October 27, 2017

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 Response to NRC Request for Additional Information No. 214 (eRAI No. 8858) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 214 (eRAI No. 8858)," dated September 01, 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 Enclosures to this letter contain NuScale's response to the following RAI Questions from NRC eRAI No. 8858:

- 03.08.02-1
- 03.08.02-2
- 03.08.02-3
- 03.08.02-4
- 03.08.02-5
- 03.08.02-7
- 03.08.02-8
- 03.08.02-9
- 03.08.02-10
- 03.08.02-11
- 03.08.02-12
- 03.08.02-13

The response to question 03.08.02-6 will be provided by December 14, 2017.

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 214 (eRAI No. 8858). 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-8G9A
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8858, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 8858, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-1017-56887

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8858, proprietary

Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 8858, nonproprietary

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-1

10 CFR 52.47 requires the design certification applicant to include a description and analysis of the structures, systems, and components with sufficient detail to permit understanding of the system designs.

The two figures referenced in DCD Section 3.8.2.1, Figure 3.8.2-1 and Figure 6.2-1 do not provide the geometry of the containment vessel, including sketches showing plan views at various elevations and sections in at least two orthogonal directions . The drawings should indicate ASME Class or Quality Group boundaries, and some drawings are missing measurements. For example, drawings of boundaries between the CNV and the RPV should be provided (RPV support and support ledge) and elevation drawings showing the dimensions from the bottom of the CNV support to the important features of the CNV such as the refueling flange, the centerline of the various access ports, and the RVV trip and trip/reset housing penetrations. Provide the various sketches showing plan views.

NuScale Response:

The dimensions in the text of FSAR Tier 2, Section 3.8.2.1.2 through Section 3.8.2.1.9 have been added to FSAR Tier 2, Figure 3.8.2-1, Figure 3.8.2-4, Figure 3.8.2-5, Figure 3.8.2-7, Figure 6.2-1, Figure 6.2-2a and Figure 6.2-3a. Views of the containment vessel-reactor pressure vessel (CNV-RPV) boundary at the supports have been added as Figure 3.8.2-8 and Figure 3.8.2-9. Reference to figures showing the plan views, figures providing dimensions, and the new figures identifying the CNV boundary have been added to Section 3.8.2.1.2.

The CNV components are all classified as ASME Code Class MC components and the CNV is constructed and stamped as an ASME BPVC Class 1 vessel as specified in FSAR Tier 2, Section 3.8.2.2.2. Accordingly, no ASME code class boundary has been identified on the FSAR figures.

Impact on DCA:

The FSAR Tier 2, Section 3.8.2.1.2 and Figure 3.8.2-1, Figure 3.8.2-4, Figure 3.8.2-5, Figure 3.8.2-7, Figure 6.2-1, Figure 6.2-2a, and Figure 6.2-3a have been revised as described in the response above and as shown in the markup provided with the response to question 03.08.02-12.

NuScale Power

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-2

10 CFR 52.47 requires the design certification applicant to include a description and analysis of the structures, systems, and components with sufficient detail to permit understanding of the system designs.

DCD Section 3.8.2.3, Load Combinations, states that the load combinations are consistent with RG 1.57. However the load combinations given in Table 3.8.2-2 and 3.8.2-3 and the last paragraph in DCD Section 3.8.2.3 state that typical RPV load combinations for Class 1 vessels are used. Clarify how the load combinations are consistent with RG 1.57 when alternatives to RG 1.57 load combinations are presented in the DCD. Revise the DCD accordingly.

NuScale Response:

Design-Specific Review Standard (DSRS) 3.8.2 Subsection II.3 specifies that Regulatory Guide (RG) 1.57 should be considered for determination of the load combinations in the design of steel containment, since ASME Subsection NB does not explicitly state load combinations. The load combinations in RG 1.57 apply to the design, fabrication, testing and inspection of a Class MC structure. Consequently, application of these load combinations adds excessive conservatism for a Class 1 component, which already has tighter control of design, fabrication, inspection and testing. NUREG 0800, SRP 3.9.3 provides load combinations directly applicable for Class 1 components that are used for the containment vessel (CNV).

To address DSRS 3.8.2, Subsection II.3, FSAR Tier 2, Section 3.8.2.3 states that the intent of RG 1.57 is being met (i.e. LOCA, seismic, hydrogen burn, etc. are included), but that RG 1.57 is not explicitly followed. The “Alternatives to Regulatory Guide 1.57 Load Combinations” discussion in Section 3.8.2.3 provides a discussion of the difference between the RG 1.57 load combinations and SRP 3.9.3 Class 1 load combinations.

The statement in FSAR Section 3.8.2.3 that load combinations are “consistent” with RG 1.57 has been corrected to state that the guidance of RG 1.57 is considered.

Impact on DCA:

The FSAR Tier 2, Section 3.8.2.3 has been revised as described in the response above and as shown in the markup provided with the response to question 03.08.02-12.

NuScale Power

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-3

10 CFR 50, Appendix A, GDC 2 requires systems, structures, and components important to safety be designed to withstand appropriate combinations of the effects of normal and accident conditions with the effects of natural phenomena including earthquake. TR-0916-51502-P, Rev. 0, Section 8.4.3 describes the calculated displacement and acceleration time-histories, maximum relative displacements, in-structure response spectrum, and maximum forces and moments at representative component interfaces. The description is insufficient and the report does not provide the seismic and LOCA stress results. Please provide the seismic analysis details and stress results under Service Level D conditions for the CNV.

The analysis should include description of structure modelling, input motion (time history or in-structure response spectrum), major assumptions, acceptance criteria, fluid structural interaction considerations, mass distribution, damping values, dominant frequency and modes shape plots, gap/impact modeling, and seismic and LOCA stress results under Service Level D condition.

NuScale Response:

The NuScale Power Module (NPM) Seismic Analysis technical report TR-0916-51502 Revision 0, Section 4.1 describes the seismic model used to generate loads on the containment vessel (CNV). Specifically, Section 4.1.1 discusses the CNV portion of the model. Table 4-1 provides the CNV mass distribution and Section 4.1.8, the combined NPM model mass. The CNV fluid-structure interaction with the reactor pool is discussed in Section 4.1.1.2. Boundary condition interaction with the reactor pool and reactor pressure vessel are discussed in Section 4.1.1.2 and Section 4.1.2.2, respectively. Section 8.2 discusses the NPM modal analysis performed and provides the dominate frequencies and amount of mass excited. The natural frequencies determined from the modal analysis are used in the NPM seismic time history analyses. The damping values used in the seismic analysis are discussed in Section 8.1. The seismic time histories applied to the NPM used to generate the loads and in-structure response spectra (ISRS) on the CNV, are discussed in Section 5.0. The resulting ISRS in the regions of nozzle penetrations are used to generate loads on the CNV nozzles.

The NuScale Short Term Transient Analysis technical report TR-1016-51669 describes the blowdown events (design basis pipe break (DBPB), which include spurious valve actuation conditions) evaluated for the NPM. Section 5.1.2 and Section 6.2 discuss the modeling and fluid-structure interaction used to generate the dynamic response of the NPM due to blowdown events. The dynamic loads associated with blowdown and the corresponding asymmetric cavity pressure on the NPM are evaluated using a transient structural analysis. The maximum loads and time history response on the CNV, caused by the dynamic response of the NPM to the transient structural analysis, are discussed in Section 6.2.4. The resulting time history response in the regions of nozzle penetration are used to generate loads on the CNV nozzles.

The above RAI question states, "the (seismic technical) report does not provide seismic and LOCA stress results." FSAR Tier 2, Section 3.8.2.3 (Loads and Load Combinations) clarifies that the Loss-of-Coolant Accident (LOCA) dynamic loads are produced by a postulated pipe break on a primary coolant pipe with a break larger than RCS make-up. In the NPM, there are no piping systems that fall in this category. Consequently, LOCA loads are not applicable to the NuScale design.

The shell and nozzle loads based on the seismic and DBPB (blowdown) analysis of the NPM are combined and evaluated to ASME Subsection NB Level D requirements. The CNV primary stresses on the CNV are developed using a combination of 3-D finite element models and hand calculations. Table 1 below provides the limiting Level D stress ratios calculated for the CNV. The loads and combinations considered for Service Level D stress evaluation of the CNV are provided in FSAR Tier 2, Table 3.9-2 and Table 3.8.2-2, respectively.

Table 1: CNV Limiting Level D Stress Intensities

Location	Classification(1)	Stress Ratio(2)
CNV Top Head	P_m	{{
	P_L+P_b	
CNV Shell (near penetration)	P_m	
	P_L+P_b	
CNV Lug	P_m	
	P_L+P_b	
CNV Shell	P_m	
	P_L+P_b	
CNV Nozzle	P_m	
	P_L+P_b	}}2(a),(c)

Note:

1. Primary membrane (P_m) and Primary membrane (general or local) plus primary bending (P_L+P_b) stress intensity
2. Stress Ratio is defined as the calculated stress intensity / allowable stress intensity limit

Impact on DCA:

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

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-4

10 CFR 52.47 requires the design certification applicant to include a description and analysis of the structures, systems, and components with sufficient detail to permit understanding of the system designs.

In accordance with NUREG/CR-6906 "Containment Integrity Research at Sandia National Laboratories - An Overview", if the CNV model is not based on one as listed in Table A-1 of the NUREG, explain how geometric detail and proper mesh discretization were obtained. Were multiple models run and compared? NUREG/CR-6906 discusses the RIKS method, which may be used to compute and apply deformation-based selections of load increments. When successfully applied, this allows solutions to reach maximum pressure and continue to track somewhat past peak pressure (while wall-thinning is occurring) with reasonable accuracy. Was the RIKS method utilized?

NuScale Response:

NUREG/CR-6906 Table A-1 provides a list of the analytical models used in the Sandia National Laboratories containment study, but does not provide guidance on what model type to use. Regulatory Guide 1.216, Section C.1.a provides guidance that 3-D finite element models (full, half or wedge models) are acceptable, as well as axisymmetric models.

The NuScale containment vessel (CNV) ultimate pressure integrity analysis uses five 3-D finite element models to evaluate the CNV. Three models are used to evaluate the internal pressure capacity and two models to evaluate the torispherical head knuckle buckling created by the internal pressure. The models used are:

- A quarter slice of the CNV top section, including: the CNV Head Manway (CNV 24) [nominal pipe size (NPS) 18]; CRDM Access (CNV 25) [67 inch diameter]; and CRDM Power (CNV 37) [NPS 18] penetrations.
- A one eighth slice of the CNV middle section which includes the SG Inspection Port (CNV 30) [38 inch diameter], the PZR Heater Access port (CNV 31) [44 inch diameter], and the RPV support.

- A 1/96th slice of the CNV bottom section including the refueling flange and a refueling flange closure bolt.
- Buckling models that are full models of the top and bottom head. The CNV Head Manway (CNV 24) and CRDM access (CNV 25) openings are included in the CNV top head buckling model. The CNV bottom head buckling model includes the CNV support skirt.

The following modeling simplifications are made to the 3-D models:

- Nozzle penetrations and small I&C openings less than NPS 18 are not modeled.
- Parent material, cladding and threaded inserts are modeled as separate material properties with shared boundaries. Other bolting components are modeled as separate parts in the three internal pressure capacity models.
- Fasteners are modeled using minimum minor (thread root) bolt diameters.
- Chamfers, small radius fillets, and alignment features are removed.
- O-ring grooves are removed.
- Top support structure frame and supports are removed.
- Vent holes from the support skirt are removed
- Components external to the CNV shell (Excore holders, support lugs, lifting trunnions, and etc.) are removed.
- Welds are full penetration welds and modeled as part of the base metal and are not as a separate integral part.

The RIKS method was not used in evaluation of the NuScale CNV. The RIKS method allows the analysis to continue evaluation of the structure as the material exceeds its ultimate strength and thinning of the wall occurs. The use of this method is not pertinent to the evaluation of the NuScale design because the limiting failure mode (failure of a seal on an opening cover) occurs well before the material reaches ultimate strength.

