



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

December 22, 2023

The Honorable Christopher T. Hanson  
Chair  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: SUMMARY REPORT – 711<sup>th</sup> MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, DECEMBER 6-7, 2023**

Dear Chair Hanson:

During its 711<sup>th</sup> meeting, December 6-7, 2023, which was conducted in person and virtually, the Advisory Committee on Reactor Safeguards (ACRS) discussed several matters. The ACRS completed the following correspondence:

**LETTER**

Letter to Daniel H. Dorman, Executive Director for Operations (EDO), U.S. Nuclear Regulatory Commission (NRC) from Joy L. Rempe, Chairman, ACRS:

- Review of Advanced Reactor Content of Application Project/Technology-Inclusive Content of Application Project Guidance, dated December 20, 2023, Agencywide Documents Access and Management System (ADAMS) Accession No. ML23348A182.

**MEMORANDA**

Memoranda to Daniel H. Dorman, EDO, NRC, from Scott W. Moore, Executive Director, ACRS:

- Documentation of Receipt of Applicable Official NRC Notices to the Advisory Committee on Reactor Safeguards for December 2023, dated December 14, 2023, ADAMS Accession No. ML23347A107.
- Regulatory Guides, dated December 13, 2023, ADAMS Accession No. ML23347A116.

## HIGHLIGHTS OF KEY ISSUES

### a. Review on Advanced Reactor Content of Application Project/Technology-Inclusive Content of Application Project Guidance

The Committee heard from the NRC staff and issued a December 20, 2023, letter, with the following conclusions and recommendations:

1. The Application Project (ARCAP)/Technology-Inclusive Content of Application Project (TICAP) documents represent a significant effort by staff and industry to develop guidance for risk-informed technology-inclusive non-light water reactor applications, including the use of the Licensing Modernization Project (LMP) methodology.
2. The 12-chapter structure in an ARCAP/TICAP Safety Analysis Report is a logical ordering of the information. This structure enhances the focus on the important safety-relevant features in the design and should provide for efficient reviews of LMP-based applications.
3. The pre-application engagement guidance found in Appendix A of the ARCAP roadmap is excellent and supports our past recommendations on this topic. It should serve design developers and the staff as a useful starting point to align expectations for the application process and promote high quality submissions.
4. Further comments on specific guidance documents are found in the body of the letter.

### b. Transportation Framework for Micro-Reactors

During the discussion on this topic, the committee was briefed on the staff's evaluation of the Pacific Northwest National Laboratory (PNNL) Report, PNNL-33524, "Development and Demonstration of a Risk Assessment Approach for Approval of a Transportation Package of a Transportable Nuclear Power Plant [TNPP] for Domestic Highway Shipment." This topic was also reviewed by the Plant Operations, Radiation Protection, and Fire Protection Subcommittee on November 17, 2023.

PNNL-33524 was developed as part of the U.S. Department of Defense (DOD) project, "Pele," to construct and demonstrate a prototype transportable microreactor or Transportable Nuclear Power Plant (TNPP). While the Pele prototype will remain on the Idaho National Laboratory site, future TNPP units may operate at other DOD sites and require transportation of the irradiated TNPP on public roads and highways. Such shipments would likely be regulated by the NRC and U.S. Department of Transportation (DOT). The transportation of TNPPs has, so far, not been licensed by the NRC and could be a challenge, especially if the TNPP contains irradiated fuel.

PNNL-33524 includes the development and implementation of a Probabilistic Risk Assessment (PRA) that includes, "Proposed risk evaluation guidelines, technical information, data, and example analyses that provide a potential template for a microreactor vendor to follow when requesting an exemption from the NRC for transportation of a TNPP. It also addresses important supporting PRA-related analyses such as the treatment of key assumptions and sources of modeling uncertainty and the concept of defense-in-depth and safety margin."

In the draft methodology evaluation provided to ACRS, the staff concluded the approach to use a PRA, supplemented with evaluations of defense-in-depth and safety margins as described in PNNL-33524, has the potential to provide a risk-informed framework to technically justify necessary exceptions to the deterministic requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71.

