November 03, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 27 (eRAI No. 8788) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 27 (eRAI No. 8788)," dated May 22, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 27 (eRAI No.8788)," dated July 19, 2017

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

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Question from NRC eRAI No. 8788:

- 08.01-1

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com.

Sincerely,

Zackary W. Rad
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8788

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Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8788

NUSCALE POWER™

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

eRAI No.: 8788
Date of RAI Issue: 05/22/2017

NRC Question No.: 08.01-1

General Design Criteria (GDC) 50, "Containment Design Basis," requires, in part, that the design of containment penetrations, including electrical penetrations containing circuits of the ac power system and the capability of electrical penetration assemblies in containment structures to withstand a loss-of-coolant (LOCA) without loss of mechanical integrity and the external circuit protection for such penetrations. The staff has reviewed the following sections in the design certification application and noted some inconsistencies in addressing the Electrical Penetration Assemblies (EPA) and their conformance to GDC 50.

- FSAR Tier 2 Section 3.1.5.1 states that the NuScale Power Plant Design conforms to GDC 50. However, FSAR Tier 2, Section 8.1.4.3, bullet 3, states that "the AC and DC electrical power system circuits do not penetrate the containment vessels; therefore, conformance with GDC 50 is not necessary."
- FSAR Tier 2, Section 8.3.1.2.7, under GDC 50, states that "the only circuits that penetrate the CNVs are I&C circuits that serve to control power and operate safety-related and nonsafety-related equipment (e.g., sensors, execute devices) associated with each NPM as described in Section 7.0.4. There are no AC electrical power system cables that penetrate the CNVs".
- FSAR Tier 2, Section 8.3.2.2.2, under GDC 50 compliance, states that "The CNV electrical penetration assemblies for the Class 1E and non- Class 1E circuits are included in the containment design and conform to GDC 50 as discussed in FSAR Tier 2 Section 6.2.1." EPAs are further discussed in the following:
    - Electrical penetration assemblies (example: CNV38/39) are indicated in FSAR Tier 2 Table 6.1-1,
    - FSAR Tier 2 Figure 6.2-2b shows electrical penetration assembly,
    - FSAR Tier 2, Section 6.2.4, under Containment Isolation, itemized Electrical Penetration for power supply as 3 total on the top head, and,
    - FSAR Tier 2, Section 6.2.6.2 describes the leakage tests for Electrical Penetration Assemblies (EPA)
- FSAR Tier 1, Section 2.1.1, under Design Commitments, the 10th bullet states that "The NPM Class 1E containment electrical penetration assemblies are sized to power their design loads." In addition, FSAR Tier 1 Section 2.1.1, the last bullet states, "The CNTS Class 1E containment electrical penetration assemblies are rated to withstand fault

currents for the time required to clear the fault from its power source."

- FSAR Tier 1 Table 2.1-2, and Table 2.1-3 lists Class 1E electrical penetrations for CNTS pressurizer heater power, and control rod drives. It is not specific whether these equipment require AC/DC power supply.

The staff requests NuScale to:

1. clarify whether or not electrical penetration assembly in the Class 1E containment conforms to GDC 50,
2. clarify whether there are electrical penetration assemblies for power circuits and supplies,
3. provide a list of the safety-related low voltage power circuits and control power circuits (AC and DC) that penetrate the containment (i.e., EPA), and
4. if there is a Class 1E circuit that is included in the containment design, as stated in FSAR Tier 2 Section 8.3.2.2.2, explain why the EPA will not meet GDC 50 as Class 1E containment EPA, as stated in FSAR Tier 2 Section 8.1.4.3.

NuScale Response:

This response supplements the docketed response originally provided to Request for Additional Information (RAI) No. 27 (eRAI No. 8788) by NuScale letter RAIO-0717-55011 dated July 19, 2017. Pursuant to conference calls between NRC staff and NuScale on August 23, 2017 and October 4, 2017, NuScale has revised certain FSAR sections related to the design and testing of containment electrical penetration assemblies (EPAs) to address NRC staff comments on the original response.

FSAR Section 3.8.2.1.6 was revised to add additional information on the mechanical design of the EPAs. FSAR Table 3.11-1 was revised to add clarity to the EPA component descriptions for environmental qualification purposes, and a table note for commodity items was added. FSAR sections on EPA testing were revised consisistent with these FSAR changes. Certain FSAR sections that describe the EPA design and refer to FSAR Section 8.3.1 as applicable information were changed to FSAR Section 8.3 to not exclude relevant parts of FSAR Section 8.3.2. The remaining revisions are conforming changes.

The revisions to the EPA design descriptions are consistent with the acceptance criteria for EPAs described in Part 6 of the DSRS Acceptance Criteria in NuScale DSRS 8.3.1, AC Power Systems (Onsite) and in Part 7 of the Technical Rationale in NuScale DSRS 8.3.2, DC Power Systems (Onsite).

The revised FSAR sections and tables are listed below.

- Table 1.9-2 Conformance with Regulatory Guides
- Table 1.9-3 Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standard (DSRS)
- 3.1.5 Reactor Containment

- 3.8.2.1.6 Containment Electrical Penetration Assemblies and 3.8.2.8 References
- Table 3.11-1 List of Environmentally Qualified Electrical/I&C and Mechanical Equipment Located in Harsh Environments
- Section 8.1.4.3 Regulatory Requirements and Guidance
- Table 8.1-1 Acceptance Criteria and Guidelines for Electric Power Systems
- Section 8.3.1.2.5 Containment Electrical Penetration Assemblies
- Table 14.3-1 Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference

In addition to the FSAR changes above, the following Tier 1 sections and tables were revised.

- Section 2.1.1 (NuScale Power Module) Design Description
- Table 2.1-2 NuScale Power Module Mechanical Equipment
- Table 2.1-3 NuScale Power Module Electrical Equipment
- Table 2.1-4 NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria
- Section 2.8.1 (Equipment Qualification) Design Description
- Table 2.8-1 Module Specific Mechanical and Electrical/I&C Equipment
- Table 2.8-2 Equipment Qualification Inspections, Tests, Analyses, and Acceptance Criteria

Impact on DCA:

The FSAR and Tier 1 sections have been revised as described in the response above and as shown in the markup provided in this response.

