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Subject:	Request for Additional Information No. 83, RAI 8899
Attachments:	Request for Additional Information No. 83 (eRAI No. 8899).pdf

Attached please find NRC staff's request for additional information concerning review of the NuScale Design Certification Application.

Please submit your response within 60 days of the date of this RAI to the NRC Document Control Desk.

If you have any questions, please contact me.

Thank you.

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301-415-0546

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Request for Additional Information No. 83 (eRAI No. 8899)

Issue Date: 07/07/2017
Application Title: NuScale Standard Design Certification - 52-048
Operating Company: NuScale Power, LLC
Docket No. 52-048
Review Section: 19.01 - Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed
Application Section: 19

QUESTIONS

19.01-1

10 CFR 52.47(a)(27) states that a Design certification application (DCA) must contain a Final Safety Analysis Report (FSAR) that includes a description of the design-specific probabilistic risk assessment (PRA) and its results. In SECY 93-087, the Commission approved use of the seismic margin approach (SMA) for DCAs in lieu of a seismic PRA. Per the guidance in DC/COL-ISG-20, "Interim Staff Guidance on Implementation of a Probabilistic Risk Assessment-Based Seismic Margin Analysis for New Reactors," and Regulatory Guide 1.200, the seismic fragility calculation should use the response spectrum shape defined as the DCA's Certified Seismic Design Response Spectra (CSDRS).

In FSAR Section 19.1.5.1.1.2, "Seismic Input Spectrum," only the peak ground acceleration (pga) for the seismic input spectrum is described. The staff requests that the applicant include a definition of the review level earthquake (RLE), including the shape and magnitude, in the FSAR. The applicant should also clarify the following FSAR statements related to the seismic input.

- In FSAR Section 19.1.5.1.1.1, "Seismic Analysis Methodology and Approach," the applicant states, "The SMA analysis must be performed relative to a review level earthquake of 1.67 times the safe shutdown earthquake (SSE)." The staff requests that the applicant clarify that the RLE is defined relative to the CSDRS.
- In FSAR Section 19.1.5.1.1.2, "Seismic Input Spectrum," the applicant states, "The component fragility is referenced to the peak ground acceleration defining the uniform hazard response spectra for a site, which is the [safe shutdown earthquake (SSE)]." An identical statement also exists on page 19.1-59 of the FSAR. Because a DCA does not contain site-specific information, the staff requests that the applicant describe the applicability of the uniform hazard response spectra (UHRS) to the PRA-based SMA.
- In the same FSAR statement referenced above, the staff notes that reference is made only to the component fragility. The staff requests that the applicant clarify that the RLE is the seismic input for the fragility evaluation of structures, systems, and components (SSCs).

19.01-2

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results in lieu of a seismic PRA. SECY 93-087 approves an alternative approach to seismic PRA for the DCA and ISG-20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

In FSAR Tier 2, Section 19.1.5, the staff identified the use of the terms "PRA-critical" and "Non-critical." The staff requests that the applicant provide a definition of the terms "PRA-critical" and "non-critical" that are consistent with their usage as listed below and applicability to the PRA-based SMA.
The terms are used in the following sections.

- "Non-critical"
    - Section 19.1.5.1.1.3, Page 19.1-54
- "PRA-critical"
    - Section 19.1.5.1.1.3, Page 19.1-58
    - Section 19.1.5.1.1.3, Page 19.1-59
    - Section 19.1.5.1.2, Page 19.1-63

- Section 19.1.5.1.2, Page 19.1-64

Additionally in Section 19.1.5.1.1.3, the 2nd paragraph describes the methodologies used to determine the seismic capacity and demand for the SMA. The staff requests that the applicant clarify if the 1st sentence in that paragraph is referring to PRA-critical structures and components. The applicant should also clarify if non-critical components are modeled in the SMA and whether there are any non-critical structures.

