NuScale Power

RAIO-0718-60731

July 02, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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Rockville, MD 20852-2738

**SUBJECT:** NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 26 (eRAI No. 8840) on the NuScale Design Certification Application

**REFERENCES:**

1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 26 (eRAI No. 8840)," dated May 22, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 26 (eRAI No.8840)," dated July 19, 2017
3. NuScale Power, LLC Supplemental Response to NRC "Request for Additional Information No. 26 (eRAI No. 8840)," dated May 14, 2018

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) supplemental response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Question from NRC eRAI No. 8840:

- 19-2

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Paul Infanger at 541-452-7351 or at pinfanger@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8840

**Enclosure 1:**

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8840

# Response to Request for Additional Information
# Docket No. 52-048

**eRAI No.:** 8840
**Date of RAI Issue:** 05/22/2017

**NRC Question No.:** 19-2

10 CFR 52.47(a)(27) states that a DC application must contain a Final Safety Analysis Report (FSAR) that includes a description of the design-specific probabilistic risk assessment (PRA) and its results. In accordance with the Statement of Consideration (72 FR 49387) for the revised 10 CFR Part 52, the staff reviews the information contained in the applicant's FSAR Chapter 19, and issues requests for additional information (RAI) and conducts audits of the complete PRA (e.g., models, analyses, data, and codes) to obtain clarifying information as needed. The staff uses guidance contained in Standard Review Plan (SRP) Chapter 19.0 Revision 3, "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors." In accordance with SRP Chapter 19.0 Revision 3, the staff determines if "the PRA reasonably reflects the as-designed, as-built, and as-operated plant, and the PRA maintenance program will ensure that the PRA will continue to reflect the as-designed, as-built, and as- operated plant, consistent with its identified uses and applications."

The staff has reviewed the information in the FSAR and examined additional clarifying information from the audit of the complete PRA and determined that it needs additional information to confirm that the PRA reasonably reflects the as-designed plant. The containment isolation function supports the passive core cooling and heat removal key safety functions by ensuring sufficient coolant inventory in the reactor pressure vessel and the containment vessel. The staff notes that FSAR Table 19.1-6, "System Success Criteria per Event Tree Sequence," assumes that containment isolation is guaranteed to succeed except for the chemical and volume control system (CVCS) pipe breaks outside containment and the steam generator tube failure (SGTF). The containment isolation function is accordingly not questioned in any of the Level 1 event trees except for the CVCS pipe breaks outside containment and the SGTF.

To allow the staff to evaluate the Level 1 model and assumptions related to the containment isolation function, the staff requests the applicant to explain how the containment isolation function can be guaranteed to succeed in the Level 1 accident sequences. In your response, please provide the following:

a. Identify the potential scenarios (combinations of pathways, equipment failures and human failure events) that could lead to coolant inventory loss from the reactor pressure vessel to outside of the containment vessel.
b. For the scenarios identified in a), explain how the containment isolation function is

accounted for in the Level 1 model, if this function is necessary to support any key safety functions (e.g., passive safety functions).

c. For the scenarios identified in a), if the containment isolation function is not necessary to support any key safety functions, please describe any relevant analyses used to support this conclusion. Describe any uncertainty analyses performed for these supporting analyses.
d. Augment FSAR Table 19.1-21, "Key Assumptions for the Level 1 Full Power Internal Events Probabilistic Risk Assessment," and/or Table 19.1-23, "Key Insights from Level 1 Full Power, Internal Events Evaluation," accordingly with a discussion of the dependency of the passive safety functions on the containment isolation function. Include a discussion of the safety-significance of the active backup systems for scenarios resulting in failure of containment isolation.

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**NuScale Response:**

NuScale is supplementing its response to RAI 8840 (Question 19-2) originally provided in letter RAIO-0717-55003, dated July 19, 2017, and supplemented in letter RAIO-0518-59975, dated May 14, 2018. This supplemental response is provided as a result of discussions with the NRC during a public meeting held on May 22, 2018; the following information is added to the response to Item c of the supplemental response that was provided in letter RAIO-0518-59975:

The simulations were performed with the NRELAP5 code as identified in FSAR Section 19.1.4.1.1.6. The NRELAP5 analysis did not credit active pool cooling systems, inventory addition, or ambient heat loss from the pool to the surrounding structures. In the NRELAP5 model, the ultimate heat sink (UHS) consists of the reactor pool and refueling pool, and is modeled as a well-mixed, bulk volume. The temperature of the UHS affects the CNV pressure during a postulated accident sequence and in turn, the potential inventory loss that may be released through an open CES line penetration. That is, cooler UHS temperatures maintain the CNV near atmospheric pressure while warmer UHS temperatures can result in higher CNV pressures and a relatively higher inventory loss rate. As described in FSAR Section 9.2.5.2, the UHS temperature is maintained within an operational control band; the UHS normal operating temperature is 100 degrees Fahrenheit.

To evaluate the use of NRELAP5 with its well-mixed, bulk volume UHS model, an additional analysis was performed to independently model heat transfer and mixing in the UHS. Specifically, a computational fluid dynamics (CFD) model was used to analyze the flow of heated fluid in the UHS from a module bay to the volume of the refueling pool. The refueling pool was treated as a steady-state boundary condition of 100 degrees Fahrenheit. The best estimate, end-of-cycle decay heat from a module is less than 2.0 megawatts after approximately two hours and less than 1.0 megawatt after approximately 17 hours; the CFD analysis conservatively assumed a constant heat load of 2.0 megawatts. The CNV heat load boundary condition is representative of steady state ECCS operation and is independent of initiating event. The CFD analysis results demonstrate that effective mixing in the UHS occurs, as indicated by insignificant local heatup in the module bay. The temperature in the module bay remains within three degrees of the bulk UHS temperature; this minor temperature increase supports the assumption in the NRELAP5 model that the UHS will be well-mixed, and hence it is realistic to represent the UHS as a bulk volume. Similarly, the CFD analysis supports the NRELAP5 result that the CNV remains near or below atmospheric pressure thereby minimizing the amount of coolant lost from the CNV. While the simulations were performed at a pool temperature of 100 degrees Fahrenheit, temperature-dependent properties of water including viscosity and thermal expansivity indicate that natural circulation flow and mixing will be enhanced at higher temperatures. The NRELAP5 results also indicate that a heatup of the UHS above 150 degrees Fahrenheit is required before the CNV would begin to increase above atmospheric pressure (and hence result in additional coolant inventory loss); Technical Specification 3.5.3 specifies a limiting condition of operation on UHS temperature of less than or equal to 140 degrees Fahrenheit. Initial UHS temperatures below 100 degrees Fahrenheit would extend the time of UHS heatup and the associated potential CNV pressure increase.

Although spent fuel could add an additional heat load to the UHS, the effect of this contribution is insignificant because the potential additional heat load contributed to the UHS is offset by the additional pool inventory in the spent fuel pool (SFP). Considering the bounding case of a maximum heat load from 18 years of spent fuel and one batch of freshly unloaded fuel per FSAR Section 9.2.5.4, and the additional water volume of the SFP, the resulting temperature increase in the bulk UHS is less than five degrees Fahrenheit over a 72 hour period. Similarly, a scenario that results in all twelve modules rejecting heat to the UHS (e.g., an extended loss of power) does not affect the conclusion of successful ECCS cooling for 72 hours if a module experiences an open CES line penetration.

**Impact on DCA:**

There are no impacts to the DCA as a result of this response.