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July 2020

NRC Staff White Paper

Questions Supporting ACRS and Public Interactions on Developing a Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors (NRC-2019-0062; RIN 3150-AK31)

SUMMARY:

The U.S. Nuclear Regulatory Commission (NRC) is issuing this white paper to support interactions with stakeholders on the development of a proposed rule. The goal of the rulemaking is to develop the regulatory infrastructure to support the licensing of advanced nuclear reactors. The term “advanced nuclear reactor,” for purposes of this rulemaking, means a nuclear fission or fusion reactor with significant improvements compared to commercial nuclear reactors under construction as of January 2019. This rulemaking would revise the NRC's regulations by adding a risk-informed, technology-inclusive regulatory framework for advanced nuclear reactors, in response to a growing interest in possible licensing and deployment of advanced nuclear reactors and the related requirements of the Nuclear Energy Innovation and Modernization Act (NEIMA; Public Law 115-439). The NRC plans to solicit public comment on the contemplated action and to invite stakeholders and interested persons to participate during the rulemaking process. The NRC plans to hold a public meeting to promote `full understanding of the contemplated action and facilitate public participation.

In addition, the staff will hold public meetings and workshops with the industry organizations, other Government agencies, reactor developers, and other stakeholders throughout the development of the proposed rulemaking.

BACKGROUND:

The NRC has engaged in several pre-application interactions with advanced nuclear reactor designers and developed policies and guidance to support the potential licensing of advanced nuclear reactor facilities. The NRC first published its policy statement on the regulation of advanced nuclear reactors in the *Federal Register* on July 8, 1986 (51 FR 24643), with the objective of providing all interested parties, including the public, with the Commission's views concerning the desired characteristics of advanced nuclear reactor designs. The NRC acknowledged in its “Report to Congress: Advanced Reactor Licensing,” (ADAMS Accession No. ML12153A014; dated

August 2012) that while the safety philosophy inherent in current regulations apply to all reactor technologies, the specific and prescriptive aspects of those regulations clearly focus on the current fleet of large light water reactor facilities. More recently, the report "NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness," (ADAMS Accession No. ML16356A670; dated December 2, 2016) identified a potential long-term rulemaking to establish a regulatory framework for advanced nuclear reactor licensing that would be risk-informed, performance-based, and technology-inclusive. Earlier efforts by the NRC to establish a technology-neutral approach to the regulation of nuclear reactors are described in an advance notice of proposed rulemaking titled "Approaches to Risk-Informed and Performance-Based Requirements for Nuclear Power Reactors" (71 FR 26267; dated May 4, 2006).

This present rulemaking is required by NEIMA, which directs the NRC to "complete a rulemaking to establish a technology-inclusive, regulatory framework for optional use by commercial advanced nuclear reactor applicants for new reactor license applications" by December 31, 2027. Because NEIMA provides discretion to the NRC regarding the content and scope of the rule, the staff is soliciting ideas from a variety of stakeholders on possible approaches to establishing a technology-inclusive framework and stakeholder views on a number of challenges associated with the licensing and regulation of advanced nuclear reactors or subsets of advanced nuclear reactor technologies.

As stated in Section 103(a) of NEIMA, the purpose of the statute is, in part, to provide "a program to develop the expertise and regulatory processes necessary to allow innovation and the commercialization of advanced nuclear reactors." NEIMA includes the following definitions for an "advanced nuclear reactor," a "regulatory framework," and a "technology-inclusive regulatory framework":

- (1) **ADVANCED NUCLEAR REACTOR.**—The term "advanced nuclear reactor" means a nuclear fission or fusion reactor, including a prototype plant (as defined in sections 50.2 and 52.1 of title 10, Code of Federal Regulations (as in effect on the date of enactment of this Act)), with significant improvements compared to commercial nuclear reactors under construction as of the date of enactment of this Act, including improvements such as—
- (A) additional inherent safety features;
 - (B) significantly lower levelized cost of electricity;
 - (C) lower waste yields;
 - (D) greater fuel utilization;
 - (E) enhanced reliability;
 - (F) increased proliferation resistance;
 - (G) increased thermal efficiency; or
 - (H) ability to integrate into electric and nonelectric applications.
- (9) **REGULATORY FRAMEWORK.**—The term "regulatory framework" means the framework for reviewing requests for certifications, permits, approvals, and licenses for nuclear reactors.

