July 22, 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. 154 (eRAI No. 8938) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 154 (eRAI No. 8938)," dated August 07, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 154 (eRAI No.8938)," dated December 05, 2018
3. NuScale Power, LLC Supplemental Response to NRC "Request for Additional Information No. 154 (eRAI No. 8938)," dated January 24, 2019

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. 8938:

- 03.12-1

Enclosure 1 is the proprietary version of the NuScale Supplemental Response to NRC RAI No. 154 (eRAI No. 8938). 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-8H12
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8938, proprietary

Enclosure 2: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8938, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0719-66375

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8938, proprietary

Enclosure 2:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8938, nonproprietary

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

eRAI No.: 8938

Date of RAI Issue: 08/07/2017

NRC Question No.: 03.12-1

SECY-90-377 and the NRC white paper on piping level of detail for design certification (ML14065A067) discuss the design information that is required at design certification without the need for design acceptance criteria (DAC) for the NRC staff to be able to make a final safety determination on piping issues at the design certification stage that meets the applicable requirements of 10 CFR 52. Specific to FSAR Tier 2, Section 3.12, provide the following information to support the staff's safety determination.

1. To demonstrate that the piping, which has been structurally evaluated based on the graded approach described in FSAR Tier 2, Section 14.3.2.3, conforms to the requirements of ASME Boiler and Pressure Vessel Code (BPV Code) Section III, mandated by 10 CFR 50.55a, provide the following information in response to this request. The information need not be included in the FSAR unless the applicant chooses to do so.

   a) A tabulated, quantitative summary of the calculated maximum stresses and fatigue usage factors (if applicable) with a comparison to ASME BPV Code allowable stress values for each code equation. Include only maximum stresses and data at critical locations, including anchors, flued head anchor penetrations, nozzles, penetrations, flanged connections, valve and relief valve connections, branching pipe connections and pipe supports. List all applicable loads in load combination cases for each service level and code equation.

   b) For equipment nozzles, a tabulated quantitative summary of the calculated reaction loads compared to specific nozzle allowable values.

c) For containment penetrations, quantitative maximum calculated results compared to allowable values from the penetration structural qualifications which include loads from both sides of the penetration.

NuScale Response:

The original response to this question was submitted by NuScale letter RAIO-1218-63709 on December 5, 2018, providing the stress analysis results for the Reactor Coolant System (RCS) discharge line and for the main steam (MS) and feedwater (FW) lines, inside and outside of the containment vessel (CNV). This response was later supplemented with stress analysis results for the MS piping in the area above containment, by NuScale letter RAIO-0119-64288 dated January 24, 2019.

This supplement provides final stress analysis results, reflecting the completion of the detailed piping evaluations for the high-energy systems inside and outside of the CNV. This information supersedes the original and Supplement 1 responses in their entirety.

NuScale has utilized a 'graded level of detail approach' for evaluation of the NPM piping. As part of this approach, detailed stress analyses were performed for representative systems: the RCS discharge line, the main steam lines, and the feedwater lines.

A description of the requested piping stress analysis and a quantitative summary of the analysis results is provided below.

Stress results are summarized by listing the locations with the highest stress ratio for each code equation. However, in order to provide a clearer picture of the overall stress state in the system, reporting the results for nodes that are in close proximity or similar locations is avoided. Examples are provided for clarification.

- Example 1: If the branch side of a tee joint has the highest stress, then the connecting branch pipe joint adjacent to the tee is not chosen as the second highest stress location. These are considered one location.
- Example 2: In the case of the main steam lines, Line 1 and Line 2 have similar geometries. If one of the four RPV nozzle locations has the highest stress, the other three RPV nozzle locations having similarly high stress are not chosen as the next highest stress location. These are all considered to represent one location.

Loads acting on the nozzles of the RPV and CNV are also listed; however, they are not compared to allowable loads. Instead, these loads are used as inputs to the the RPV and CNV stress analyses. Piping sizes in the NuScale design are relatively small compared to traditional PWRs and the CNV penetrations robust. Therefore, nozzle loads for the NuScale NPM are not a limiting design consideration. Other notes are provided below for clarification.

1. The loads applicable to each loading combination are provided in FSAR Table 3.12-1 for Class 1 piping and FSAR Table 3.12-2 for Class 2 piping.