Impact on DCA:

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

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-5

10 CFR 52.47 requires the design certification applicant to include a description and analysis of the structures, systems, and components with sufficient detail to permit understanding of the system designs. DCD Section 3.8.2.4.5 does not discuss how it addresses the containment penetrations in the ultimate capacity evaluation such as mechanical and electrical penetrations as described in RG 1.57 III.C and RG 1.216 C.1.g. Address the other containment leak paths NPS 18 and smaller.

NuScale Response:

Regulatory Guide (RG) 1.57 III.C and RG 1.216 C.1.g specify that the major penetrations must also be evaluated for the internal pressure capacity. The containment vessel (CNV) penetrations greater than nominal pipe size (NPS) 18, including the CNV head manway nozzle, control rod drive mechanism (CRDM) access, and CRDM power nozzle shown in FSAR Figure 3.8.2-5, and the pressurizer (PZR) access and steam generator (SG) access nozzles shown in FSAR Figure 3.8.2-1, are explicitly evaluated. The SG access nozzle evaluation bounds the SG access nozzles, and the PZR access nozzle evaluation bounds both PZR access nozzles.

The access openings in the CNV are a bolted cover design, with a pair of concentric, self-energizing metallic O-rings at the interface between the bolted cover and the CNV access opening flange. Major access and electrical penetration assemblies were considered to “fail” when a gap of 0.03” was reached above the metallic self-energizing O-ring. Covers on several major penetrations have additional sealing outside of the bolt circle as a result of prying and the cover surface pressing against the nozzle surface. Penetrations with this design are: CRDM access (67”) O-ring sealed to {{ }}$^{2(a),(c)}$; SG inspection access (38”) O-ring sealed to {{ }}$^{2(a),(c)}$; and PZR heater access (44”) sealed to {{ }}$^{2(a),(c)}$. The PZR heater access cover producing the limiting ultimate pressure opens above the seal, however the metal surfaces outside of the seal are pressed together restricting any loss around the seal.

Other penetrations, including those less than NPS 18, have a cover design that has a gap between the cover and nozzle and cannot pry against each other. The non-prying designs

evaluated are: CNV head manway (NPS 18) O-ring remains sealed until {{ }}[2(a),(c)]; and CRDM power (NPS 18) remains sealed {{ }}[2(a),(c)].

The electrical penetration assembly (EPA) glass-to-metal seal is not evaluated in the CNV ultimate pressure integrity analysis. An evaluation assumption is that penetrations less than NPS 18 are bounded by the larger penetration. Displacement of a bolted flange cover, with the same pressure applied to the cover, is proportional to the ratio of the diameter to the cover thickness. The ratio for the larger opening bounds the smaller diameter bolted openings, so this assumption is reasonable.

Inspection of the results shows that the two penetrations with designs similar to the penetrations less than NPS 18 (CNV head manway and CRDM power nozzles) remain sealed at a pressure of {{ }}[2(a),(c)] or greater. Therefore, the penetrations on the CNV head shown in FSAR Figure 3.8.2-5 that are less than NPS 18 and not evaluated (I&C nozzle (NPS 3); PZR power nozzle (NPS 12); I&C nozzle (NPS 8); and CRDM control nozzle (NPS 10)) are expected to remain sealed at a pressure greater than {{ }}[2(a),(c)].

Impact on DCA:

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

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-7

In accordance with GDC 50 and 10 CFR 50.44, the reactor containment structure, including access openings, penetrations, and the containment heat removal system shall be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident. This margin shall reflect consideration of (1) the effects of potential energy sources which have not been included in the determination of the peak conditions, such as energy in steam generators and as required by 10 CFR 50.44 energy from metal-water and other chemical reactions that may result from degradation but not total failure of emergency core cooling functioning, (2) the limited experience and experimental data available for defining accident phenomena and containment responses, and (3) the conservatism of the calculational model and input parameters.

In DCD Section 3.8.2.4.5, Containment Vessel Ultimate Capacity, Table 3.8.2-4 provides the key assumptions for CNV ultimate pressure analysis. However, for 3 of the 8 items, no explanation is given beyond "engineering judgement". Provide a detailed explanation for these items, identifying how these assumptions are conservative.

NuScale Response:

FSAR Tier 2, Table 3.8.2-4 has been modified to provide additional information to support the CNV ultimate pressure analysis key assumptions.

Impact on DCA:

FSAR Tier 2, Table 3.8.2-4 has been revised as described in the response above and as shown in the markup provided with the response to question 03.08.02-12.

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-8

In accordance with GDC 50 and 10 CFR 50.44, the reactor containment structure, including access openings, penetrations, and the containment heat removal system shall be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident.

In DCD Section 3.8.2.4.5, the ultimate pressure capacity was evaluated to be 1240 psi for criteria D, where a gap of 0.03 inches was reached at the outer O-ring of the pressurizer access flange. However, the minimum hydrostatic test pressure is 1250psi, which is greater than the ultimate pressure capacity as indicated above per criteria D. Explain why the ultimate pressure capacity is exceeded by a hydrostatic test for structural integrity.

NuScale Response:

The hydrostatic test for the containment vessel (CNV) is performed to the requirements of ASME Boiler and Pressure Vessel Code (BPVC) Subarticle NB-6200. The minimum pressure for the CNV hydrostatic test is 1,250 psig and a maximum pressure of up to 1,325 psig is allowed/possible. The hydrostatic pressure is held for a minimum of 10 minutes. The pressure is then reduced to the design pressure and held while examining for leaks. The joints, connections, and regions of high stress, such as around openings and thickness transition sections, are examined for leakage. The CNV design specification does not allow for leakage, including gasketed joints. Additionally, after hydrostatic testing, the CNV pressure boundary welds are volumetrically inspected prior to being put into service. Based on the hydrostatic test, and regardless of the calculated ultimate pressure integrity, the minimum ultimate pressure integrity of the CNV is between 1,250 and 1,325 psi.

The ultimate pressure calculated for the CNV results from the application of conservative material modeling methodology. The values from this analysis were not compared to the hydrostatic test pressure, because the basis of Regulatory Guide (RG) 1.216 methodology is different than the ASME BPVC. Application of the RG 1.216 methodology can result in an indicated ultimate pressure capacity lower than that demonstrated by the ASME BPVC

Subsection NB code (by empirically demonstration through a hydrostatic test), demonstrating that the ultimate pressure methodology is conservative.

There are conservatisms in the ultimate pressure analysis material modeling:

1. Material properties are based on ASME BPVC minimum properties as required by RG 1.216. The hydrostatic test is based on the actual material properties, which are typically greater than the ASME BPVC minimum properties. Additionally, the minimum properties are based on a temperature greater than the design-basis accident temperature (see item 2 below), thereby reducing the minimum material properties.
2. Material and stress-strain curve properties taken at the design temperature of 550 ^{o}F are used to evaluate the CNV structural response. RG 1.216 C.1.d permits the properties to correspond to the design-basis accident temperature. The design-basis accident temperature will quickly spike and then drop off. The average metal temperature at the peak produces a lower metal temperature than the design temperature. The lower average metal temperature for the design-basis accident allows for greater material properties and increased plastic modulus on the stress-strain curve.
3. The material modeling for plastic behavior uses a single slope plastic modulus to represent the non-linear portion of the stress-strain curve. This curve has a low slope and falls below the the calculated stress-strain curve based on ASME BPVC minimum properties at design temperature. The lower plastic modulus slope reduces stiffness and therefore increases displacements when the material becomes plastic. RG 1.216 C.1.d permits the representative stress-strain curve to be used (i.e. multiple slopes following closer to the calculated stress-strain curve). Nevertheless, the ultimate pressure analysis used a more conservative single slope below the stress-strain curve.

The ultimate pressure 1,240 psi value is associated with an analytical determination that leakage occurs when a 0.03 inch gap is reached at the top and bottom regions of the outer O-ring on the PZR heater access. As a result of material modeling in the ultimate pressure calculation, the displacement at the flange opening is calculated at a lower pressure than what is expected. Adjusting the ultimate pressure calculation material properties on design-basis accident temperature and using multiple curves to represent the calculated stress strain curve produces stiffer material and increases the pressure needed to open a 0.03 inch gap at the outer O-ring. Actual leakage of the O-ring for ultimate pressure is expected to occur at a higher pressure than 1,240 psi. The 1.5% total hoop strain limit is therefore a more reasonable representation of the CNV ultimate pressure. The 1.5% total hoop strain is reached at about 1,750 psi.

In summary, the hydrostatic test is a physical test performed on every CNV and has material properties equal to or greater than the minimum properties. The CNV ultimate pressure integrity analysis is conservative in that it uses ASME BPVC minimum properties and conservative material modeling assumptions and approaches. Every CNV is verified to meet the hydrostatic test requirements or is not permitted to go into service. The hydrostatic test verifies that the CNV ultimate pressure exceeds 1,250 psi.

Impact on DCA:

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

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-9

10 CFR 52.47 requires the design certification applicant to include a description and analysis of the structures, systems, and components with sufficient detail to permit understanding of the system designs. DCD Section 3.8.2.7 describes testing and inservice inspection requirements for the CNV. For those CNV pressure boundary items defined as Code, Section III, Class 1, preservice examinations are in accordance with Code, Section III, Subsubarticle NB-5280 and ASME Section XI, Subarticle IWB-2200 using examination methods of ASME Code, Section V except as modified by NB-5111. These preservice examinations include 100 percent of the pressure boundary welds. For those portions of the CNV pressure boundary defined as ASME Code Class MC, preservice examinations are in accordance with Subarticle IWE-2200. In addition, due to the high pressure design of the CNV, the preservice examination requirements of Subarticle IWB-2200 are conservatively applied. Final preservice examinations are performed after hydrostatic testing but prior to code stamping."

However in DCD Section 6.2.1.6 it states, "Preservice examinations of ASME Code Class 1 containment pressure boundary items are conducted in accordance with NB-5280 and IWB-2200 using the examination methods of ASME BPVC Section V except as modified by NB-5111. Preservice inspections include 100 percent of the pressure boundary welds."

There is no mention of Class MC portions as noted in DCD Section 3.8.2.7. If there are portions of the CNV pressure boundary defined as MC instead of Class 1, it is not clearly designated in any of the drawings or figures or discussed in DCD Section 3.8.2, or Section 6.2.1. Address the inconsistency in DCD Section 3.8.2.7 regarding the treatment of pressure boundary items and provide information denoting which sections of the CNV are ASME Code, Section III, Class 1 and which are designated as ASME Code, Section III, Class MC.

NuScale Response:

There are no Class MC welds on the containment vessel (CNV). The wording in FSAR Tier 2, Section 3.8.2.7 referencing Class MC welds has been deleted. Discussion of the preservice examination to be performed after hydrostatic testing, but prior to code stamping for the Class 1 welds, has been added to Section 3.8.2.7.

Impact on DCA:

The FSAR Tier 2, Section 3.8.2.7 has been revised as described in the response above as as shown in the markup provided with the response to question 03.08.02-12.

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-10

10 CFR 52.47 requires the design certification applicant to include a description and analysis of the structures, systems, and components with sufficient detail to permit understanding of the system designs.

DCD Section 3.8.2.1.8 states that the RPV supports that sit on the RPV support ledges (that are within the CNV) are bolted with “6-8 stud and nuts”. Does 6-8 refer to the dimension of the stud? Explain this nomenclature. Section 6.1.1.1 states that the RPV to CNV support ledge shell stud materials are Alloy 718. Revise DCD Section 3.8.2.1.8 to include the stud and nut material, SB-637 Alloy 718 (UNS N07718)

Table 6.1-1 lists RPV ledge bolts, nuts and flat washers. However, DCD Section 3.8.2.1.8 only discusses studs and nuts. Correct each section to ensure that they use consistent terms.

Table 6.1-2 lists Material Specifications for CNV Related non-ESF Components. This is currently not mentioned in Section 3.8.2.6 which discusses CNV materials. Revise DCD Section 3.8.2.6 and other locations, such as Table 3.8.2-1, Design and Operating Parameters, Section 3.8.2.1.1, 3.8.2.1.2, which also reference CNV materials, to also reference Table 6.1-2 to include all CNV materials.

