RAIO-0818-61558

August 24, 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. 110 (eRAI No. 8932) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 110 (eRAI No. 8932)," dated July 30, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 110 (eRAI No.8932)," dated May 22, 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. 8932:

- 03.07.02-6

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 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
Marieliz Vera, NRC, OWFN-8G9A

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8932

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8932

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

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

eRAI No.: 8932
Date of RAI Issue: 07/31/2017

NRC Question No.: 03.07.02-6

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.

a. DSRS 3.7.2 provides guidance that effects of potential separation or loss of contact between the structure and the soil during the earthquake should be considered in SSI analysis. On Page 3.7-23 of the FSAR, in the second paragraph from the bottom, the applicant states, “To model the soil separation, the Young's modulus of the backfill elements down to a depth of 25’ (the top four layers of backfill elements) was decreased by a factor of 100.” The applicant is requested to provide a basis for 25 ft of separation depth. Also, please clarify if the modulus reduction by a factor of 100 applies only to the backfill elements interfacing with the exterior walls or to all the backfill elements outside the exterior walls.

b. On Page 3.7-23 of the FSAR, in the bottom paragraph, the applicant states, “Soil separation has negligible effect on the response of the structure. The primary point of comparison is at the NPM. The study showed that the maximum reaction force at the base of the NPMs decreased by approximately 5 percent, and the maximum reaction force at the NPM lug restraints decreased by more than 15 percent.” The applicant is requested to provide information on soil separation effect on computed transfer functions and seismic demands (forces, ISRS) at critical section locations and external walls. Please provide comparison plots for results between the intact and soil-separated cases. When soil- separation results in increased seismic demands, such increased demands should be taken into account in establishing the design basis seismic demands.

c. The staff notes that a soil-separation study was conducted for the RXB but not for the CRB. The applicant is requested to provide a technical justification for not conducting a similar study for the CRB.

NuScale Response:

During a Public Meeting on July 10, 2018, the NRC requested NuScale submit a supplemental response to this RAI. Further, the NRC provided the following details concerning past submittals for this question and clarification needed in the new supplemental response:

In its 05/22/2018 response to RAI 8932, Question 03.07.02-6, the applicant described a sensitivity study and provided an evaluation of soil separation effect on seismic demands for the Reactor Building (RXB) and Control Building (CRB).

1) The sensitivity study indicates enhanced ISRS due to soil separation at several locations; e.g. Figure 3.7.2-138 in the proposed FSAR markup (vertical ISRS for a CRB slab) indicates approximately 15% increase at the peak due to soil separation; however, no specific discussion of such exceedance is included in the markup. The applicant should discuss this exceedance and potential impact on equipment qualification for the affected floor in the FSAR markup as appropriate.

Response:

In the soil separation study, 11 locations were selected for comparison. The comparison of 33 ISRS with and without soil separation shows that the exceedances are isolated incidences. Most ISRS with soil separation are either bounded by or only slightly exceed (~ 5%) those without soil separation.

This comparison (Figure 3.7.2-138) is based on one analysis case of the cracked CRB, embedded in Soil Type 7, and subjected to the CSDRS-compatible Capitola input. However, since final qualification is based on the average of 5 inputs, the difference would be even smaller for the final design ISRS. The enveloping floor ISRS at CRB elevation 63′ 3" shown in FSAR Figure 3.7.2.117 has significant margin to envelop the 15% exceedance shown in Figure 3.7.2-138.

Therefore, the exceedance of ISRS at floor frequencies is of no concern.

In addition, a COL item has been added to the FSAR to require a site-specific evaluation to assess the effects of soil separation.

2) The applicant indicates that increases in seismic structural demands are within the design margins of the building components, leaving the building design unaltered. Please clarify/confirm whether this finding is applicable when all other concurrent loads are considered together with the increased seismic demands.

Response

It is confirmed that this is applicable when all other concurrent loads are considered with the seismic demands. The RXB and CRB have ample structural design margins to cover the seismic increases due to soil separation.

3) In the RAI, the staff indicated that when soil separation results in increased seismic demands; such increased demands should be taken into account in establishing the design basis seismic demands. The applicant is requested to evaluate whether the ISRS from the cases of soil separation in the sensitivity study are bounded by the design-basis ISRS envelope (described in FSAR Section 3.7.2.5). In such bounding evaluation, the applicant should make sure that a consistent structural damping value (4% or 7%) is used. If the increased ISRS due to soil separation are not bounded by the design-basis ISRS envelope, the applicant should provide a method that will ensure conservative equipment seismic demands.