19.01-3

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the seismic margin approach (SMA) for DCAs in lieu of a seismic PRA. As specified in ISG-20, a PRA-based SMA for a DCA provides results that include all identified seismically initiated accident sequences, the Seismic Equipment List with High Confidence of Low Probability of Failure (HCLPF) values and associated failure modes, and plant and sequence HCLPFs, as well as risk insights for seismic events.

a. The staff reviewed Table 19.1-38 and noted that approximately 20 SSCs have HCLPF values below 0.88g. Some of these are addressed in the text of the report, for instance, the reactor module corbel bearing failure HCLPF capacity. The staff requests that the applicant provide additional information in the FSAR to clarify that these SSCs do not contribute to the plant level HCLPF capacity or otherwise provide justification for HCLPF capacities below 0.88g. The staff additionally requests that the applicant include a column in Table 19.1-38 that includes the HCLPF capacities for the listed SSCs.

b. In FSAR Section 19.1.5.1.2, Subheading, “Significant Component Failure Modes,” the applicant states, “Moreover, component fragilities reported in Table 19.1-38 show a high degree of component seismic robustness.” The staff requests that the applicant quantify what is meant by seismic robustness. The applicant should also clarify whether this statement applies to PRA-critical SSCs only or all SSCs listed in Table 19.1-38.

19.01-4

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results in lieu of a seismic PRA. SECY 93-087 approves an alternative approach to seismic PRA for the DCA and ISG-20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a design certification (DC).

In FSAR Tier 2, Subsection 19.1.5.1.1.3, the applicant provides a list of three criteria for selecting structures for fragility evaluation. The 2nd criterion states the structures directly connected to the module interface are the reactor bay walls, pool wall, and pool floor. The latter two are bounded in terms of fragility by the reactor building (RXB) outer wall failure. The 3rd criterion states that the roof of the RXB and the pool wall fragility are bounded by the outer wall fragility analysis. The staff requests that the applicant provide the technical basis for the assumption that the RXB roof, pool floor, and pool walls are bounded by the RXB outer wall failure.

19.01-5

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA for DCAs in lieu of a seismic PRA.

The staff reviewed FSAR Tier 2, Section 19.1.5, and finds that the DCA lacks information on equipment qualified via tests. As described in Section 5.1.2 of ISG-20, a description of the procurement specifications (including the enhanced required response spectra (RRS)) should be provided in the DCA. The staff requests that the applicant address the RRS in the DCA or otherwise justify that the procured equipment qualified via tests will have adequate margin.

19.01-6

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA for DCAs in lieu of a seismic PRA.

In FSAR Section 19.1.5.1.2 “Uncertainties,” the applicant states, “For PRA-critical SSC that are the subject of detailed fragility, uncertainty parameters are also assigned to each sub-factor that contributes to the overall safety factor.” The staff requests that the applicant describe whether the method used to assign uncertainties to each sub-factor is consistent with the derivation of the overall safety factor as described in EPRI TR-103959 or provide additional information on the methods used to determine uncertainty parameters.

19.01-7

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA for DCAs in lieu of a seismic PRA.

The staff reviewed Table 19.1-40, and noted that for row eight, which describes the fragility evaluation of SSC that do not contribute significantly to the seismic safety margin, the basis is engineering judgement and common engineering practice. The staff requests that the applicant justify the approach and explain whether it is consistent with the American Society of Mechanical Engineers (ASME)/American Nuclear Society (ANS) PRA Standard (ASME/ANS RA-Sa-2009, “Addenda to ASME/ANS Ra-S-2008 Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications"). The staff requests that this justification include a description of the basis for determining which SSCs do not contribute significantly to the seismic safety margin.

19.01-8

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DCA and ISG 20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

The staff reviewed FSAR Section 19.1.5.1.1.3, Subsection “NuScale Power Module Supports,” and could not find information it needs to verify the adequacy of the PRA-based SMA. The FSAR states, “Corbel bearing failure is expected to crush the corbel concrete in compression, causing minor axial rotation of the module resulting in a displacement assumed to be no more than 1 inch for the CNV. Because the flexibility in the piping is in the section between the isolation valve and the wall penetration, there is no credible mechanism for the bearing failure displacement to cause piping on top of the CNV to shear off the vessel.” The staff requests that the applicant describe the analysis that provides the technical basis for concluding that minor axial rotation of the module results in a displacement assumed to be no more than 1 inch. The applicant should also clarify how the flexibility in the piping prevents the piping on top of the CNV from shearing off of the vessel. The staff additionally requests that the applicant identify the entries in Table 19.1-38 that correspond to the containment isolation valves (CIVs) for this sequence.