NuScale Response:

FSAR Tier 2, Section 3.8.2.1.8 states that the RPV supports that sit on the RPV support ledges are bolted with "6-8 stud and nuts." The nomenclature, "6-8" is a standard callout for a six inch diameter stud with 8 threads per inch. Section 3.8.2.1.8 is revised to clarify and to specify the stud size, series, and class as well as the material for the stud, nut and washer. Also, reference to FSAR Tier 2, Table 6.1-2 has been added in FSAR Section 3.8.2.1.1, Section 3.8.2.1.2, Section 3.8.2.6 and Table 3.8.2-1.

Impact on DCA:

The FSAR Tier 2, Section 3.8.2.1.8, Section 3.8.2.1.1, Section 3.8.2.1.2, Section 3.8.2.6, and Table 3.8.2-1 have been revised as described in the response above and as shown in the markup provided with the response to question 03.08.02-12.

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-11

10 CFR 50, Appendix A, GDC 1, requires that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

DSRS 3.8.2.I.6.B states that the quality control program proposed for the fabrication of the containment with emphasis on the extent of compliance with Articles NB-2000, NB-4000, and NB-5000 of ASME BPV Code, Section III, Division 1, Subsection NB, as incorporated by reference in 10 CFR 50.55a, are reviewed, however no quality control program is discussed in the DCD Tier 2, Section 3.8.2.6.

Provide details of the quality control provisions in the DCD that will be applied to the design, fabrication, erection, and testing of the containment.

NuScale Response:

The quality control program requirements that are applied to the design, fabrication, erection and testing of the containment have been added to FSAR Tier 2, Section 3.8.2.6.

Impact on DCA:

The FSAR Tier 2, Section 3.8.2.6 has been revised as described in the response above as as shown in the markup provided with the response to question 03.08.02-12.

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-12

Regarding ISI, DCD Section 3.8.2.2.1, Codes, Standards, and Specifications states that ASME Boiler and Pressure Vessel Code, Section V, "Nondestructive Examination," 2013 Edition with no Addenda will be used, however it is not clear which Article will be used. DCD Section 3.8.2.3 states that the CNV inspection elements are similar to those required for the RPV. Will Article I-2110, Reactor Vessels, of ASME Section XI will also be applied for the CNV?

DCD Section 3.8.2.7 also states that In-service inspection of the CNV is performed as described in Section 6.2.1.6. However Section 6.2.1.6 refers to Table 6.2-3, Containment Vessel Inspection Elements and there is no mention of the interval which these are performed. Clarify the Article used for ISI of the CNV, what intervals at which the inspections will be performed, and the level of rigor used.

NuScale Response:

FSAR Tier 2, Section 3.8.2.2.1 identifies the applicable code and standards utilized in the containment vessel (CNV) design. Specific articles used for inspection of the CNV are identified in FSAR Section 3.8.2.7. NB/NF-5000 is called out in FSAR Section 3.8.2.7 for use of the methods specified in Section V, except as modified by NB/NF. NB/NF-5000 specifies the applicable article from Section V to be used for the inspection method. Since NB/NF-5000 defines the applicable Section V article, it was not repeated in the FSAR.

The wording in FSAR Section 3.8.2.3 has been modified to remove the phrase “inspection is similar to the RPV” and to reference Section 3.8.2.7 for all CNV inspection requirements. Article I-2110 is invoked for the CNV, since Section 3.8.2.7 invokes IWB-2200, which in turn invokes Mandatory Appendix I for ultrasonic inspection.

FSAR Tier 2, Section 6.2.1.6 has been modified to clarify that the CNV is inspected to Article IWB-2000. Table 6.2-3 specifically identifies the IWB-2500 table to be used in the “Examination Category” column (e.g. B-A identifies Table IWB-2500-1 (B-A) is to be used).

FSAR Section 6.2.1.6 states that the CNV inspection follows Class 1 requirements specified in

Section XI, Article IWB-2000. IWB-2500 specifies that Table IWB-2500-1 (B-A) through Table IWB-2500-1 (B-Q) be used for examination methods. Table IWB-2500-1 (B-A) through Table IWB-2500-1 (B-Q) provides the intervals required for inspection. Since IWB-2000 is invoked and the inspection intervals are specified in IWB-2000, the intervals are not repeated in the FSAR.

Since the CNV is following Class 1 requirements, the in-service inspections of all CNV pressure boundary welds are required to be 100% UT inspected, and to follow the requirements specified in Section XI, Subarticle IWB-2400. Per Article 14 of Section V, the referencing Code Section stipulates the required level of rigor.

Impact on DCA:

The FSAR Tier 2, Section 3.8.2.3, and Section 6.2.1.6 have been revised as described in the response above and as shown in the markup provided with this response.

3.8.2 Steel Containment

3.8.2.1 Description of Containment

3.8.2.1.1 General

The containment vessel (CNV) is an integral portion of the NuScale Power Module (NPM). The CNV houses, supports, and protects the reactor pressure vessel (RPV), reactor coolant system (RCS), and associated structures, systems, and components. The NPM is located in the Reactor Building (RXB) and the majority of the NPM (and thus the CNV) is partially immersed in the reactor pool to facilitate decay heat removal during postulated design basis events.

The primary functions of the CNV are to:

- provide an essentially leak-tight barrier to contain fission product releases for the reactor coolant pressure boundary during design basis events
- contain the mass and energy release from a postulated loss-of-coolant accident (LOCA) and secondary-system pipe ruptures
- support operation of the emergency core cooling system (ECCS) by containment of reactor coolant and heat transfer through the CNV wall
- contain and support the RPV, RCS, and associated structures, systems, and components

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

The materials in contact with the reactor pool water are corrosion-resistant alloy or stainless-steel cladded, low-alloy steel and do not exhibit unacceptable degradation in service. This includes external surfaces of the CNV and threaded holes, which are submerged in the reactor pool. During refueling, the internal surfaces of the CNV are exposed to reactor pool water, and during design basis events, are exposed to RCS water. Thus, the internal surfaces of the low-alloy steel materials are also cladded with stainless steel. The materials of construction are included in Table 6.1-1 and Table 6.1-2.

The design of the CNV complies with the provisions of:

- General Design Criterion (GDC) 1 - The CNV is subject to the design, manufacturing, and operating quality assurance requirements in the NuScale Quality Assurance Program Description.
- GDC 2 - Seismic design to withstand the effects of a safe shutdown earthquake (SSE) regarding the CNV is met by using the guidance provided in Regulatory Guide (RG) 1.29, "Seismic Design Classification," Revision 4.
- GDC 4 -The CNV is designed to accommodate the effects of and be compatible with environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs.
- GDC 16 - The CNV is designed to provide a leak-tight barrier and to contain the CNV design pressure during design basis events.

- GDC 50 - The CNV is designed to ensure the component, access openings, penetrations, and containment heat removal systems have the capability to accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from a LOCA.
- GDC 53 - The CNV is designed with provisions to permit inspection and testing for periodic verification that the CNV remains within the limits defined by the design basis.

3.8.2.1.2 Containment Configuration Description

The NuScale Power Plant CNV consists of an upright cylinder with torispherical top and bottom heads. The CNV has an upper and lower section connected with an approximate 218-inch diameter bolted flange. The flange connection permits the CNV to be separated to provide access to the RPV for refueling. Figure 3.8.2-1 provides a view of the CNV. The design characteristics, including elevations, of the CNV are shown in Table 3.8.2-1.

The lower CNV shell and bottom head are made of SA-965 FXM-19 stainless steel with a wall thickness of 3.00 inches. The lower shell has an approximate outside diameter of 135 inches. The bottom head is torispherical with an approximate outside knuckle radius of 25 inches and an approximate outside crown radius of 119 inches. The bottom head is attached to the lower CNV shell with a full-penetration weld. The shell connected to the bottom head transitions to a larger shell outside diameter of approximately 177 inches in the flange region. The shell regions are joined with full-penetration circumferential welds. The lower CNV shell in the flange region and the transition region of the lower CNV is also SA-965 FXM-19 and has a wall thickness of 3.25 inches. There are no penetrations located in the lower CNV shell or bottom head.

The upper CNV shell and top head are fabricated from SA-508 Grade 3, Class 2 low-alloy steel. The upper shell and top head are stainless steel cladded with 0.125 inches on the inside surfaces and 0.250 inches on the outside surfaces. The upper CNV shell base metal wall thickness is 3.00 inches and has an approximate outside diameter of 177 inches. The CNV has a torishperical top head with a base metal wall thickness of 5.00 inches, an approximate outside knuckle radius of 31 inches, and an approximate outside crown radius of 142 inches. The top head is attached to the upper CNV shell with a full-penetration weld.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

~~Cutaway~~Section views of the CNV are shown in Figure 6.2-1 and Figure 6.2-2a. Plane elevation views are shown in Figure 6.2-3a. The boundaries between the CNV and RPV are shown in Figure 3.8.2-8 and Figure 3.8.2-9. The CNV design and operating characteristics are shown on Table 3.8.2-1. Materials used in construction of the CNV are shown in Table 6.1-1 and Table 6.1-2.

The CNV is housed in the reactor pool within the RXB, which is a Seismic Category I structure primarily embedded in soil. The discussion of the RXB is provided in Section 3.8.4 and Section 3.8.5. The CNV is partially immersed in the reactor pool to

access opening location and elevation. Each access openings has a convex cover plate bolted (stud/nuts) to the opening on the outside of the CNV. Each cover plate is made of SA-240 Type 304/304L stainless steel, is bolted with SB-637 UNS N07718 studs and nuts, and has a double O-ring seal with provisions for leak detection in the annular span between the dual O-rings. Figure 3.8.2-6 shows a typical access cover plate and O-ring seal.

The center of the CNV top head has a 67-inch diameter opening in the center of the top head to provide access to the CRDMs located on the top of the RPV. The CRDM access cover is a convex cover bolted (stud/nuts) to the top head and is sealed with double O-rings with an annular space for leak detection. The cover is made of SA-182 Grade F304/F304L stainless steel, and the studs and nuts are SA-564 Grade 630, S17400 (17-4 PH) Condition H1100. The top head also has an 18-inch diameter manway access to the CRDM platform. The manway opening has a bolted flat cover plate with double O-ring seals with provisions for leak detection in the annular span between the dual O-rings. Figure 3.8.2-5 shows the CRDM access and manway access.

Section 3.13 provides design requirements for Alloy 718 threaded fasteners for the mitigation of SCC.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

3.8.2.1.5 ~~Mechanical~~Piping Penetrations

Penetrations on the CNV top head and upper shell are provided for process piping, ECCS trip and reset valves, electrical power, and instrumentation. No penetrations are located in the lower CNV. Fluid system penetrations are through integral or full-penetration welded nozzles on the CNV top head and upper shell. Safe ends are welded to the internal and/or external ends of the nozzles. The safe ends and the penetration nozzle-to-safe end welds are part of the CNV. Figure 3.8.2-7 shows a typical penetration configuration through the CNV shell. The CNV boundary is at the end of the safe ends furthest from the CNV shell. The pipe-to-safe end welds are part of the attached piping. This applies to the following nozzles and safe ends which are shown on Figure 3.8.2-4:

- Two nominal pipe size (NPS) 5 Sch. 120 feedwater nozzles (top head, azimuth 16 degrees and 344 degrees)
- Two NPS 12 Sch. 120 main steam nozzles (top head, azimuth 136 degrees and 225 degrees)
- Three NPS 2 Sch. 160 (inside), NPS 4 Sch. 160 (outside) chemical and volume control system nozzles (top head, azimuth 63 degrees, 180 degrees, and 248 degrees)
- One NPS 4 Sch. 160 containment evacuation system nozzle (top head, azimuth 290 degrees)
- One NPS 2 Sch. 160 containment flooding and drain system nozzle (top head, azimuth 0 degrees)

- Two NPS 2 Sch. 160 (inside), NPS 4 Sch. 160 (outside) reactor component cooling water system nozzles (top head, azimuth 0 degrees and 245 degrees)
- One NPS 2 Sch. 160 (inside), NPS 4 Sch. 160 (outside) RPV high point degasification nozzle (top head, azimuth 290 degrees)
- Two NPS 2 Sch. 160 decay heat removal system nozzles (upper CNV, elevation 56'-5" azimuth 120 degrees and 240 degrees) (these penetrations are not shown in Figure 3.8.2-4 but each has a similar configuration as the top head penetrations)

Reinforcement of the shell due to the penetration opening is provided by the nozzle and any additional thickness in the shell greater than the minimum wall thickness of the shell as calculated in accordance with American Society of Mechanical Engineers (ASME) Code, Section III, Paragraph NB-3324. The penetration designs are evaluated for external loads imposed by the attached valves and piping systems.

