide examples of the RIPB programs and activities for the operating fleet. To expand on the context of this paper, some of the examples in Appendices A and B are further binned in specific regulatory framework components as follows:

- Component 1
 - RIPB technical specifications
 - RIPB surveillance frequency control program
 - RIPB Inservice Inspection
 - RIPB fire protection program
 - RIPB Structures, Systems, and Components (SSCs) categorization
- Component 3
 - Significance Determination Process (SDP)
 - Notice of Enforcement Discretion (NOED)
- Component 4—Encompasses operational experience, including “Event Assessment” and “Generic Issues,” for which RIPB approaches are used to rightsize evaluations and the resulting requirements.

Proposed Initiatives

As discussed in the previous section, RIPB approaches should be further developed in all components of the regulatory framework for the current fleet. Appendices A and B provide additional examples of such approaches. These programs and approaches have been partially developed and are being further developed based on learnings from 40 years of experience with the regulatory framework. These experiences have led to the recognition that for the nuclear systems to be a commercially viable option for energy generation, systematic and holistic modernization of regulatory requirements in all four components is needed. Establishing such a framework will enable the achievement of excellence in safety and operational flexibility. Additionally, it will enable innovation because empowering innovation in a regulated industry requires a flexible and yet predictable (i.e., agile) and resilient framework. The implementation of these learnings is particularly important for the ANLWRs because the variety of technologies and designs which are being considered require the consistent, coherent, and timely establishment of technical and oversight requirements for all designs to:

- Significantly reduce regulatory uncertainty for reactor developers, future owner-operators, investors, and other stakeholders.

⁴ Staff Requirements Memorandum M060503B, “Briefing on Status of Risk-Informed and Performance-Based Reactor Regulation,” June 2006.

- Encourage safer, simpler advanced reactor designs through a more transparent and safety-focused approach to developing and maintaining the licensing basis.
- Accelerate the commercial deployment of advanced reactor technologies.

Modernizing the regulatory framework to, at the very least, offer the same types of programs as those available to the current fleet requires a platform that does not rely on LWR surrogate safety measures of core damage frequency and large early release frequency because these surrogates are not technology inclusive and are not directly applicable to many advanced non-LWR designs. Additionally, due to the significant number of programs that need to be modernized, long-term planning is needed. As part of this planning, it is essential that near-term goals are set to enable a holistic approach. For example, priority should be given to the regulatory components and the programs within each component that are more foundational and have near-term impacts. With this objective in mind, the Licensing Modernization Project (LMP) and the Technology Inclusive Content of Application Project (TICAP) were initiated. To continue with this foundation-setting philosophy, Appendix C provides a list of programs to be modernized.

Additionally, the following three specific example initiatives are proposed to facilitate a systematic modernization of all the components in an integrated manner:

- Component 1 Example—The NRC and its subcontractor are currently working on providing guidance on RIPB technical specifications. The proposed near-term roadmap project will monitor those activities but will not take a leading role in providing guidance. However, the project will develop proposals for modernizing 10 CFR 50.59 and developing industry guidance for implementation, which establishes the conditions under which licensees may make changes to their facilities or procedures and conduct tests or experiments without prior NRC approval.

It should be noted that the licensee is responsible for constructing and operating the plant safely in accordance with NRC regulations, irrespective of whether NRC approval of a change, test, or experiment is required. That is, licensee safety reviews (during construction and operation) are not substituted for 10 CFR 50.59 reviews by the licensees, which are focused on assessing the need for NRC approval prior to implementation.

The industry's desire and efforts to transition 10 CFR 50.59 to a systematic RIPB process have been on-going for over 25 years.^{5,6} For advanced reactors, particularly non-light water reactors (non-LWRs), these efforts must be supplemented and expanded to formulate a technology inclusive, as well as RIPB, methodology.

⁵ Memorandum to J. T. Larkins from J. N. Sorensen, August 11, 1998, Subject: NEI Approach to Making Part 50 Risk Informed, [ML082740210].

⁶ "Use of Risk Insights to Support 10 CFR 50.59 Evaluations," Industry Team Update, NRC Public Meeting, October 8, 2020, ML20281A252.

