RAIO-0917-56104

September 20, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 111 (eRAI No. 8976) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 111 (eRAI No. 8976)," dated July 30, 2017

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

The Enclosure to this letter contains NuScale's response to the following RAI Question from NRC eRAI No. 8976:

- 03.08.04-2

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 Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8976

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8976

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

eRAI No.: 8976
Date of RAI Issue: 07/30/2017

NRC Question No.: 03.08.04-2

10 CFR 50, Appendix A, GDC 1, 2, and 4, provide requirements to be met by SSC important to safety. In accordance with these requirements, DSRS Section 3.8.4 provides review guidance pertaining to the design of seismic Category I structures, other than the containment.

FSAR Section 3.8.4.6.1.4 states that “the NuScale Power Plant primary safety-related structure design does not uses steel-concrete modules.” Also, FSAR Section 3.8.4.6.3 states that “modular construction, where wall or slab elements (or the rebar reinforcement) is pre-fabricated and then incorporated into the building, will be used when possible. This process is expected to leave sacrificial (non-structural) steel within the buildings.” Additionally, FSAR Section 3.8.4.1.12 states that “the design of the Seismic Category I RXB and CRB structural walls does not include steel-concrete (SC) modular subsystems. Modular construction techniques (including sacrificial steel) that do not alter the design, normal construction techniques, or analysis may be employed.”

Appendix B figure 3B-14 (and others) for SAP2000 Elevation View and Shell Element Numbers show the inclusion of steel partition walls in the model. Further, Figure 3B-15 describe these walls as being walls with steel plates and concrete in-fill.

The staff request the applicant to clarify the applicability, if any, of the above FSAR statements to the walls shown in Figures 3B-14 and 3B-15. Further, clarify what the seismic Category is for the steel plate walls in Figures 3B-14 and 3B-15, and describe the applicable analysis and design criteria. Further, describe the input properties for elements used in the SAP2000 model for these walls.

NuScale Response:

FSAR Tier 2, Section 3.8.4 statements regarding modular construction apply only to main structural concrete members. The steel partition walls shown in Figures 3B-14 and 3B-15 do not apply to statements in Section 3.8.4 because these walls are not part of the main lateral force resisting system.

Figures 3B-14 and 3B-15 show the inclusion of partition walls in the SAP2000 model. The input properties for elements used in the SAP2000 model for the steel partition walls are shown in Table 1.

Table 1: Input Properties for Elements Used in the SAP2000 Model

Material Property	**1'-6" Thick Steel Partition Wall**	**1'-8" Thick Steel Partition Wall**
Weight per unit volume	1.8938 pci	2.074 pci
Modulus of Elasticity, E	29,000,000 psi	29,000,000 psi
Poisson, U	0.29	0.29
Coefficient of Thermal Expansion, A	6.5E-6 1/degrees F	6.5E-6 1/degrees F
Shear Modulus, G	11,240,310 psi	11,240,310 psi

The steel partition walls and roof slabs with concrete infill are modeled with plate elements. The plate elements have a Young's modulus of steel with an equivalent thickness and density to give the same bending stiffness and weight of the composite section.

For the calculations shown below, ts is the thickness of the steel in the steel partition wall, h is the thickness of the concrete infill in the steel partition wall, b is the width of the steel partition wall, and teq is the equivalent thickness of the steel partition wall.

Considering only the steel skin and equating the moments of inertia,

$2\times b\times ts\times((h+ts)/2)^2 = b\times teq^3/12$

Or the equivalent bending thickness, $teq = (6\times ts\times(h+ts)^2)1/3$

For the membrane (axial) stiffness, only the steel will be considered, or $t_{membrane}=2\times ts$

Equating the weights of the sections,

$(2\times\gamma s\times ts+\gamma c\times h) = \gamma eq\times teq$

Or, the equivalent density, $\gamma eq = (2\times\gamma s\times ts+\gamma c\times h) / teq$

For the 18″ thick steel partition walls, the equivalent properties are:

$Teq = (6\times0.5\times(18+0.5)^2)1/3 = 10.1$ inches (equivalent bending thickness)

$\gamma eq = (2\times0.2836\text{ pci}\times0.5+0.0894\text{ pci}\times18) / 10.1 = 0.1875$ pci (for teq=10.1″)

But SAP2000 uses the membrane thickness for the mass and weight calculation, therefore, use

$\gamma eq = 0.1875$ pci $(teq/t_{membrane}) = 0.1875\times(10.1/(2\times0.5) = 1.89375$ pci (for $t_{membrane}=1.0''$)

For the 20″ thick steel partition walls, the equivalent properties are:

$Teq = (6\times0.5\times(20+0.5)^2)1/3 = 10.8$ inches (equivalent bending thickness)

$\gamma eq = (2\times0.2836$ pci$\times0.5+0.0894$ pci$\times20) / 10.8 = 0.192$ pci (for teq=10.8″)

But SAP2000 uses the membrane thickness for the mass and weight calculation, therefore, use

$\gamma eq = 0.192$ pci $(teq/t_{membrane}) = 0.192\times(10.8/(2\times0.5) = 2.074$ pci (for $t_{membrane}=1.0''$)

The steel partition walls in the reactor building (RXB) are non-Category I structures. All non-Category I structures shall be assessed to determine whether their failure under SSE conditions could impair the integrity of Seismic Category I SSCs, or result in incapacitating injury to control room occupants. Each non-Seismic Category I structure shall meet at least one of the following criteria:

i. The collapse of the non-Category I structure will not cause the non-Category I structure to strike a Category I SSC.
ii. The collapse of the non-Category I structure will not impair the integrity of Seismic Category I SSCs, nor result in incapacitating injury to control room occupants.
iii. The non-Category I structure will be analyzed and designed to prevent its failure under SSE conditions.

Due to the complexity of the steel partition configuration, a local SAP2000 model of the steel partitions was created to obtain the demands for designing the steel partitions and the anchorages of the steel partitions. A review of the partition walls indicated the walls on Elevation 100 ft between Grid Lines B, D, 6 and 7 have a longer vertical span than other locations and represents a bounding case. Also, the steel partitions at this elevation will have higher loadings from the ISRS than the partitions at the lower elevations.

For the seismic loading, a response spectrum analysis was performed. The response spectra input are the CSDRS 4% damped floor response spectra at Elevation 100 ft.

The design of steel partitions and the anchorages of the steel partitions were evaluated and found to preclude failure under seismic conditions.

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