Observations on Application of Risk-Based Approach  
Docket No. 71-9396  
Project Pele

By request dated February 20, 2023 (Agencywide Documents Access and Management System Accession No. ML23066A202), on behalf of the Strategic Capabilities Office within the Department of Defense, the Pacific Northwest National Laboratory (PNNL) requested U.S. Nuclear Regulatory Commission (NRC) review of PNNL's document titled "Development and Application of Risk Assessment Approach for Transportation Package Approval of a Transportable Nuclear Power Plant for Domestic Highway Shipment."

This enclosure contains observations that an applicant might find useful when implementing the risk-informed methodology in an application for package approval.

General Observations

1. The report provides an example of a risk-informed framework. As stated in the report, there are a few informational needs in the framework, to such an extent that determining the actual risk for event scenarios will depend on the final transportable nuclear power plant (TNPP) design and the results of the analyses performed on that design, to predict the extent of the damage to the TNPP after an accident.

The framework established in the report is based on numerous assumptions, which, while adequate for the purposes of demonstrating a methodology for risk informing the transportation of a TNPP after having operated for 3 years, will need to contain adequate justifications for all assumptions in the final report submitted with the TNPP package application.

2. When the applicant develops the actual risk-informed report for transporting the TNPP it is designing, it must be done under an NRC-approved Quality Assurance Program (QAP) in accordance with Title 10 of the Code of Federal Regulations (10 CFR) Part 71, Packaging and Transportation of Radioactive Material, Subpart H, Quality Assurance, and Paragraph 71.37, Quality Assurance; with originators, independent checkers, and approvers.

As demonstrated by the risk framework report, there will be numerous inputs included in the final report that will have to be independently verified by a checker. By developing the report under an NRC-approved QAP, the NRC would not have to independently verify all the input information.

3. The TNPP packaging application should include detailed operating procedures and acceptance tests/maintenance program chapters which accurately reflect the actual procedures that will be used to maintain, inspect, test, and otherwise prepare the package for transportation. Consideration should be given to providing procedures for Compensatory measures to address different transportation issues or accident scenarios that could occur with the TNPP packaging.

4. The risk-informed approach is based on the request for a “route-specific” approval, given the details included on the route from Idaho National Laboratory to the White Sands Missile Base. Consideration should be given to whether the TNPP application will
request a route-specific approval, or approval of a “generic” route. The environmental assessment process for materials licensees provided in NUREG-1748, “Environmental Review Guidance for Licensing Actions Associated with NMSS [Office of Nuclear Materials Safety and Safeguards] Programs,” describes, in Appendix D, the state consultation process for draft environmental assessments. If the application is route-specific and the route were to change, NRC would have to evaluate whether the environmental assessment should be sent to additional states for review. If a generic environmental assessment is provided (i.e., not route-specific), the NRC would have to determine whether there is a state consultation process outside of Idaho. Similarly, NUREG-1748 also describes consultation efforts with Tribal agencies that may be impacted by any proposed route.

1.0 INTRODUCTION

1. The description of the TNPP transportation risk assessment approach provided should clearly state whether the approach will show that the risk is low for all accident sequences, or only for those sequences in which the regulatory requirements are not met.

Section 1.5.3 states: "Because the Project Pele prototype TNPP will meet many, but not all, of the 10 CFR Part 71 deterministic requirements, a full scope evaluation of all possible accident scenarios is not needed, particularly those accidents resulting in low radiological dose consequences."

2.0 DEFINITION OF REGULATORY APPROACH

No questions.

3.0 DEFINITION OF SAFETY GOALS AND RISK EVALUATION GUIDELINES

1. Clarify the statement in the last paragraph of section 3.3, “Proposed Surrogate Risk Evaluation Guidelines Based on the Safety Goal QHOs [quantitative health objective]," page 33, which argues that summation should be done within each bounding representative accident group, but that "summation of the risk results from multiple bounding accidents produces grossly conservative and unrealistic results."

The unit produced by summing the calculated risk values (total risk to a hypothetical individual who is always the maximally exposed individual for every accident) would not necessarily be conservative and not directly comparable to a more typical summed unit (e.g., total risk to an average offsite individual).

2. Clarify the proposed risk evaluation guidelines in table 3-6, “Comparison of Selected Dose-Consequence Limit Surrogates to the Limiting QHGs [quantitative health guidelines].”