2. Global Coordinate System: The Y-axis is vertical and is coincident with the centerline of the CNV, with the location of zero elevation at the base. The positive X-axis is horizontal and along the CNV 90 degree axis. The positive Z-axis (in accordance with the right-hand-rule) is orthogonal to the X-axis and is along the CNV 180 degree axis. For nozzle loading, some tables present reaction forces whereas others present member forces. This results in the sign being flipped for the reaction forces. Dynamic loads should be taken as occurring in both directions (+/-) regardless of the sign shown.

3. DFL = Dynamic Fluid Loads (time-history analysis of valve opening/closing transients, water hammer, and pipe break cases). Note that where applicable, the maximum pipe break loads and water hammer loads are listed separately, as these loads are applied concurrently.

RCS Discharge Line

The RCS discharge line was analyzed from the reactor pressure vessel nozzle connection to the first anchor (i.e., restraint in six degrees of freedom) on the outboard side of the reactor bay wall. Inside containment, this line is classified as ASME Class 1, while outside containment, it is classified as B31.1 with limited portions classified as Class 1 and Class 3.

The stress analysis of this line is split into two separate analysis models, for inside the CNV and outside the CNV, because the CNV penetration acts as an anchor. The analysis model for the Class 1 line inside the CNV is shown in Figure 1 through Figure 3, with the stress results and nozzle loads shown in Table 1 through Table 3.

The analysis model for the RCS discharge line outside the CNV is shown in Figure 4 and Figure 5, with the stress results and nozzle loads shown in Table 4 and Table 5. This analysis model includes the RCS injection line and the PZR spray line because they are connected to the RCS discharge line and cannot be decoupled from the analysis. Although the stress results for these other lines are not listed here, they also pass applicable ASME Code criteria. The weld between the CIV and the CNV nozzle safe-end is classified as ASME Class 1 piping and is evaluated in a separate calculation using NB-3200 methods, as allowed by NB-3630(b).

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Figure 1 - RCS Discharge Line Inside the CNV - Entire Model

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Figure 2 - RCS Discharge Line Inside the CNV -Upper Portion

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Figure 3 - RCS Discharge Line Inside the CNV - Lower Portion

Table 1. ASME Class 1 RCS Discharge Line Inside the CNV

ASME Code Level	Combination	Joint	Component	Stress(psi)	Allowable Stress(psi)	Ratio
Design	ASME Eq. (9)	A00	Pipe to RPV12 Nozzle Connection	{{		
		A03	Bend			
		A04	Bend			
A-B-C	ASME Eq. (10)	A03	Bend			
		A04	Bend			
		A25	Bend			
A-B-C	ASME Eq. (12)	A18	Bend			
		A23	Bend			
		A03	Bend			
A-B-C	ASME Eq. (13)	A03	Bend			
		A00	Pipe to RPV12 Nozzle Connection			
		A18	Bend			
A-B	Thermal Stress Ratchet	All	All			
A-B-C	ASME NB-3653.5 Cumulative Damage (In-Air Fatigue)	A00	Pipe to RPV12 Nozzle Connection			
		A18	Bend			
		A03	Bend			
A-B-C	Cumulative Damage Considering Environmental Effects	A00	Pipe to RPV12 Nozzle Connection			
		A18	Bend			
		A03	Bend			
B	ASME Eq. (9)	A03	Bend			
		A00	Pipe to RPV12 Nozzle Connection			
		A07	Bend			
C	ASME Eq. (9)	A00	Pipe to RPV12 Nozzle Connection			
		A03	Bend			
		A15	Straight Pipe at Support Guide			
D	ASME Eq. (9)	A00	Pipe to RPV12 Nozzle Connection			
		A03	Bend			
		A15	Straight Pipe at Support Guide			
D	ASME NB-3656(b) (2)Sustained Stress Due to Weight	A00	Pipe to RPV12 Nozzle Connection			
		A03	Bend			
		A04	Bend			}}2(a),(c)

