RAIO-1018-62392

October 31, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 221 (eRAI No. 9114) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 221 (eRAI No. 9114)," dated September 12, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 221 (eRAI No.9114)," dated November 13, 2017
3. NuScale Power, LLC Supplemental Response to "NRC Request for Additional Information No. 221 (eRAI No. 9114)" dated February 21, 2018
4. NuScale Power, LLC Supplemental Response to "NRC Request for Additional Information No. 221 (eRAI No. 9114)" 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 Enclosures to this letter contain NuScale's supplemental response to the following RAI Question from NRC eRAI No. 9114:

- 03.07.02-31

Enclosure 1 is the proprietary version of the NuScale Supplemental Response to NRC RAI No. 221 (eRAI No. 9114). NuScale requests that the proprietary version be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The enclosed affidavit (Enclosure 3) supports this request. Enclosure 2 is the nonproprietary version of the NuScale response.

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

If you have any questions on this response, please contact Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9114, proprietary

Enclosure 2: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9114, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-1018-62393

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9114, proprietary

Enclosure 2:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9114, nonproprietary

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

eRAI No.: 9114

Date of RAI Issue: 09/12/2017

NRC Question No.: 03.07.02-31S3

10 CFR 52.47(a)(20) requires that an application for Design Certification must include the information necessary to demonstrate that the standard plant complies with the earthquake engineering criteria in 10 CFR 50, Appendix S. 10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake (SSE) through design, testing, or qualification methods.

FSAR Tier 2, Section 3A.1 states the seismic analysis of the NuScale Power Module (NPM) is provided in technical report, TR-0916-51502, “NuScale Power Module Seismic Analysis”. In TR-0916-51502, Section 3.1, the applicant indicates that NPM simplified beam models developed in ANSYS are incorporated into the RXB system model used in SAP2000 and SASSI2010 analyses. In TR-0916-51502, Section 6.0, the applicant discusses how NPM simplified beam models were derived from the corresponding NPM detailed 3D models in ANSYS. However, the staff notes that the NPM beam models depicted in Figure 6- 1 (dry) and Figure 6-13 (wet) in TR-0916-51502 appear to be different than the model shown in FSAR Figure 3.7.2-28, which FSAR Section 3.7.2.1.2.2 states represents the SASSI2010 NPM beam model.

Therefore, the applicant is requested to explain how the NPM beam models included in the SAP2000/SASSI2010 RXB models were developed and validated (e.g., comparison of dynamic characteristics between the detailed and simplified models).

NuScale Response:

NRC Supplemental Questions:

In its 05/15/2018 response to RAI 9114, Question 03.07.02-31, the applicant provided a table (Table 1) that compares the dynamic modal properties between the simplified NPM beam model and detailed 3D model and stated that the simplified beam model captures the overall dynamic behavior of the 3D model.

1. The staff notes that there are some differences between the tables included in RAI responses dated 02/21/2018 and 05/15/2018, particularly in the values of 3D model modal frequencies. Please explain why these differences exist between the two responses? - addressed in 6/26 call, no change necessary
2. In Table 1, values for X-Frequency and X-Effective Mass for the 3D model corresponding to the 3rd mode of the beam model (17.14 Hz and 284 slinch) are missing. Explain or clarify this omission. - addressed in 6/26 call, no change necessary
3. Based on Table 1, the cumulative effective masses for the beam model in the X, Y, and Z directions are 6775, 6802, and 4874, respectively. Explain the low cumulative mass for the Z direction.
4. Staff requested (in staff's 04-17-18 feedback) that the applicant provide more detailed information about the parameters and their values considered in the model validation process and an assessment of how they demonstrate the dynamic compatibility between the NPM beam model and 3D model. However, the response did not include any such assessment. Please provide an assessment (narrative) as to how the dynamic properties shown in Table 1 demonstrate dynamic compatibility of the two models.
5. In the previous RAI response (dated 02/21/2018), the applicant proposed to include the comparison table in the FSAR. However, in the current RAI response, the proposed table was deleted in the FSAR markup. The staff considers this comparison table to be an important basis of staff's determination of acceptability of the NPM beam model integrated into the RXB dynamic model for SSI analysis. Therefore this information should be included in the FSAR.