The penetrations have containment isolation valves (CIVs) attached to the outside safe end and designed to allow passage of fluids and gases through the CNV boundary while preserving the integrity of the boundary and preventing or limiting the release of fission products under postulated accident conditions. The primary system CIVs are welded directly to the nozzle safe ends of the CNV penetration nozzles on the CNV top head. Secondary system CIVs are welded close to the nozzle safe ends to accommodate the decay heat removal system taps on the main steam lines and other space constraints. The CIVs are discussed in Section 6.2.4.

3.8.2.1.6 Electrical Penetrations

The CNV has multiple electrical penetrations on the top head. The electrical penetration assembly boundaries are at the face of the CNV flange surface for the penetration opening. The bolting (studs/nuts) is part of the electrical penetration. This applies to the following electrical penetration assembly penetrations shown in Figure 3.8.2-5:

- Two NPS 3 Class 900 instrument and control (top head, azimuth 63 degrees and 180 degrees)
- Two NPS 12 Class 900 pressurizer power (top head, azimuth 41 degrees and 319 degrees)
- Four NPS 8 Class 900 instrument and control (top head, azimuth 111 degrees, 162.5 degrees, 197.5 degrees and 268 degrees)
- One NPS 18 Class 900 CRDM power (CRDM access cover, azimuth 45 degrees)
- Two NPS 10 Class 900 CRDM control (CRDM access cover, azimuth 180 degrees and 270 degrees)

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12, RAI 08.01-1S1

Reinforcement of the shell due to the electrical penetration assembly openings is provided by the nozzle and any additional thickness in the shell greater than the

minimum wall thickness of the shell as calculated in accordance with ASME Code, Section III, Paragraph NB-3324. There are no external loads imposed by the electrical penetration assemblies on their corresponding CNV flange.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

3.8.2.1.7 Emergency Core Cooling System Trip/Reset Valve Penetrations

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

The ECCS valve trip/reset assembly penetrations and safe ends are welded to the external side of the CNV upper shell. Two reactor recirculation trip/reset valves, NPS 23 Sch. 160 penetrations are located at an elevation of 58'-11.9", azimuth 7 degrees and 353 degrees. Three reactor vent trip/reset valves, NPS 23 Sch. 160 penetrations are located at an elevation of 89'-6.85" and azimuth 68 degrees, 188 degrees and 308 degrees, and one reactor vent trip valve, NPS 23 Sch. 160 penetration is located at an elevation of 89'-6.85" and azimuth 200 degrees. The safe ends and the penetration nozzle-to-safe end welds are part of the CNV. The valve assembly is welded to the penetration nozzle safe end. The CNV boundary is at the valve assembly-to-safe end welds and the welds are part of the CNV.

3.8.2.1.8 Attachments

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

The CNV provides lateral and vertical support to the RPV at four locations. Each RPV support rests on the RPV support ledge and is connected with a 6-8SB-637 UNS N07718 six inch diameter, 8 threads per inch (6-8 UN 2A) stud and, nuts, and washer. The connection is a slotted hole to allow for radial growth of the RPV and the stud prevents lateral motion in the support. The CNV boundary includes the RPV support ledge and attachment weld up to the support surface. The attachment stud and nut are part of the CNV.

Lateral support of the RPV is provided at the CNV inside surface at the bottom of the CNV by an integral guide support. The guide support allows free vertical motion of the RPV, but prevents lateral motion. The CNV boundary is located at the face of the guide support.

Lateral support of the CRDMs is provided by the CNV at the inside diameter of the CRDM access opening in the CNV top head. The CRDM support frame consists of four pieces equally spaced around the opening at azimuth 45 degrees, 135 degrees, 225 degrees, and 315 degrees. Each piece of the frame is welded to the CNV shell and the CRDM access nozzle with full-penetration welds. For the purposes of the CNV, the CRDM support frame is a nonstructural attachment in accordance with ASME Code, Section III, Subarticle NE-1130 because it is not pressure retaining and does not contribute to support of the CNV. The boundary is at the surface of the CNV shell and the weld between the CRDM support frame and the CNV shell is considered part of the attachment.

temperature gradients in the CNV from the thermal analysis and NRELAP5 pressure transient data are then applied to a CNV structural model to determine stresses on the CNV.

External Environment Loading

The effects of missiles and external events such as a hurricane, tornado, aircraft hazards, and explosion pressure waves are not considered because the CNV is protected from these effects by the Seismic Category I RXB.

Lifting and Transportation

The lifting and handling loads analysis considers the full range of positions during transportation evolution, field installation work, transfer to and from the upender, and installation in the plant. Lifting and handling loads are also considered for the full NPM refueling evolution, including lift and transport of the NPM and its subassemblies using the RXB crane, assembly and disassembly of the CNV and the RPV, and flange fastener tensioning and de-tensioning.

Transportation loads are evaluated with the CNV in the horizontal position. Shipping restraints are installed between the CNV and the RPV at the location of the lateral support lugs at the CNV upper flange.

RAI 03.09.03-1

The lifting, handling, and transportation load ~~is a~~contains a 15% dynamic load factor, for a total load of 115 ~~percent~~% times the DW load applied at all lifting and transportation support points.

RAI 03.09.03-1

Lifting, handling, and transportation loads are not required to meet ASME stress limits. However, the Service Level B primary limits are used as the allowable limits for the lifting, handling, and transportation loads. The platform mounting assemblies are analyzed to ensure minimum safety factors of ~~ten~~five for material ultimate strength and ~~six~~three for material yield strength per ~~NUREG-0612 (~~Reference 3.8.2-3~~)~~ and are maintained for dual-load-path loading conditions considering the dynamic load factor specified above.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Load Combinations

The ASME Code Design, service level (Level A, Level B, Level C, Level D) and Test loads and load combinations for the CNV and CNV support design are shown in Table 3.8.2-2 and for the CNV bolts are shown in Table 3.8.2-3. ~~The load combinations are consistent with RG 1.57, "Design Limits and Loading Combinations for Metal Primary Reactor Containment System Components," Revision 2, and meet the requirements of ASME Code, Section III, Paragraph NCA-2141(b).~~The load combinations meet the requirements of ASME Code, Section III, Paragraph NCA-2141(b) and consider the guidance of RG 1.57, “Design Limits and Loading Combinations for Metal Primary Reactor Containment System Components,” Revision 2. The loads and load

Regulatory Guide 1.57 provides recommended load combinations and service levels for hydrogen pressure due to 100 percent fuel clad metal-water reaction, hydrogen burn, and post-accident carbon dioxide inerting. The CNV hydrogen detonation event is evaluated to Level C service limits, which bounds pressure due to 100 percent fuel clad metal-water reaction. Hydrogen detonation with deflagration-to-detonation transition is evaluated to Level D service limits and bounds pressure due to hydrogen burn. The CNV design does not include post-accident carbon dioxide inerting; thus any load due to this event is not applicable. Control of hydrogen within the CNV is discussed in TR-0716-50424-P, "Combustible Gas Control," (Reference 3.8.2-4).

Inservice inspection (ISI) provides an essential function for containment system integrity by ensuring no new leakage paths are present. Age-based failure mechanisms are detected and mitigated through the compact and accessible design of the CNV, along with inspections and examinations performed in accordance with ASME Code, Section XI, Division 1. The CNV components and welds are fully capable of being inspected. The CNV design allows for visual inspection of the entire inner and outer surfaces and is designed to accommodate comprehensive inspections of welds, including volumetric and surface inspections. Welds are accessible and there are no areas that cannot be inspected. Periodic, comprehensive ISI ensures that any degradation mechanism is detected and addressed before CNV integrity is threatened.

ASME Code, Section XI, Subsection IWE requires, for Class MC structures, only 80 percent of the containment boundary be accessible for a single-side visual examination for structures, systems, and components subject to normal degradation and aging. This requirement is less restrictive than the examination requirements applied to the NuScale CNV design as discussed below.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Based on the high pressure and the safety function of the CNV, enhanced inspection requirements are needed for the CNV. Therefore, the CNV is inspected to ASME Code NB Class 1 requirements. ~~The CNV inspection elements are similar to those required for the RPV.~~See Section 3.8.2.7 for CNV inspection requirements. The CNV design allows visual inspection of the entire inner and outer surfaces; therefore, developing an undetected leak through the metal pressure boundary is unlikely.

The CIVs are located outside of the CNV. The reduced ISI requirements permitted by ASME Code, Section XI for small primary system pipe welds between the CNV and the CIVs are not applied to these welds. Welds between the CNV and the CIVs are ASME Code NB Class 1 and are inspected with a volumetric and surface exam at each test interval. The CNV design allows comprehensive inspections of welds, including volumetric and surface inspections. Pressure boundary welds are accessible and there are no areas that cannot be inspected.

The simplicity of the NPM design includes minimizing the number of containment penetrations required. As discussed in Section 3.8.1.2.4 and Section 3.8.1.2.6, the CNV has a limited number of access openings (7), manways (2), and electrical penetration assemblies (11), and each penetration uses the same seal design. The CNV flange separating the upper and lower CNV assemblies uses the same seal design as the RPV, and is similar to the access opening and manway seal designs. As discussed in Section

3.8.2.4.7 Containment Vessel Cyclic Fatigue

The CNV is evaluated for fatigue based on the ASME Code, Section III, Paragraph NB-3222. Applicable cyclic, dynamic, pressure, and thermal transient loads and load combinations discussed in Section 3.8.2.3, are considered in the fatigue evaluation. For CNV process fluid penetrations classified as ASME Code Class 1, the fatigue analysis considers the effects of the PWR environment in accordance with the requirements of RG 1.207 and NUREG/CR-6909.

In accordance with 10 CFR 50, Appendix S, OBE seismic loads need not be explicitly analyzed in the design analysis; however, they are considered in the fatigue analysis. The OBE load is defined as one-third of the SSE loads.

During the life of the plant, at least one SSE and five OBEs with 10 maximum stress cycles per event are assumed. The fatigue analysis may consider one of the following.

- Two SSE events with 10 maximum stress cycles each for a total of 20 full cycles. This is considered equivalent to the cyclic load basis of one SSE and 4 OBEs.
- The number of fractional vibratory cycles equivalent to that of 20 full SSE vibratory cycles may be used (but with an amplitude not less than the OBE) when derived in accordance with IEEE Std. 344-2004 (see Section 3.8.2.2.1), Annex D. When this method is used and if the amplitude of the vibration is taken as the OBE, then ($3^{2.5}$ x 20)= 312 fractional amplitude SSE cycles are considered.

3.8.2.5 Structural Acceptance Criteria

The CNV structural integrity acceptance criteria limits are developed in accordance with ASME Code, Section III, Subarticle NB-3200 and Subarticle NF-3200 for plate-type and shell-type supports for the CNV support. The ASME Code limits for the defined load combinations is shown in Table 3.8.2-2 and Table 3.8.2-3. The CNV is also fabricated, installed and tested according to ASME Code, Section III, Subsection NB and Subsection NF.

In addition, the CNV is designed to meet the maximum leakage rate as discussed in Section 6.2. The items that form the CNV pressure boundary and support are stamped in accordance with the applicable section of the ASME Code used for their design or fabrication.

3.8.2.6 Materials, Quality Control, and Special Construction Techniques

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

The CNV materials conform to the requirements of Article NB-2000. The CNV fabrication conforms to the requirements of Article NB-4000 and Article NF-4000. The quality control program involving materials, welding procedures and nondestructive examination of welds conforms with Subsection NB-2000, NB-4000 and NB-5000 of the ASME Code. The CNV uses no special construction techniques. The materials of construction are shown in Table 6.1-1 and Table 6.1-2.

3.8.2.7 Testing and Inservice Inspection Requirements

Nondestructive examination of the CNV pressure-retaining and integrally attached materials meet the requirements of ASME Code, Section III, Article NB-5000 and NF-5000 using examination methods of ASME Code Section V except as modified by NB and NF.