19.01-9

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DCA, and ISG 20 provides guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

During its audit of the NuScale PRA (ML17087A109), the staff reviewed ER-P040-7026-R0, “Seismic Margin Assessment Notebook,” Appendix J, and discovered that the applicant identified a chemical volume and control system (CVCS) isolation valve (ISV) as a PRA-critical component. The staff requests that the applicant identify the valves listed in Table 19.1-38 that correspond to the CVCS ISVs. Additionally, the staff requests that the applicant identify other generically named SSCs in Table 19.1-38.

19.01-10

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DCA and ISG 20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

a. The staff reviewed FSAR Section 19.1.5.1.2 and identified the following statement, “This leaves corbel shear failure and Reactor Building Crane (RBC) failure as having the limiting HCLPFs.” Because structural events are assumed to lead to core damage, and Table 19.1-35 appears to identify the Reactor Building Wall and the Reactor Bay Wall (also see RAI 8899, Question 30006) as more limiting than corbel shear failure, the staff requests that the applicant clarify what is meant by this statement in the context of Table 19.1-35.

b. The staff reviewed Key Insights in FSAR Section 19.1.5.1.2 and noted the following passage: “A structural failure sequence involving collapse of the reactor crane is the most important contributor to the seismic margin. Other sequences include one or more random failures after the seismic event. These failures occur among the same general components and sequences that lead to core damage in the internal events PRA” The staff requests that the applicant clarify in the FSAR whether other structural events, in addition to collapse of the reactor crane, are important contributors to the seismic margin.

19.01-11

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DCA and ISG 20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

The staff reviewed FSAR Section 19.1.5 and Table 19.1-38 and noted that the reactor internals and core assembly are not included as a component in Table 19.1-38. The staff determined it needs additional information to verify the adequacy of the fragility evaluation. Specifically, the staff requests that the applicant provide the basis for why the reactor internals and core assembly are not included in the fragility analysis. The applicant should consider the configuration of the reactor internals and core assembly for at power and low power/shutdown conditions when providing the basis.

19.01-12

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA for DCAs in lieu of a seismic PRA.

a. During an audit of the PRA (ML17087A109), the staff reviewed ER-P040-7026-R0, “Seismic Margin Assessment Notebook,” Appendix J. The applicant summarized the contractor-supplied fragility calculations for PRA-critical SSCs. The staff identified the emergency core cooling system (ECCS) reactor vent valves (RVVs) as PRA-critical. Because these valves are PRA-critical components, the staff requests that the applicant provide additional information that demonstrates the ECCS RVVs do not contribute to the plant level seismic margin.

b. Based on the staff's review of ER-P040-7026-R0 during its audit of the PRA (ML17087A109), the staff identified inconsistencies between the HCLPF capacities calculated by separate contractors for the ECCS RVVs. The results are summarized below.

	Capacity (A_m)	Uncertainty (β_c)	HCLPF (g)
1	17.45	0.46	6.09
2	2.38	0.57	0.66

The HCLPF value in FSAR Tier 2 Table 19.1-38 corresponds to the lower HCLPF capacity in the table above. The staff requests that the applicant describe the differences in the calculations that contributed to a variance (by an order of magnitude) on the evaluation of HCLPF capacity for the ECCS RVVs

19.01-13

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA) for DCAs in lieu of a seismic PRA.

During its audit of the PRA (ML17087A109), the staff reviewed ER-P040-7026-R0, "Seismic Margin Assessment Notebook," Appendix J. The applicant summarized the contractor-supplied fragility calculations for PRA-critical SSCs. The staff identified inconsistencies between the HCLPF capacities calculated by separate contractors for the Control Rod Guide Tube (CRGT). The results are summarized below.

