January 28, 2019

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. 164 (eRAI No. 8935) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 164 (eRAI No. 8935)," dated August 11, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 164 (eRAI No.8935)," dated November 29, 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. 8935:

- 03.07.02-26

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-8H12
Samuel Lee, NRC, OWFN-8H12
Marieliz Vera, NRC, OWFN-8H12

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8935

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8935

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

eRAI No.: 8935

Date of RAI Issue: 08/11/2017

NRC Question No.: 03.07.02-26

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. In FSAR Subsection 3.7.2.5.2, the applicant indicates that the ISRS from the triple building model were considered for the design of SSCs in the RXB but not for the CRB." It is expected that the structure-soil-structure interaction (SSSI) effect would be more pronounced on a lighter building (CRB) than a neighboring heavier building (RXB). The applicant is requested to provide justification for not considering the ISRS from the triple building model for the design of SSCs in the CRB.

b. Figures 3.7.2-106 and 107 in the FSAR present the Reactor Building ISRS for floor at EL 24' and EL 25', respectively, which indicates noticeable difference in ISRS (both in shape and amplitude) for an elevation difference of only 1 foot. The applicant is requested to discuss the factors contributing to this observed difference.

NuScale Response:

The following supplemental response to RAI 8935 03.07.02-26 addresses staff feedback, discussed January 23, 2019, to include additional FSAR markups to add/correct statements in Sections 3.7.2.4.6 and 3.7.2.5.2 with regard to the control building (CRB) triple building in-structure response sprectra (ISRS).

Section 3.7.2.4.6 is revised to include the CRB triple building ISRS in the list of analysis cases used to determine the seismic demand for Seismic Category I SSC. Section 3.7.2.5.2 is revised to state that ISRS are used for the design of structures, systems, and components in the CRB.

Impact on DCA:

FSAR Tier 2, Sections 3.7.2.4.6 and 3.7.2.5.2 have been revised as described in the response above and as shown in the markup provided in this response.

element and are referred to in the global axes. These stress components are shown in Figure 3.7.2-93 using an infinitesimal cube at the centroid of a solid element:

- Normal stress σ_{xx} in the global X-direction normal to the Y-Z plane
- Normal stress σ_{yy} in the global Y-direction normal to the Z-X plane
- Normal stress σ_{zz} in the global Z-direction normal to the X-Y plane
- Shear stress T_{xy} in the global Y-direction parallel to the Y-Z plane
- Shear stress T_{xz} in the global Z-direction parallel to the Y-Z plane
- Shear stress T_{yz} in the global Z-direction parallel to the Z-X plane

These stresses are then combined as described in Section 3.7.2.4.1. Steps 2 and 3 of this process are illustrated in Table 3.7.2-25 for an example solid element.

3.7.2.4.5 Relative Displacements at Selected Locations

Multiple locations on both the RXB and CRB have been selected for presentation of relative displacement. The node numbers and their global coordinates of the selected locations are shown in Table 3.7.2-26 for the RXB and Table 3.7.2-27 for the CRB. These locations can be seen in Figure 3.7.2-94 for the RXB and in Figure 3.7.2-95 for the CRB.

The relative displacement results from the different cases are post-processed using the steps described in Section 3.7.2.4.1.

The relative displacements calculated for the selected locations in both the standalone models and the triple building model are presented in Table 3.7.2-28 and Table 3.7.2-29. The displacements are in the global directions.

3.7.2.4.6 Design Approach

The initial structural analysis of the RXB was performed with the entire suite of analysis cases as described above. The CRB analysis did not include all the triple building model cases. For the triple building model, Soil Type 7 was evaluated with the CSDRS and Soil Type 9 was evaluated with the CSDRS-HF. These cases are selected because they represent controlling conditions. In general, Soil Type 7 with the CSDRS is controlling for both the RXB and the CRB.