Response

Four percent concrete and steel damping was used for the design basis ISRS generation and 7% concrete and 4% steel damping was used to determine the design basis structural demand forces and moments. However, the ISRS with soil separation effects comparison is based on one SSI analysis with cracked concrete, Soil Type 7, and 7% concrete and 4% steel damping subjected to one CSDRS-compatible Capitola input. The ISRS differences would be smaller for the averaged 5 CSDRS-compatible input time histories.

It should be noted that, regardless of which structural damping value was used for this study, the changes in the design demand forces and moments are small enough to be enveloped by the design margins of the buildings. All large equipment are explicitly modeled. Small equipment and components are modeled as distributed floor masses, therefore, small, narrow-band, peak ISRS exceedances are adequately checked in the comparison of structural demand forces and moments.

4) It is noted that the sensitivity study was performed using cracked concrete and 7% structural damping (FSAR Section 3.7.2.1.1.3, “Soil Separation” subsection). Please clarify if the ISRS from the sensitivity study are generated using 7% structural damping.

Response

For the soil separation study, 7% damping was used for both the RXB and CRB. Therefore, the ISRS comparison was based on the results with 7% damping. However, for the calculation of design ISRS without soil separation, 4% concrete damping was used, which is compatible with the FSAR models.

5) The staff notes that no evaluation is included in the RAI response for a reactor building crane support. Staff believes the crane support is a key location and should be included in the list.

Response

For the RXB crane, the shell elements on the north pool wall under the crane support nodes have been investigated. The maximum forces and moments among the selected elements calculated using the cracked, full FSAR RXB model with and without soil separation at 7% structural damping are compared. The maximum increase due to soil separation effects is observed to be less than 10%, which is covered by the design margin of the pool walls.

Impact on DCA:

FSAR Section 1.8 and 3.7.2 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 01-61, RAI 02.04.13-1, RAI 03.04.01-4, RAI 03.04.02-1, RAI 03.04.02-2, RAI 03.04.02-3, RAI 03.05.01.04-1, RAI 03.05.02-2, RAI 03.06.02-15, RAI 03.06.03-11, RAI 03.07.01-2, RAI 03.07.01-3, RAI 03.07.02-6S1, RAI 03.07.02-8, RAI 03.07.02-12, RAI 03.08.04-23S1, RAI 03.08.04-23S2, RAI 03.08.05-14S1, RAI 03.09.02-15, RAI 03.09.02-48, RAI 03.09.02-67, RAI 03.09.02-69, RAI 03.09.03-12, RAI 03.09.06-5, RAI 03.09.06-6, RAI 03.09.06-16, RAI 03.09.06-16S1, RAI 03.09.06-27, RAI 03.11-8, RAI 03.11-14, RAI 03.11-14S1, RAI 03.11-18, RAI 03.13-3, RAI 04.02-1S2, RAI 05.02.03-19, RAI 05.02.05-8, RAI 05.04.02.01-13, RAI 05.04.02.01-14, RAI 06.04-1, RAI 09.01.02-4, RAI 09.01.05-3, RAI 09.01.05-6, RAI 09.03.02-3, RAI 09.03.02-4, RAI 09.03.02-5, RAI 09.03.02-6, RAI 09.03.02-8, RAI 10.02-1, RAI 10.02-2, RAI 10.02-3, RAI 10.02.03-1, RAI 10.02.03-2, RAI 10.03.06-1, RAI 10.03.06-5, RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3, RAI 10.04.10-2, RAI 11.01-2, RAI 12.03-55S1, RAI 13.01.01-1, RAI 13.01.01-1S1, RAI 13.02.02-1, RAI 13.03-4, RAI 13.05.02.01-2, RAI 13.05.02.01-2S1, RAI 13.05.02.01-3, RAI 13.05.02.01-3S1, RAI 13.05.02.01-4, RAI 13.05.02.01-4S1, RAI 14.02-7, RAI 19-31, RAI 19-31S1, RAI 19-38, RAI 20.01-13