A non-destructive examination plan will be prepared and implemented for the examinations to be performed to satisfy the fabrication and preservice examination requirements of ASME Code, Section III, Article NB-5000 and Article NF-5000, as applicable, and Section XI.

All surfaces to be clad are magnetic particle or liquid penetrant examined in accordance with ASME Code, Section III, Paragraph NB-2545 or NB-2546 prior to cladding.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

For those CNV pressure boundary items defined as ASME Code, Section III, Class 1, preservice examinations are in accordance with ASME Code, Section III, Subsubarticle NB-5280 and ASME Section XI, Subarticle IWB-2200 using examination methods of ASME Code, Section V except as modified by NB-5111. These preservice examinations include 100 percent of the pressure boundary welds. Final preservice examinations are performed after hydrostatic testing but prior to code stamping.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

~~For those portions of the CNV pressure boundary defined as ASME Code Class MC, preservice examinations are in accordance with Subarticle IWE-2200. In addition, due to the high pressure design of the CNV, the preservice examination requirements of Subarticle IWB-2200 are conservatively applied. Final preservice examinations are performed after hydrostatic testing but prior to code stamping.~~

In-service inspection of the CNV is performed as described in Section 6.2.1.6.

Each Type B penetration is local leak-rate tested in accordance with 10 CFR 50, Appendix J prior to performance of the hydrostatic test. For electrical penetration assemblies, this only includes the flange seals. The sheath modules are tested as part of another specification.

The test pressure is the containment peak accident pressure. The leak rate is established by containment leakage rate program.

Pneumatic testing at a pressure not to exceed 25 percent of design pressure may be applied prior to a hydrostatic test, as a means of locating leaks, in accordance with ASME Code, Section III, Paragraph NB-6112.1(b).

Hydrostatic testing of the CNV is done in accordance with the requirements of NB-6000. The CNV is pressurized using water to a minimum pressure of 1,250 psig and a maximum pressure of 1,325 psig, the pressure being measured at the bottom of the CNV. The test is performed with the CNV at a minimum temperature of 70 degrees F

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Table 3.8.2-1: Design and Operating Parameters

Parameter	Value
Upper vessel diameter (uncladded) (approximate)	177 in.
Lower vessel diameter (approximate)	135 in.
Height from support base to crown of CNV top head cover (top auxiliary mechanical access structure not included) (approximate)	76 ft
Bottom of CNV building elevation (reactor pool floor)	25 ft
Top of CNV elevation (approximate)	101 ft
Design internal pressure	1,000 psia
Design temperature	CNV: 550 °F Support Skirt: 300 °F
External design pressure	60 psia(2)
Normal operating internal pressure (nominal)	See Note 1
Normal operating external pressure (nominal)	60 psia(2)
Normal operating temperature (nominal)	295 °F
Materials	See Table 6.1-1 and Table 6.1-2.

Notes:

1) Pressure inside the CNV is maintained less than the saturation pressure corresponding to the reactor pool pressure; this results in a vacuum condition less than 0.1 psia.

2) Includes reactor pool water static head pressure for a depth of 100 feet.

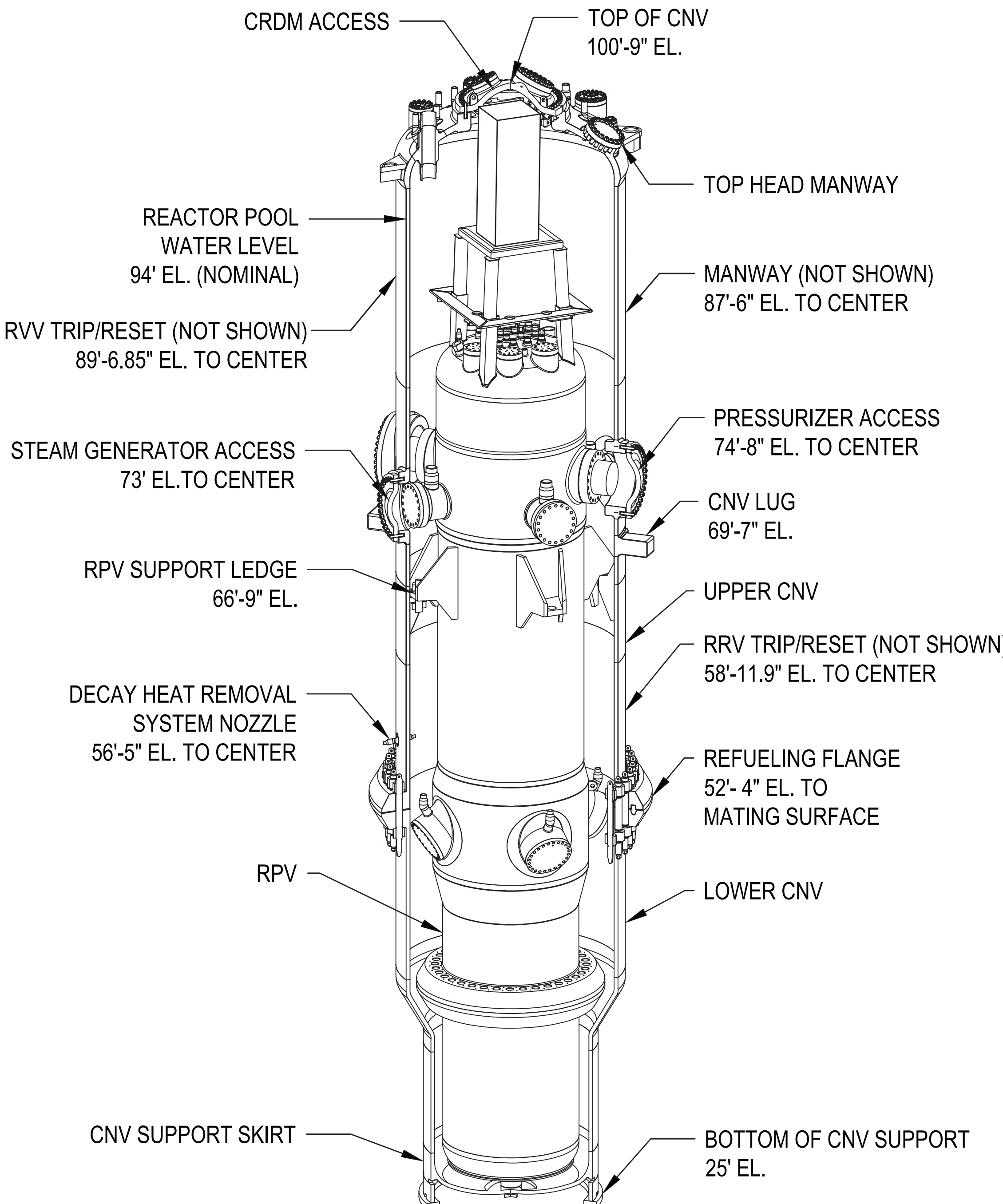
RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Table 3.8.2-4: Key Assumptions for CNV Ultimate Pressure Analysis

Assumption	Basis
O-rings used to seal the CNV bolted openings are assumed to be of the self-energizing O-ring type or similar. Therefore, for flanged openings on the CNV, zero compression pressure is required to produce a seal.	Engineering judgment.Bolted openings on the CNV are designed for two self-energizing O-rings. By definition, the self-energizing O-rings and gaskets do not require compression pressure to produce a seal.
The maximum allowable gap between flanges (or flange cover - top of flange) at the center of the outer O-ring is assumed to be 0.03 inch.	Engineering judgment based on typical manufacturer tolerances.The maximum allowable gap is based on a review of O-ring groove depth tolerances for several O-ring manufacturers.
The stud preload is assumed to be applied at cold conditions via direct tension. Thermal stress relaxation effects are not considered in this calculation.	Engineering judgment.The studs are tensioned while in the refueling bay filled with reactor pool water. This establishes the cold conditions for tensioning. The stud preloads are based on 2/3 of yield strength, which produces the maximum preload for the stud. This preload is large enough to prevent loss of preload at thermal conditions seen by the stud and still maintain margin.
The static coefficient of friction is 0.2 for wet steel.	The coefficient of friction of wet steel is conservatively assumed to be equal to that of greased steel. A lower coefficient of friction results in conservative flange gap values.
CNV components on the outer surface, electrical penetrations, Control Rod Drive Mechanism (CRDM) support frame, and piping penetrations such as feedwater lines, steam lines, valves, etc., do not affect the ultimate pressure capacity of the CNV and can be excluded from finite element analysis models.	The steam and feedwater lines do not form part of the CNV pressure boundary. Per the guidance in Appendix A of NUREG/CR-6906 (Reference 3.8.2-2), small CNV penetrations can be reasonably ignored in terms of their effect on the overall containment response. The proximity of these penetrations to CNV bolted openings is judged not to negatively impact the ultimate pressure capacity of the CNV. Because the force on a bolted flange cover is proportional to the square of the diameter on which the pressure acts, it is reasonable to assume that the larger diameter bolted openings will fail before smaller diameter bolted openings.
Mechanical properties of all CNV welds are at least equal to the properties of the parent material and failure of the CNV will not occur at the welds or in the heat affected zone of the parent material.	Per normal practice, welds will be post weld heat treated to minimize residual stresses at or near the welds.
The dead weight of the reactor module (RXM) access platform, including instrumentation does not negatively affect the ultimate pressure capacity of the CNV and is excluded from the model.	The weight of the RXM access platform is transferred to the CNV via four platform mount supports on the CNV top head, mainly resulting in shear loads on four areas on the outside surface of the CNV top head. These loads are small relative to the hoop stress induced in the CNV at the design pressure.
Buckling will not occur if the first ten load multipliers (eigenvalues) based on the first ten buckling mode shapes for a linear (eigenvalue) buckling analysis are negative. Positive load multipliers correspond to internal pressure in this analysis.	The first buckling mode shape always yields the lowest load multiplier. Therefore, additional buckling mode shapes generate higher load multipliers. If the first ten mode shapes yield load multipliers that are all negative, it is highly unlikely that additional mode shapes will yield positive load multipliers.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

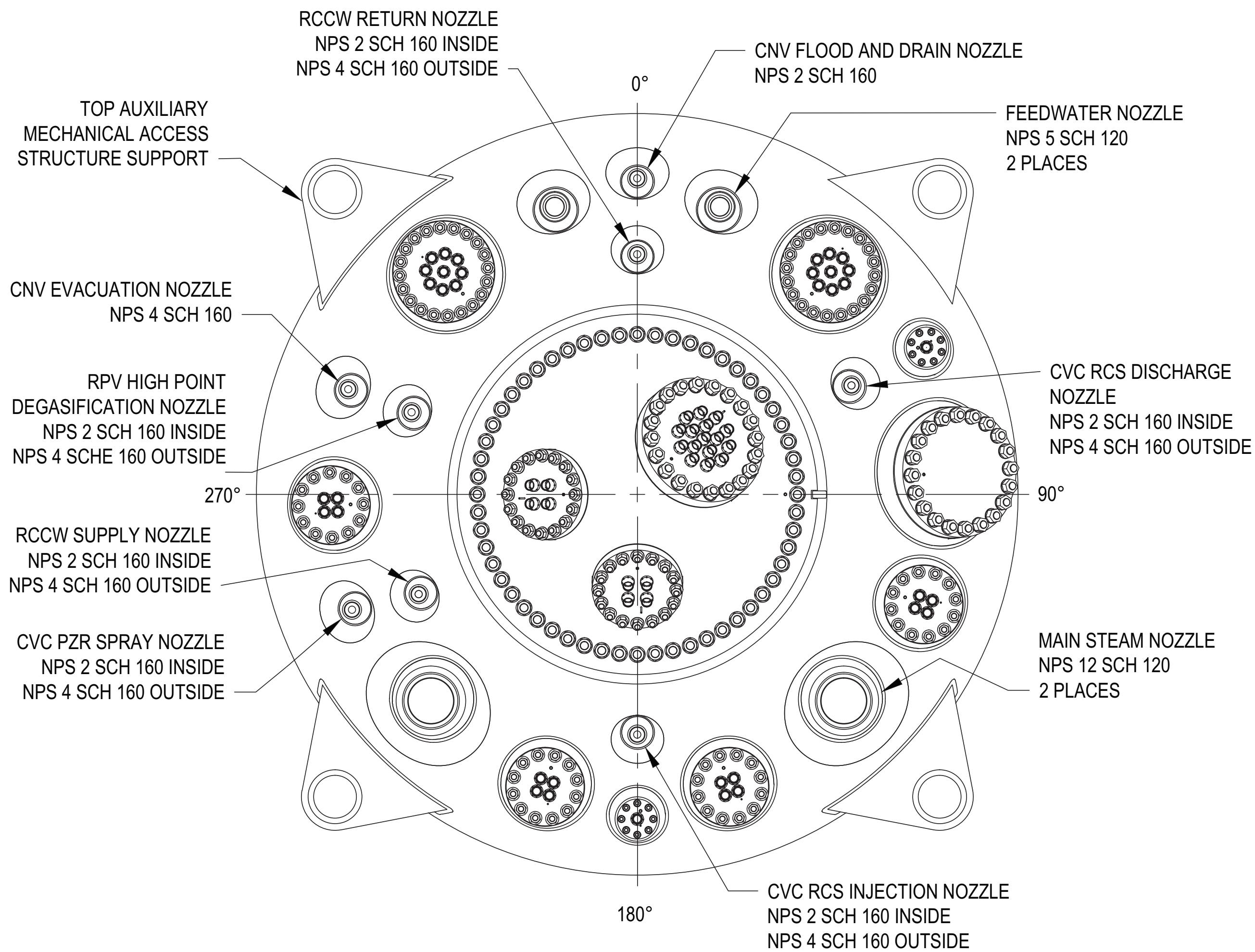
Figure 3.8.2-1: Containment Vessel Components and Building Elevations



NOTE:
1. ALL DIMENSIONS ARE APPROXIMATE.