In addition to the proposed focus on monitoring RIPB Technical Specification guidance and development of RIPB 10 CFR 50.59 modernization proposals, further proposed priorities for Component 1 initiatives are outlined in Appendix C.

- Component 3 Example—This example will entail developing an owner-controlled RIPB approach to complement Construction Inspection (both for construction permit and combined license applicants). The construction inspection program objectives, described in NRC Inspection Manual Chapter 2506, “Construction Reactor Oversight Process General Guidance and Basis Document,” are to:
 - “Determine whether or not appropriate quality controls are implemented in the development of applications that will be or have been submitted to the NRC;
 - Provide reasonable assurance that the facility has been constructed and will be operated in conformity with the license, the provisions of the Act, and the Commission’s rules and regulations.”

Inspections to address the quality controls associated with applications are conducted pursuant to the guidance in NRC Inspection Manual Chapter 2501, “Construction Inspection Program: Early Site Permit (ESP),” and Chapter 2502, “Construction Inspection Program: Pre-Combined License (Pre-COL) Phase.” The significance of associated findings is determined using traditional enforcement methods. Inspections to provide reasonable assurance that the facility has been constructed and will be operated in conformance with the license are conducted pursuant to the guidance in NRC Inspection Manual Chapter 2502, “Construction Inspection Program: Pre-Combined License (Pre-COL) Phase,” Chapter 2503, “Construction Inspection Program: Inspections of Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC),” and Chapter 2504, “Construction Inspection Program: Inspection of Construction and Operational Programs.” The significance of associated findings is determined using the construction SDP.

For advanced reactors (particularly non-LWRs), all of these inspection processes must be modernized with the following objectives:

- Develop and obtain NRC endorsement of a modernized process for owners to assess the safety significance of deviations from the approved design and the need to report to the NRC
- Modernize the SDP for assessing deviations from the construction permit using the RIPB framework
- Develop RIPB ITAAC definitions and template constructs plus clearer definitions of the safety significance of ITAACs with a goal of moving ITAACs to normal construction inspections

Such a guidance will reduce the impact on both licensee and NRC resources and improve the efficiency of addressing construction-related issues as they arise.

- Component 4 Example—This example involves developing an RIPB owner-controlled program for managing and reporting operational experience (both the event selection part and the generic issues program). As stated by the NRC Office of the Inspector General, “NRC defines a Generic Issue as a well-defined, discrete, technical or security issue, the risk or safety significance of which can be adequately determined, and which: (1) applies to two or more facilities and/or licensees/certificate holders, or holders of other regulatory approvals (including design certification rules); (2) affects public health and safety, the common defense and security, or the environment; (3) is not already being processed under an existing program or process; and (4) can be resolved by new or revised regulation, policy, or guidance or voluntary industry initiatives.”⁷

All licensees have an operating experience (OE) program for evaluating and initiating actions based on operating experience to identify and transfer lessons learned from other stations into measures that enhance the safety and reliability of their plants.

Additionally, the Institute of Nuclear Power Operations (INPO) has established a Significant Event Evaluation and Information Network (SEE-IN), which has been recognized by NRC as an effective program to assess events and recommend solutions. As early as 1982, NRC concluded that “use of SEE-IN will relieve individual nuclear plant operators and constructors of the necessity of setting up large staffs to obtain and screen the large volume of raw data pertaining to operational experience throughout the industry. The NRC believes that full participation in SEE-IN will enhance your ability to meet the intent of the procedures approved under TMI Action Plan Item I.C.5.”⁸

This proposed near-term roadmap project will review INPO and industry OE programs as well as the NRC’s Event Assessment and Generic Issue programs. The project will recommend that the NRC endorse the following:

- An RIPB process for enhancing INPO and owner/operator-specific OE programs to evaluate and address events consistent with NRC expectations and definition of generic issues assessment and resolution
- An RIPB process for NRC to provide oversight of the INPO owners/operators’ OE programs to validate their effectiveness and address their shortcomings
- A process for evaluating plant enhancements proposed by NRC or consideration of remedies for deficiencies that considers integrated plant risk, including defense-in-depth, against the total cost to implement

Development and implementation of a modernized, integrated, and holistic RIPB regulatory framework must meet the following objectives:

⁷ “Audit of NRC’s Screening and Assessment of Proposed Generic Issues,” OIG-19-A-07, Office of the Inspector General, January 23, 2019.

