UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

March 19, 2019

The Honorable Kristine L. Svinicki
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: DRAFT SECY PAPER AND GUIDANCE DOCUMENTS TO IMPLEMENT A TECHNOLOGY-INCLUSIVE, RISK-INFORMED, AND PERFORMANCE-BASED APPROACH TO INFORM THE CONTENT OF APPLICATIONS FOR LICENSES, CERTIFICATIONS, AND APPROVALS FOR NON-LIGHT-WATER REACTORS

Dear Chairman Svinicki:

During the 660th meeting of the Advisory Committee on Reactor Safeguards, February 6-8, 2019, we reviewed the draft SECY paper entitled, "Technology-Inclusive, Risk-Informed, and Performance-Based Approach to Inform the Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," and the associated draft Regulatory Guide DG-1353 and Nuclear Energy Institute (NEI) guidance document NEI 18-04. Our Future Plant Designs Subcommittee also reviewed this matter during meetings on June 22 and October 30, 2018. During these meetings we had the benefit of discussions with representatives of the NRC staff and of the nuclear power industry. We also had the benefit of the referenced documents.

CONCLUSIONS AND RECOMMENDATION

1. The draft SECY paper proposes the next evolution of a licensing approach that has been developed over the past thirty years.

2. The paper proposes an approach to accomplish three objectives: to select licensing basis events; to classify structures, systems, and components; and to assess the adequacy of defense-in-depth for new designs. The approach has matured to the point of being ready for application.

3. We recommend that the Commission adopt the approach proposed by the staff for a technology-inclusive, risk-informed, and performance-based methodology for informing the licensing basis and content of applications for non-light-water reactors.

4. The guidance proposed in DG-1353 is adequate to support implementation of the approach described in the SECY paper, with the exception that guidance for developing mechanistic source terms should be expanded.

5. DG-1353 should be finalized and published for comment.

BACKGROUND

The Commission policy statement regarding advanced reactors, issued on October 14, 2008, outlined the Commission expectation that advanced reactors provide at least the same degree of protection of the environment and public health and safety, and the common defense and security as is required for current generation light-water reactors. Additionally, the Commission expected enhanced margins of safety and use of simplified, inherent, passive, or other innovative means to accomplish these safety and security functions. The proposed approach neither exempts any reactor design from existing regulations, nor does it address all regulations applicable to nuclear power plants.

As the staff prepares to review and regulate the new generation of non-light-water reactors (non-LWRs), the NRC developed a vision and strategy to assure NRC readiness to efficiently and effectively conduct its mission for these technologies, including fuel cycles and waste forms. "NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Mission Readiness," published in December 2016, is the overarching document that describes the objectives, strategies, and contributing activities necessary to achieve non-LWR mission readiness.

The project was organized into two phases. Phase 1 was the conceptual planning phase that was completed in December 2016, with the issuance of the final non-LWR Vision and Strategy Document. Phase 2 includes detailed work planning efforts and task execution, including the development of implementation action plans (IAPs). Six parallel strategies were identified for achieving non-LWR licensing readiness. In our report of March 21, 2017, we recommended that the highest priority be given to implementing action plan Strategy 3, a flexible regulatory review process, and Strategy 5, technology-inclusive policy issues. We wrote several reports as that work progressed including those on the staff's guidance for developing principal design criteria, functional containment performance criteria, and emergency preparedness for small modular reactors and other new technologies. The current SECY paper is the culmination of the staff work.

Phase 2 is broken down into three periods: near-term (0-5 years), mid-term (5-10 years), and long-term (greater than 10 years). The near-term actions have been further developed. The purpose of the IAPs is to identify specific, actionable tasks that, once completed, will lead to accomplishment of the NRC's non-LWR vision and strategy objectives: enhance technical readiness, optimize regulatory readiness, and optimize communications.

Among the six strategies in the near-term IAPs, Strategy 3 is "Develop guidance for a flexible non-LWR regulatory review process within the bounds of existing regulations, including the use of conceptual design reviews and staged-review processes." Strategy 3 has activities in support of the following:

1. Establish criteria, as necessary, to reach a safety, security, or environmental finding for non-LWR technologies;

2. Determine appropriate licensing bases and accident sets for non-LWR technologies;

3. Identify and resolve gaps in current regulatory framework associated with non-LWR reactors and the associated fuel cycle;

4. Develop a regulatory review “roadmap” reflecting design development lifecycle and appropriate interactions, including potential research and test reactor interactions;

5. Update prototype reactor guidance;

6. Engage on technology- or design-specific licensing project plans and develop regulatory approaches commensurate with the risks posed by the technology;

7. Support longer-term efforts to develop, as needed, a new non-LWR regulatory framework that is risk-informed and performance-based, and that feature staff review efforts commensurate with the demonstrated safety performance of the non-LWR nuclear power plant design being considered.

The technology-inclusive, risk-informed, and performance-based approach has evolved over the past thirty years starting with the U.S. Department of Energy (DOE)/General Atomics modular high-temperature gas-cooled reactor application in 1986 and refined during the NRC’s development of NUREG-1860, and DOE’s Next Generation Nuclear Plant white papers. These were addressed in our letters of October 13, 1988, September 26, 2007, and May 15, 2013.

The current *Licensing Modernization Project* is an effort led by Southern Company, with others from industry contributing, and cost-shared by DOE. It has features that support activities number (2) and (7), and depending on the outcomes, perhaps contribute to activity number (1). The project builds on best practices, as well as previous activities through DOE and industry-sponsored non-LWR licensing initiatives. This effort was initiated with the submittal of four working draft documents, which were commented on by NRC staff. Those four documents, with NRC comments addressed, were compiled into NEI 18-04.