Comparison of the proposed risk evaluation guidelines to QHGs (table 3-6), at certain anchor points, may not be useful since the units are completely different (individual scenario frequency and dose to the maximally exposed offsite individual [MOI] vs. total [all scenarios] frequency and dose to the average individual [averaged between 1 and 10 miles]). MOI risk is necessarily higher than average risk, but scenario MOI risk is not necessarily higher than total average individual risk. Consider noting and
discussing of these differences in the report; however, if the point is to demonstrate compliance with the RIDM QHGs in the report, it is the staff's position that this calculation will not accomplish this. Further, the analysis compares the lower end of the anchor points to the QHGs, not the upper end (i.e., in the stair step figure the points compared are the lower part of the steps not the upper edge).

4.0 TNPP TRANSPORTATION PRA METHODOLOGY, DATA, AND RESULTS

1. While the NRC does not have any comments on the depletion methodology used to determine the source term at shipping (60-90 days after shutdown) at this time, the applicant did not preclude a criticality incident due to water intrusion. If that continues to be the case, then the maximum source term may need to also include the severity of any criticality excursion that might be expected.

2. Vendor package scoping evaluations has demonstrated that the packaging structure (not including seals and/or closures) will likely tolerate the expected normal conditions of transport; however, there does not appear to be an evaluation of the tri-structural isotropic (TRISO) fuel due to mechanical impact and the potential release fractions rely on the integrity of the silicon carbide layer and how well it performs in a mechanical impact under accident conditions.

3. Section 4.2.1 states: “This inventory is only that associated with burnup of the fuel and does not include the inventory due to the activation of the reactor materials of construction or the coolant.” All radioactive material available for release should be considered in the consequence analyses unless it can be demonstrated that material does not escape the containment boundary.

Staff notes the statement made in Section 4.2.3.3, that “A portion of this material will be more mobile, within the so-called ‘circulating inventory’, and, thus more readily releasable in a transportation accident as opposed to certain plate out and fines that are more tightly bound to interior surfaces within the primary pressure boundary.” This appears to indicate that there is material outside of the core region that is available for release.

4. Section 4.6.3.1, “External Dose Due to Photons,” states: “There are two possible forms of unshielded radioactive material: (1) material that is released from the TNPP package to the environment, and (2) material that is not released from containment but because there is a loss or degradation in the shielding is a source of direct radiation dose to the worker; however, radiation dose from unreleased radioactive material is not considered.” NRC expects that total dose to the maximally exposed individual be evaluated and from all sources of radiation (see item 3 immediately above) from the TNPP.

5.0 DEFENSE-IN-DEPTH AND SAFETY MARGIN CONCERNS

1. The transportation of a TNPP should not rely on a risk evaluation only. There should be actual defense-in-depth measures taken to further lessen the chances of an accident or event happening during transport (such as administrative controls) or to mitigate the consequences of an event. Some administrative controls could include:

   1. All transports should be made under “good” weather and road conditions, with the term “good” needing to be defined.
2. Leading and trailing escort vehicles (of some sort) to provide blocking for the front and rear of the TNPP package tractor/trailer, also known as “rolling” roadblocks.

3. Restricting the speed limits on the convoy to a prescribed maximum, based on the actual structural analysis performed for the TNPP transportation package.

4. Reducing the speed of the convoy over bridges and overpasses to lower than the maximum restricted open highway speed. Again, the structural analysis for the TNPP and transportation packaging, from a drop height and accident analyses perspective, may influence this speed.

5. Restrict travel to avoid traffic.

6. Plan the route to avoid long tunnels.

7. Restrict travel to only certain weather temperature ranges, based on the evaluation of environmental conditions.

8. Use only newer trucks and trailers with complete maintenance records.

9. Consider requiring two individuals in the truck cab during transportation.

10. Limit the number of hours that individual truck drivers drive each day, below the maximum allowed by the DOT.

11. Consider real-time monitoring of the TNPP primary coolant temperature and pressure.

12. Consider continuous air monitoring of the TNPP trailer packaging for radioactive material.

13. Include a fire suppression system in the TNPP trailer.

14. Include cameras in the trailer packaging to provide real-time monitoring capability of the TNPP during transportation.

15. Consider monitoring shock and vibration of the trailer packaging during transportation to ensure that these parameters fall within the maximum limits determined from the TNPP and transportation packaging structural analysis.

16. All written procedures involved with transporting the TNPP should be triple checked and signed off by different individuals.

6.0 TECHNICAL ADEQUACY OF TRANSPORTATION RISK ASSESSMENT

No questions.

7.0 CONCLUSIONS

No questions.
RAI 1 on Project Pele Risk-Based Approach DATE April 14, 2023

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