⁸ “Use of INPO See-in Program (Generic Letter No. 82-04)” Nuclear Regulatory Commission, March 9, 1982.

- Provide clarity and transparency in ensuring that RIPB programs that support reasonable assurance of adequate protection are established and maintained
- Provide an RIPB process that will allow licensees to implement and NRC staff to oversee the regulations in a more efficient and effective manner, resulting in improved safety and operational flexibility

In summary, the proposed initiative will facilitate the furtherance of:

- The industry's long-standing focus on continuous improvement
- The industry goal of having RIPB, safety-focused reviews, which minimizes the burden of generating and supplying safety-insignificant information
- NRC and industry objective of reaching a common understanding of how to implement adequate protection for non-LWRs
- NRC's stated objective and policy statement regarding the use of risk-informed decision-making to improve regulatory decisions, conserve NRC resources and reduce regulatory burden on licensees

Appendix A: Examples of RIPB Currently Available for and Deployed in Operating Fleet

Examples of Regulatory Required Applications

- Maintenance Rule (a1)-(a)(3), (a)(4)
- Mitigating Systems Performance Indicator
- Significance Determination Process
- Notice of Enforcement Discretion
- NRC Security Initiatives such as Target Set Evaluations
- Time Critical Operator Action
- Risk-Informed Inspection Program (e.g., supporting NRC triennials)

Examples of Voluntary Risk-Informed Applications for Operating Reactors

- Risk-Informed Inservice Inspection
- Risk-Informed Mode Change
- Risk-Informed Missed Surveillance
- Risk-Informed Surveillance Frequency Program
- Risk-Informed Completion Time
- Risk-Informed Structures, Systems, and Components Categorization (10 CFR 50.69)
- Risk-Informed Fire Protection Program
- Risk-Informed Approach to Address Generic Issues
 - Risk-Informed Pressurized-Water Reactor Sump Performance (Risk-Informed GS-191)
 - Risk-Informed Approach to Address Fukushima Response (seismic evaluation)

Appendix B: List of NRC's RIPB Activities for Operating Fleet

- [Risk-Informed Reviews of Instrumentation and Control \(I&C\) Systems and Components: Integrating Risk Insights into the Digital I&C Regulatory Framework](#)
- [Use of Systems-Theoretic Accident Model and Processes \(STAMP\)-based Methods for Digital Nuclear Safety System Evaluation](#)
- [Technical Assistance for Research on Innovative Methods and Technologies to Enhance Seismic Safety for Design and Construction of Commercial Reactors](#)
- [Technical Assistance for Integration of Risk-Informed Performance Based Approach to Seismic Safety of Nuclear Facilities](#)
- [Revisions to NUREG-0654, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness for NPP](#)
- [Revision to NUREG/CR-7002, "Criteria for Development of Evacuation Time Estimate Studies"](#)
- [Power Reactor Cyber Security Program Improvements](#)
- [Ensure Force-on-Force \(FoF\) Scenarios Are Realistic and Reasonable](#)
- [Risk-Informed Compensatory Measures](#)
- [Consequence-based Security for Advanced Reactors](#)
- [Revision of the Emergency Preparedness Significance Determination Process](#)
- [Baseline Security Program Revision](#)
- [State-of-the-Art Reactor Consequence Analyses](#)
- [Probabilistic Methodologies for Component Integrity Assessment](#)
- [Implementing Lessons Learned from Fukushima](#)
- [Accident Sequence Precursor \(ASP\) Program](#)
- [Design Compliance Enforcement Discretion \(DCED\): a Risk-Informed Approach for Addressing Low Risk, Low Safety Significance Design Compliance Issues](#)
- [Probabilistic Flood Hazard Assessment \(PFHA\)](#)
- [Risk Assessment of Operation Events \(RASP Handbook\)](#)
- [Maintenance and Development of the Systems Analysis Programs for Hands-on Analysis Integrated Reliability Evaluations \(SAPHIRE\) Code](#)
- [Standardized Plant Analysis Risk Models \(SPAR\)](#)
- [Full-Scope Site Level 3 PRA](#)
- [Data Collection for Human Reliability Analysis \(HRA\)](#)
- [Human Reliability Analysis \(HRA\) Methods and Practices](#)
- [National Fire Protection Association \(NFPA\) Standard 805](#)
- [Assess Debris Accumulation on Pressurized Water Reactor \(PWR\) Sump Performance, Generic Safety Issue \(GSI\)-191](#)
- [Develop Risk-Informed Improvements to Standard Technical Specifications \(STS\)](#)
- [Implement 10 CFR 50.69: Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors](#)
- [Graded Approach to the Use of Safety Significance in the Low Safety Significance Issue Resolution Process](#)
- [Guidance for Unattended Opening Evaluations](#)
- [Risk-Informed Adversary Timeline Calculations](#)
- [Transition from Physical Security Plan to Safeguards Contingency Plan](#)
- [Emergency Preparedness \(EP\) Program Review 24-Month Frequency Performance Indicators Development to Satisfy 10 CFR 50.54\(t\) Requirements](#)