DISCUSSION

The staff has prepared a draft SECY paper and guidance document (DG-1353) to implement a technology-inclusive, risk-informed, and performance-based approach to inform the content of applications for licenses, certifications, and approvals for non-light-water reactors. The SECY paper seeks Commission approval to adopt that methodology. The draft regulatory guide endorses, with clarifications, the methodology documented in NEI 18-04. The methodology would be used by licensees to select licensing basis events; to classify structures, systems, and components; and to assess the adequacy of defense-in-depth for new designs. This is an iterative approach, one beginning in the design stage and continuing through operations.

The draft SECY paper and DG-1353 are an integrated set, with the paper describing the new approach and the DG describing how the approach can be applied. In the SECY paper, the staff argues convincingly that the proposed methodology is consistent with 2008 Commission policy statement on advanced reactors, and the Staff Requirements Memoranda for SECY-03-0047 and SECY-15-0168.

Over the past thirty years, we have supported careful development of the evolving approach described in the SECY paper, given that the gaps in the methodology would be addressed and undefined details would be developed. The paper emphasizes three technical areas.

For the identification of licensing basis events (LBEs), the recommended approach is essentially the same as described in NUREG-1860 and the Next Generation Nuclear Plant white papers. The licensing basis events are defined by scenarios developed in a probabilistic risk

assessment (PRA) that meets NRC standards. The PRA must be based on design-specific required safety functions. LBEs are tested against frequency-consequence (F-C) target goals given in NEI 18-04. Scenarios that do not meet these goals must be improved, by developing design, procedural, or administrative changes to lower the scenario frequency or consequences. Comparison of LBEs against the F-C target must be done in a way that prevents the analyst from arbitrarily splitting one scenario into many more scenarios with much lower frequencies. This is generally accomplished by combining scenarios into LBE families, each having similar initiating event, challenge to a PRA safety function, plant response, end state, and mechanistic source term. The total integrated plant risk must also meet separate integrated risk goals.

The LBEs include anticipated operational occurrences, design basis events, and beyond design basis events, all now defined unambiguously by the PRA frequency results. The staff has set a lower bound on beyond design basis events of 5×10^{-7} per year. Design basis accidents are derived from the design basis events, based on the capabilities and reliabilities of safety-related structures, systems, and components (SSCs) needed to mitigate and prevent the event sequences. They are used to set design criteria and performance objectives for the design of safety-related SSCs.

For classifying SSCs, the paper extends and makes operational the concepts that were expressed in NUREG-1860 and the Next Generation Nuclear Plant white papers. Essentially, SSCs are selected from important risk contributors in the PRA, with special treatment assigned based on importance to risk. The safety classification process and the corresponding special treatments serve to control the frequencies and consequences of the LBEs in relation to F-C target goals and ensure that cumulative risk metrics are not exceeded. We previously addressed these concepts in reports of September 26, 2007, and April 26, 2012, and find the approach logically sound, based on safety importance, and not bound by historical practice.

For defense-in-depth, the paper provides an operational structure for evaluation. It bridges the gap between frameworks as described in NUREG-1860, NUREG/KM-0009, and NUREG-2150, and viable regulatory actions. The paper describes a defense-in-depth approach that includes probabilistic and deterministic assessment techniques using a combination of plant capabilities and programmatic controls. As part of the evaluation, each LBE is evaluated to confirm that risk targets are met without exclusive reliance on a single element of design, single program, or single defense-in-depth attribute.

NEI 18-04 explains that one of the primary motivations of employing defense-in-depth attributes is to address uncertainties, including those that are reflected in the PRA estimates of frequency and consequence, as well as other uncertainties which are not sufficiently characterized for uncertainty quantification and are not amenable to sensitivity analyses. The designer is to convene an Integrated Decision Panel to make the kinds of judgments involving quantitative and qualitative factors akin to the integrated decision process in Regulatory Guide 1.174. The panel supports the overall design effort including selection of LBEs and classification of SSCs, and conducts the defense-in-depth adequacy evaluation for the design. This process has not been fully deployed in any of the table top exercises. Therefore, although the approach appears to be well conceived, we reserve judgment on how the guidance prepares the applicant to effectively carry out the integrated decision process.

DG-1353 provides guidance on using a technology-inclusive, risk-informed, and performance-based methodology to inform the licensing basis and the content of applications for non-LWRs. It endorses, with clarifications, the principles and methodology in NEI 18-04, as one acceptable method for determining the appropriate scope and level of detail for parts of applications for

licenses, certifications, and approvals for non-LWRs. The guidance in DG-1353 and NEI 18-04 are adequate for an applicant to successfully prepare an acceptable application. One area that remains vague in both documents is how an applicant should develop mechanistic source terms for scenarios to be used in the PRA, which is a design-specific process. Developing a mechanistic source term for every scenario in the PRA is no easy task. It involves complex physics and chemical phenomena, including the evolution and transport of aerosols. Applicants need to know the level of detailed analysis and experimentation that will be required.

SUMMARY

The approach presented in the SECY paper is ready for use to select LBEs; to classify SSCs; and to assess the adequacy of defense-in-depth for new designs. We look forward to following the staff's efforts, as described in the SECY paper and DG-1353. We expect to see applications using this methodology and the staff's approach for review of such submittals.

Sincerely,

/RA/

Peter C. Riccardella
Chairman

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