D	ASME NB-3656(b) (3)Pressure + Weight + Reversing Dynamic (SSE Inertia)	A15	Straight Pipe at Support Guide	{{		
		A03	Bend			
		A00	Pipe to RPV12 Nozzle Connection			
D	ASME NB-3656(b) (4)SAM Bending	A01	Bend			
		A29	Pipe to CNV13 Nozzle Connection			
		A26	Bend			
D	ASME NB-3656(b) (4)SAM Axial	A25-A26	Bend			
		A22-A23	Bend			
		A17-A19	Bend			}}2(a),(c)

Table 2. RCS Discharge Line Inside the CNV - RPV Nozzle Loads

Joint A00 - RPV12

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL(1)						
Max Level C DFL(2)						
Max Level D DFL(2)						}}2(a),(c)

1. Max of Time History Cases 1, 2, 4, 5

2. Max of Time History Cases 3, 6

Table 3. RCS Discharge Line Inside the CNV - CNV Nozzle Loads

Joint A29 - CNV13

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL(1)						
Max Level C DFL(2)						
Max Level D DFL(2)						}}2(a),(c)

1. Max of Time History Cases 1, 2, 4, 5

2. Max of Time History Cases 3, 6

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Figure 4. CVCS Discharge, Injection, and PZR Spray Outside the CNV - Entire Model

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Figure 5. CVCS Discharge Line Outside the CNV - ASME Class 3 Portion Highlighted in Red - Other Lines Hidden for Clarity

Table 4. ASME Class 3 RCS Discharge Line Outside the CNV

ASME Code Level	Combination	Joint	Component	Stress (psi)	Allowable Stress (psi)	Ratio
Design	ASME Eq. (8)	H03	Drain Branch Connection	{{		
		A23	Straight Pipe			
		A49	Straight Pipe to Valve Connection at Class 3 Boundary			
A	ASME Eq. (9a)	H03	Drain Branch Connection			
		A23	Straight Pipe			
		A49	Straight Pipe to Valve Connection at Class 3 Boundary			
A	ASME Eq. (11a)	A08-A09	Straight Pipe to Check Valve to CIV Weld			
		A10	Bend			
		A41	Reducer			
B	ASME Eq. (9a)	H03	Drain Branch Connection			
		A49	Straight Pipe to Valve Connection at Class 3 Boundary			
		A16	Straight Pipe			
B	ASME Eq. (11a)	A08-A09	Straight Pipe to Check Valve to CIV Weld			
		A10	Bend			
		A41	Reducer			
C	ASME Eq. (9a)	A14	Straight Pipe			
		H03	Drain Branch Connection			
		A13	Tee			
D	ASME Eq. (9a)	A14	Straight Pipe			
		A12**	Straight Pipe with Lug Attachment at Support Location			
		H03	Drain Branch Connection			
D	ND-3655(b)(2) Sustained Stress Weight	A23	Straight Pipe			
		A16-A21	Straight Pipe-Bend			
		A13	Tee			
D	ND-3655(b)(4) SAM Bending	A33	Bend			
		A34	Bend			
		A39	Bend			}}2(a),(c)

D	ND-3655(b)(4) SAM Axial	A39-A38A**	Bend - Straight Pipe	{{		
		A10	Bend			
		A11	Bend			
--	Appendix Y-5410(c) Eq. (5)	A12	Straight Pipe with Lug Attachment at Support Location			
		A38A	Straight Pipe with Lug Attachment at Support Location			
		A33A	Straight Pipe with Lug Attachment at Support Location			
--	Appendix Y-5410(c) Eq. (6)	A12	Straight Pipe with Lug Attachment at Support Location			
		A38A	Straight Pipe with Lug Attachment at Support Location			
		A33A	Straight Pipe with Lug Attachment at Support Location			}}2(a),(c)

Note: **Joints A12, A33A, and A38A are locations having a welded attachment and also analyzed using the requirements in Nonmandatory Appendix Y, Article Y-5000.

Table 5. RCS Discharge Line Outside the CNV - CNV Nozzle Loads in Local Coordinates

Joint A03 - Discharge Line CNV Nozzle

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Feedwater Lines

The two feedwater lines were analyzed from the reactor pressure vessel nozzle connection to anchor supports on the outboard side of the reactor bay wall. Inside containment, these lines are classified as ASME Class 2, while outside containment, the majority of this piping is classified as B31.1 with a limited portion classified as Class 2.