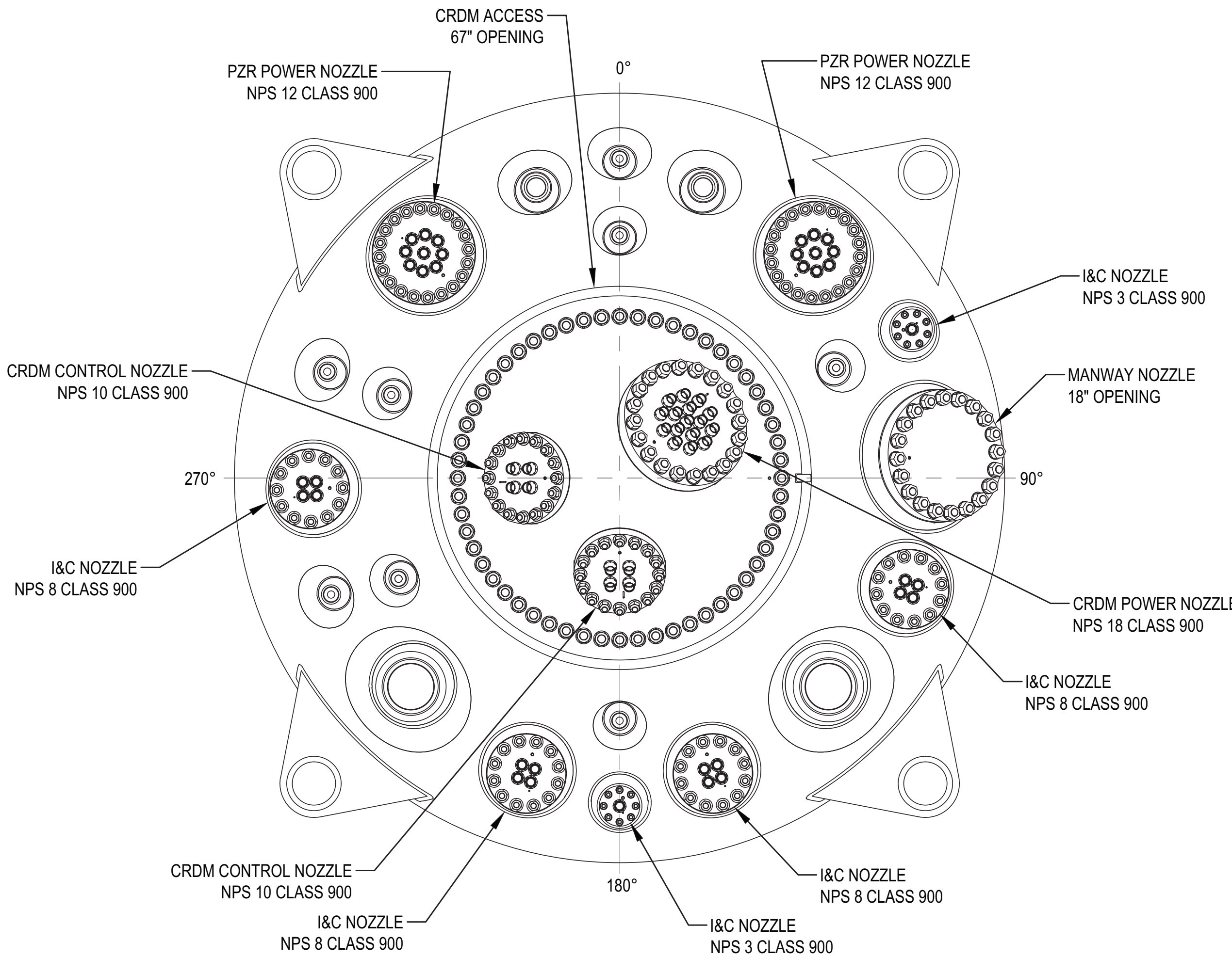
RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Figure 3.8.2-4: Containment Vessel Top Head Mechanical Penetrations



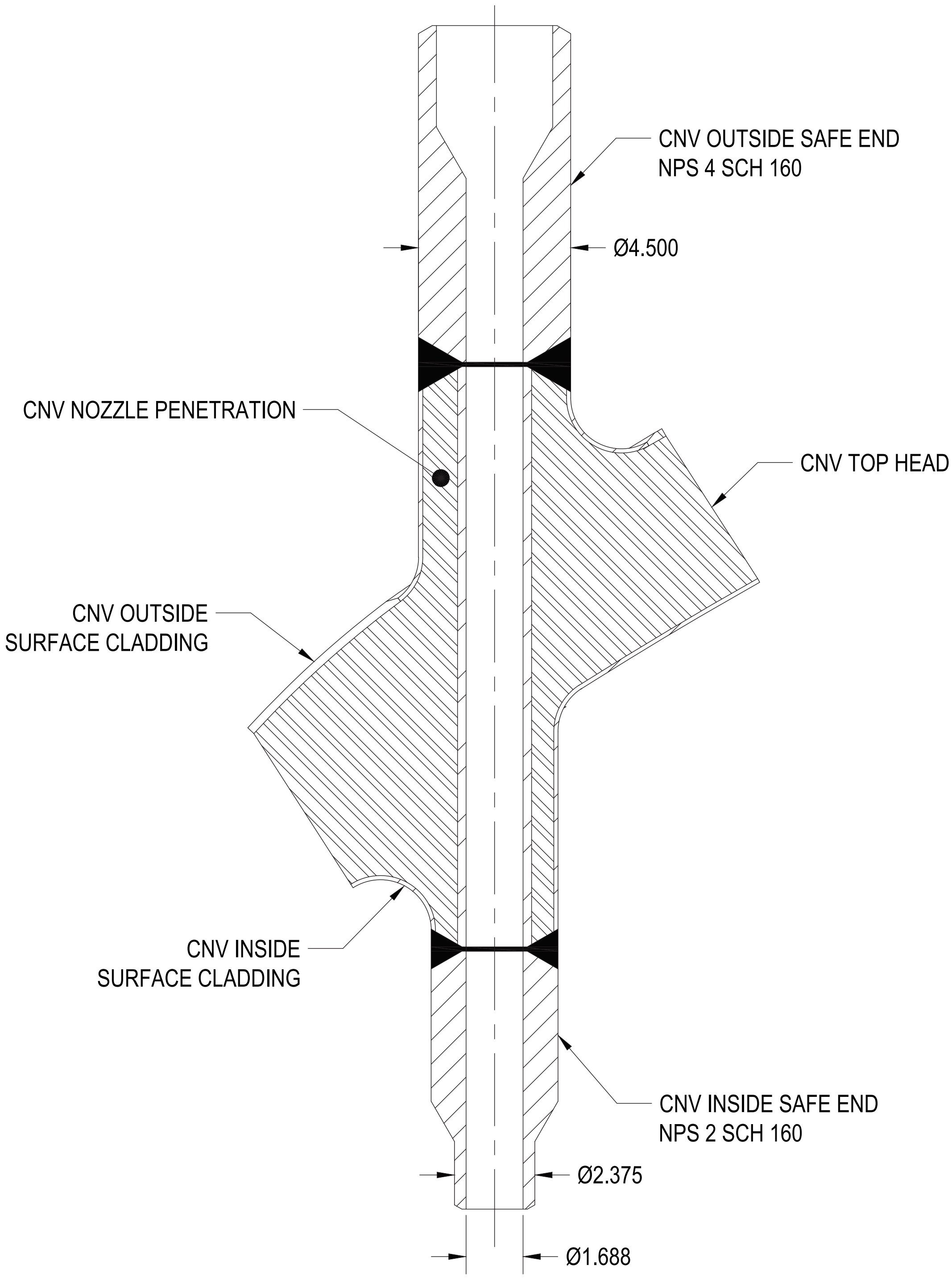
RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Figure 3.8.2-5: Containment Vessel Top Head Instrumentation and Controls, Electrical, and Access Penetrations



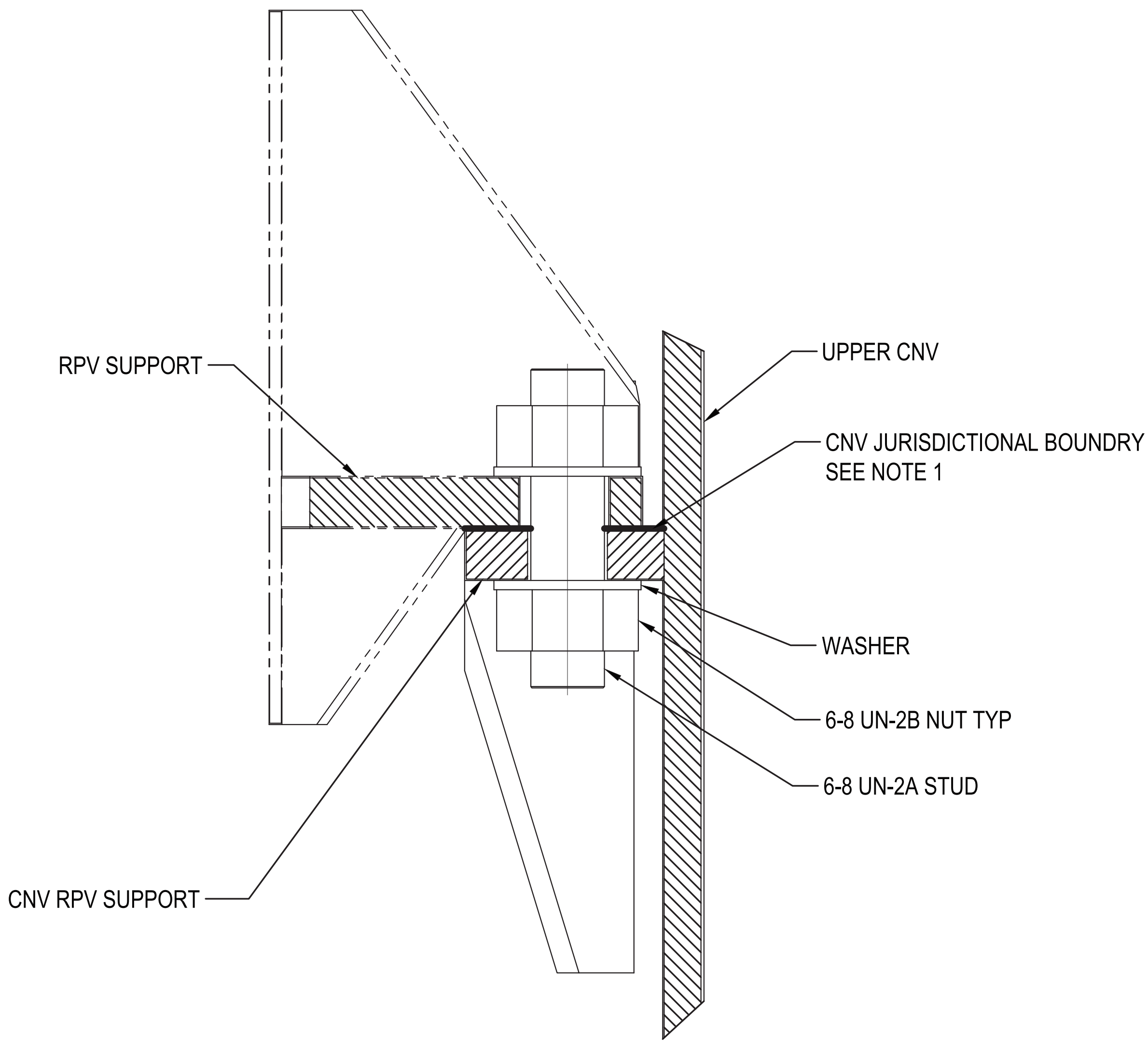
RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Figure 3.8.2-7: Typical Non Secondary Side Containment Vessel Penetration Configuration



RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

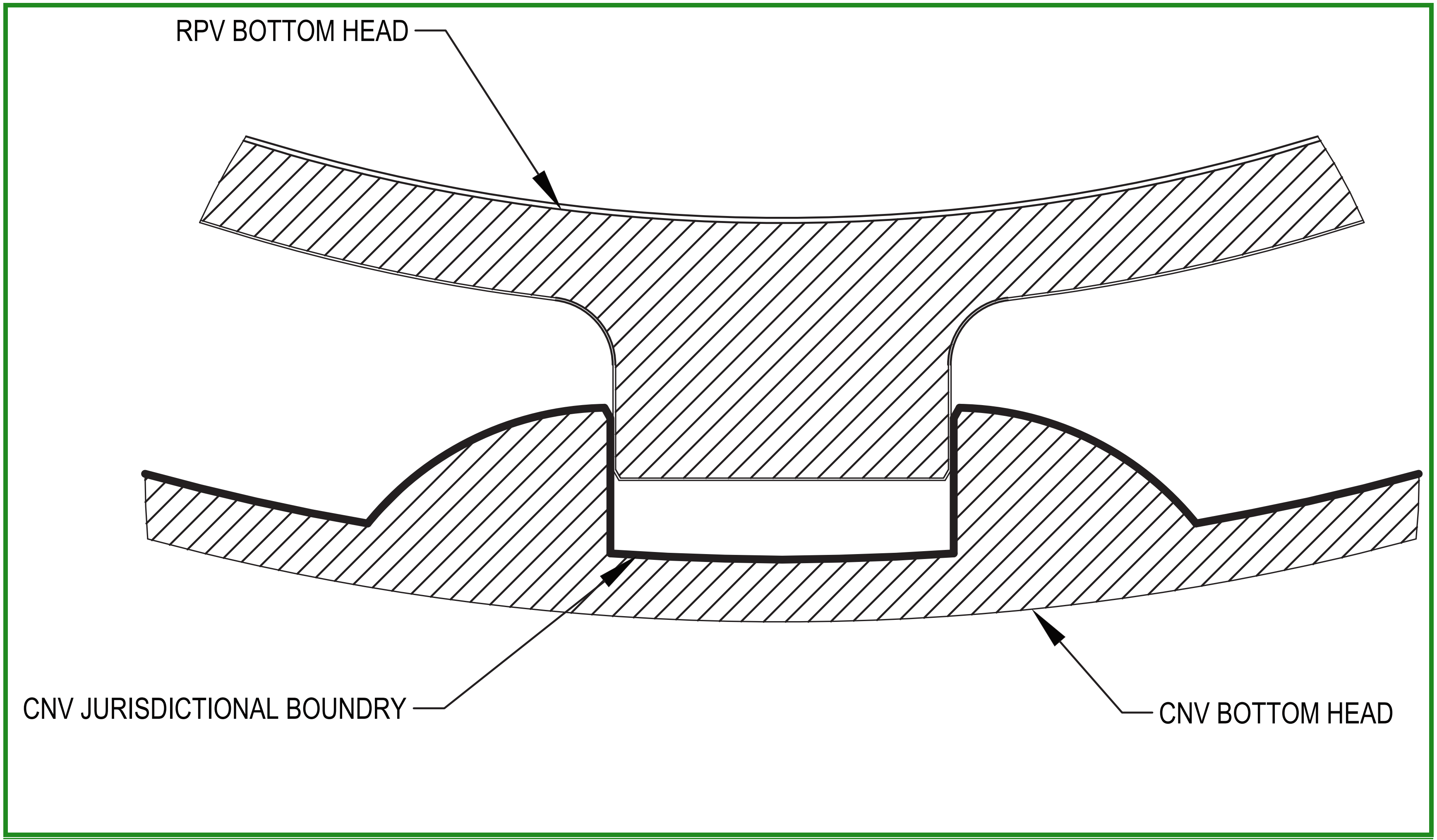
Figure 3.8.2-8: Containment Vessel Reactor Pressure Vessel Support Boundary



NOTE:
1. STUD, NUT, AND WASHER BELONG TO THE CNV.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Figure 3.8.2-9: Containment Vessel Bottom Head Boundary



The CNV is hydrostatically tested in accordance with ASME BPVC Section III, Subsection NB-6000 at a minimum test pressure (highest point) of 1250 psig and maximum test pressure (lowest point) of 1325 psig. Piping installed inside the CNV during hydrostatic testing is vented to the CNV to preclude a net external pressure on the piping during the test.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12, RAI 06.02.02-2

Based on the high pressure and the safety functions of a NuScale CNV, enhanced inspection requirements are provided for the CNV in excess of the Class MC requirements of ASME BPVC, Section XI, Subsection IWE. The CNV augmented inspections are based on Class 1 requirements of ASME BPVC, Section XI. Specifically, rather than just a visual examination as required for an ASME Class MC containment, many of the NuScale CNV pressure boundary welds are required to have a volumetric or surface examination performed per ASME BPVC, Section XI, ~~Subsection IWB~~Article IWB-2000.

The CNV inspection elements are provided in Table 6.2-3. An inspection element is a combination of a component and the inspection requirements.

A description of the ISI requirements for Class 2 and 3 components is provided in Section 6.6.

6.2.1.7 Instrumentation Requirements

Instrumentation is provided to monitor the conditions inside the containment and to actuate the appropriate engineered safety features, should those conditions exceed predetermined levels. Instruments are provided to measure containment pressure, temperature, and water level. Instrumentation to monitor RCS leakage into containment and compliance with RG 1.45 is described in subsection 5.2.5.

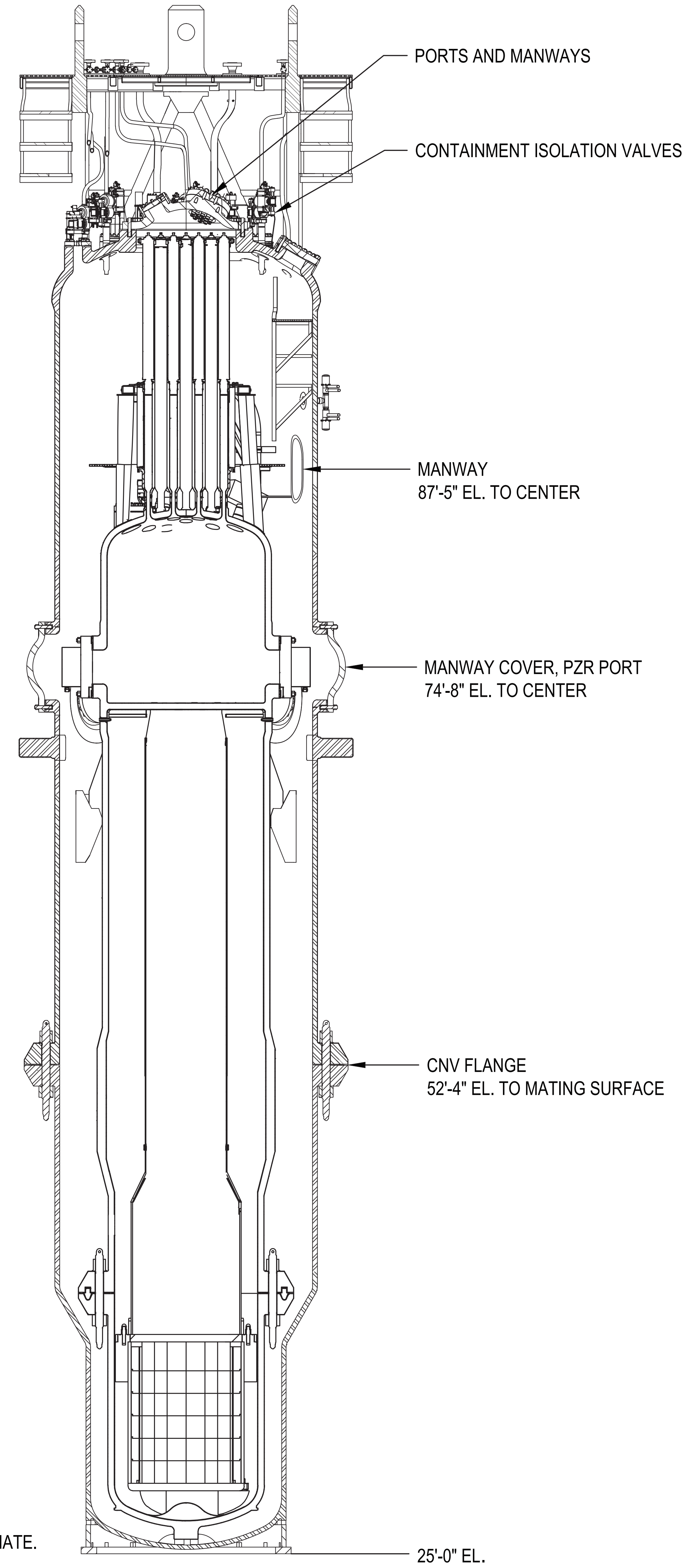
Containment pressure instrumentation is provided for continuous control room indication to monitor containment pressure boundary integrity, RCS pressure boundary integrity and ECCS performance and to support the actuation of critical safety functions (reactor trip, decay heat removal actuation, CVCS isolation and containment isolation functions).

Containment pressure is measured and monitored by four narrow range, ~~Class 1E~~safety-related, instruments and two wide range nonsafety-related~~non-Class 1E~~ instruments. The narrow range sensors (transducer/transmitter type) are located inside the CNV wall enclosure near the top of containment. There are four independent channels of narrow range CNV pressure instrumentation. The wide range sensors (transducer/transmitter type) are located inside the CNV wall enclosure near the top of containment. There are two independent channels of wide range CNV pressure instrumentation.