Table 1.8-2: Combined License Information Items

Item No.	Description of COL Information Item	Section
COL Item 1.1-1:	A COL applicant that references the NuScale Power Plant design certification will identify the site-specific plant location.	1.1
COL Item 1.1-2:	A COL applicant that references the NuScale Power Plant design certification will provide the schedules for completion of construction and commercial operation of each power module.	1.1
COL Item 1.4-1:	A COL applicant that references the NuScale Power Plant design certification will identify the prime agents or contractors for the construction and operation of the nuclear power plant.	1.4
COL Item 1.7-1:	A COL applicant that references the NuScale Power Plant design certification will provide site-specific diagrams and legends, as applicable.	1.7
COL Item 1.7-2:	A COL applicant that references the NuScale Power Plant design certification will list additional site-specific piping and instrumentation diagrams and legends as applicable.	1.7
COL Item 1.8-1:	A COL applicant that references the NuScale Power Plant design certification will provide a list of departures from the certified design.	1.8
COL Item 1.9-1:	A COL applicant that references the NuScale Power Plant design certification will review and address the conformance with regulatory criteria in effect six months before the docket date of the COL application for the site-specific portions and operational aspects of the facility design.	1.9
COL Item 1.10-1:	A COL applicant that references the NuScale Power Plant design certification will evaluate the potential hazards resulting from construction activities of the new NuScale facility to the safety-related and risk significant structures, systems, and components of existing operating unit(s) and newly constructed operating unit(s) at the co-located site per 10 CFR 52.79(a)(31). The evaluation will include identification of management and administrative controls necessary to eliminate or mitigate the consequences of potential hazards and demonstration that the limiting conditions for operation of an operating unit would not be exceeded. This COL item is not applicable for construction activities (build-out of the facility) at an individual NuScale Power Plant with operating NuScale Power Modules.	1.10
COL Item 2.0-1:	A COL applicant that references the NuScale Power Plant design certification will demonstrate that site-specific characteristics are bounded by the design parameters specified in Table 2.0-1. If site-specific values are not bounded by the values in Table 2.0-1, the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of its combined license application.	2.0
COL Item 2.1-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site geographic and demographic characteristics.	2.1
COL Item 2.2-1:	A COL applicant that references the NuScale Power Plant design certification will describe nearby industrial, transportation, and military facilities. The COL applicant will demonstrate that the design is acceptable for each potential accident, or provide site-specific design alternatives.	2.2
COL Item 2.3-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific meteorological characteristics for Section 2.3.1 through Section 2.3.5, as applicable.	2.3
COL Item 2.4-1:	A COL applicant that references the NuScale Power Plant design certification will investigate and describe the site-specific hydrologic characteristics for Section 2.4.1 through Section 2.4.14, ~~as applicable~~except Section 2.4.8 and Section 2.4.10.	2.4
COL Item 2.5-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific geology, seismology, and geotechnical characteristics for Section 2.5.1 through Section 2.5.5, below.	2.5

Table 1.8-2: Combined License Information Items (Continued)

