RAIO-0419-65152

April 09, 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. 202 (eRAI No. 8911) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 202 (eRAI No. 8911)," dated August 25, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 202 (eRAI No.8911)," dated December 21, 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. 8911:

- 03.09.02-18

Enclosure 1 is the proprietary version of the NuScale Supplemental Response to NRC RAI No. 202 (eRAI No. 8911). 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
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8911, proprietary

Enclosure 2: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8911, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0419-65153

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8911, proprietary

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RAIO-0419-65152

Enclosure 2:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8911, nonproprietary

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

eRAI No.: 8911
Date of RAI Issue: 08/25/2017

NRC Question No.: 03.09.02-18

10 CFR 52.47 requires the design certification applicant to include a description and analysis of the structures, systems, and components (SSCs) sufficient to permit understanding of the system designs. TR-0916-51502-P, Rev. 0, "NuScale Power Module Seismic Analysis" describes the methodologies and structural models that are used to analyze the dynamic structural response due to seismic loads acting on the NuScale Power Module (NPM). The description is insufficient for staff to reach a safety finding. Specifically, the report does not provide the seismic and LOCA stress results. Please provide the seismic analysis details and stress results under Service Level D condition for the following reactor internals components. Include the requested information in the NPM Seismic Report or in separate reports.

- core support assembly (core barrel, lower core plate, reflector, upper core plate, upper core support)
- lower riser assembly
- upper riser assembly (upper riser, upper riser hanger support)
- control rod assembly guide tube, control rod assembly guide tube support, control rod assembly card, control rod drive shaft, and control rod drive shaft support
- steam generator tubes and tube supports
- control rod assembly guide tubes

The component analysis should include a brief description of the component structure modelling, input motion (time history or in-structure response spectrum), major assumptions, acceptance criteria under Service Level D condition including stress and deflection limits, fluid modelling, mass distribution, damping values, gap considerations, dominant modes and frequencies, and seismic and LOCA stress results and ASME B&PV Code Section III stress evaluation under Service Level D condition.

NuScale Response:

The initial response to RAI 8911 Question 03.09.02-18 was submitted by NuScale letter RAIO-1218-63980, dated December 21, 2018 and addressed NRC questions on the Steam Generator (SG) Assembly and Reactor Vessel Internals (RVI). In a subsequent followup public meeting with NRC on February 6, 2019, questions were asked specific to the SG Assembly portion of this response. The following information addresses these additional RAI 8911 Question 03.09.02-18 (SG) questions and supersedes the original response only under the subsection 'SG Assembly,' in its entirety.

Question SG1 - Is the SG stress evaluation performed with the multi-point response spectrum analysis method? If so, state it in the RAI response. Otherwise, provide the bounding spectra used in the analysis in Figures 1, 2, and 3 (Bounding Seismic Spectra in X, Y, and Z directions).

NuScale response - Yes, the SG stress evaluation is performed with the multi-point response spectrum (MPRS) analysis method. This clarification has been included in the attached 'SG Assembly' response, second paragraph, and in the 'Input loading' section, Item 9.

Question SG2 - Provide a table that defines various Load Steps in the analysis (e.g., Load steps in Table 6, “Bounding Stresses in Upper Portion of SG Tube Support Column”).

NuScale response - Table 2 has been added in the attached 'SG Assembly' text.

Question SG3 - Provide number of elements in each of the SG super element.

NuScale response - Table 3 has been added in the attached 'SG Assembly' text.

Question SG4 - Provide description and element type of the tube support column.

NuScale response - The description has been added in the attached 'SG Assembly' text, 'Component structural modeling,' Item 5 'Tube Support modeling'.

Question SG5 - In the Assumptions Section, the RAI response states that the MSPB and FWPB loads acting on secondary side of the SG tubes are not available. The reaction forces at the SG tube supports and the upper and lower SG supports due to MSPB and FWPB do not affect the conclusions of the analysis since the stress ratios at these supports are not controlling. The RAI response further states that this assumption is tracked by a NuScale open design item and the MSPB and FWPB loads will be evaluated in order to close this open item. Provide updated SG stress ratios when MSPB and FWPB loads are available or demonstrate the MSPB and FWPB loads are smaller than the values of the LOCA loads that are described in the RAI response in the Input Loading section.

