POLICY ISSUE
NOTATION VOTE

RESPONSE SHEET

TO: Annette L. Vietti-Cook, Secretary

FROM: Commissioner Baran

SUBJECT: 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

Approved X **Disapproved** ____ **Abstain** ____ **Not Participating** ____

COMMENTS: **Below** ____ **Attached** X **None** ____

Entered in "STARS"
Yes X
No ____

Jeffery M. Baran

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Commissioner Baran's Comments on 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"

Vendors are pursuing a variety of non-light-water reactor designs. These designs feature a range of coolants, fuels, and safety systems that differ significantly from those of the light-water reactors that comprise the current U.S. nuclear power plant fleet. As a result, these designs present different accident sequences that the reactors' structures, systems, and components (SSCs) will need to protect against.

This raises the question of how to go about classifying non-light-water reactor SSCs (and determining the regulatory standards that will apply to them) and selecting licensing basis events. The traditional approach for licensing light-water reactors relied on engineering judgment and conservative deterministic analyses with specific types of postulated accidents. The NRC staff recommends a technology-neutral approach that makes increased use of probabilistic risk assessment (PRA) insights while retaining some deterministic elements.[1]

I am persuaded that there are several advantages to a more technology-neutral, risk-informed approach. Aside from the fact that it would be very challenging to establish technology-specific prescriptive standards for each potential non-light-water reactor design, the proposed methodology provides a more systematic way of identifying the risk significance of SSCs and determining appropriate licensing basis events.

At the beginning of the design process, before the PRA is fully developed, designers will rely heavily on engineering judgment. But as a particular design's PRA matures, designers will benefit from additional risk insights. Where a PRA lacks data from reactor operating experience (as it will for many of the new designs that have not previously been built), uncertainties about licensing basis events and the effectiveness and reliability of SSCs will be greater, and the proposed methodology would require additional defense-in-depth measures to address those uncertainties. Despite the increased reliance on PRAs, the proposed methodology retains a deterministic design basis accident analysis like the one used in the licensing of existing light-water reactors. Outside this process, there is a separate NRC regulation providing that new non-light-water reactor designs will be approved only if the performance of each safety feature is demonstrated and if sufficient data on the safety features exist to assess the analytical tools used for the safety analyses.[2]

The proposed methodology arguably does a better job of addressing multi-module nuclear power plants than the traditional approach. A designer using the methodology is expected to have a PRA that includes "event sequences involving two or more reactor modules

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[1] The staff recognizes that there is still work to do before the proposed methodology can be fully implemented. As the ACRS noted, "One area that remains vague ... 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." ACRS Letter Report, "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," March 19, 2019 (ML19078240).

[2] 10 CFR 50.43(e).

as well as two or more sources of radioactive material."[3] The risk targets used for identifying SSCs, selecting licensing basis events, and determining the adequacy of a design's defense-in-depth must be met for an entire multi-module plant. Moreover, "[p]lants comprised of multiple reactor modules require consideration of event sequences that impact reactor modules independently as well as those that impact two or more reactor modules concurrently."[4] In other words, designers are expected to analyze events or hazards that could independently impact every module simultaneously or that could result in failures of systems and structures shared by multiple modules. Ultimately, the methodology aims to ensure that licensing basis events "involving radiological releases from two or more reactor modules do not make a significant contribution to risk and to ensure that measures to manage the risks of multi-reactor module or multi-source events are taken."[5]

The proposed methodology also calls for a designer to assess the overall adequacy of a plant's defense-in-depth using a combination of plant capabilities (such as barriers and design margins) and programmatic controls (such as maintenance, inspections, procedures, and technical specifications). Based on quantitative evaluation and engineering judgment, designers are to continue assessing the adequacy of overall defense-in-depth until the process "no longer identifies risk-significant vulnerabilities where potential compensatory actions can make a practical, significant, improvement to the [licensing basis event] risk profiles or risk significant reductions in the level of uncertainty in characterizing the [licensing basis event] frequencies and consequences."[6] When judging the adequacy of defense-in-depth, the methodology advises designers to "continually keep in mind that errors are possible, equipment can fail, and real events do not always mimic analytical events."[7] Although the methodology does not require the use of the traditional single failure criterion, it should result in designers considering all types of failures, as well as multiple failures, and compensating for such potential failures with diverse or redundant SSCs or layers of defense using physical and functional barriers. The overall adequacy of a design's defense-in-depth will be reviewed by NRC.

For these reasons, I approve use of the proposed methodology to inform the licensing basis and content of applications for non-light-water reactors with one modification. Unlike current practice, the methodology permits anticipated operational occurrences, which are events expected to occur one or more times during the operation of the plant, to be mitigated solely by non-safety-related SSCs. Given the expected frequency of these events, the methodology should require a design to include a safety-related means of mitigating each anticipated operational occurrence in addition to any non-safety-related SSCs.

A design's PRA obviously will play a critical role in the use of this methodology. As a result, for applicants that use this method of demonstrating the safety of their designs, the rulemaking for non-light-water reactor licensing will need to require the PRA to become part of the licensing basis of the plant, with appropriate controls on PRA completeness, quality, and documentation. With this kind of risk-informed methodology, the NRC staff has long recognized

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[3] Risk-Informed Performance Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development, NEI 18-04 Revision 1 (2019) at 21 (ML19241A472). Aside from radioactive material in the reactor, the PRA would need to consider other sources, such as spent nuclear fuel and radioactive waste.
[4] *Id.* at 23.
[5] *Id.* at 16.
[6] *Id.* at 58, 67.
[7] *Id.* at 71.

the need for a heightened focus on non-light-water reactor PRAs.[8] I would expect that the new regulation also would require a new design's PRA to be updated throughout the design process and during operation of the plant to account for design changes and insights gleaned from operating experience.

In addition, although there are references in the methodology guidance document to emergency planning zone size and siting restrictions, these defense-in-depth requirements will actually be determined separately from this process.[9] NRC is actively considering changes to regulations and guidance to address non-light-water reactor emergency planning zones and siting.

[8] *See, e.g.*, Policy Issues Related to Licensing Non-Light-Water Reactor Designs, SECY-03-0047 (2003; ML030160002) at 6 ("It should be noted that this recommendation expands the use of probabilistic risk assessment (PRA) into forming part of the basis for licensing and thus puts greater emphasis on PRA quality, completeness, and documentation"), Attachment 4 at 4 ("this option requires that PRA become part of the licensing basis of the plant, with appropriate controls on PRA completeness, quality and documentation).

[9] *See, e.g.*, NEI 18-04 at 17 ("Such design improvements could be motivated by a desire to … limit the need for restrictions on siting or emergency planning"), 70 ("Is the emergency planning zone appropriate for the full set of [design basis events] and [beyond design basis events] identified in the [licensing basis event] selection process?).