- The CNTS supports the DHRS by closing CIVs for main steam valves and feedwater valves when actuated by MPS for DHRS operation.
- The ECCS supports the RCS by opening the ECCS reactor vent valves and RRVs when their respective trip valve is actuated by MPS.
- The DHRS supports the RCS by opening the DHRS actuation valves on a DHRS actuation signal.
- The CNTS supports the MPS by providing electrical penetration assemblies to route instrument cables for MPS actuation through the CNV.

The NPM performs the following nonsafety-related, risk-significant function that is verified by Inspections, Tests, Analyses, and Acceptance Criteria:

- The CNTS supports the RXB crane by providing lifting attachment points that the RXB crane can connect to so that the NPM can be lifted.

The NPM performs the following nonsafety-related functions that are verified by Inspections, Tests, Analyses, and Acceptance Criteria:

- The CNTS supports the SG by providing structural support for the SG piping.
- The CNTS supports the CRDS by providing structural support for the CRDS piping.
- The CNTS supports the RCS by providing structural support for the RCS piping.
- The CNTS supports the feedwater system by providing structural support for the feedwater system piping.

Design Commitments

- The NPM American Society of Mechanical Engineers (ASME) Code Class 1, 2 and 3 piping systems listed in Table 2.1-1 comply with ASME Code Section III requirements.
- The Nuscale Power Module ASME Code Class 1 and 2 components conform to the rules of construction of ASME Code Section III.
- The Nuscale Power Module ASME Code Class CS components conform to the rules of construction of ASME Code Section III.
- Safety-related structures, systems, and components (SSC) are protected against the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems.
- The Nuscale Power Module ASME Code Class 2 piping systems and interconnected equipment nozzles are evaluated for leak-before-break (LBB).
- The RPV beltline material has a Charpy upper-shelf energy of greater than 75 ft-lb.
- The CNV serves as an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.
- The CIV closure times limit potential releases of radioactivity.
- The length of piping shall be minimized between the containment penetration and the associated outboard CIVs.

RAI 08.01-1S1

- The ~~NPM Class 1E~~CNTS containment electrical penetration assemblies are sized to power their design loads.
- Physical separation exists between the redundant divisions of the MPS Class 1E instrumentation and control current-carrying circuits, and between Class 1E instrumentation and control current-carrying circuits and non-Class 1E instrumentation and current-carrying circuits. The scope of this commitment includes the cables from the NPM disconnect box to the instrument.
- The RPV is provided with surveillance capsule holders to hold a capsule containing RPV material surveillance specimens.
- The CNTS safety-related valves change position under design differential pressure.
- The ECCS safety-related valves change position under design differential pressure.
- The DHRS safety-related valves change position under design differential pressure.
- The RCS safety-related check valves change position under design differential pressure and flow.
- The RCS safety-related excess flow check valves change position under excess flow conditions.
- The CNTS safety-related hydraulic-operated valves fail to their safety-related position on loss of electrical power under design differential pressure.
- The ECCS safety-related RRVs and RVVs fail to their safety-related position on loss of electrical power to their corresponding trip valves under design differential pressure.
- The DHRS safety-related hydraulic-operated valves fail to their safety-related position on loss of electrical power under design differential pressure.
- The CNTS safety-related check valves change position under design differential pressure and flow.

RAI 08.01-1S1

- The CNTS ~~Class 1E~~ containment electrical penetration assemblies are rated to withstand fault currents for the time required to clear the fault from its power source.

2.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.1-4 contains the inspections, tests, and analyses for the NPM.

RAI 08.01-1S1

Table 2.1-2: NuScale Power Module Mechanical Equipment

Equipment Name	Equipment Identifier	ASME Code Section III Class	Valve Actuator Type	Containment Isolation Valve
RCS integral RPV/SG/Pressurizer	RPV-VSL-0001	1	N/A	N/A
RVI upper core plate	N/A	CS	N/A	N/A
RVI core barrel	N/A	CS	N/A	N/A
RVI reflector blocks	N/A	CS	N/A	N/A
RVI lower core plate	N/A	CS	N/A	N/A
RVI core support blocks	N/A	CS	N/A	N/A
CNTS containment vessel	CNV-VSL-0001	1	N/A	N/A
RCS reactor safety valve	RCS-PSV-0003A	1	N/A	No
RCS reactor safety valve	RCS-PSV-0003B	1	N/A	No
RCS pressurizer spray check valve	RCS-CKV-0323	1	N/A	No
RCS injection check valve	RCS-CKV-0332	1	N/A	No
RCS discharge excess flow check valve	RCS-CKV-0333	1	N/A	No
RCS high point degasification excess flow check valve	RCS-CKV-0400	1	N/A	No
ECCS reactor vent valve	ECC-HOV-0101A	1	Hydraulic	No
ECCS reactor vent valve trip valve	ECC-SV-0102A	1	Solenoid	~~Yes~~No
ECCS reactor vent valve reset valve	ECC-SV-0103A	1	Solenoid	~~Yes~~No
ECCS reactor vent valve	ECC-HOV-0101B	1	Hydraulic	No
ECCS reactor vent valve trip valve	ECC-SV-0102B	1	Solenoid	~~Yes~~No
ECCS reactor vent valve reset valve	ECC-SV-0103B	1	Solenoid	~~Yes~~No
ECCS reactor vent valve	ECC-HOV-0101C	1	Hydraulic	No
ECCS reactor vent valve trip valve	ECC-SV-0102C	1	Solenoid	~~Yes~~No
ECCS reactor vent valve reset valve	ECC-SV-0103C	1	Solenoid	~~Yes~~No
ECCS reactor recirculation valve	ECC-HOV-0104A	1	Hydraulic	No
ECCS reactor recirculation valve trip valve	ECC-SV-0105A	1	Solenoid	~~Yes~~No
ECCS reactor recirculation valve reset valve	ECC-SV-0106A	1	Solenoid	~~Yes~~No
ECCS reactor recirculation valve	ECC-HOV-0104B	1	Hydraulic	No
ECCS reactor recirculation valve trip valve	ECC-SV-0105B	1	Solenoid	~~Yes~~No
ECCS reactor recirculation valve reset valve	ECC-SV-0106B	1	Solenoid	~~Yes~~No
ECCS reactor recirculation valve trip valve	ECC-SV-0107	1	Solenoid	~~Yes~~No
CNTS solenoid valves	None	1	Solenoid	No
CNTS reactor coolant system injection inboard CIV	CNT-CVC-ISV-0331	1	Electro-hydraulic	Yes
CNTS reactor coolant system injection outboard CIV	CNT-CVC-ISV-0329	1	Electro-hydraulic	Yes
CNTS pressurizer spray inboard CIV	CNT-CVC-ISV-0325	1	Electro-hydraulic	Yes
CNTS pressurizer spray outboard CIV	CNT-CVC-ISV-0323	1	Electro-hydraulic	Yes
CNTS reactor coolant system discharge inboard CIV	CNT-CVC-ISV-0334	1	Electro-hydraulic	Yes
CNTS reactor coolant system discharge outboard CIV	CNT-CVC-ISV-0336	1	Electro-hydraulic	Yes
CNTS reactor pressure vessel high point degasification inboard CIV	CNT-CVC-ISV-0401	1	Electro-hydraulic	Yes