	Capacity (A_m)	Uncertainty (β_c)	HCLPF (g)
1	3.63	0.49	1.19
2	1.17	0.50	0.37

The data provided in FSAR Tier 2 Table 19.1-38 corresponds to the 1st row above. Because the calculated HCLPF varies substantially between the contractors and the CRGT is a PRA-critical component, the staff requests that the applicant justify the use of the selected HCLPF capacity given that the median capacities supplied by the separate contractors vary from 1.17 to 3.63 and the HCLPF capacity from 0.37g to 1.19g. The applicant should also describe whether the CRGT contributes to the plant level seismic margin.

19.01-14

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the seismic margin approach (SMA) for DCAs.

During its audit of the PRA (ML17087A109), staff reviewed ER-P040-7026-R0, "Seismic Margin Assessment Notebook," Appendix J. The applicant summarized the contractor-supplied fragility calculations for PRA-critical SSCs. The staff identified differences between the contractor-supplied HCLPF capacities for the RBC. The results are summarized below.

	Capacity (A_m)	Uncertainty (β_c)	HCLPF (g)
1	2.64	0.48	0.88
2	2.33	0.50	0.74

The HCLPF capacity provided in the FSAR corresponds to the higher HCLPF capacity (in row 1 above) supplied by the contractors. The failure modes considered are for the bridge and trolley seismic restraint assemblies. The controlling HCLPF capacity is determined to correspond to the seismic bridge restraint weldment.

A note is provided below Table J.10 in relation to the lower HCLPF capacity (in row 2 above). The note states that "The fragility for the reactor building crane is with respect to a bridge girder failure in shear. Upon further evaluation, catastrophic bridge girder failure will be preceded by bridge seismic restraint failure. Due to this realization, failure of the bridge seismic restraints are the controlling failure mode, rather than the bridge girder." This information is also summarized in Section 19.1.5.1.1.3, Subsection "Reactor Building Crane."

Based on the staff's review of ER-P-040-7026-R0, Appendix J, during its audit of the PRA (ML17087A109), the staff needs additional information to understand the basis for eliminating bridge girder failure in shear as a controlling failure mode for the RBC fragility evaluation. Because the RBC is PRA-critical and controls the plant level HCLPF capacity, the staff requests that the applicant provide further justification for eliminating the bridge girder failure in shear in the RBC fragility evaluation.

19.01-15

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DCA and ISG 20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

Based on the staff's review of NuScale FSAR Tier 2, Section 19.1.5, the staff needs additional information to confirm the validity of the applicant's HCLPF capacities. The staff expectation at the DC stage is that the design of structures within the scope of DC is essentially complete. To evaluate the application, the staff requests that the applicant demonstrate that the seismic margin of 1.67 times the CSDRS is met for the seismic Category I structures against seismic-induced sliding and overturning.

19.01-16

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DCA, and ISG 20 provides guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC. In accordance with ISG 20, the operating modes to be considered include at power, low power, and shutdown.

The staff reviewed FSAR Tier 2 Section 19.1.6.3, "Safety Insights from the External Events Probabilistic Risk Assessment for Low Power and Shutdown Operation" and noted that the Containment Vessel Flange Tool (CFT) and the Reactor Vessel Flange Tool (RFT) are not included in the SMA even though in FSAR Section 9.1.5 (1) the RFT and the Module Lifting Adapter are classified as Seismic Category I and (2) the CFT is classified as Seismic Category II. The RFT, the CFT, and the Module Lifting Adapter are not listed in FSAR Table 3.3-2. The staff requests that the applicant include the RFT, the Module Lifting Adapter, and the CFT in the SMA and in FSAR Table 3.3-2 or justify why these components are not listed in the table.

19.01-17

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA for DCAs in lieu of a seismic PRA.