Item No.	Description of COL Information Item	Section
COL Item 3.7-11:	A COL applicant that references the NuScale Power Plant design certification will perform a site-specific analysis that, if applicable, assesses the effects of soil separation. The COL applicant will confirm that the in-structure response spectra in the soil separation cases are bounded by the in-structure response spectra shown in FSAR Figure 3.7.2-107 through Figure 3.7.2-122.	3.7
COL Item 3.8-1:	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific program for monitoring and maintenance of the Seismic Category I structures in accordance with the requirements of 10 CFR 50.65 as discussed in Regulatory Guide 1.160. Monitoring is to include below grade walls, groundwater chemistry if needed, base settlements and differential displacements.	3.8
COL Item 3.8-2:	A COL applicant that references the NuScale Power Plant design certification will confirm that the site independent Reactor Building and Control Building are acceptable for use at the designated site.	3.8
COL Item 3.8-3:	A COL applicant that references the NuScale Power Plant design certification will identify local stiff and soft spots in the foundation soil and address these in the design, as necessary.	3.8
COL Item 3.9-1:	A COL applicant that references the NuScale Power Plant design certification will provide the applicable test procedures before the start of testing and will submit the test and inspection results from the comprehensive vibration assessment program for the NuScale Power Module, in accordance with Regulatory Guide 1.20.	3.9
COL Item 3.9-2:	A COL applicant that references the NuScale Power Plant design certification will develop design specifications and design reports in accordance with the requirements outlined under American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III (Reference 3.9-1). A COL applicant will address any known issues through the reactor vessel internals reliability programs (i.e. Comprehensive Vibration Assessment Program, steam generator programs, etc.) in regards to known aging degradation mechanisms such as those addressed in Section 4.5.2.1.	3.9
COL Item 3.9-3:	A COL applicant that references the NuScale Power Plant design certification will provide a summary of reactor core support structure ASME service level stresses, deformation, and cumulative usage factor values for each component and each operating condition in conformance with ASME Boiler and Pressure Vessel Code Section III Subsection NG.	3.9
COL Item 3.9-4:	A COL applicant that references the NuScale Power Plant design certification will submit a Preservice Testing program for valves as required by 10 CFR 50.55a.	3.9
COL Item 3.9-5:	A COL applicant that references the NuScale Power Plant design certification will establish an Inservice Testing program in accordance with ASME OM Code and 10 CFR 50.55a.	3.9
COL Item 3.9-6:	A COL applicant that references the NuScale Power Plant design certification will identify any site-specific valves, implementation milestones, and the applicable ASME OM Code (and ASME OM Code Cases) for the preservice and inservice testing programs. These programs are to be consistent with the requirements in the latest edition and addenda of the OM Code incorporated by reference in 10 CFR 50.55a in accordance with the time period specified in 10 CFR 50.55a before the scheduled initial fuel load (or the optional ASME Code Cases listed in Regulatory Guide 1.192 incorporated by reference in 10 CFR 50.55a).	3.9
COL Item 3.9-7:	Not Used.	
COL Item 3.9-8:	A COL applicant that references the NuScale Power Plant design certification will develop specific test procedures to allow detection and monitoring of power-operated valve assembly performance sufficient to satisfy periodic verification design basis capability requirements.	3.9
COL Item 3.9-9:	A COL applicant that references the NuScale Power Plant design certification will develop specific test procedures to allow detection and monitoring of emergency core cooling system valve assembly performance sufficient to satisfy periodic verification of design basis capability requirements.	3.9

forces due to soil separation are within design margins of the building components, leaving the building design unaltered. See Figure 3.7.2-136 through Figure 3.7.2-141 and Table 3.7.2-41 and Table 3.7.2-43.

RAI 03.07.02-6

Based on the results of these studies, it is concluded that modeling the structures as fully embedded is an acceptable design approach.

RAI 03.07.02-6S1

COL Item 3.7-11: A COL applicant that references the NuScale Power Plant design certification will perform a site-specific analysis that, if applicable, assesses the effects of soil separation. The COL applicant will confirm that the in-structure response spectra in the soil separation cases are bounded by the in-structure response spectra shown in FSAR Figure 3.7.2-107 through Figure 3.7.2-122.

3.7.2.1.2 Finite Element Models

RAI 03.07.02-1

Meshing of the area elements was done automatically using SAP2000 by defining a maximum element size in each direction. The aspect ratios were also kept as low as possible (closer to square shape), and internal sharp angles were avoided.

RAI 03.07.02-1

Meshing for both the RXB and CRB models were refined further, and it is shown that further refinement does not affect the structural response. The mesh refinement was done by dividing each side of the area elements into two, breaking each element to four elements. The structural responses compared include both local and global responses of the structure. The comparison shows that effects of further mesh refinement on the structural response is negligible. In addition to the modal analysis, to compare the natural frequencies and mass participation ratios, static analysis cases due to 1g loading in the x, y or z directions were used to make different comparisons. Soil elements' height were determined based on 1/5th of the wave length.

RAI 03.07.02-1, RAI 03.07.02-1S1

Minor changes in the natural frequencies and their mass participation ratios indicate that other dynamic characteristics of the building models would not change by mesh refinement. To show that mesh refinement does not have a major impact on ISRS, comparisons were made of the ISRS based on the CSDRS-compatible Capitola ground motion and the CSDRS-HF-compatible Lucerne ground motion at a few key locations. The comparisons were between the same RXB and CRB stand-alone SAP2000 model and refined mesh building models used for the other compared structural responses. Results show that mesh refinement has an insignificant effect on the ISRS. ~~Therefore, there is no need to study the effects of the mesh refinement on the SSI, ISRS, or SSSI.~~ The triple building model has the same mesh as the stand-alone model. Also, as it was mentioned, the SSSI