RAI 03.07.02-24

The analysis cases used to determine the seismic demand for Seismic Category I SSC can be labeled using ~~eight~~nine identification codes:

RAI 03.07.02-24

1) RXB Standalone Structural Response

RAI 03.07.02-24

2) RXB Triple Building Structural Response

RAI 03.07.02-24

3) RXB Stand-Alone ISRS

RAI 03.07.02-24

4) RXB Triple Building ISRS

RAI 03.07.02-24

5) NPM ISRS

RAI 03.07.02-24

6) CRB Stand-Alone ISRS

RAI 03.07.02-24

7) CRB Stand-Alone Structural Response

RAI 03.07.02-24

8) CRB Triple Building Structural Response

9) CRB Triple Building ISRS

RAI 03.07.02-24

Each code represents a different combination of the 540 CSDRS cases and the 72 CSDRS-HF cases listed in Section 3.7.2.4. Table 3.7.2-33 provides the tabulated seismic parameter combinations for the eight identification codes to identify: seed input time history, soil type, direction, building model, concrete condition, and damping. Table 3.7.2-34 provides a list of the Seismic Category I SSC and the associated identification codes for the analysis used to calculate the seismic demands.

RAI 03.07.02-24

The methodology for combining the results of these seismic analysis cases is described in Section 3.7.2.4.1.

3.7.2.5 Development of In-Structure Floor Response Spectra

Development of ISRS follows the guidance in RG 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components" Rev. 1. The SASSI2010 MOTION module is used to produce accelerations for ISRS development. A 4 percent structural damping is used for both cracked and uncracked concrete.

3.7.2.5.1 Averaging and Combining Analysis Cases

Step 1. At each selected nodal location, the three co-directional ISRS from a single soil, time history, and stiffness are combined using SRSS.

Step 2. Step 1 is repeated for each of the cases that were analyzed.

Step 3. The ISRS from the five CSDRS time histories is averaged for each soil type and stiffness. For the CSDRS-HF no averaging is necessary since there is only one CSDRS-HF compatible input.

Step 4. For each selected area, all of the ISRS (this usually includes more than one node) are combined and the envelope obtained for each of the three directions.

Step 5. Each envelope response spectra is broadened by ±15%.

Step 6. Steps 1 through 5 are repeated to generate ISRS at damping ratios of 2%, 3%, 4%, 5%, 7%, and 10%.

This process is shown for a single node in Figure 3.7.2-99 through Figure 3.7.2-103. The first three figures show the development of the average ISRS for the three soil cases (7, 8, and 9) and two stiffnesses (cracked and uncracked). Figure 3.7.2-102 shows the combination of averages and the development of the ISRS envelope. The upper three plots show this process for the CSDRS compatible time histories and soil cases and the bottom three plots show the process for the ISRS from the CSDRS-HF compatible time histories and soil cases. Figure 3.7.2-103 shows the development of the broadened spectra at various damping values. The upper three plots show the envelop ISRS for each direction and the different damping ratios. In these plots the broadening of the 2 percent damping results is shown. The bottom three plots provide the broadened results for all damping ratios.

3.7.2.5.2 Comparison of In-Structure Response Spectra between Single and Triple Building Models

The structure-soil-structure interaction of the triple model has an effect on the ISRS of the RXB. Other than the ISRS at top of basemat, the ISRS of the standalone model are higher than those of the triple building model. The reduction in the ISRS of the triple building model is attributed to the extra damping effect provided by the close presence of the RWB and the CRB on the sides of the RXB.

This can be seen in Figure 3.7.2-104, Figure 3.7.2-105 and Figure 3.7.2-106.

~~The ISRS from the triple building model were not created for the CRB.~~

Because neither the standalone nor triple building model produce bounding results at all locations, ISRS enveloping the two models are used for design of structures, systems, and components in the RXB and CRB.

3.7.2.5.3 Reactor Building In-Structure Response Spectra

RAI 03.08.04-23, RAI 03.08.04-23S2

For convenience in design of components and supports that need to be Seismic Category I or Seismic Category II, ISRS at multiple nodes at each floor are combined to develop a single ISRS for each floor. The ISRS corresponding to each main floor of the RXB identified below are provided in the listed figures. Although ISRS are provided at the NPM base (floor at EL. 25' 0"), time histories were used as input for the evaluation of the NPMs as described in Appendix 3A. The governing ISRS