During the Subcommittee and Full Committee discussions on this topic, individual members offered several comments regarding the following aspects of the PNNL-33524 methodology:

- *Safety Functions* - PNL-33524 identifies four primary safety functions: (1) providing containment of radiological materials, (2) providing radiation shielding, and (3) maintaining a criticality-safe configuration. The fourth safety function, maintaining adequate heat dissipation, was subsequently determined to not be a concern. Neither PNL-33524 nor the staff evaluation discuss other safety functions that were considered and dismissed. Because the staff-endorsed approach may be broadened to consider a range of microreactor designs with different coolants and materials, it would be helpful to clarify expectations regarding the spectrum of safety functions that should be identified in such submittals. An approach similar to that proposed for 10 CFR Part 53 (e.g., primary safety functions with several supporting functions to ensure appropriate safety functions are identified) could be considered.
- *Qualitative Safety Goals* - The quantitative goals proposed as acceptance criteria focus on individual risk metrics, such as dose limits to the maximally exposed individual. However, individual risk metrics may not adequately account for the risk associated with transport of a reactor through an area with high population density, such as a major city. In such a case, the consequences of an accident scenario could affect many people. While the 1986 Commission safety goals policy statement does not include a quantitative health objective for such societal risk, it does have a qualitative safety goal that states: "Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks."
- *More Detailed Frequency and Consequence Evaluations* - PNNL-33524 states that accidents are assumed to be randomly distributed along the length of the route. Hence, the methodology has the potential to underestimate the resulting risk from a truck accident that will lead to severe consequences. This method assumes the probability of a truck accident at a location with the potential for a large drop or water immersion is equal to the average accident probability over the entire route. Locations with the potential for large drop or immersion into water may be associated with road conditions (such as tight turns or road narrowing) that make truck accidents more likely. Hence, the use of the average probability over the entire route could underestimate the likelihood of accidents at the limiting locations unless compensatory actions or measures are also considered for these locations. Additionally, as discussed above, the proximity of such a hazard to a population center could result in more severe consequences than a hazard located in an unpopulated area. Accurate estimates of the likelihood and consequences of potential accidents require consideration of the location and characteristics of identified hazards along a route. If there are limitations associated with the location-dependent accident frequency data along the route, it is important to require a detailed environmental assessment that identifies location-specific hazards. This assessment should either refine estimates of the likelihood and consequences of potential accidents at such locations (using techniques such as expert elicitation); or, if

needed, it should require compensatory measures (e.g., weather limitations, speed limitations, escort vehicles, etc.) to reduce the likelihood of potential accidents at such locations.

Moreover, the reliance on route-specific spatially derived hazards, while potentially appropriate for a single shipment, implies that a transportable reactor with multiple destinations would require a separate route-specific PRA for every intended route. Since the DOT regulations (49 CFR 397.103) require each transportation route to get a detailed review that will address route-specific hazards, a more generic PRA approach may be practical. Such an approach could reduce the need to redo the analysis each time a new destination and/or new route is proposed (while recognizing that those individuals living or working near the origination site might experience risk from shipments to multiple different destinations).

- ***Cliff Edge Effects*** – The treatment of inadvertent criticality as a hazard in PNNL-33524 is unclear. In a conventional transportation package, inadvertent criticality is precluded by deterministic design requirements. In PNNL-33524, criticality was assumed to occur if the package were flooded, with the likelihood of flooding leading to inadvertent criticality estimated as just below the frequency cutoff for required additional consideration of 5E-7 per year. Criticality was screened out based on low likelihood, and the consequences of criticality were not assessed. Although it was not stated in either PNNL-33524 or the staff evaluation, representatives from PNNL and the staff indicated the potential for “cliff edge” effects should be assessed for events with frequency near the cutoff level. Without assessment of the consequences of criticality, it is not possible to determine whether those consequences would be significantly worse than the analyzed scenarios and represent a “cliff edge.” Furthermore, the staff indicated they would not have accepted the potential for inadvertent criticality during transport based on the justification that was provided in PNNL-33524. It is important to clarify expectations regarding the required evaluations to demonstrate that cliff edge effects and the potential for inadvertent criticality have been addressed.

During the Full Committee meeting, staff indicated that several changes were being made to their evaluation to address comments offered by individual members during the November 17, 2023, subcommittee meeting and additional changes would be made to address items noted by members during the Full Committee meeting. However, a revised evaluation was not yet available for members to review. Staff offered to provide a copy of the revised evaluation to ACRS when it is available. At that time, members agreed that cognizant members will review the revised evaluation and report back to the Full Committee on their assessment of whether additional actions by ACRS were needed. For the above reasons, members concurred that a formal ACRS letter was not appropriate at this time.

c. Discussions at the Planning and Procedures Session

1. The Committee discussed the Full Committee and Subcommittee schedules through May 2024 as well as the planned agenda items for Full Committee meetings. At the end of the Full Committee meeting, the ACRS decided the special Full Committee meeting, which was scheduled for December 15, 2023, would not be needed and should be cancelled. The ACRS staff took appropriate actions to do so.
2. The ACRS Executive Director led a discussion of significant notices issued by the Agency since the last Full Committee meeting in November 2023. The Executive

Director documented this activity in a memorandum dated December 14, 2023, ADAMS Accession No. ML23347A107.