NuScale response - Calculation of the MSPB and FWPB loads is in progress. When finished, the loads will be included in an updated SG analysis to calculate the SG stress ratios, if the loads are not bounded by the LOCA loads. The updated SG stress ratios will be provided in an updated RAI response.

Question SG6 - Describe which SG components are included in Table 6, Bounding Stresses in Upper Portion of SG Tube Support Column, Table 7, Bounding Stresses in Lower Portion of SG Tube Support Column, Table 10, Bounding Stresses in the Upper SG Support Welds, and Table 11, Bounding Stresses in Lower SG Support Welds.

NuScale response - These locations have been indicated in Figure 15. The description has also been added in the attached 'SG Assembly' text, 'Results,' Item 2.

Question SG7 - Describe the location of SG tubes in Table 9, Bounding Stresses SG Tubes where the maximum stress ratio occurs.

NuScale response - The location is indicated in Figure 19 in the attached 'SG Assembly' text.

SG Assembly

Detailed stress analysis for the steam generator (SG) assembly under Service Level D conditions was performed in accordance with the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC). Analysis details and stress results are summarized below.

The components and welds included in the SG assembly evaluation are:

1. SG tubes
2. SG tube support column assemblies
3. Upper SG supports & associated weld
4. Lower SG supports & associated weld

In this evaluation, a 3D ANSYS model of the SG assembly, reactor pressure vessel (RPV), and the upper riser is used. A modal analysis is performed up to a minimum of 100 Hz to capture the dynamic effect due to seismic events and is followed by mode superposition multiple point response spectrum (MPRS) analysis to calculate the seismic response. The loss of coolant accident (LOCA) acceleration, dead weight, and pressure are analyzed using static analysis.

Assumptions

1. MSPB and FWPB loads are bounded by design bases LOCA loads: This evaluation assumes that the main steam pipe break (MSPB) and feedwater pipe break (FWPB) Service Level D loads defined in the Design Specification are bounded by the design bases LOCA loads. The MSPB and FWPB Service Level D loads acting on the internal secondary side of the tubing are not available. However, because the SG tube external pressure is {{ }}2(a),(c) psia and the internal pressure is {{ }}2(a),(c) psia under normal operating conditions, it is assumed that the SG tube differential pressure generated from a MSPB or FWPB is bounded by the maximum total Level D pressure, {{ }}2(a),(c) psia, applied in this analysis (see Input 1, below). In addition, the reaction forces at the SG tube supports and the upper and lower SG supports due to MSPB and FWPB do not affect the conclusions of the analysis since the stress ratios at these supports are not controlling (see the Results section, below). This assumption is tracked by a NuScale open design item and the MSPB and FWPB loads will be evaluated in order to close this open item.
2. LOCA Loads: It is assumed that the LOCA loads obtained on the RPV at the top and bottom of the SG are bounding. The loads from locations on the upper riser are not used

because the upper riser in the blowdown model is not supported in the radial direction in the blowdown calculation. Actually, the upper riser is coupled to the RPV shell in the radial direction via the stacks of SG tube supports. Therefore, due to this coupling, it is assumed that the loads on the RPV are representative of the loads at corresponding elevations on the upper riser.

Input loading

The load combinations applicable to this analysis are provided in Table 1. Each of the loads provided in Table 1 is discussed below.