Table 2.1-2: NuScale Power Module Mechanical Equipment (Continued)

Equipment Name	Equipment Identifier	ASME Code Section III Class	Valve Actuator Type	Containment Isolation Valve
CRDM heat exchanger	CRDS-CRD-004	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-005	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-006	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-007	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-008	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-009	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-010	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-011	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-012	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-013	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-014	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-015	2	N/A	N/A
CRDM heat exchanger	CRDS-CRD-016	2	N/A	N/A
CRDM cooling water supply flex hose	CRDS-FHS-0101 thru CRDS-FHS-0116	2	N/A	N/A
CRDM cooling water return flex hose	CRDS-FHS-0201 thru CRDS-FHS-0216	2	N/A	N/A
CRDM latch housing	N/A	1	N/A	N/A
CRDM rod travel housing	N/A	1	N/A	N/A
CRDM rod travel housing plug	N/A	1	N/A	N/A
CNTS ~~instrumentation and controls division I electrical penetration~~I&C Division I Electrical Penetration Assembly (EPA)	CNV8	1	N/A	N/A
CNTS ~~instrumentation and controls division II electrical penetration~~I&C Division II Electrical Penetration Assembly (EPA)	CNV9	1	N/A	N/A
CNTS ~~pressurizer heater power #1 electrical penetration~~PZR Heater Power #1 Electrical Penetration Assembly (EPA)	CNV15	1	N/A	N/A
CNTS ~~pressurizer heater power #2 electrical penetration~~PZR Heater Power #2 Electrical Penetration Assembly (EPA)	CNV16	1	N/A	N/A
CNTS ~~instrumentation and controls channel A electrical penetration~~I&C Channel A Electrical Penetration Assembly (EPA)	CNV17	1	N/A	N/A
CNTS ~~instrumentation and controls channel B electrical penetration~~I&C Channel B Electrical Penetration Assembly (EPA)	CNV18	1	N/A	N/A
CNTS ~~instrumentation and controls channel C electrical penetration~~I&C Channel C Electrical Penetration Assembly (EPA)	CNV19	1	N/A	N/A
CNTS ~~instrumentation and controls channel D electrical penetration~~I&C Channel D Electrical Penetration Assembly (EPA)	CNV20	1	N/A	N/A
CNTS ~~control rod drive system electrical penetration~~CRD Power Electrical Penetration Assembly (EPA)	CNV37	1	N/A	N/A

Table 2.1-2: NuScale Power Module Mechanical Equipment (Continued)

Equipment Name	Equipment Identifier	ASME Code Section III Class	Valve Actuator Type	Containment Isolation Valve
CNTS ~~rod position indication group #1 electrical penetration~~RPI Group #1 Electrical Penetration Assembly (EPA)	CNV38	1	N/A	N/A
CNTS ~~rod position indication group #2 electrical penetration~~RPI Group #2 Electrical Penetration Assembly (EPA)	CNV39	1	N/A	N/A
~~RCS instrumentation and controls channel A electrical penetration~~	~~RPV39~~	~~1~~	~~N/A~~	~~N/A~~
~~RCS instrumentation and controls channel B electrical penetration~~	~~RPV40~~	~~1~~	~~N/A~~	~~N/A~~
~~RCS instrumentation and controls channel C electrical penetration~~	~~RPV41~~	~~1~~	~~N/A~~	~~N/A~~
~~RCS instrumentation and controls channel D electrical penetration~~	~~RPV42~~	~~1~~	~~N/A~~	~~N/A~~