- (14) **TECHNOLOGY-INCLUSIVE REGULATORY FRAMEWORK.**—The term "technology-inclusive regulatory framework" means a regulatory framework developed using methods of evaluation that are flexible and practicable for application to a variety of reactor technologies, including, where appropriate, the

use of risk-informed and performance-based techniques and other tools and methods.

Current regulations for nuclear reactor licensing are found in 10 CFR Parts 50 and 52. This rulemaking is expected to create 10 CFR Part 53 in keeping with the NRC Vision and Strategy and the statutory provisions in NEIMA Section 103(a)(4).

DISCUSSION:

This rulemaking would establish alternative regulatory requirements that could be used by applicants for licenses, certifications, or approvals from the NRC related to advanced nuclear reactors. The regulatory requirements that may be developed by this rulemaking would use risk-informed and performance-based methods that are flexible and practicable to a variety of advanced nuclear reactor technologies.

The purpose of this white paper is to support soliciting ideas from the Advisory Committee on Reactor Safeguards (ACRS) and a variety of stakeholders on possible approaches to establishing a technology-inclusive framework and to understand stakeholder views on challenges associated with the licensing and regulation of advanced nuclear reactors. The NRC staff has provided a list of specific questions for consideration in the section "Specific Considerations," below. The NRC plans to hold a public meeting to promote a full understanding of the questions, support the fullest possible exchange of ideas and views, and facilitate public participation.

This white paper is structured around questions intended to solicit information that: 1) Defines the scope of stakeholder interest in a rulemaking to develop a technology-inclusive framework for advanced nuclear reactors, 2) identifies major issues and challenges related to technology-inclusive approaches to licensing and regulating a wide variety of advanced nuclear reactor designs, 3) supports prioritizing and developing plans to resolve identified issues within the rulemaking for the wide variety of advanced nuclear reactor designs, and 4) supports the development of the proposed rule and related guidance. Commenters will be free to provide feedback on any aspect of developing a technology-inclusive regulatory framework to support the regulatory objective, whether or not in response to a question listed in this white paper or future solicitations.

Regulatory Objective:

The NRC is developing a proposed rule that would provide a technology-inclusive framework to support the licensing and regulation of advanced nuclear reactors. By issuing a technology-inclusive rule for the licensing and regulation of advanced nuclear reactors, the NRC would establish regulations to maintain safety

and security at reactor sites while acknowledging advances in reactor technologies, scientific knowledge, and analytical capabilities. Specifically, the rulemaking has the following objectives: 1) Provide reasonable assurance of adequate protection of the public health and safety and common defense and security at reactor sites at which advanced nuclear reactor designs are deployed, to at least the same degree of protection as required for current-generation light water reactors; 2) Protect health and minimize danger to life or property to at least the same degree of protection as required for current-generation light water reactors; 3) Provide greater operational flexibilities where supported by enhanced margins of safety that may be provided in advanced nuclear reactor designs; 4) Ensure that the requirements for licensing and regulating advanced nuclear reactors are clear and appropriate; and 5) Identify, define, and resolve additional areas of concern related to the licensing and regulation of advanced nuclear reactors.

A. Applicability to NRC Licenses, Certifications and Approvals

The NRC would apply these new requirements to applicants for licenses, certifications, or approvals associated with advanced nuclear reactors and subsequently to the holders of such licenses, certificates or approvals under a proposed new part to Title 10 of the *Code of Federal Regulations* (10 CFR). The proposed new Part 53, "Licensing and Regulation of Advanced Nuclear Reactors" would be an alternative to the current application and licensing requirements developed for large light-water and non-power reactors, as outlined in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

B. Interim Regulatory Actions

The NRC recognizes that it will take several years to issue a final rule. If the NRC receives applications related to an advanced nuclear reactor design before implementation of the final rule, the NRC anticipates that licensees will continue to use existing regulatory processes (for example, requests for exemptions and proposed license conditions, as needed) to establish an appropriate regulatory framework.

Specific Considerations:

The NRC will be seeking stakeholders' input and recommendations on the following specific areas related to licensing and regulating advanced nuclear reactors. The NRC will ask that commenters provide the bases for their comments (i.e., the underlying rationale for the position(s) stated in the comment and any supporting documentation) to enable the NRC to have a complete understanding of commenters' positions.