The stress analysis of these lines is split into three separate analysis models. There are two models for the feedwater lines inside the CNV, one for each train of the the feedwater system. The analysis model for feedwater line 1 inside the CNV is shown in Figure 6 through Figure 9, with the stress results and nozzle loads shown in Table 6 through Table 9. The analysis model for feedwater line 2 inside the CNV is shown in Figure 10 through Figure 12, with the stress results and nozzle loads shown in Table 10 through Table 13.

The analysis model for the feedwater lines outside the CNV is shown in Figure 13, with the stress results and nozzle loads shown in Table 14 and Table 15. In this case, only one model is necessary to qualify both trains of the feedwater system because the physical layout of the piping is symmetrical about the z-y plane. Stress results are only provided for the ASME Class 2 piping weld between the CIV and the CNV nozzle safe-end as other piping is B31.1. Although the stress results for the B31.1 portion are not listed here, they also pass applicable ASME Code criteria as required by the design specification (i.e., meets level D stress limits for the SSE).

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Figure 6. Feedwater Line 1 Inside the CNV - Entire Model

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Figure 7. Feedwater Line 1 Inside the CNV - Upper Portion

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Figure 8. Feedwater Line 1 Inside the CNV - Middle Portion

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Figure 9. Feedwater Line 1 Inside the CNV - Lower Portion

Table 6. ASME Class 2 - Feedwater Line 1 Inside the CNV

ASME Code Level	Combination	Joint	Component	Stress (psi)	Allowable Stress (psi)	Ratio
Design	ASME Eq. (8)	A04-A05	Reducer	{{		
		A15	Bend			
		A16	Bend			
A & B	ASME Eq. (9a)	D02	Weldolet to Weld Neck Connection at Relief Valve			
		A06-A07	Straight Pipe to Bend			
		A00	Straight Pipe			
A & B	ASME Eq. (10a)	A27	Bend			
		A47	Tee at Relief Valve			
		A25	Bend			
A & B	ASME Eq. (11)	A27	Bend			
		A47	Tee at Relief Valve			
		A25	Bend			
D	ASME Eq. (9a)	A26	Support with weld on NPS 5 piping			
		D02	Weldolet to Weld Neck Connection at Relief Valve			
		A27	Bend			}}2(a),(c)

Table 7. Feedwater Line 1 Inside the CNV - CNV Nozzle Loads

Joint A29 - CNV1

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table 8. Feedwater Line 1 Inside the CNV - RPV Nozzle Loads

Joint A00 - RPV3

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table 9. Feedwater Line 1 Inside the CNV - RPV Nozzle Loads

Joint A06 - RPV5

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

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Figure 10. Feedwater Line 2 Inside CNV - Entire Model

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Figure 11. Feedwater Line 2 Inside the CNV - Upper Portion

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Figure 12. Feedwater Line 2 Inside the CNV - Lower Portion

Table 10. ASME Class 2 - Feedwater Line 2 Inside the CNV

ASME Code Level	Combination	Joint	Component	Stress (psi)	Allowable Stress (psi)	Ratio
Design	ASME Eq. (8)	B04-B05	Reducer	{{		
		B27-B28	Bend			
		B10	Tee			
A & B	ASME Eq. (9a)	B46	Tee at Relief Valve			
		D02	Weldolet to Weld Neck Connection at Relief Valve			
		B00	Straight Pipe			
A & B	ASME Eq. (10a)	B46	Reducer			
		B20	Support with weld on NPS 5 piping			
		B12	Reducer at DHRS Condensate			
A & B	ASME Eq. (11)	B46	Reducer			
		B20	Support with weld on NPS 5 piping			
		B12	Reducer at DHRS Condensate			
D	ASME Eq. (9a)	B46	Reducer			
		B20	Support with weld on NPS 5 piping			
		D02	Weldolet to Weld Neck Connection at Relief Valve			}}[2(a),(c)]

Table. 11 Feedwater Line 2 Inside the CNV - CNV Nozzle Loads

Joint B30 - CNV2

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table. 12 Feedwater Line 2 Inside the CNV - RPV Nozzle Loads

Joint B00 - RPV4

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table. 13 Feedwater Line 2 Inside the CNV - RPV Nozzle Loads

Joint B06 - RPV6

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

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Figure 13. Feedwater Line 1 and 2 Outside the CNV - Entire Model