RAI 08.01-1, RAI 08.01-1S1

Table 2.1-3: NuScale Power Module Electrical Equipment

Equipment Name	Equipment Identifier	Remotely Operated	Loss of Motive Power Position	CIV Closure Time (sec)[1]
ECCS reactor vent valve trip valve	ECC-SV-0102A	Yes	Open	N/A
ECCS reactor vent valve reset valve	ECC-SV-0103A	Yes	Close	N/A
ECCS reactor vent valve trip valve	ECC-SV-0102B	Yes	Open	N/A
ECCS reactor vent valve reset valve	ECC-SV-0103B	Yes	Close	N/A
ECCS reactor vent valve trip valve	ECC-SV-0102C	Yes	Open	N/A
ECCS reactor vent valve reset valve	ECC-SV-0103C	Yes	Close	N/A
ECCS reactor recirculation valve trip valve	ECC-SV-0105A	Yes	Open	N/A
ECCSreactor recirculation valve reset valve	ECC-SV-0106A	Yes	Close	N/A
ECCS reactor recirculation valve trip valve	ECC-SV-0105B	Yes	Open	N/A
ECCS reactor recirculation valve reset valve	ECC-SV-0106B	Yes	Close	N/A
ECCS reactor recirculation valve trip valve	ECC-SV-0107	Yes	Open	N/A
CNTS reactor coolant system injection inboard CIV	CNT-CVC-ISV-0331	Yes	Closed	<≤ 57
CNTS reactor coolant system injection outboard CIV	CNT-CVC-ISV-0329	Yes	Closed	<≤ 57
CNTS pressurizer spray inboard CIV	CNT-CVC-ISV-0325	Yes	Closed	<≤ 57
CNTS pressurizer spray outboard CIV	CNT-CVC-ISV-0323	Yes	Closed	<≤ 57
CNTS reactor coolant system discharge inboard CIV	CNT-CVC-ISV-0334	Yes	Closed	<≤ 57
CNTS reactor coolant system discharge outboard CIV	CNT-CVC-ISV-0336	Yes	Closed	<≤ 57
CNTS reactor pressure vessel high point degasification inboard CIV	CNT-CVC-ISV-0401	Yes	Closed	<≤ 57
CNTS reactor pressure vessel high point degasification outboard CIV	CNT-CVC-ISV-0403	Yes	Closed	<≤ 57
CNTS containment evacuation inboard CIV	CNT-CE-ISV-0101	Yes	Closed	<≤ 57
CNTS containment evacuation outboard CIV	CNT-CE-ISV-0102	Yes	Closed	<≤ 57
CNTS flood and drain inboard CIV	CNT-CFD-ISV-0130	Yes	Closed	<≤ 57
CNTS flood and drain outboard CIV	CNT-CFD-ISV-0129	Yes	Closed	<≤ 57
CNTS reactor component cooling water system supply inboard CIV	CNT-RCCW-ISV-0185	Yes	Closed	<≤ 57
CNTS reactor component cooling water system supply outboard CIV	CNT-RCCW-ISV-0184	Yes	Closed	<≤ 57
CNTS reactor component cooling water system return inboard CIV	CNT-RCCW-ISV-0190	Yes	Closed	<≤ 57
CNTS reactor component cooling water system return outboard CIV	CNT-RCCW-ISV-0191	Yes	Closed	<≤ 57
CNTS feedwater #1 CIV	CNT-FW-ISV-1003	Yes	Closed	<≤ 57
CNTS feedwater #2 CIV	CNT-FW-ISV-2003	Yes	Closed	<≤ 57
CNTS main steam #1 CIV	CNT-MS-ISV-1005	Yes	Closed	<≤ 57
CNTS main steam line #1 bypass valve CIV	CNT-MS-ISV-1006	Yes	Closed	< 10N/A (see Note 1)
CNTS main steam #2 CIV	CNT-MS-ISV-2005	Yes	Closed	< 57
CNTS main steam line #2 bypass valve CIV	CNT-MS-ISV-2006	Yes	Closed	< 10N/A (see Note 1)

Table 2.1-3: NuScale Power Module Electrical Equipment (Continued)

Equipment Name	Equipment Identifier	Remotely Operated	Loss of Motive Power Position	CIV Closure Time (sec)[1]
DHRS actuation valve	DHR-HOV-1002A	Yes	Open	N/A
DHRS actuation valve	DHR-HOV-1002B	Yes	Open	N/A
DHRS actuation valve	DHR-HOV-2002A	Yes	Open	N/A
DHRS actuation valve	DHR-HOV-2002B	Yes	Open	N/A
CNTS ~~instrumentation and controls division I electrical penetration~~I&C Division I Electrical Penetration Assembly (EPA)	CNV8	N/A	N/A	N/A
CNTS ~~instrumentation and controls division II electrical penetration~~I&C Division II Electrical Penetration Assembly (EPA)	CNV9	N/A	N/A	N/A
CNTS ~~pressurizer heater power #1electrical penetration~~PZR Heater Power #1 Electrical Penetration Assembly (EPA)	CNV15	N/A	N/A	N/A
CNTS ~~pressurizer heater power #2 electrical penetration~~PZR Heater Power #2 Electrical Penetration Assembly (EPA)	CNV16	N/A	N/A	N/A
CNTS ~~instrumentation and controls channel A electrical penetration~~I&C Channel A Electrical Penetration Assembly (EPA)	CNV17	N/A	N/A	N/A
CNTS ~~instrumentation and controls channel B electrical penetration~~I&C Channel B Electrical Penetration Assembly (EPA)	CNV18	N/A	N/A	N/A
CNTS ~~instrumentation and controls channel C electrical penetration~~I&C Channel C Electrical Penetration Assembly (EPA)	CNV19	N/A	N/A	N/A
CNTS ~~instrumentation and controls channel D electrical penetration~~I&C Channel D Electrical Penetration Assembly (EPA)	CNV20	N/A	N/A	N/A
CNTS ~~control rod drive system electrical penetration~~CRD Power Electrical Penetration Assembly (EPA)	CNV37	N/A	N/A	N/A
CNTS ~~rod position indication group #1 electrical penetration~~RPI Group #1 Electrical Penetration Assembly (EPA)	CNV38	N/A	N/A	N/A
CNTS ~~rod position indication group #2 electrical penetration~~RPI Group #2 Electrical Penetration Assembly (EPA)	CNV39	N/A	N/A	N/A
~~RCS instrumentation and controls channel A electrical penetration~~	~~RPV39~~	~~N/A~~	~~N/A~~	~~N/A~~
~~RCS instrumentation and controls channel B electrical penetration~~	~~RPV40~~	~~N/A~~	~~N/A~~	~~N/A~~
~~RCS instrumentation and controls channel C electrical penetration~~	~~RPV41~~	~~N/A~~	~~N/A~~	~~N/A~~
~~RCS instrumentation and controls channel D electrical penetration~~	~~RPV42~~	~~N/A~~	~~N/A~~	~~N/A~~

Note:

1) CNTS main steam line #1 and #2 bypass valves receive a containment isolation signal. The bypass valves have no CIV closure time requirement because they are passive valves that are normally closed, fail closed, and are only open for short durations during plant startup.