Appendix C: Additional Integrated RIPB Initiatives

Surveillance Frequency Control Program (SFCP)

Operating LWRs have successfully deployed an owner-controlled SFCP that relocates the Technical Specification Surveillance Requirement Frequencies to the licensee-controlled program. NEI 10-04, “Risk-Informed Method for Control of Surveillance Frequencies,” provided the industry with guidance for the implementation of an acceptable program.

The methodology for accomplishing functionality confirmed by existing LWR surveillances and associated time intervals for new technologies will be vastly different from operating LWRs. However, the beneficial RIPB principles should be captured and guidance adapted for new technologies.

Recommendations—In order to promote the efficient implementation of an SFCP during the initial licensing phase of new technology, develop guidance that will facilitate an owner-controlled SFCP for new technologies. This initiative should coordinate with NRC RIPB Technical Specification development to promote seamless integration.

Risk-Informed Inservice Inspection

The objective of the Inservice Inspection (ISI) Program is to identify degraded conditions that are precursors to material failures. Regulatory requirements for ISI are specified in 10 CFR 50.55a.

The focus of ISI programs for LWRs is to assure the reliability of the reactor coolant system pressure boundary components that must be classified as Safety-Related (SR). LWRs were originally licensed with deterministically based, fixed ISI requirements for these SR SSCs. Risk-Informed ISI was introduced as a risk-informed option to focus inspection plans on high-risk elements of piping systems and reduce or eliminate inspections on low-risk segments. The application of these risk insights has resulted in improved safety and a reduction in cost and radiation exposure.

For ANLWRs, ISI programs are one of the types of Special Treatments (STs) that may be applied to either SR or Non-Safety Related with Special Treatment (NSRST) SSCs, if deemed necessary, to meet the user-defined reliability and capability requirements that are established in the LMP Integrated Decision-Making Process (IDP) (ref. NEI 18-04). In addition, for ANLWRs, reactor coolant boundary components are not necessarily classified as SR and may not be classified as NSRST in the LMP framework.

ASME Section XI, Division 2 has been developed to support LMP-type applications for passive SSCs in advanced non-LWRs as well as LWRs. This division is referred to as “Reliability Integrity Management.” Like LMP, this program includes the development of reliability targets and the selection of design, surveillance, and inspection strategies to achieve the targets. It also includes an evaluation of defense-in-depth. Reliability Integrity Management was developed to

implement the approach to ST that was developed in the Next Generation Nuclear Plant (NGNP) program, which was a precursor to TICAP.

Recommendations—Review ASME Section XI, Division 2 for applicability to the refinements made to the NGNP approach to ST included in TICAP. In the guidance to be developed, expand the treatment of SSCs covered in Division 2 to address all SR and NSRST SSCs beyond the types considered in Division 2.

SSC Quality Requirements

For SR SSCs, TICAP indicates QA requirements will be consistent with 10 CFR 50 Appendix B but should be RIPB rather than compliance-based. TICAP documents (SC-29980-102 and 106) provide for the use of ST for SR and NSRST SSCs.