Table 14. ASME Class 2 Feedwater Lines 1 & 2 Outside the CNV

ASME Code Level	Combination	Joint	Component	Stress (psi)	Allowable Stress (psi)	Ratio
Design	ASME Eq. (8)	C00	CNV Nozzle Safe- End to CIV Weld	{{		
A & B	ASME Eq. (9a)	C00	CNV Nozzle Safe- End to CIV Weld			
A & B	ASME Eq. (10a)	C00	CNV Nozzle Safe- End to CIV Weld			
C	ASME Eq. (9a)	C00	CNV Nozzle Safe- End to CIV Weld			
D	ASME Eq. (9a) (Pipe Break Only)	C00	CNV Nozzle Safe- End to CIV Weld			
D	ASME Eq. (9a) (Pipe Break + SSE)	C00	CNV Nozzle Safe- End to CIV Weld			
D	NC-3655(b) (4)SAM Bending	C00	CNV Nozzle Safe- End to CIV Weld			
D	NC-3655(b) (4)SAM Axial	C00	CNV Nozzle Safe- End to CIV Weld			}}2(a),(c)

(Note: Stress results provided for the only joint in the model classified as ASME Class 2. All other piping is B31.1)

Table 15. Feedwater Lines 1 & 2 Outside the CNV - CNV Nozzle Loads

Joint C00 - CNV1 and CNV2

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level D DFL						}}2(a),(c)

Main Steam Lines

The two main steam lines were analyzed inside containment from the reactor pressure vessel nozzle connection to the containment vessel nozzle connection. These lines are classified as ASME Class 2. The stress analysis of these lines is contained in a single analysis model shown in Figure 14. The stress results and nozzle loads are shown in Table 16 through Table 22. The two trains of the main steam system are included in the same analysis model, but do not interact and are not physically connected.

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Figure 14. Main Steam Line 1 & 2 Inside the CNV - Entire Model

Table 16. ASME Class 2 Main Steam Line 1 & 2 Inside the CNV

ASME Code Level	Combination	Joint	Component	Stress (psi)	Allowable Stress (psi)	Ratio
Design	ASME Eq. (8)	C10	Tee at Branch Connection	{{		
		D01	Tee at Branch Connection			
		C09	Reducer			
A & B	ASME Eq. (9a)	C10	Tee			
		D01	Tee at Branch Connection			
		A00	Straight Pipe at RPV10 Nozzle			
A & B	ASME Eq. (10a)	C07	Bend			
		C09	Reducer			
		C05	Bend			
A & B	ASME Eq. (11)	C09	Reducer			
		C07	Bend			
		C05	Bend			
D	ASME Eq. (9a)	C07	Bend			
		C10	Tee at Branch Connection			
		C09	Reducer			
D	ASME NC-3655(b)(4) SAM Bending	A06	Bend			
		A11	Reducer			
		C07	Bend			
D	ASME NC-3655(b)(4) SAM Axial	A03	Bend			
		A02	Bend			
		B04	Bend			}}2(a),(c)

Table 17. Main Steam Line 1 Inside the CNV - RPV Nozzle Loads

Joint A00 - RPV10

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table 18. Main Steam Line 1 Inside the CNV - RPV Nozzle Loads

Joint B07 - RPV8

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table 19. Main Steam Line 1 Inside the CNV - CNV Nozzle Loads

Joint A10 - CNV3

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table 20. Main Steam Line 2 Inside the CNV - RPV Nozzle Loads

Joint C00 - RPV9

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table 21. Main Steam Line 2 Inside the CNV - RPV Nozzle Loads

Joint D09 - RPV7

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Table 22. Main Steam Line 2 Inside the CNV - CNV Nozzle Loads

Joint C11 - CNV4

Load	**FX (lbf)**	**FY (lbf)**	**FZ (lbf)**	**MX (ft-lbf)**	**MY (ft-lbf)**	**MZ (ft-lbf)**
Gravity	{{					
Max Thermal						
SSE (Inertia)						
SSE (SAM)						
Max Level A DFL						
Max Level B DFL						
Max Level C DFL						
Max Level C Pipe Break						
Max Level D DFL						
Max Level D Pipe Break						}}2(a),(c)

Main Steam Lines within the Break Exclusion Zone

The two high-energy ASME Class 2 main steam lines were analyzed from the containment vessel nozzle connection to the first six-way anchor restraint beyond the reactor bay wall. The stress analysis of these lines is contained in a single representative analysis model (Train 2) shown in Figures 1 and 2. The single analysis is representative as the two lines are mirror images about the CNV z-axis. The two trains of the main steam system do not interact and are not physically connected. The stress results and nozzle loads are shown in Table 23 and Table 24.