1. Pressure (P): Per the Design Specification, the maximum primary/secondary side pressure is {{ }}[2(a),(c)] psia. This maximum pressure is added to the maximum acoustic time history pressure of {{ }}[2(a),(c)] psia (determined from LOCA loading, below) such that a total Level D pressure applied is {{ }}[2(a),(c)] psia.
2. Deadweight (DW): The deadweight of the SG items, identified within the scope of this calculation, is captured by applying a specifying linear acceleration of 386.09 in/s^2 in the positive vertical direction to simulate the downward effect of gravity.
3. Buoyancy (B): Buoyancy is not included and therefore the full DW is considered. This provides minimal conservatism as the full DW contributes a small amount of stress to the final stress as compared to other applicable Level D loads.
4. External mechanical loads (EXT): The only applicable EXT loads are the reaction forces at RPV-RVI interfaces. These are captured via model boundary conditions and connections (see Boundary conditions information under the Component structural modeling description).
5. Piping mechanical or thermal loads (M): There are no applicable M loads for the SG model.
6. Rod ejection accident (REA): REA is not applicable to the SG model.
7. MSPB/FWPB: See discussion in Assumption 1 above.
8. SCRAM (SCR): SCRAM loads due to the drop of the CRD shaft and the control rod assembly (CRA) do not affect the SG stress analysis.
9. Safe-shutdown earthquake (SSE): SSE response spectra for the SG assembly are obtained at locations on the upper riser and at the top and bottom of the SG for the MPRS analysis. Bounding spectra from locations on the upper riser are developed for the lower riser end. The broadened enveloped in-structure response spectra (ISRS) with 4% damping at the applicable locations is utilized to generate bounding spectra for application within this analysis. Figure 1 through Figure 3 present the seismic response spectra used in this evaluation.

10. LOCA: In-structure LOCA acceleration time histories are obtained at the top and bottom of the SG (see Assumption 2 above). In-structure spectra are developed using the acceleration time histories with 4% damping ratio. The maximum spectrum acceleration is {{ }}[2(a),(c)] in the horizontal direction and {{ }}[2(a),(c)] in the vertical direction. These values are applied statically in the LOCA evaluation portion with a factor of 1.5.

    LOCA acoustic pressure time histories are obtained along the RPV {{ }}[2(a),(c)], at the lower riser {{ }}[2(a),(c)], and at the core barrel {{ }}[2(a),(c)]. For these locations, a maximum acoustic pressure of {{ }}[2(a),(c)] psia is identified. This value was multiplied by a factor of 1.5 to obtain a maximum acoustic pressure of {{ }}[2(a),(c)] is used in this evaluation). This pressure was added to the Level D maximum pressure identified above and applied statically in the LOCA evaluation. Thus, the total Level D pressure applied is {{ }}[2(a),(c)] psia.

This evaluation considers the following Service Level D load combination for the primary stress qualification:

$$|P+DW|+SRSS(SSE,LOCA)$$

where SRSS is the square root sum of the squares.

When considering the LOCA load combinations for the X, Y (vertical), and Z axes and the acoustic pressures (primary = {{ }}[2(a),(c)] psia and secondary = {{ }}[2(a),(c)] psia, denoted by Max+AccP1; primary = {{ }}[2(a),(c)] psia and secondary = {{ }}[2(a),(c)] psia, denoted by Max+AccP2), the load combinations in Table 2 are evaluated within this calculation.

Component structural modeling

1. Overview

    A 3D ANSYS model was created wherein the SG tubes are modeled as BEAM188 elements. The element type was modified to PIPE288 in order to apply appropriate tube pressure. The model consists of 21 SG tube columns and 21 x 8 SG tube support column assemblies. Tube columns 1, 11, and 21 are explicitly modeled while the other tube columns are modeled with each bundle of tubes being represented by a super element (ANSYS Matrix50 element). Super element use for the tube models is necessary due to the large number of degrees of freedom. The RPV and the upper riser are partially modeled to provide proper boundary conditions to the SG model. Due to the large number of degrees of freedom in the RPV and upper riser model, the RPV and upper riser model was converted to a super element, with the nodes interfacing with SG tube supports selected as master nodes. The remote points corresponding to the SG top section, the SG bottom section, the lower end of the upper riser, the upper SG supports, and the lower SG supports are also selected as master nodes to apply boundary conditions and connections. The SG model and the adjacent upper riser and RPV are illustrated in Figure 4. The number of elements in each super element are listed in Table 3.