RAI 08.01-1, RAI 08.01-1S1

Table 2.1-4: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1.	The NuScale Power Module ASME Code Class 1, 2 and 3 piping systems listed in Table 2.1-1 comply with ASME Code Section III requirements.	An inspection will be performed of the NuScale Power Module ASME Code Class 1, 2 and 3 as-built piping system Design Reports required by ASME Code Section III.	ASME Code Section III Design Reports for the NuScale Power Module ASME Code Class 1, 2 and 3 as-built piping systems listed in Table 2.1-1 meet the requirements of ASME Code Section III, NCA-3550.
2.	The NuScale Power Module ASME Code Class 1 and 2 components conform to the rules of construction of ASME Code Section III.	An inspection will be performed of the NuScale Power Module ASME Code Class 1 and 2 as-built component Data Reports required by ASME Code Section III.	ASME Code Section III Data Reports for the NuScale Power Module ASME Code Class 1 and 2 components listed in Table 2.1-2 and interconnecting piping exist and conclude that the requirements of ASME Code Section III are met.
3.	The NuScale Power Module ASME Code Class CS components conform to the rules of construction of ASME Code Section III.	An inspection will be performed of the NuScale Power Module ASME Code Class CS as-built component Data Reports required by ASME Code Section III.	ASME Code Section III Data Reports for the NuScale Power Module ASME Code Class CS components listed in Table 2.1-2 exist and conclude that the requirements of ASME Code Section III are met.
4.	Safety-related SSC are protected against the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems.	An inspection will be performed of the as-built high- and moderate-energy piping systems and protective features for the safety-related SSC.	Protective features are installed in accordance with the as-built Pipe Break Hazard Analysis Report and safety-related SSC are protected against or qualified to withstand the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems.
5.	The NuScale Power Module ASME Code Class 2 piping systems and interconnected equipment nozzles are evaluated for LBB.	An analysis will be performed of the ASME Code Class 2 as-built piping systems and interconnected equipment nozzles.	The as-built LBB analysis for the ASME Code Class 2 piping systems listed in Table 2.1-1 and interconnected equipment nozzles is bounded by the as-designed LBB analysis.
6.	The RPV beltline material has a Charpy upper-shelf energy of greater than 75 ft-lb.	A vendor test will be performed of the Charpy V-Notch specimen of the RPV beltline material.	An ASME Code Certified Material Test Report exists and concludes that the initial RPV beltline material Charpy upper-shelf energy is greater than 75 ft-lb.
7.	The CNV serves as an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.	A leakage test will be performed of the pressure containing or leakage-limiting boundaries, and CIVs.	The leakage rate for local leak rate tests (Type B and Type C) for pressure containing or leakage-limiting boundaries and CIVs meets the requirements of 10 CFR Part 50, Appendix J.
8.	Containment isolation valve closure times limit potential releases of radioactivity.	A test will be performed of the automatic CIVs.	Each CIV listed in Table 2.1-3 travels from the full open to full closed position in less than or equal to the time listed in Table 2.1-3 after receipt of a containment isolation signal.

Table 2.1-4: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
9.	The length of piping shall be minimized between the containment penetration and the associated outboard CIVs.	An inspection will be performed of the as-built piping between containment penetrations and associated outboard CIVs.	The length of piping between each containment penetration and its associated outboard CIV is less than or equal to the length identified in Table 2.1-1.
10.	The ~~NPM~~CNTS ~~Class 1E~~ containment electrical penetration assemblies are sized to power their design loads.	i. An analysis will be performed of the ~~NPM~~CNTS as-designed ~~Class 1E~~ containment electrical penetration assemblies. ii. An inspection will be performed of ~~NPM~~CNTS ~~Class 1E~~ as-built containment electrical penetration assembly.	i. An electrical rating report exists that defines and identifies the required design electrical rating to power the design loads of each ~~NPM~~CNTS ~~Class 1E~~ containment electrical penetration assembly listed in Table 2.1-3. ii. The electrical rating of each ~~NPM~~CNTS ~~Class 1E~~ containment electrical penetration assembly listed in Table 2.1-3 is greater than or equal to the required design electrical rating as specified in the electrical rating report.
11.	Physical separation exists between the redundant divisions of the MPS Class 1E instrumentation and control current-carrying circuits, and between Class 1E instrumentation and control current-carrying circuits and non-Class 1E instrumentation and current-carrying circuits. The scope of this commitment includes the cables from the NPM disconnect box to the instrument.	An inspection will be performed of the MPS Class 1E as-built instrumentation and control current-carrying circuits.	i. Physical separation between redundant divisions of MPS Class 1E instrumentation and control current-carrying circuits is provided by a minimum separation distance, or by barriers (where the minimum separation distances cannot be maintained), or by a combination of separation distance and barriers. ii. Physical separation between MPS Class 1E instrumentation and control current-carrying circuits and non-Class 1E instrumentation and control current-carrying circuits is provided by a minimum separation distance, or by barriers (where the minimum separation distances cannot be maintained), or by a combination of separation distance and barriers.
12.	The RPV is provided with surveillance capsule holders to hold a capsule containing RPV material surveillance specimens.	An inspection will be performed of the as-built RPV surveillance capsule holders.	Four surveillance capsule holders are installed in the RPV beltline region at approximately 90 degree intervals.
13.	The remotely-operated CNTS containment isolation~~safety-related~~ valves change position under design differential pressure.	A test will be performed of the CNTS safety-related valves.	Each remotely-operated CNTS ~~safety-related~~ containment isolation valve listed in Table 2.1-2 strokes fully open and fully closed by remote operation.
14.	The ECCS safety-related valves change position under design differential pressure.	A test will be performed of the ECCS safety-related valves.	Each ECCS safety-related valve listed in Table 2.1-2 strokes fully open and fully closed by remote operation.

2.8 Equipment Qualification

2.8.1 Design Description

System Description

The scope of this section is equipment qualification (EQ) of equipment specific to each NuScale Power Module. Equipment qualification applies to safety-related electrical and mechanical equipment located in harsh environments and digital instrumentation and controls equipment in mild environments. The electrical equipment identified in 10 CFR 50.49 as electric equipment are subject to EQ.

Design Commitments

- The Seismic Category I equipment, including its associated supports and anchorages, withstands design basis seismic loads without loss of its safety-related function(s) during and after a safe shutdown earthquake (SSE).

RAI 08.01-1S1

- The Class 1E electrical equipment located in a harsh environment, including ~~its~~ associated connection assemblies, withstand~~s~~ the design basis harsh environmental conditions experienced during normal operations, anticipated operational occurrences (AOOs), design basis accidents (DBAs), and post-accident conditions, and performs its function for the period of time required to complete the function.
- The non-metallic parts, materials, and lubricants used in safety-related mechanical equipment perform their safety-related function up to the end of their qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.
- The Class 1E computer-based instrumentation and control systems located in a mild environment withstand design basis mild environmental conditions without loss of safety-related functions.
- The Class 1E digital equipment performs its safety-related function when subjected to the design basis electromagnetic interference, radio frequency interference, and electrical surges that would exist before, during, and following a DBA.
- The safety-related valves are functionally designed and qualified to perform their safety-related function under the full range of fluid flow, differential pressure, electrical conditions, and temperature conditions up to and including DBA conditions.
- The safety-related relief valves provide overpressure protection.
- The safety-related decay heat removal system (DHRS) passive condensers have the capacity to transfer their design heat load.