- 1. Regulatory Objectives:** Are the regulatory objectives, as articulated above, understandable and achievable? If not, why not? Should there be additional objectives? If so, please describe the additional objectives and explain the reasons for including them.
- 2. Scope and Types of Advanced Nuclear Reactors:** Should the scope of the rulemaking be limited to advanced nuclear reactors as defined in NEIMA or should the scope include all future applications for licenses, certifications, or approvals for

commercial nuclear reactors regardless of design?

3. **Technical Requirements versus Licensing Process:** Should the framework focus only on those regulations related to technical standards (i.e., design, operational and programmatic requirements) and rely on the existing licensing processes in Parts 50 (e.g., construction permit and operating license) and 52 (e.g., early site permit, combined license, etc.) or should the framework develop a new alternative licensing process that looks different than the existing processes? If the latter, what should this new licensing process look like? Should this new process be “self-contained,” such that it would provide its own licensing, procedural, administrative, and reporting requirements?
4. **Performance Criteria:** NEIMA calls for a technology-inclusive framework for advanced nuclear reactors, which encompasses a wide range of reactor technologies and power levels. To what extent should the NRC try to define a single set of performance criteria for all technologies and sizes (e.g., estimated offsite doses from postulated events), versus developing specific regulatory approaches for different categories of advanced nuclear reactors such as microreactors and fusion reactors?
5. **Risk Metrics:** In a risk-informed performance-based regulatory regime, should risk metrics be included in the regulations? Possible examples of risk metrics include the quantitative health objectives described in the NRC’s Safety Goals for the Operation of Nuclear Power Plants Policy Statement (51 FR 28004, Aug. 4, 1986, as corrected and republished, 51 FR 30028, Aug. 21, 1986) and the frequency-consequence targets described in SECY-19-0117, “Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors.”
6. **Facility Life Cycle:** How could the new Part 53 licensing and regulatory framework align with the design, construction, operation, and decommissioning phases of an advanced nuclear reactor facility’s life cycle?
7. **Definitions:** Should terms in the new Part 53 have identical definitions to terms in Parts 50 and 52? For example, SECY-19-0117 proposes to accept definitions for terms such as “safety related” and “design basis event” for non-light water reactors applications that differ from the definitions provided in 10 CFR Part 50. If possible, please provide alternative terminology for non-LWR technologies.
8. **Performance-Based Regulation:** How should the requirements developed for this alternative regulatory framework incorporate performance-based concepts such as those described in NUREG/BR-0303, “Guidance for Performance-Based Regulation”?
9. **Identifying Levels of Protection:** Regulatory requirements in Parts 50 and 52 have been imposed as either needed to: 1) ensure a facility provides adequate protection to the health and safety of the public and is in accord with the common defense and security; or 2) provide a substantial increase in the overall protection of the public health and safety or the common defense in security when the costs of implementation are justified in view of the increased protection. Should specific requirements developed in this Part 53 rulemaking be identified as either needed to

provide reasonable assurance of adequate protection or justified as cost-effective safety improvements?

- 10. Integrated Approach to Rulemaking:** In developing the requirements for this alternative regulatory framework, how can an integrated approach be developed to address areas such as safety, security, emergency preparedness, and other means to prevent or mitigate the potential release of radionuclides from an advanced nuclear reactor?
- 11. Consistency with Historical Standards:** SECY-19-0117 describes a methodology that is meant to support the licensing process through identifying key safety functions, events that might challenge those functions, performance criteria for equipment and related programmatic controls, and defense in depth. The methodology uses risk-informed and performance-based criteria that are derived from existing regulations related to potential offsite doses and from the NRC's Safety Goal Policy Statement (51 FR 30028; dated August 21, 1986). Should this rulemaking use these existing criteria or should this opportunity be used to adopt or develop alternative criteria? If so, please describe possible alternatives and explain the reasons for using them within the regulatory framework being developed for advanced nuclear reactors.
- 12. Quality Assurance:** Should quality assurance, as it is currently defined in Appendix B to Part 50, be a requirement in the new risk-informed, performance-based regulatory framework? Alternatively, should NRC regulations defer to internationally recognized, independent certification schemes for assessing quality processes at commercial nuclear facilities and at suppliers of equipment and services?
- 13. Stakeholder Documents, Standards, Guidance:** The NRC encourages active stakeholder participation through development of proposed supporting documents, standards, and guidance. In such a process, the proposed documents, standards, and guidance would be submitted to and reviewed by NRC staff, and the NRC staff could endorse them, if appropriate. Is there any interest by stakeholders to develop proposed supporting documents, standards, or guidance?
- 14. Other Issues:** Are there significant issues, possible approaches, or other topics related to the initial crafting of a regulatory framework for advanced nuclear reactors that are not addressed in the above questions? If so, please identify the subject areas and, if possible, provide a suggestion on how the new framework could resolve the issue or incorporate a proposed approach.