TICAP implementation guidance clarifies that commercial-grade components may be used in SR applications with the appropriate ST strategy. TICAP document SC-29980-106 states, “not all SR SSCs are automatically classified as Class 1E.” Although these capabilities are endorsed by the TICAP documents, process guidance and examples are not provided. While existing regulatory guidance provides leeway in the use of commercial-grade SSCs, NEI 18-04 envisions a broader application of STs linked to capability and performance characteristics and greatly reduced low-value deterministic requirements. This approach is potentially of very high value to developers that endeavor to employ reliable and cost-effective components and maximize vendor availability.

For NSRST components, NEI 18-04 references Standard Review Plan (SRP) 17.4 “Reliability Assurance Program” (RAP), which further references SRP 17.5 (QA Program Description) for non-safety-related SSC guidance. SRP 17.5 Section U, “Non-Safety Related SSC Quality Controls,” provides a prescriptive list of quality requirements. NEI 18-04 states that NSRST will apply RIPB elements and targeted STs rather than the compliance-based prescriptive treatments.

Recommendations—Compare the QA requirements allowed for by NEI 18-04 to 10 CFR Appendix B and other regulatory requirements/guidance for SR and NSRST SSCs and identify impediments to realizing the full benefit of the RIPB process. Develop process guidance and examples that leverage more broadly available commercial-grade components and effectively implement RIPB quality requirements for SR and NSRST SSCs.

ASME Section III Application to New Technology

Section III design rules and construction requirements were specifically developed to meet the needs of LWR designers. Service conditions and safety functions for the range of non-LWRs were not contemplated and cannot be reasonably accommodated under existing code guidance. For new technology, code relevance may apply to a narrower list of functions compared with existing Section III.

An initiative has been proposed to develop a set of alternate requirements that are commensurate with safety and risk and results in a lower total construction cost. The proposal is to modify requirements in quality assurance, materials, examinations, and testing. The expected result would be a Code Case that facilitates the “Alternate” and “Special” treatment requirements of SSC classification processes. The Code Case would provide design rules specifically for nuclear applications. Construction rules would be risk-informed and more closely aligned with commercial construction codes.

Anticipated features of the Code Case include:

- Primarily applicable to NEI 18-04 NSRST SSCs and SR SSCs where the Section III requirements need to be specialized for non-LWR safety functions
- Contains a quality program using industrial/commercial standards (not NQA-1)
- Maintains Authorized Nuclear Inspector involvement
- Allows commercial materials
- Incorporates Non-Destructive Examination requirements for vessels and piping
- Has no requirements for audits of subcontracted services
- Maintains Section III design, fabrication, overpressure protection, and stamping requirements

Recommendations—Follow the progress of the proposed Code Case to confirm scope and schedule support the RIPB development of non-LWR technologies and leverage economies envisioned by NEI-18-04.

Seismic Assessment of SSCs

NEI 18-04 directs the selection of Design Basis External Hazard Levels (DBEHLs) that form an important part of the design and licensing basis. These DBEHLs define the design basis seismic events and other external events that the SR SSCs will be required to withstand. When supported by available methods, data, design, site information, and supporting guides and standards, the DBEHLs are informed by a probabilistic external hazards analysis and are included in the PRA after the design features that are incorporated to withstand these hazards are defined.

NEI 18-04 references 10 CFR 100 Appendix A for the development of the seismic design basis. RG 1.29, “Seismic Design Classification for Nuclear Power Plants,” provides a method acceptable to the NRC for identifying and classifying those features of LWRs that must be designed to withstand the effects of the safe shutdown earthquake. RG 1.29 guidance is based on LWR designs and deterministic evaluations.

NEI 18-04 references 10 CFR 100 Appendix A and RG 1.100, “Seismic Qualification of Electrical and Active Mechanical,” for seismic qualification testing. RG 1.100 provides an NRC acceptable

approach to component qualification. This regulatory guide was developed based on LWR equipment scopes and functions.

Recommendations—Review seismic design regulatory guidance and identify which apply to the need to protect Safety Related SSCs to ensure required safety functions (RSFs) can be performed and to meet capability and reliability targets for NSRST SSCs. Ensure that process improvements fully leverage RIPB benefits to reduce LMP implementation burden. Develop a seismic design guideline for non-LWRs. Assess guidance for seismic qualification and testing against the intent of the LMP RIPB DBEHLs to identify areas of misalignment and potential regulatory impediments to implementation.