RAI 08.01-1S1

- The CNTS containment electrical penetration assemblies located in a harsh environment, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, anticipated operational occurrences (AOOs), design basis accidents (DBAs), and post-accident conditions, and performs its function for the period of time required to complete the function.

RAI 06.02.04-2, RAI 08.01-1S1, RAI 14.03.03-2

Table 2.8-1: Module Specific Mechanical and Electrical/I&C Equipment

Equipment Identifier	Description	Location	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category(1)
Containment System							
CNV-8	~~I&C Div I Nozzle~~CNTS I&C Division I Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	~~Yes~~No	A
CNV-9	~~I&C Div II Nozzle~~CNTS I&C Division II Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	~~Yes~~No	A
CNV-15	~~PZR Heater Power #1 Nozzle~~CNTS PZR Heater Power #1 Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	~~Yes~~No	A
CNV-16	~~PZR Heater Power #2 Nozzle~~CNTS PZR Heater Power #2 Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	~~Yes~~No	A
CNV-17	~~I&C Channel A Nozzle~~CNTS I&C Channel A Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	Yes	A
CNV-18	~~I&C Channel B Nozzle~~CNTS I&C Channel B Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	Yes	A
CNV-19	~~I&C Channel C Nozzle~~CNTS I&C Channel C Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	Yes	A
CNV-20	~~I&C Channel D Nozzle~~CNTS I&C Channel D Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	Yes	A
CNV-37	~~CRD Power Nozzle~~CNTS CRD Power Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	~~Yes~~No	A
CNV-38	~~RPI Group #1 Nozzle~~CNTS RPI Group #1 Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	~~Yes~~No	A
CNV-39	~~RPI Group #2 Nozzle~~CNTS RPI Group #2 Electrical Penetration Assembly (EPA)	RXB - Top of Module ~~CNV-6~~ RXB - Inside Containment	Harsh	Electrical Mechanical	Yes	~~Yes~~No	A
MS-ISV-1005	MS #1 CIV (MSIV #1)	RXB - Top of Module	Harsh	Electrical Mechanical	Yes	Yes	A B
MS-ISV-2005	MS #2 CIV (MSIV #2)	RXB - Top of Module	Harsh	Electrical Mechanical	Yes	Yes	A B
MS-ISV-1006	MS line #1 Bypass Valve (MSIV Bypass #1)	RXB - Top of Module	Harsh	Electrical Mechanical	Yes	Yes	A B
MS-ISV-2006	MS line #2 Bypass Valve (MSIV Bypass #2)	RXB - Top of Module	Harsh	Electrical Mechanical	Yes	Yes	A B

RAI 08.01-1S1

Table 2.8-2: Equipment Qualification Inspections, Tests, Analyses, and Acceptance Criteria

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1.	The Seismic Category I equipment, including its associated supports and anchorages, withstands design basis seismic loads without loss of its safety-related function(s) during and after an SSE.	i. A type test, analysis, or a combination of type test and analysis will be performed of the Seismic Category I equipment, including its associated supports and anchorages. ii. An inspection will be performed of the Seismic Category I as-built equipment, including its associated supports and anchorages.	i. A seismic qualification record form exists and concludes that the Seismic Category I equipment listed in Table 2.8-1, including its associated supports and anchorages, will withstand the design basis seismic loads and perform its safety function during and after an SSE. ii. The Seismic Category I equipment listed in Table 2.8-1, including its associated supports and anchorages, is installed in its design location in a Seismic Category I structure in a configuration bounded by the equipment's seismic qualification record form.
2.	The Class 1E electrical equipment located in a harsh environment, including ~~its~~associated connection assemblies, withstand~~s~~ the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions and performs its function for the period of time required to complete the function.	i. A type test or a combination of type test and analysis will be performed of the Class 1E electrical equipment, including ~~its~~associated connection assemblies. ii. An inspection will be performed of the Class 1E as-built electrical equipment, including ~~its~~associated connection assemblies.	i. An EQ record form exists and concludes that the Class 1E electrical equipment listed in Table 2.8-1, including ~~its~~associated connection assemblies, perform~~s~~ ~~its~~their function under the environmental conditions specified in the EQ record form for the period of time required to complete the function. ii. The Class 1E electrical equipment listed in Table 2.8-1, including ~~its~~associated connection assemblies, ~~is~~are installed in ~~its~~their design location in a configuration bounded by the EQ record form.
3.	The non-metallic parts, materials, and lubricants used in safety-related mechanical equipment perform their safety-related function up to the end of their qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.	A type test or a combination of type test and analysis will be performed of the non-metallic parts, materials, and lubricants used in safety-related mechanical equipment.	A qualification record form exists and concludes that the non-metallic parts, materials, and lubricants used in safety-related mechanical equipment listed in Table 2.8-1 perform their safety-related function up to the end of their qualified life under the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) specified in the qualification record form.

Table 2.8-2: Equipment Qualification Inspections, Tests, Analyses, and Acceptance Criteria (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
8.	The safety-related DHRS passive condensers have the capacity to transfer their design heat load.	A type test or a combination of type test and analysis will be performed of the safety-related DHRS passive condensers.	A report exists and concludes that the safety-related DHRS passive condensers listed in Table 2.8-1 have a heat removal capacity sufficient to transfer their design heat load.
9.	The CNTS containment electrical penetration assemblies located in a harsh environment, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and postaccident conditions and performs its function for the period of time required to complete the function.	i. A type test or a combination of type test and analysis will be performed of the CNTS containment electrical penetration assemblies equipment including associated connection assemblies. ii. An inspection will be performed of the containment CNTS electrical penetration assemblies, including associated connection assemblies.	i. An EQ record form exists and concludes that the CNTS electrical penetration assemblies listed in Table 2.8-1, including associated connection assemblies, performs their function under the environmental conditions specified in the EQ record form for the period of time required to complete the function. ii. The CNTS electrical penetration assemblies listed in Table 2.8-1, including associated connection assemblies, are installed in their design location in a configuration bounded by the EQ record form.