Public Meeting:

The NRC staff will participate in a meeting with the ACRS and subsequently conduct a public meeting to discuss the contents of this paper and to answer questions from the public regarding the contents of this paper. The NRC will publish a notice of the location, time, and agenda of the meeting on the NRC's public meeting Web site at least 10 calendar days before the meeting. Stakeholders should monitor the NRC's public meeting Web site for information about the public meeting at: <http://www.nrc.gov/public-involve/public-meetings/index.cfm>. In addition, the meeting information will be posted on www.regulations.gov under Docket ID NRC-2019-0062. For instructions on how to receive alerts when changes or additions occur in a docket folder, see Section "Availability of Documents" of this document.

Cumulative Effects of Regulation:

The NRC has implemented a program to address the possible Cumulative Effects of Regulation (CER), in the development of regulatory bases for rulemakings. The CER describes the challenges that licensees, or other impacted entities (such as State partners) may face while implementing new regulatory positions, programs, and requirements (e.g., rules, generic letters, backfits, inspections). The CER is an organizational effectiveness challenge that results from a licensee or impacted entity implementing a number of complex positions, programs or requirements within a limited implementation period and with available resources (which may include limited available expertise to address a specific issue). The NRC is specifically requesting comment on the cumulative effects that may result from this potential rulemaking. In developing comments on this paper relative to CER, consider the following questions:

- 1) In light of any current or projected CER challenges, what should be a reasonable effective date, compliance date, or submittal date(s) from the time the final rule is published to the actual implementation of any new proposed requirements including changes to programs, procedures, or the facility?
- 2) If current or projected CER challenges exist, what should be done to address this situation (e.g., if more time is required to implement the new requirements, what period of time would be sufficient, and why such a time frame is necessary)?
- 3) Do other (NRC or other agency) regulatory actions (e.g., orders, generic communications, license amendment requests, and inspection findings of a generic nature) influence the implementation of the potential proposed requirements?
- 4) Are there unintended consequences? Does the potential proposed action create conditions that would be contrary to the potential proposed action's purpose and objectives? If so, what are the consequences and how should they be addressed?
- 5) Please provide information on the costs and benefits of the potential proposed action. This information will be used to support any regulatory analysis performed by the NRC.

Availability of Documents:

The documents identified in the following table are available to interested persons through one or more of the following methods, as indicated.

Document	ADAMS Accession Number/Federal Register Citation
NUREG/BR-0303, "Guidance for Performance-Based Regulation," December 2002	ML023470659
Advance notice of proposed rulemaking, "Approaches to Risk-Informed and Performance-Based Requirements for Nuclear Power Reactors," dated May 4, 2006.	71 FR 26267
SRM-SECY-10-0121, "Modifying the Risk-Informed Regulatory Guidance for New Reactors," dated March 2, 2011.	ML110610166
Nuclear Energy Innovation and Modernization Act, dated January 14, 2019.	Public Law 115-439
Regulatory Guide RG-1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," issued June 2020.	ML20091L698
NEI 18-04, Revision 1, "Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development," issued August 2019.	ML19241A472
SECY-19-0117, "Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," dated December 2, 2019.	ML18311A264
SRM-SECY-19-0117, "Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," dated May 26, 2020.	ML20147A504
SECY-20-0032, Rulemaking Plan On "Risk-Informed, Technology-Inclusive Regulatory Framework For Advanced Reactors," dated April 13, 2020	ML19340A056

The NRC may post additional materials to the Federal rulemaking Web site at www.regulations.gov, under Docket NRC-2019-0062. The Federal rulemaking Web site allows you to receive alerts when changes or additions occur in a docket folder. To subscribe: 1) navigate to the docket folder [NRC-2019-0062]; 2) click the "Sign up for E-mail Alerts" link; and 3) enter your e-mail address and select how frequently you would like to receive e-mails (daily, weekly, or monthly).

Rulemaking Process:

The NRC does not intend to provide detailed comment responses for information provided in response to this white paper. The NRC will consider comments on this paper in the rule development process. There will be an opportunity for additional public comment when the proposed rule is published. If supporting guidance is developed for the proposed rule, stakeholders will have an opportunity to provide feedback on the guidance as well.