NuScale Response to Supplemental Questions:

1. Addressed in a meeting on June 26, 2018, no changes required.
2. Addressed in a meeting on June 26, 2018, no changes required.
3. The low cumulative mass in the Z (vertical) direction is due to less added water mass in vertical direction compared to X and Y (horizontal or lateral) directions. The NPM is a partially-submerged cylindrical body, and the added mass which is the mass of the water around the NPM that will be displaced as NPM moves is significantly lower in vertical direction than the horizontal directions. The total dry mass of the beam model is {{4218 slinch, and the total wet masses are 7099 and 4874 slinch}}[2(a),(c)] in horizontal and vertical directions, respectively. Directional mass elements were used in developing the ANSYS beam model to account for the difference in mass between horizontal and vertical directions. The beam model cumulative masses provided in Table 1 closely match the total mass in X, Y, and Z directions.
4. A narrative has been added to demonstrate dynamic compatibility between the NPM beam model and the 3D model using the results from the modal analysis.
5. The table is included below. It should be noted that this table contains NuScale proprietary information, and thus will not be included in the FSAR. However, it is included in TR-0916-51502, the NuScale Power Module Seismic Analysis, Revision 1.

Table 1: Mode comparisons between simplified NPM beam model and 3D model for development

{{

}}2(a),(c)

Impact on DCA:

FSAR Section 3.7.2 and TR-0916-51502 have been revised as described in the response above and as shown in the markup provided with this response.

The rigid springs have a zero length and have a stiffness value large enough to simulate rigid connection. The large stiffness used is arbitrarily chosen to be ten billion lbs per inch, or 10^{10} lbs/inch, in the three global directions.

The model dimensions, the quantities of elements and masses, and structural damping ratios used for the SASSI2010 model are summarized in Table 3.7.2-1.

The NPMs and the Reactor Building crane (RBC) are included in the RXB model as beam models. These two subsystems are discussed in the following sections.

RAI 03.08.05-12S2

The reactor building basemat is designed using a combination of different models. First, the structural responses from the building models are extracted. Then they are applied to separate basemat models to determine structural design forces and moments for the basemat. Table 3.7.2-49 and Table 3.7.2-50 show which models are used, what results are extracted, and how these results are used to design the basemat.

3.7.2.1.2.2 NuScale Power Modules

Up to twelve NPMs will be inside the RXB. The modules are partially immersed in the reactor pool. The NPMs are not permanently bolted or welded to the pool floor or walls. Instead they are geometrically supported and constrained at four locations. The geometrical constraints are designed to keep each NPM in its location before, during, and after a seismic event.

The base support is a steel skirt that rests outside a permanently installed ring plate attached at the bottom of the reactor pool. The other three geometrical supports are steel lug restraints located on the walls of each bay at approximately the midpoint of the module (~EL. 75'). The NPM has lugs that align with a slot in the restraint. Each restraint prevents movement in the direction parallel to the wall and allows the NPM to move freely in the upward direction. In other words, the lug and restraint provides only horizontal restraint in the in-plane direction for the supporting wall.

The lug and lug restraint combination is shown in Figure 3.7.2-22. Figure 3.7.2-23 shows the top view of a restrained NPM. The placement of the twelve NPMs in the model of the RXB is shown in Figure 3.7.2-24. An enlarged view of the NPM pool region is shown in Figure 3.7.2-25.

Figure 3.7.2-26 shows a view of the RXB model with twelve NPMs within the support walls. The lug restraints can be seen near the mid-height of the NPMs in the figure. Figure 3.7.2-27 shows a single NPM. In this figure, the lug restraint can be seen at the upper part of the NPM and the support skirt can be seen at the base of the NPM.