2. Fluid modeling and mass distribution
   a. Secondary water in SG tubes: The SG tubes are modeled assuming that the tubes are filled with half liquid secondary water and half steam. In reality, the portions are not 50/50 and the density is not uniform. However, the overall modal response of the SG is not sensitive to the distribution of the mass of the secondary side water, just that the total mass of water in the secondary side is close to the actual value. The 50/50 mix is a reasonable assumption as it captures the appropriate mass of the structure and a reasonable distribution of mass in the tubes.
   b. Simplified representation of RCS water: The RCS water in the annulus between the upper riser and the RPV shell is represented by Fourier nodes for the elevation between {{ }}$^{2(a),(c)}$. The RCS water inside the upper riser is calculated by the total volume, neglecting any components inside the upper riser, and is distributed onto the upper riser using point masses.

3. Gap considerations
   a. Innermost column unconstrained circumferentially by riser: The SG assembly was modeled assuming that the riser backing strips do not provide circumferential constraint to the tube support tabs for the innermost column. The backing strips are designed to provide radial support to the innermost bar. The gap between the tabs and the backing strips allows the bar to have small circumferential motion.
   b. Tube support-to-tube support force distribution to tabs: At each support location, the tube support-to-tube support radial force is carried by the support tabs, not the tubes. A large force on the tab is required to close the diametric gaps and distribute load to the SG tubes. The force on the tab due to Level D loading is significantly lower than the force required to close the gaps. Thus, the radial force at the tube support is only distributed to the tabs, not to the tubes.

4. Boundary conditions

   The super element for the RPV and upper riser, the 18 super elements for SG tubes in Columns 2-10 and 12-20, the support bars, and the three tube columns are combined to form the final model using ANSYS parametric design language (APDL). The following connections and boundary conditions are applied to the combined model:

   a. SG tubes at the feedwater plenum are constrained in Ux, Uy, Uz, ROTx, ROTy, and ROTz directions to simulate the interface between the SG tube and the RPV feedwater plenum. Refer to Figure 5 and Figure 6 for additional details.
   b. SG tubes at steam plenum are constrained in Ux, Uy, and Uz, ROTx, ROTy, and ROTz to simulate the interface between the SG tube and the steam plenum of the PZR. Refer to Figure 7 and Figure 8 for additional details.
   c. SG inner tube support column 1 is coupled to the master nodes in the RPV and upper riser model super element to simulate the interfacing between the SG column tabs and riser OD in Ux (radial direction in the cylindrical coordinate systems) and ROTz, as shown in Figure 9. Note that the backing strips on the riser are not designed to constrain the circumferential displacement of the tab tips. The gap between the tabs and the backing strips allows the bar to have small circumferential motion.
   d. SG outer tube support column 21 is coupled to the master nodes in the RPV and upper riser model super element to simulate the interfacing between the SG column bars and the RPV ID in Ux (radial direction in the cylindrical coordinate systems) and ROTz, as shown in Figure 10.
   e. SG tubes are coupled to support tabs middle nodes for Ux, Uy, and Uz in the local coordinate systems shown in Figure 11. SG tube nodes ROTy and ROTz (local coordinate system) are coupled to support tabs root nodes ROTz and ROTy (cylindrical coordinate system), respectively.
   f. Between any two adjacent columns, the tab tip nodes are coupled to the bar back nodes in Ux and Uy in the cylindrical coordinate system. The ROTz is also constrained.
   g. SG tube support bar upper ends are coupled to the upper SG supports in Uy and Uz directions, as illustrated in Figure 12.
   h. SG tube support bar lower ends are coupled to the lower SG supports in Uy direction in the cylindrical CS, as illustrated in Figure 13.

5. Tube Support modeling

   Tube support columns are modeled using BEAM188 element with rectangular section (see Figure 14(a)). The cross section parameters (w and t) are calculated to represent the equivalent bending stiffness in both the strong and weak bending directions of a true configuration Solid model, shown in Figure 14(b). This is done by first performing a static analysis on the Solid model, where the bottom surface is fixed and the top surface is applied with a unit force along the Z axis and Y axis in two separate steps. The resultant directional displacements (δz and δy) at the top surface are then used in a generic beam deflection formula ($\delta = \frac{PL^3}{3EI}$) to solve the two unknown cross section parameters for the Beam model.