3. The ACRS Executive Director led a discussion of two draft regulatory guides/regulatory guides and the potential for Committee review. The Executive Director documented the Committee's decision in a memorandum dated December 13, 2023, ADAMS Accession No. ML23347A116.
4. The proposed ACRS Full Committee and Subcommittee calendar for 2025 was discussed. The Committee approved the proposed 2025 calendar (the 2024 calendar was previously approved).
5. The Executive Director led a discussion of the next planned meeting between the Commission and the ACRS. The meeting has been tentatively scheduled for Friday, June 7, 2024. It was discussed that the Committee would need to propose topics and presenters by the end of the March 2024 Full Committee meeting.
6. Member Roberts led a discussion about knowledge management (KM) efforts. The ACRS is developing a KM SharePoint site to capture all previous white papers and other important historical documents of potential interest to members and staff. The Committee discussed what background documents should be posted on the KM site.
7. Vice Chairman Kirchner led a discussion about the NuScale review. On November 10, 2023, Carbon Free Power Project (CFPP) and NuScale Power jointly submitted a request to withdraw the request for exemption and other related documents associated with the CFPP Combined License Application (COLA). This request followed the November 8, 2023, announcement by Utah Associated Municipal Power System and NuScale Power on the termination of the CFPP (ADAMS Accession No. ML23317A110). Separately, NuScale Power informed the staff of its plan to request that NRC staff complete the CFPP COLA Readiness Assessment. On October 9, 2023, NuScale submitted Revision 0 of the topical report entitled, "NuScale US460 Fuel Storage Rack Design Topical Report," TR-145417-P. The purpose of this submittal is to request that the NRC review and approve the fuel storage rack design. This topical report contains a summary of the analytical inputs, interpretations, and methodologies used to design and analyze the fuel storage racks to demonstrate compliance with applicable regulations. The fuel storage racks are designed in accordance with the requirements of 10 CFR Part 50, Appendix B and American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance-1 ( NQA-1). This report examines the fuel storage racks in the areas of mechanical structure, thermal hydraulics, materials, and nuclear criticality. Vice Chairman Kirchner recommends that the Committee review the topical report. The Committee agreed with Vice Chairman Kirchner's recommendation.
8. Member Bier led a discussion about the General Atomics reactor design activities. General Atomics has submitted Revision 3 of its quality assurance plan topical report entitled, "Fast Modular Reactor Quality Assurance Program Description," (ADAMS Accession No. ML23212B189). The plan commits to specific program controls being applied to non-safety-related structures systems, and components that are significant contributors to plant safety (for which 10 CFR Part 50, Appendix B, is not applicable). Therefore, Member Bier had no concerns about the completeness and coverage of the

plan and recommends the Committee not review this topical report. The Committee agreed with Member Bier's recommendation.

9. Member-At-Large Petti led a discussion of the planned Committee's review of the NRC's Safety Research Program which is now performed on a triennial basis. Some potential topics (and leads) to be covered in this review are:

- Source term issues for advanced reactors (Member-At-Large Petti)
- Digital Twins (Member Bier)
- Material Harvesting (Member Sunseri)
- Code Investment Plan (Member Martin)
- Level 3 PRA (Member Dimitrijevic)
- Artificial Intelligence (Member Bier)
- Cyber Security (Member Bier)

The ACRS staff, in consultation with Member-At-Large Petti, will coordinate interactions with the Office of Nuclear Regulatory Research. Member Petti is planning a virtual meeting with RES Division Directors in early 2024 to discuss the scope of the review

10. There were no reconciliations at this meeting.
11. The annual officer elections were conducting in accordance with the ACRS bylaws with the following results:

- Chairman: Kirchner
- Vice Chairman: Halnon
- Member-At-Large: Petti

The newly elected officers will serve from January 1, 2024, until December 31, 2024.

12. There was a planning and procedures closed session to discuss proprietary Committee Engagement Plans as well as sensitive administrative and personnel issues.

d. Scheduled Topics for the 712<sup>th</sup> ACRS Meeting

The following topics are on the agenda for the 712<sup>th</sup> ACRS meeting scheduled for February 7-9, 2024:

- Integrated low level radioactive waste disposal proposed rule, and
- NuScale topical reports on subchannel analysis and rod ejection accident methodologies.

Sincerely,



Signed by Rempe, Joy  
on 12/22/23

Joy L. Rempe  
Chairman

December 22, 2023

SUBJECT: SUMMARY REPORT – 711<sup>th</sup> MEETING OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, DECEMBER 7-8, 2023

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**If Sensitive, which category?**

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