NuScale Power Module Model Included in the Reactor Building SASSI2010 Model

RAI 03.07.02-10S1, RAI 03.07.02-20, RAI 03.07.02-20S1, RAI 03.07.02-31S1, RAI 03.07.02-31S2, RAI 03.07.02-31S3

Within the SASSI2010 building model, the NPM is represented by a beam model as shown in Figure 3.7.2-28. The beam model was developed to have similar dynamic characteristics as a 3-D ANSYS model of a single NPM bay. To validate the NPM beam model, a modal analysis in three directions was performed in order to tune the simplified model to match the detailed 3-D model response. The frequencies for the most significant modes are shown in Table 6-21 of TR-0916-51502 and demonstrate dynamic compatibility with the 3-D model by matching mode frequencies with significant mass participation, thereby assuring adequate force transfer through the building dynamic response. The simplified beam model captures the overall dynamic behavior of the 3-D NPM model required for the building response analyses used in the SASSI2010 and SAP2000 models. The skirt support at the base of the containment restricts horizontal and vertical movements. Eight rigid beams arranged like the legs of a spider are modeled to connect the NPM model containment skirt to nodes in the building model located at the interface of the skirt and pool floor. Table 3.7.2-36 and Table 3.7.2-37 outline the NPM beam model to RXB model interface boundary conditions for the SASSI2010 and ANSYS models, respectively.

RAI 03.07.02-10S1

Detailed NuScale Power Module Model Included in the Reactor Building SASSI2010 Model

RAI 03.07.02-10S1

The RXB-NPM interface and NPM specific analyses replace the simplified beam model with a more detailed NPM beam model. The reactor building is structurally similar to the SASSI2010 model previously described. The NPM beam models are replaced with the detailed beam models for selected SSI analyses to evaluate the RXB-NPM interactions. The development and validation of the detailed beam model and the SASSI2010 reactor building model with detailed beam model are provided in Appendix 3A. The RXB analysis produces local acceleration time histories that are used as input to the NPM seismic analysis. The seismic analysis of the NPM is discussed in Appendix 3A.

RAI 03.07.02-10, RAI 03.07.02-10S1, RAI 03.07.02-10S2

At the interface between the NPM and the RXB, the design loads for the skirt supports are defined as the envelope of the SASSI2010 building model and the 3-D model discussed in Appendix 3A and Appendix 3B.2.7. The lug supports are designed for a generic capacity in a detailed submodel and checked against the design loadsreaction forces from the SASSI2010 building model and 3-D model. This is described in more detail in Appendix 3B.2.7.

3.7.2.1.2.3 Reactor Building Crane

The RBC is a bridge crane used to transport modules between the operating locations and the refueling and disassembly area and the drydock. The RBC travels on rails on the top of the reactor pool walls at EL. 145'-6". When not in use, the RBC is parked over the refueling pool with the trolley at the north end

6.7 Beam Model Used for Building Analyses

Another simplified NPM beam model was used for the reactor building analyses as discussed in Section 3.7 of the FSAR. This beam model was developed to have similar dynamic characteristics as a simplified 3D ANSYS model in a single NPM bay. To validate the NPM beam model, a modal analysis was performed in order to tune the simplified model to match the detailed 3D model response. The frequencies for the most significant modes are shown in Table 6-21 which demonstrate dynamic compatibility with the simplified 3D model by matching mode frequencies with significant mass participation, thereby assuring adequate force transfer through the building dynamic response. The simplified beam model captures the overall dynamic behavior of the 3D NPM model required for the building response analyses used in the SASSI2010 and SAP2000 models. This simplified beam model is compatible with the approach by which the fluid mass was applied in the building structure, as described in Section 3.7.2.1.2.4 of the FSAR.

Verification was performed to demonstrate that the building model is not susceptible to the differences between the simplified and detailed NPM beam model. This check was performed in the NPM support walls to show that the RXB design is robust and demand to capacity ratios are acceptable. In addition, the maximum lug reactions are shown to be within the acceptable range of the NPM lug support capacity for both models. This proves that the changes in models have minimal impact to the RXB response, and that either model provides adequate dynamic response for the design of the building structure.