Containment water level instrumentation is provided for continuous control room indication to monitor containment pressure boundary integrity, RCS pressure boundary integrity and ECCS performance and to support the actuation of critical safety functions.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

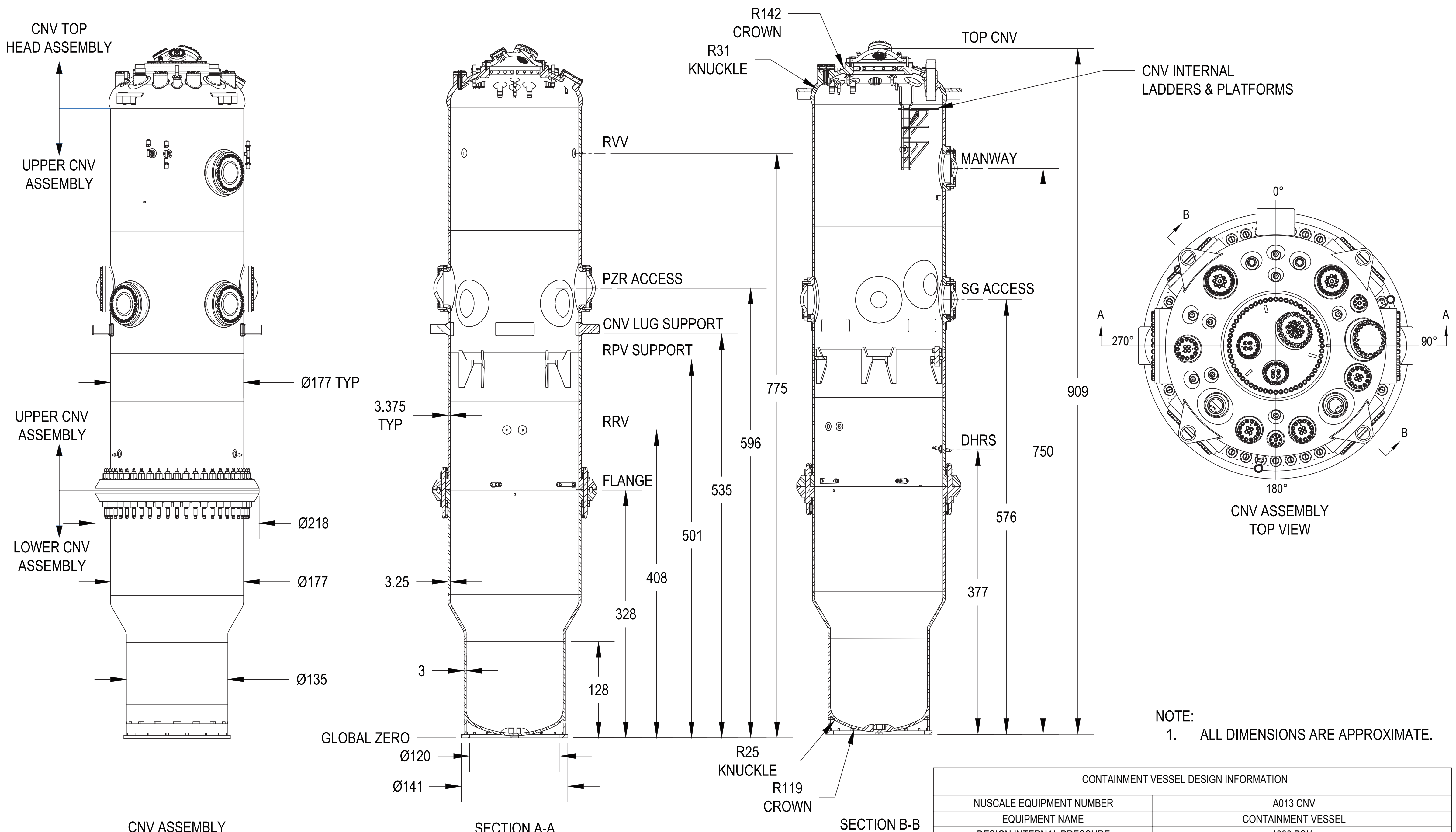
Figure 6.2-1: Containment System



NOTE:
1. ALL DIMENSIONS ARE APPROXIMATE.

RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Figure 6.2-2a: Containment Vessel Assembly

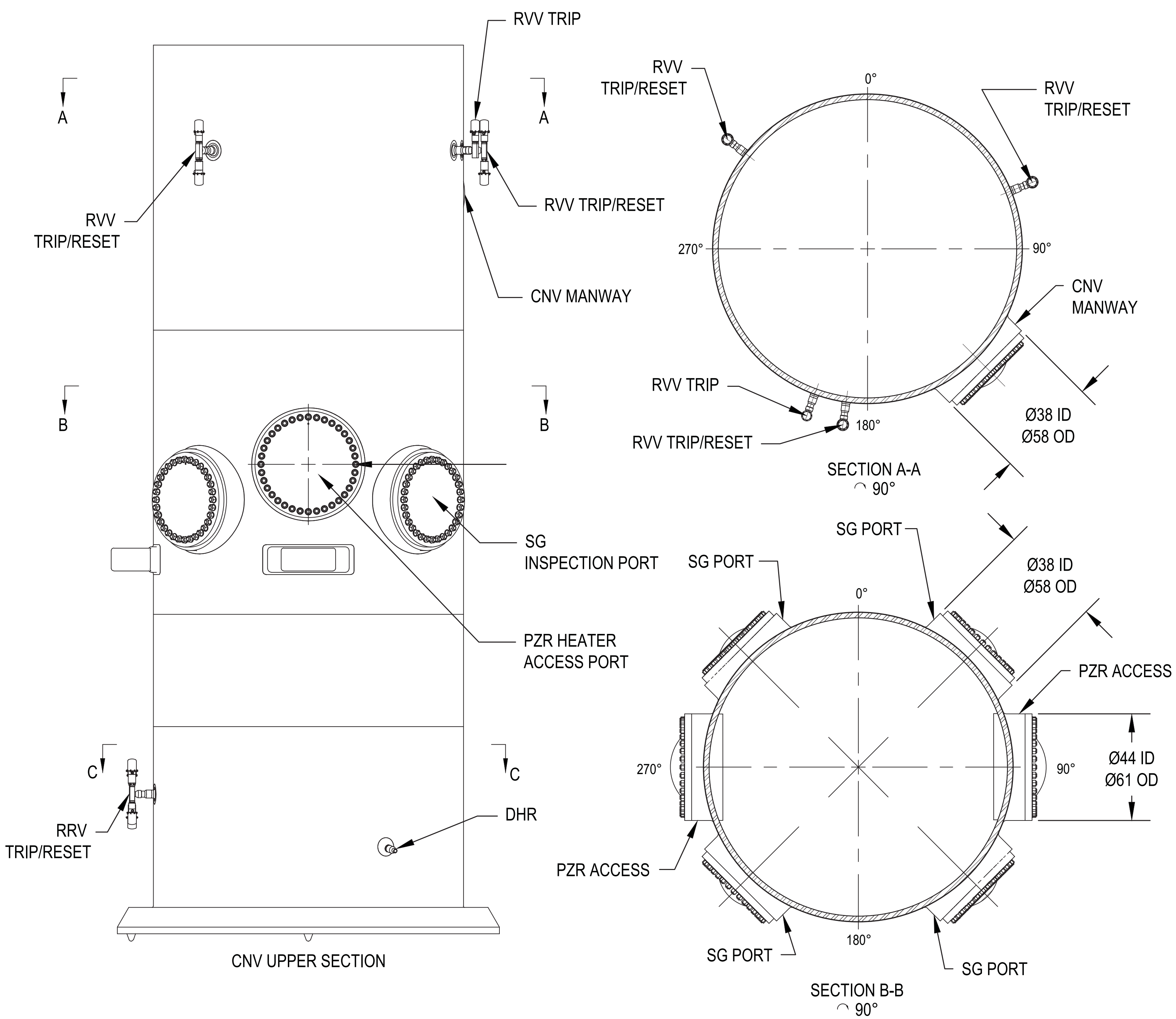


CONTAINMENT VESSEL DESIGN INFORMATION	
NUSCALE EQUIPMENT NUMBER	A013 CNV
EQUIPMENT NAME	CONTAINMENT VESSEL
DESIGN INTERNAL PRESSURE	1000 PSIA
DESIGN TEMPERATURE	550˚F
DESIGN EXTERNAL PRESSURE	EXTERNAL POOL WATER WITH < 1 PSIA INTERNAL PRESSURE
SHOP HYDROSTATIC PRESSURE/TEMPERATURE	1250 PSIG/70˚F - 140°F

ECN-A013-4420

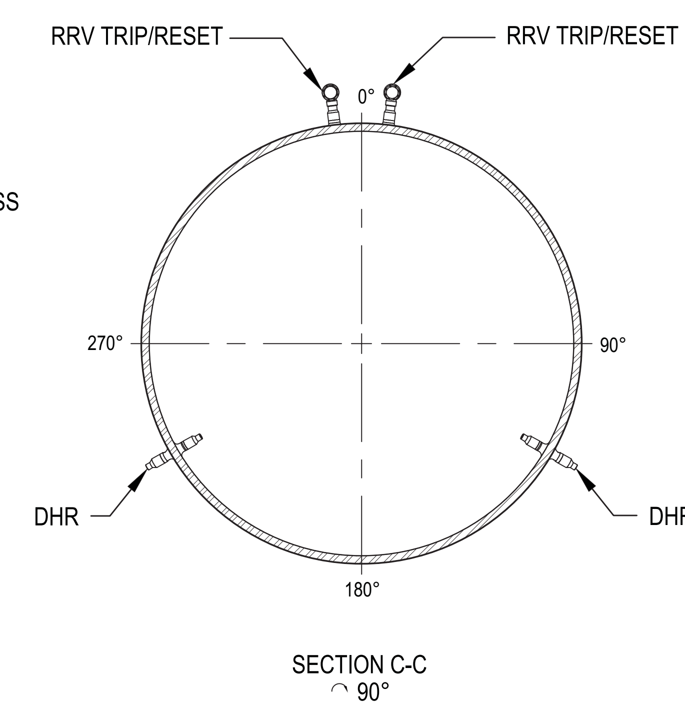
RAI 03.08.02-1, RAI 03.08.02-2, RAI 03.08.02-7, RAI 03.08.02-9, RAI 03.08.02-10, RAI 03.08.02-11, RAI 03.08.02-12

Figure 6.2-3a: Containment Vessel Penetrations



CNV NOZZLE SCHEDULE	
NOZZLE OPENING OR NOMINAL SIZE	DESCRIPTION
NPS 2	DECAY HEAT REMOVAL 1
NPS 2	DECAY HEAT REMOVAL 2
38	CNV MANWAY
38	SG INSPECTION PORT 1
38	SG INSPECTION PORT 2
38	SG INSPECTION PORT 3
38	SG INSPECTION PORT 4
44	PZR HEATER ACCESS PORT 1
44	PZR HEATER ACCESS PORT 2
NPS 3	RVV TRIP/ RESET
NPS 3	RVV TRIP/ RESET
NPS 3	RRV TRIP/ RESET
NPS 3	RRV TRIP/ RESET
NPS 3	RVV TRIP/ RESET
NPS 3	RVV TRIP

NOTE:
1. ALL DIMENSIONS ARE APPROXIMATE.



NuScale Power

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

eRAI No.: 8858
Date of RAI Issue: 09/01/2017

NRC Question No.: 03.08.02-13

DCD Section 3.8.2.1.5 describes the CNV boundary being “at the end of the safe ends furthest from the CNV shell”.

However, DCD Section 3.8.2.1.7 describes the CNV boundary being “at the valve assembly-to-safe end welds and the welds are part of the CNV.”

These two statements are inconsistent as to where the CNV boundary is. Clarify in DCD Sections 3.8.2.1.5, 3.8.2.1.7, and any other related sections where the CNV boundary ends.

NuScale Response:

The boundaries defined in FSAR Tier 2, Section 3.8.2.1.5 (Mechanical Penetration) and FSAR Tier 2, Section 3.8.2.1.7 (Emergency Core Cooling System (ECCS) Valve Penetrations) do not overlap. They cover distinct elements of the containment vessel (CNV). Section 3.8.2.1.5 discusses the nozzles with piping attached, with the welds attaching the pipe to the safe end belonging to the pipe. This puts the boundary at the end of the safe end farthest from the CNV shell. The ECCS trip/reset and trip valves discussed in Section 3.8.2.1.7, and shown in FSAR Tier 2, Figure 6.2-3a (CNV33-CNV35, CNV40-CNV41), attach directly to the CNV nozzle safe ends, with no piping between the valve and safe end. The CNV design specification has defined this boundary at the valve attachment weld. The weld therefore, belongs to the CNV. ASME Boiler and Pressure Vessel Code (BPVC) Subparagraph NB-1132.2(g) permits the boundary to be defined at this location if specified in the design specification.

Impact on DCA:

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

Enclosure 3:

Affidavit of Zackary W. Rad, AF-1017-56887

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 analyses by which NuScale develops its power module seismic analysis and distinguishing aspects of components in the NuScale design.

    NuScale has performed significant research and evaluation to develop a basis for this method, analyses, and component design 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. 214, eRAI No. 8858. 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 10/27/2017.

Zackary W. Rad