Acceptance criteria

Per ASME BPVC, Section III, Paragraph NB-3225 and NG-3225, the rules in Section III Nonmandatory Appendix F may be used in evaluating Service Level D (Faulted Condition) loads. Therefore, Appendix F, Paragraph F-1331, “Criteria for Components” is used in the evaluation.

The material design stress intensity, Sm, the material yield strength, S_y, and the material ultimate strength, S_u, are taken from ASME BPVC, Section II, Part D at a temperature of 600°F.

The following qualification criteria are applicable:

1. F-1331.1 for general primary membrane stresses, local primary membrane stresses, general or local membrane plus bending primary stresses and average primary pure shear stress.
2. NB-3227 (SG tubes) & NG-3227 (SG supports) for special stress limits

Applicable Service Level D stress limits are summarized in Table 4.

The SG upper and lower tube support bars are welded to the RPV with a full penetration bevel weld. In accordance with the design specification, the welds between the upper and lower SG supports and the integral steam plenum and RPV shell are part of the RPV and constructed in accordance with ASME BPVC, Section III, Subsection NB, where no weld quality factors are required.

The SG tube and SG tube support bar deflections in the cylindrical coordinate systems are extracted for the load cases. The maximum deflections are found for radial, circumferential and vertical directions. There are no specific limits for the deflections. Deflections are provided for information only.

Results

1. Modal results

   The significant mode in each direction is listed in Table 5, and plotted in Figure 16 through Figure 18. Note that the total simulated mass participation ratios are {{ }}[2(a),(c)] for X, Y and Z directions, respectively. The low total ratios are due to the fact that the RPV has the majority of the mass ({{ }}[2(a),(c)]) which is not activated with significant effective mass at lower frequencies.

2. Stress results

   The maximum membrane stress intensity (Pm) and membrane plus bending stress intensity (Pm + Pb) in the SG assembly components and associated welds are provided in Table 6 through Table 11. The locations of the stress results provided in Table 6, Table 7, Table 10, and Table 11 are indicated in Figure 15. The bounding stress location for the SG tube (Column 21 listed in Table 9) is indicated in Figure 19.

3. Deflections

   The deflections in the SG tubes and the SG tube support bars are provided in Table 12 and Table 13, respectively.

Conclusions

The analysis described above demonstrates that the design of the SG assembly—specifically the SG tubes, the SG tube support column assembly, the upper and lower SG supports, and the SG support welds—satisfies the structural requirements of the ASME BPVC for Service Level D loads.

Table 1. Service Level D load combinations

Plant Event	Service Level	Load Combination	Allowable Limit
Rod Ejection Accident	D	P + DW + B + EXT + M + REA + SCR	Level C
Main Steam and Feedwater Pipe Breaks		P + DW + B + EXT + M + MSPB/FWPB + SCR	Level D
SSE + DBPB-MSPB-FWPB		P + DW + B + EXT + M + SCR ± SRSS(SSE + DBPB-MSPB-FWPB)	Level D
Hydrogen Detonation with DDT		P + DW + B + EXT + HDDT	Level D