In reviewing FSAR Tier 2 Section 19.1.5, the staff identified several statements that require clarification. The staff requests that the applicant clarify the following descriptions:

a. In FSAR Tier 2 Section 19.1.5.1.2, "Results from the Seismic Risk Evaluation," the applicant states, "SMAs are required to show that the plant level HCLPF is greater than 1.67 times the design basis SSE, which equates to a 0.84g peak ground acceleration for NuScale." The staff requests that the applicant clarify that the design basis SSE and the SSE are the same.

b. In FSAR Tier 2, Table 19.1-35, the parameters associated with the "reactor module supports – corbel bearing failure" do not produce the HCLPF in the table. The β_u uncertainty value is also inconsistent with that provided in Table 19.1-38. The staff requests that the applicant clarify which are the correct parameters and HCLPF capacity.

c. In FSAR Tier 2, Table 19-1-38, the applicant provides the seismic correlation class information, which includes structural fragility parameters. The staff requests that the applicant confirm that, consistent with Section 19.1.5.1.1.3, which states that all SSC modeled in the internal events PRA were included in the fragility analysis, Table 19.1-38 comprehensively includes these SSCs.

d. In FSAR Tier 2, Table 19.1-35, the values provided for the reactor bay wall median capacity and uncertainties are inconsistent with the HCLPF capacity provided. The staff requests that the applicant clarify the correct HCLPF capacity, median capacity and uncertainties in Table 19.1-35 and Table 19.1-38.

19.01-18

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA for DCAs in lieu of a seismic PRA. Per the guidance in DC/COL-ISG-20, combined operating license (COL) action items ensure a coherent and consistent process for the quality of PRA-based seismic margin assessment to adequately meet 10 CFR 52.47(a)(27).

Based on the staff's review of NuScale FSAR Tier 2 Section 19.1.5 and COL Item 19.1-7, the staff finds that additional information is needed by the COL application to incorporate the DC by reference. Consistent with DC/COL-ISG-20, Section 5.1.4, the staff requests the applicant to address the following and include this information in the FSAR:

a. A COL applicant should ensure that the PRA-based seismic margin analysis and its results remain valid and reflect the site-specific and plant-specific information for the site. The NRC staff requests that the applicant should evaluate site-specific effects such as soil liquefaction and slope failure as applicable.
b. A COL holder should verify the plant- and sequence-level HCLPF capacity based on the as-designed, as-built configuration of the plant before the initial loading of reactor fuel. This includes a seismic walk-down of the as-built plant.
c. A COL holder should ensure the failure of non-seismic Category I SSCs does not impact Seismic Category I SSCs for the review level earthquake. Explain how this will be confirmed by the COL holder.

19.01-19

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the (SMA for DCAs in lieu of a seismic PRA.

During its audit of the NuScale PRA (ML17087A109), In ER-P040-7026, “Seismic Margin Assessment Notebook,” Section 6.8, “Multi-Module Implications”, the applicant states that possible further refinements could be made to the SMA once additional information is available. The staff requests that the applicant clarify whether this additional information is from more complete NuScale design features or site-specific features and whether these are enhancements that NuScale intends to incorporate into the SMA.

19.01-20

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the SMA for DCAs in lieu of a seismic PRA.

In FSAR Section 19.1.5.1.1.3, Subheading “Reactor Building Crane,” the applicant states, “The bounding consequence of crane failure is a collapse of the crane structure, which is assumed to impact the top of the module, and lead to core damage and large release.” And in FSAR Section 19.1.7.3, “Insights Regarding External Events for Multi-Module Operation at Full Power,” the applicant states, “The bounding structural event is weldment failure on the crane bridge seismic restraints; the crane is assumed to be bearing load for the calculation of this fragility. Crane failure does not affect all modules simultaneously.”

During an audit of the PRA (ML17087A109), in ER-P040-7026-R0, “Seismic Margin Assessment Notebook,” Appendix J, staff noted that the same event is described as follows: “Significant portions of the crane (or the entire crane) are assumed to make contact with the reactor building pool during such an event. If such an event were to occur while the crane were over the reactor modules, core damage leading to large release is assumed.”

Based on the staff’s review of the above statements, the staff requests that the applicant provide additional information to support the assumption that failure of the crane does not impact multiple modules at the same time or, alternatively, include in the FSAR insights regarding external events for multi-module operation at full power assuming that crane failure impacts multiple modules.