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

October 21, 2020

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

SUBJECT: 10 CFR PART 53 LICENSING AND REGULATION OF ADVANCED NUCLEAR REACTORS

Dear Chairman Svinicki:

During the 678th meeting of the Advisory Committee on Reactor Safeguards, September 9 - 11, 2020, we reviewed the staff white paper entitled, "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors," and SECY-20-0032, "Rulemaking Plan on Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors." Our Future Plant Designs Subcommittee also reviewed this matter during a meeting on July 20, 2020. During these meetings we had the benefit of discussions with representatives of the NRC staff. We also had the benefit of the referenced documents.

CONCLUSION AND RECOMMENDATIONS

1. The staff's proposed approach for developing the Title 10 of the *Code of Federal Regulations* (10 CFR) Part 53 rule is viable.

2. The staff should ensure that applicants compensate for novel designs with uncertainties due to incompleteness in the knowledge base by performing systematic searches for hazards, initiating events, and accident scenarios with no preconceptions that could limit the creative process.

3. The rule should provide a pathway for licensing prototype facilities, when uncertainties in the knowledge base and lack of operating experience suggest that additional testing and monitoring are needed.

DISCUSSION

A number of issues have arisen since our reports on the staff's Non-light water reactor (LWR) Vision and Strategy Documents and Implementation Plans. Those issues surfaced during our review of lessons-learned from our review of the NuScale design certification application and during our preliminary reviews of topical reports for two non-LWR designs.

The purpose of this letter is to support the staff plan for developing the new 10 CFR Part 53 rule and to alert the staff to several issues that we intend to follow closely as the rulemaking process evolves.

The staff provided a rulemaking plan to the commission that included a request to eliminate the usual regulatory basis document. In its stead they plan extensive public outreach. We find this a reasonable approach, given the evolution of the proposed approach over the past thirty years and the extensive work and public meetings that have already occurred.

Novel aspects of new technologies make the identification of hazards, initiating events, and scenarios challenging; systematic searches will be needed. A process for gaining confidence in safety calculations will also be needed that focuses on the theoretical and experimental basis for fully understanding the associated physics and chemistry of possible scenarios. The levels of design and knowledgebase completeness affect our ability to have confidence in the conservatism of assumptions in traditional transient and accident analyses as well as the calculated margins. Likewise, the lack of completeness provides a challenge for probabilistic risk assessment (PRA), which should assess the resulting uncertainties explicitly.

To address uncertainties caused by limited information, there is no substitute for critical examination of the design, its safety behavior, and all aspects of operations, starting from a blank sheet of paper to avoid bias. This implies a need for compensatory measures such as alternative systematic searches for hazards, initiating events, and accident scenarios with no preconceptions that could limit the creative process. This represents a return to the earliest days of commercial nuclear power, when Edward Teller, then Chairman of the Reactor Safeguards Committee (the predecessor to the ACRS), described a ‘simple procedure’ they had developed to structure its reviews of safety. For each reactor, they asked the designers to,

> “ . . imagine the worst possible accident and to design safety apparatus guaranteeing that it could not happen. The Committee reviewed each reactor plan, trying to imagine an accident even worse than that conceived by the planner. If we could think of a plausible mishap worse than any discussed by the planner, his analysis of the potential dangers was considered inadequate. In most cases, the required discussion created a reasonable spirit of caution, and we could advise the Atomic Energy Commission that the reactor would be sufficiently safe.” (from Teller and Brown 1962).

We only suggest that new systematic approaches are available and should be used to enhance the search for hazards, initiating events and accident scenarios.

A second approach for dealing with design and knowledgebase completeness includes limitations on power ascension and focused surveillance tests during initial operation. Cases where the lack of operating experience and the inability to perform experiments with sufficient similitude to the planned full-scale design to reduce uncertainties to an acceptable level may require demonstration testing up to and including a prototype. Changes to the Atomic Energy Act of 1954, as amended, eliminated the section describing prototype or demonstration reactors. Nevertheless, prototype plants are allowed under 10 CFR Parts 50 and 52, with additional conditions (such as added safety features or instrumentation) to compensate for uncertainties with unproven safety features. The rule should provide a pathway for licensing prototype facilities.

Incorporating the concept of 10 CFR Part 50 general design criteria (GDC) into the framework of the proposed 10 CFR Part 53 rulemaking is important. The GDC were developed and included in 10 CFR Part 50 to improve the predictability and efficiency of NRC reviews of licensing applications. The GDC established requirements for design, fabrication, construction, testing, and performance, to ensure that needed structures, systems, and components (SSCs) remain functional during and following identified design basis events.

We look forward to engaging the staff on criteria similar to the GDC of 10 CFR Part 50, Appendix A. We know the staff is considering alternatives and we have already commented on the advanced reactor design criteria (ARDC) developed as part of the Non-LWR Vision and Strategy program. It is our expectation that the staff will find a logic structure that makes clear the links among critical safety functions, functional groups of GDC, and the detailed GDC themselves, and will be able to apply it to high level design criteria expected to be codified in 10 CFR Part 53 and associated detailed guidance.

10 CFR Part 53 is expected to include fusion reactors. While fusion does not sustain a critical neutron chain reaction, it shares more similar characteristics to the hazards of fission reactors than it does accelerators. Power densities and temperatures of the fusion blankets are similar to those seen in fission reactors, fusion reactors produce 14 MeV neutrons that will activate the surrounding structures producing significant radioactive material that represents an “afterheat” that must be managed, and this radioactive material could also be mobilized in an off-normal event or postulated accident. The fusion reaction requires kilogram levels of tritium in the facility. There are numerous energy sources whose failure can lead to mobilization of the radioactive materials in the plant (activated dust and tritium). Energy sources include coolant internal energy; chemical reactions of air or water with structural materials, plasma facing components, and reactive coolants; and magnet energy. These clearly affect worker risk and, depending on the selection of materials and design details, may introduce public risk comparable with fission reactors. In the early 1990s, the Department of Energy produced a fusion safety standard that can serve as a reference for the staff as they develop regulations for fusion reactors into 10 CFR Part 53.

We also expect to engage the staff on issues associated with transportation of reactors to and from sites where they will be employed. New and spent reactors must be designed to support transportation and possible accidents in transit.

SUMMARY

We support the direction planned by the staff for the development of the new rule 10 CFR Part 53. We look forward to many interactions with the staff, as they develop the new rule. In particular, we hope to see language that stresses the importance of searching for events without preconceived expectations and that provides a defined pathway for prototype facilities including clarity on the kinds of test programs, monitoring, and license limitations that may be required, before such plants can enter the period of full commercial operations.

Sincerely,

Matthew W. Sunseri Digitally signed by Matthew W. Sunseri
Date: 2020.10.21 18:42:57 -04'00'

Matthew W. Sunseri, Chairman

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