Fire Protection

10 CFR 50 Appendix A, GDC 3 provides requirements for fire protection and requires SSCs important to safety to be designed and located to minimize the probability and effect of fires and explosions. Noncombustible and heat-resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room. Fire detection and firefighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on SSCs important to safety. GDC 3 also requires that firefighting systems be designed to ensure that their rupture or inadvertent operation does not significantly impair the safety capability of these SSCs. Additional implementing requirements are found in 10 CFR 50.48, “Fire Protection,” but these requirements are not structured to support a graded risk-informed approach. Implementing guidance is structured to assure compliance with requirements in 50.48 for LWRs.

RG 1.189, “Fire Protection for Operating Nuclear Power Plants,” provides expectations for assessing fire protection for new technology. The National Fire Protection Association (NFPA) includes several relevant standards:

- NFPA 802, “Recommended Practice for Fire Protection for Nuclear Research and Production Reactors”
- NFPA 805, “Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants”
- NFPA 804, “Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants”
- NFPA 806, “Performance-Based Standard for Fire Protection for Advanced Nuclear Reactor Electric Generating Plants Change Process”

In the case of TICAP, the definition of DBEHLs includes the definition of “area events” that involve the production of harsh environments from internal plant hazards such as internal fires, internal floods, and the production of energetic missiles. In addition, there may be risk-significant LBEs involving internal hazards that need to be managed to ensure that safety-significant (SR or NSRST) SSCs are able to perform their safety-significant functions.

Recommendations—Review the current requirements for Fire Protection Programs and identify which are applicable to the need to protect SR SSCs from the performance of their RSFs and to meet the reliability and capability targets for safety-significant SSCs. Develop a template to provide a regulatory path for evaluation and regulatory approval for RIPB fire protection requirements for advanced non-LWRs.

Maintenance Rule

SRP 17.6, “Maintenance Rule,” summarizes expectations for an MR program implementing the requirements of 10 CFR 50.65. NUMARC 93-01, “Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,” was developed by the industry and identified as an acceptable means of MR implementation.

10 CFR 50.65 and supporting implementation guidance was informed by the design and experience of operating LWRs. Scoping of SSCs to be included in the MR scope was based on LWR experience. Given the innovative designs and inherent safety margins of new technology, in-scope equipment is expected to be substantially reduced. SRP 17.6 explicitly states that the interface of the MR program with the operating RAP is an area of review. NUMARC 93-01 states, “This guideline is intended to maximize the use of existing industry programs, studies, initiatives and data bases.” Advanced integration of MR requirements with the RAP or other programs will maximize efficiencies and reduce long-term operating burden.

Recommendations—Review 10 CFR 50.65 requirements against a sampling of non-LWR designs to assess likely in-scope SSCs. Identify any elements of MR that are not applicable to an LMP-based safety case. Develop a template for MR implementation for non-LWRs. Map MR requirements to the ANLWR program expected to be addressed. Integration with the RAP and any other interfacing program should be coordinated to minimize duplicated efforts. Assess the need for MR as a stand-alone program. The goal is to reduce the lifetime burden for licensees associated with on-going programs with no demonstrated RIPB benefit.

Environmental Qualification

Non-LWRs will be expected to comply with 10 CFR 50.49. The definitions and scope of equipment covered by 50.49 are LWR-based. The 50.49 scope includes equipment “important to safety” required to function in response to a design basis event and located in a “harsh” environment. This scope for non-LWRs using the RIPB process will vary greatly among LWRs due to differences in design basis events and in equipment classifications. Expectations for post-accident monitoring components will also be different and dependent on the technology and safe-plant state permitted.

Recommendations—Review 50.49 against expected non-LWR equipment scopes and environmental conditions to assess applicability. Review implementing guidance (industry and regulatory) for adequacy of existing guidance defining “harsh” environments and associated

qualification envelopes relative to non-LWRs. Review post-accident monitoring requirements to assess non-LWR applicability.

Other Regulatory Areas for Consideration

1. 10 CFR Part 21 “Reporting of Defects”
2. 10 CFR 50.72/73 “Event Reporting”
3. Emergency Planning
4. Corrective Action Program
5. Maintenance Program
6. Startup Testing
7. ITAAC
8. Updated Final Safety Analysis Report
9. Current Licensing Basis and Design Basis