Note: SRSS is the square root sum of the squares

Table 2. Overall load steps

Load Step No.	Description
1	SRSS (SSE, LOCA (+X,+Y,0)) + P (Max+AccP1) + DW
2	SRSS (SSE, LOCA (+X,-Y,0)) + P (Max+AccP1) + DW
3	SRSS (SSE, LOCA (-X,+Y,0)) + P (Max+AccP1) + DW
4	SRSS (SSE, LOCA (-X,-Y,0)) + P (Max+AccP1) + DW
5	SRSS (SSE, LOCA (0,+Y,+Z)) + P (Max+AccP1) + DW
6	SRSS (SSE, LOCA (0,+Y,-Z)) + P (Max+AccP1) + DW
7	SRSS (SSE, LOCA (0,-Y,+Z)) + P (Max+AccP1) + DW
8	SRSS (SSE, LOCA (0,-Y,-Z)) + P (Max+AccP1) + DW
9	SRSS (SSE, LOCA (+X,+Y,0)) + P (Max+AccP2) + DW
10	SRSS (SSE, LOCA (+X,-Y,0)) + P (Max+AccP2) + DW
11	SRSS (SSE, LOCA (-X,+Y,0)) + P (Max+AccP2) + DW
12	SRSS (SSE, LOCA (-X,-Y,0)) + P (Max+AccP2) + DW
13	SRSS (SSE, LOCA (0,+Y,+Z)) + P (Max+AccP2) + DW
14	SRSS (SSE, LOCA (0,+Y,-Z)) + P (Max+AccP2) + DW
15	SRSS (SSE, LOCA (0,-Y,+Z)) + P (Max+AccP2) + DW
16	SRSS (SSE, LOCA (0,-Y,-Z)) + P (Max+AccP2) + DW

Note: The pressure combinations include a one (1) g acceleration to account for deadweight of the configuration.

Table 3. Number of elements in each super element

Component	Number of elements
RPV and upper riser	114771
Tube Column 2	9632
Tube Column 3	9616
Tube Column 4	10548
Tube Column 5	10272
Tube Column 6	10272
Tube Column 7	10424
Tube Column 8	10428
Tube Column 9	11336
Tube Column 10	12300
Tube Column 12	12300
Tube Column 13	13028
Tube Column 14	13044
Tube Column 15	13060
Tube Column 16	13060
Tube Column 17	13068
Tube Column 18	13232
Tube Column 19	13252
Tube Column 20	13248

Table 4. Allowable stress limits for Service Level D

ASME Stress Category	ASME Code Paragraph	ASME Criterion
General Primary Membrane Stress Intensity, Pm	F-1331.1(a)	lesser of $2.4S_m$ and $0.7S_u$
Local Primary Membrane Stress Intensity, Pl	F-1331.1(b)	1.5 Pm
General or Local Primary Membrane plus Bending Stress Intensity, Pm+Pb	F-1331.1(c)(1)	1.5 Pm
Compressive Loads (SG Tubes) Allowable External Pressure	F-1331.5(b), Note 1	1.5 x (Pa)
Average Primary Pure Shear Stress	<u>SG Tubes</u> NB-3225, F-1331.1(d) <u>SG Supports</u> NG-3225, NG-3227, NG-3227.2	<u>SG Tubes</u> $0.42S_u$ <u>SG Supports</u> $1.2S_m$

Note:

1. Allowable external pressure (Pa) as calculated by NB-3133 is greater than or equal to the external pressure (P). Alternatively, the rules of ASME Code Case N-759-2 may be used.

Table 5. Significant modes

Direction	Freq. (Hz)	Effective Mass (Slug)	Ratio	Total simulated participation ratio
X	{{			
Y				
Z				}}2(a),(c)

Table 6. Bounding stresses in upper portion of SG tube support column

	Max Stress (psi)	Allowable Stress (psi)	Load Step	Stress Ratio	Passed
Pm	{{				Yes
Pm+Pb				}}2(a),(c)	Yes

Table 7. Bounding stresses in lower portion of SG tube support column

	Max Stress (psi)	Allowable Stress (psi)	Load Step	Stress Ratio	Passed
Pm	{{				Yes
Pm+Pb				}}2(a),(c)	Yes

Table 8. Bounding stresses in SG tube support bar tabs

(a) Tabs providing radial supports

	Max Stress (psi)	Allowable Stress (psi)	Load Step	Stress Ratio	Passed
Pm	{{				Yes
Pm+Pb				}}2(a),(c)	Yes

(b) Tabs providing circumferential supports

	Max Stress (psi)	Allowable Stress (psi)	Load Step	Stress Ratio	Passed
Pm	{{				Yes
Pm+Pb				}}2(a),(c)	Yes