RAI 08.01-1, RAI 08.01-1S1, RAI 08.02-4, RAI 08.02-6, RAI 08.03.02-1, RAI 09.02.06-1

Table 1.9-2: Conformance with Regulatory Guides

RG	Division Title	Rev.	Conformance Status	COL Applicability	Comments	Section
1.3	Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors	2	Not Applicable	Not Applicable	This guidance is only applicable to BWRs.	Not Applicable
1.4	Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors	2	Not Applicable	Not Applicable	This RG pertains to existing reactors; RG 1.183 is specified in SRP Section 15.0.3 to be used for new reactors.	Not Applicable
1.5	Safety Guide 5 - Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors	-	Not Applicable	Not Applicable	This guidance is only applicable to BWRs.	Not Applicable
1.6	Safety Guide 6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems	-	Partially Conforms	Applicable	The onsite electrical AC power systems do not contain any Class 1E distribution systems. The EDSS design conforms to the guidance for independence of standby power sources and their distribution systems.	8.3
1.7	Control of Combustible Gas Concentrations in Containment	3	Not Applicable	Not Applicable	The containment vessel design is such that its integrity does not rely on combustible gas control systems.	6.2
1.8	Qualification and Training of Personnel for Nuclear Power Plants	3	Not Applicable	Applicable	Site-specific programmatic and operational activities are the responsibility of the COL applicant.	Not Applicable
1.9	Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants	4	Not Applicable	Not Applicable	Based on reduced reliance on AC power, the design does not require or include safety-related emergency diesel generators.	8.3
1.11	Instrument Lines Penetrating the Primary Reactor Containment	1	Not Applicable	Not Applicable	No lines penetrate the NPM containment.	6.2

Table 1.9-2: Conformance with Regulatory Guides (Continued)

RG	Division Title	Rev.	Conformance Status	COL Applicability	Comments	Section
1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants	2	Not Applicable	Not Applicable	The Certified Seismic Design Response Spectra (CSDRS) was not developed using RG 1.60. However, it is demonstrated that the design envelops the RG 1.60 spectra anchored to 0.1g.	3.7
1.61	Damping Values for Seismic Design of Nuclear Power Plants	1	Conforms	Applicable	In accordance with the guidance of RG 1.61, an alternative damping value for the NPM substructure was determined. The NPM subsystem is comprised of vessels, bearing joints, cables, internals, friction surfaces, etc.	3.7 3.12 Appendix 3A 5.3
1.62	Manual Initiation of Protective Actions	1	Conforms	Applicable	This RG refers to Point 4 of BTP 7-19, Revision 5, dated March 2007. NuScale intends to apply BTP 7-19, Revision 6 (including Point 4).	7.1 7.2
1.63	Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants	3	Partially Conforms	Applicable	IEEE 741-1997 is used for external circuit protection of electrical penetration assemblies. Although IEEE 741-1997 is not endorsed by RG 1.63 (endorsing IEEE 317-1983) the design philosophy does not deviate from RG 1.63.The portion of the RG 1.63 guidance that endorses IEEE-317-1983 is applicable. IEEE 741-1997 is used for external circuit protection of electrical penetration assemblies instead of IEEE 741-1986 as endorsed by RG 1.63. The 1997 version, including the additional design enhancements, is consistent with RG 1.63.	3.113.8.2 3.11 8.1 8.3
1.65	Materials and Inspections for Reactor Vessel Closure Studs	1	Partially Conforms	Applicable	This RG provides guidance for use in selecting reactor vessel closure stud bolting materials and properties, and conducting preservice and inservice inspection of the closure studs. Performance of inservice inspection is the responsibility of the COL applicant.	3.13 5.3 6.1
1.68	Initial Test Programs for Water-Cooled Nuclear Power Plants	4	Partially Conforms	Applicable	This guidance is applicable except for aspects that (1) are BWR-specific or address specific PWR SSC design features not in the NuScale design; or (2) involve site-specific program implementation activities that are the responsibility of the COL applicant.	4.4 5.4 8.3 10.4 14.2 21.2

RAI 06.02.04-8, RAI 08.01-1, RAI 08.01-1S1, RAI 08.02-4, RAI 08.02-6, RAI 08.03.02-1, RAI 09.02.06-1, RAI 14.03.12-2, RAI 14.03.12-3

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standard (DSRS)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	COL Applicability	Comments	Section
SRP 1.0, Rev 2: Introduction and Interfaces	II.1	No Specific Acceptance Criteria	-	-	No Specific Acceptance Criteria.	X
SRP 1.0, Rev 2: Introduction and Interfaces	II.2	SRP Acceptance Criteria Associated with Each Referenced SRP section	Conforms	Applicable	None.	Ch 1
SRP 1.0, Rev 2: Introduction and Interfaces	II.3	Performance of New Safety Features and Design Qualification Testing Requirements	Conforms	Applicable	None.	Ch 1
SRP 2.0, (March 2007): Site Characteristics and Site Parameters	II.1	Specific SRP Acceptance Criteria Contained in Related SRP Chapter 2 or Other Referenced SRP sections	Conforms	Applicable	This acceptance criterion is a pointer to other SRP sections.	2.0
SRP 2.0, (March 2007): Site Characteristics and Site Parameters	II.2	COL Application Referencing an Early Site Permit	Not Applicable	Applicable	This acceptance criterion is applicable only to COL applicants that do not reference the DCA.	2.0
SRP 2.0, (March 2007): Site Characteristics and Site Parameters	II.3	COL Application Referencing a Certified Design	Not Applicable	Applicable	This acceptance criterion is for COL applicants to meet the design parameters established in the Design Certification Application.	2.0
SRP 2.0, (March 2007): Site Characteristics and Site Parameters	II.4	COL Application Referencing an Early Site Permit and a Certified Design	Not Applicable	Applicable	This acceptance criterion is for COL applicants to meet the design parameters established in the Design Certification Application.	2.0
SRP 2.0, (March 2007): Site Characteristics and Site Parameters	II.5	COL Application Referencing Neither an Early Site Permit Nor a Certified Design	Not Applicable	Applicable	This acceptance criterion is applicable only to COL applicants that do not reference the DCA.	Not Applicable
SRP 2.0, (March 2007): Site Characteristics and Site Parameters	App A	Table 1: Examples of Site Characteristics and Site Parameters	Partially Conforms	Applicable	NuScale provides design Parameters where applicable.	Table 2.0-1
SRP 2.0, (March 2007): Site Characteristics and Site Parameters	App A	Table 2: Examples of Site-Related Design Parameters and Design Characteristics	Partially Conforms	Applicable	NuScale provides design Parameters where applicable.	Table 2.0-1