Table 6-21 Major mode comparisons between simplified NuScale Power Module beam model and simplified 3D model

Simplified Beam Model[1]		Simplified 3D Model[2]	
X-Frequency (Hz)	**X-Effective Mass (slinch)**	**X-Frequency (Hz)**	**X-Effective Mass (slinch)**
{{			
			}}2(a),(c)
Z-Frequency (Hz)	**Z-Effective Mass (slinch)**	**Y-Frequency (Hz)**	**Y-Effective Mass (slinch)**
{{			
			}}2(a),(c)
Y-Frequency (Hz)	**Y-Effective Mass (slinch)**	**Z-Frequency (Hz)**	**Z-Effective Mass (slinch)**
{{			
			}}2(a),(c)

[1] Simplified NPM beam model used in dynamic building response analyses.

[2] Early adaptation of the detailed 3D model of NPM, mode frequency and effective mass closely match the updated 3D model modal analysis results detailed in Table 8-1.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-1018-62393

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
www.nuscalepower.com

NuScale Power, LLC

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

1. I am the Director, Regulatory Affairs of NuScale Power, LLC (NuScale), and as such, I have been specifically delegated the function of reviewing the information described in this Affidavit that NuScale seeks to have withheld from public disclosure, and am authorized to apply for its withholding on behalf of NuScale.
2. I am knowledgeable of the criteria and procedures used by NuScale in designating information as a trade secret, privileged, or as confidential commercial or financial information. This request to withhold information from public disclosure is driven by one or more of the following:
    a. The information requested to be withheld reveals distinguishing aspects of a process (or component, structure, tool, method, etc.) whose use by NuScale competitors, without a license from NuScale, would constitute a competitive economic disadvantage to NuScale.
    b. The information requested to be withheld consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), and the application of the data secures a competitive economic advantage, as described more fully in paragraph 3 of this Affidavit.
    c. Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.
    d. The information requested to be withheld reveals cost or price information, production capabilities, budget levels, or commercial strategies of NuScale.
    e. The information requested to be withheld consists of patentable ideas.
3. Public disclosure of the information sought to be withheld is likely to cause substantial harm to NuScale's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying Request for Additional Information response reveals distinguishing aspects about the methodology by which NuScale develops its reactor building models used in the soil-structure interaction (SSI) and load combinations for the building models.

    NuScale has performed significant research and evaluation to develop a basis for this methodology and has invested significant resources, including the expenditure of a considerable sum of money.

    The precise financial value of the information is difficult to quantify, but it is a key element of the design basis for a NuScale plant and, therefore, has substantial value to NuScale.

    If the information were disclosed to the public, NuScale's competitors would have access to the information without purchasing the right to use it or having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of NuScale's intellectual property, and would deprive NuScale of the opportunity to exercise its competitive advantage to seek an adequate return on its investment.

4. The information sought to be withheld is in the enclosed response to NRC Request for Additional Information No. 221, eRAI No. 9114. The enclosure contains the designation "Proprietary" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.
5. The basis for proposing that the information be withheld is that NuScale treats the information as a trade secret, privileged, or as confidential commercial or financial information. NuScale relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR §§ 2.390(a)(4) and 9.17(a)(4).
6. Pursuant to the provisions set forth in 10 CFR § 2.390(b)(4), the following is provided for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld:
    a. The information sought to be withheld is owned and has been held in confidence by NuScale.
    b. The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, chief technology officer or other equivalent authority, or the manager of the cognizant marketing function (or his delegate), for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside NuScale are limited to regulatory bodies, customers and potential customers and their agents, suppliers, licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or contractual agreements to maintain confidentiality.
    c. The information is being transmitted to and received by the NRC in confidence.
    d. No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.
    e. Public disclosure of the information is likely to cause substantial harm to the competitive position of NuScale, taking into account the value of the information to NuScale, the amount of effort and money expended by NuScale in developing the information, and the difficulty others would have in acquiring or duplicating the information. The information sought to be withheld is part of NuScale's technology that provides NuScale with a competitive advantage over other firms in the industry. NuScale has invested significant human and financial capital in developing this technology and NuScale believes it would be difficult for others to duplicate the technology without access to the information sought to be withheld.

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 31, 2018.

Zackary W. Rad