Table 9. Bounding stresses in SG tubes

		Max Stress (psi)	Allowable Stress (psi)	Load Step	Stress Ratio	Passed
Col. 1	Pm	{{				Yes
	Pm+Pb					Yes
Col. 11	Pm					Yes
	Pm+Pb					Yes
Col. 21	Pm					Yes
	Pm+Pb				}}2(a),(c)	Yes

Table 10. Bounding stresses in the upper SG support welds

Circ. Location		Max Stress (psi)	Allowable Stress (psi)	Stress Ratio	Passed
1	Pm	{{			Yes
	Pm+Pb				Yes
2	Pm				Yes
	Pm+Pb				Yes
3	Pm				Yes
	Pm+Pb				Yes
4	Pm				Yes
	Pm+Pb				Yes
5	Pm				Yes
	Pm+Pb				Yes
6	Pm				Yes
	Pm+Pb				Yes
7	Pm				Yes
	Pm+Pb				Yes
8	Pm				Yes
	Pm+Pb			}}2(a),(c)	Yes

Table 11. Bounding stresses in the lower SG support welds

Circ. Location		Max Stress (psi)	Allowable Stress (psi)	Stress Ratio	Passed
1	Pm	{{			Yes
	Pm+Pb				Yes
2	Pm				Yes
	Pm+Pb				Yes
3	Pm				Yes
	Pm+Pb				Yes
4	Pm				Yes
	Pm+Pb				Yes
5	Pm				Yes
	Pm+Pb				Yes
6	Pm				Yes
	Pm+Pb				Yes
7	Pm				Yes
	Pm+Pb				Yes
8	Pm				Yes
	Pm+Pb			}}2(a),(c)	Yes

Table 12. Maximum deflection in SG tubes

	Deflection (in)		
Column	**Radial**	**Hoop**	**Vertical**
1	{{		
11			
21			}}2(a),(c)

Table 13. Maximum deflection in SG tube support bars

	Deflection (in)		
Column	**Radial**	**Hoop**	**Vertical**
1	{{		
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			}}2(a),(c)

{{

}}2(a),(c)

Figure 1. Bounding seismic spectra in X

{{

}}2(a),(c)

Figure 2. Bounding seismic spectra in Y

{{

}}2(a),(c)

Figure 3. Bounding seismic spectra in Z

{{

}}2(a),(c)

Figure 4. SG model and the adjacent upper riser and RPV

{{

}}2(a),(c)

Figure 5. SG tubes at feedwater plenum - top view (ROTx, ROTy, and ROTz)

{{

}}2(a),(c)

Figure 6. SG tube columns at feedwater plenum - side view (Ux, Uy, and Uz)

{{

}}2(a),(c)

Figure 7. SG tube columns at steam plenum - side view (ROTx, ROTy and ROTz)

{{

}}2(a),(c)

Figure 8. SG tube columns at steam plenum - side view (Ux, Uy, and Uz)

{{

}}2(a),(c)

Figure 9. SG tube support column 1 - top view (Ux and ROTz)

{{

}}2(a),(c)

Figure 10. SG tube support column 21 - top view (Ux and ROTz)

{{

}}2(a),(c)

Figure 11. SG tube to support column (local coordinate system - only one tube shown)

{{

}}2(a),(c)

Figure 12. SG upper tube supports - top and side view (Uy and Uz coupling)

{{

}}2(a),(c)

Figure 13. SG lower tube supports - top and side view (Uy coupling)

{{

}}2(a),(c)

Figure 14. Simplified SG Tube Column Support Bar

{{

}}2(a),(c)

Figure 15. Base metal and weld stress locations

{{

}}2(a),(c)

Figure 16. Significant mode in X

{{

}}[2(a),(c)]

Figure 17. Significant mode in Y

{{

}}2(a),(c)

Figure 18. Significant mode in Z

{{

}}[2(a),(c)]

Figure 19. Bounding stress location in SG tubes

Impact on DCA:

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

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0419-65153

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 method by which NuScale develops its power module seismic analysis.

    NuScale has performed significant research and evaluation to develop a basis for this method 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. 202, eRAI 8911. 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 April 9, 2019.

Zackary W. Rad