Table 23. ASME Class 2 - Containment System Main Steam Piping and Main Steam System Piping Outside the CNV

ASME Code Level	Combination	Joint	Component	Stress (psi)	Allowable Stress (psi)	Ratio
Design	ASME Eq. (8)	C00	Safe-end weld to custom tee; uses SA-312 TP304 material allowable	{{		}}2(a),(c)
A	ASME Eq. (9a)	CO01	Branch connection at 8" DHRSAV tee	{{		}}2(a),(c)
A	ASME Eq. (10a)	CN04	Weld at MSIV	{{		}}2(a),(c)
B	ASME Eq. (9a)	CP01	8" Steam Piping Tee	{{		}}2(a),(c)
		C00	Safe-end weld to custom tee; uses SA-312 TP304 material allowable	{{		}}2(a),(c)
B	ASME Eq. (10a)	CP01	8" Steam Piping Tee	{{		}}2(a),(c)
		CO01	8" Steam Piping Tee	{{		}}2(a),(c)
C	ASME Eq. (9a)	CO01	Branch connection at 8" DHRSAV tee	{{		}}2(a),(c)
		CP01	8" Steam Piping Tee	{{		}}2(a),(c)
		CN03	Branch at DHRSAV tee	{{		}}2(a),(c)
D	ASME Eq. (9a)	CN06	Straight Pipe at TSS guide support	{{		}}2(a),(c)
		CN05	Straight Pipe Adjacent and Upstream of MSIV	{{		}}2(a),(c)
D	ASME NC-3655(b)(4) SAM Bending	CN06	Straight Pipe at TSS guide support	{{		}}2(a),(c)
		CN05	Straight Pipe Adjacent and Upstream of MSIV	{{		}}2(a),(c)
D	ASME NC-3655(b)(4) SAM Axial	CN05	Straight Pipe Adjacent and Upstream of MSIV	{{		}}2(a),(c)

Note:

A portion of the main steam line piping is classified to ASME B31.1. The ASME Service Level D acceptance criteria is expanded to include this portion of ASME B31.1 piping and the results are included in this table.

Table 24. Main Steam Piping Outside the CNV - Global Nozzle Loads

Joint C00 (Nozzle Safe-End to Piping Connection) - CNV 3 and CNV4

Load	FX (lbf)	FY (lbf)	FZ (lbf)	MX (ft-lbf)	MY (ft-lbf)	MZ (ft-lbf)
Max Gravity(1)	{{					}}2(a),(c)
Max Thermal	{{					}}2(a),(c)
SSE (Inertia)	{{					}}2(a),(c)
SSE (SAM)	{{					}}2(a),(c)
Max Level A DFL(2)	{{					}}2(a),(c)
Max Level B DFL(3)	{{					}}2(a),(c)
Max Level C DFL(4)	{{					}}2(a),(c)
Max Level D DFL(5)	{{					}}2(a),(c)

Notes:

(1) Gravity = Max of Operating DHRS vs. Non-Operating DHRS Conditions

(2) Time History Case 8

(3) Max of Time History Cases 1, 5, 6, 8, 10, 11, 12

(4) Max of Time History Cases 2, 7, 9, 10, 11, and 12

(5) Max of Time History Cases 15, 17, 18, 19, 20, and 21

{{

}}2(a),(c)

Figure 15. Containment System Main Steam Piping and Main Steam System Piping Outside the CNV - Overall Model

{{

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

Figure 16 - Containment System Main Steam Piping and Main Steam System Piping Outside the CNV - Detailed View near MSIV

Impact on DCA:

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

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0719-66375

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 method and results by which NuScale develops its piping analyses.

   NuScale has performed significant research and evaluation to develop a basis for this method and results 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. 154, eRAI No. 8938. 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 July 22, 2019.

Zackary W. Rad