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standard (DSRS) (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	COL Applicability	Comments	Section
NSDSRS 8.3.1, Rev 0: AC Power Systems (Onsite)	II.5	Compliance with GDC 18	Departure	Departure	The NuScale design supports an exemption from GDC 18 that includes the associated requirements for the onsite AC power system.	8.1.4 8.3.1
NSDSRS 8.3.1, Rev 0: AC Power Systems (Onsite)	II (No Number)	Compliance with GDC 33	Departure	Departure	The NuScale design supports an exemption from GDC 33.	8.3.1
NSDSRS 8.3.1, Rev 0: AC Power Systems (Onsite)	II (No Number)	Compliance with GDCs 34, 35, 38, 41, and 44	Departure	Departure	NuScale complies with a set of principal design criteria in lieu of these GDC.	8.3.1
NSDSRS 8.3.1, Rev 0: AC Power Systems (Onsite)	II.6	Compliance with GDC 50	Conforms	Applicable	~~The AC and DC electrical power system circuits do not penetrate the containment vessels; therefore, conformance with GDC 50 is not necessary.~~The electrical design requirements associated with GDC 50 for electrical penetration assemblies (EPAs) are included in Section 8.3.	8.1 8.3.~~1~~
NSDSRS 8.3.1, Rev 0: AC Power Systems (Onsite)	II.7	Compliance with 10 CFR 50.65(a)(4)	Not Applicable	Applicable	The 10 CFR 50.65(a)(4) assessment is applied to main onsite AC power system SSCs that: (1) are determined to meet the 10 CFR 50.65(b) criteria; and (2) a risk-informed evaluation process has shown to be significant to public health and safety. As indicated in Section 17.6, the development of the maintenance rule (10 CFR 50.65) program - including the identification of SSCs that require assessment per 10 CFR 50.65(a)(4) - is the responsibility of the COL applicant referencing the certified design.	8.3.1
NSDSRS 8.3.1, Rev 0: AC Power Systems (Onsite)	II.8	Compliance with 10 CFR 50.55a(h)	Not Applicable	Not Applicable	No onsite electrical AC power system equipment is required to conform to 10CFR50.55a(h) and IEEE Std.603-1991.	8.1.1 8.3.1
NSDSRS 8.3.1, Rev 0: AC Power Systems (Onsite)	II.9	Compliance with 10 CFR 52.47(b)(1)	Conforms	Applicable	None.	8.1

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standard (DSRS) (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	COL Applicability	Comments	Section
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 2	Conforms	Applicable	The onsite DC power systems conform to GDC 2 to the extent described in Section 8.3.2.2.2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 4	Conforms	Applicable	The onsite DC power systems conform to GDC 4 to the extent described in Section 8.3.2.2.2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 5	Conforms	Applicable	The onsite DC power systems conform to GDC 5 to the extent described in Section 8.3.2.2.2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 17	Departure	Departure	The NuScale design supports an exemption from GDC 17 that includes the associated requirements for the onsite DC power systems.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 18	Departure	Departure	The NuScale design supports an exemption from GDC 18 that includes the associated requirements for the onsite DC power systems.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 33	Departure	Departure	The NuScale design supports an exemption from GDC 33.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 34, 35, 38, 41, and 44	Departure	Departure	Nuscale complies with a set of principal design criteria in lieu of these GDC.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II (No Number)	Compliance with GDC 50	Conforms	Applicable	~~The DC electrical power system circuits do not penetrate the containment vessels. Therefore conformance with GDC 50 is not necessary.~~The electrical design requirements associated with GDC 50 for electrical penetration assemblies (EPAs) are included in Section 8.3.	~~8.3.2~~8.1 8.3
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.1	Conformance with RG 1.32	Partially Conforms	Applicable	See RG 1.32 in Table 1.9-2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.2	Conformance with RG 1.75	Conforms	Applicable	See RG 1.75 in Table 1.9-2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.3	Conformance with RG 1.81	Partially Conforms	Applicable	See RG 1.81 in Table 1.9-2.	8.3.2

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standard (DSRS) (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	COL Applicability	Comments	Section
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.4	Conformance with RG 1.118	Partially Conforms	Applicable	See RG 1.118 in Table 1.9-2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.5	Conformance with RG 1.153	Conforms	Applicable	See RG 1.153 in Table 1.9-2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.6	Conformance with RG 1.153	Conforms	Applicable	See RG 1.153 in Table 1.9-2.	8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.7	Conformance with RG 1.63	~~Not Applicable~~Partially Conforms	~~Not~~ Applicable	See RG 1.63 in Table 1.9-2.	8.1~~.4~~ 8.3.2
NSDSRS 8.3.2, Rev 0: DC Power Systems (Onsite)	II.8	Conformance with RG 1.160	Not Applicable	Applicable	RG 1.160 provides guidance for implementing the maintenance rule requirements of 10 CFR 50.65. As indicated in Section 17.6, the development of the maintenance rule (10 CFR 50.65) program - including the identification of SSC that require assessment per 10 CFR 50.65(a)(4) - is the responsibility of the COL applicant referencing the certified design.	8.3.2
NSDSRS 8.4, Rev 0: Station Blackout	II.1	Compliance with 10 CFR 50.63 and the guidelines of RG 1.155	Partially Conforms	Applicable	The details regarding conformance with 10 CFR 50.63 and the guidelines of RG 1.155 as they pertain to passive designs are described in Section 8.4, Station Blackout.	8.4
NSDSRS 8.4, Rev 0: Station Blackout	II.2	Use of Alternate AC Power Sources and RTNSS for Plants of Passive Design	Partially Conforms	Applicable	As described in Section 8.4, all safety-related functions can be performed without reliance on AC power for 72 hours after an SBO event, and as described in Section 19.3 a RTNSS process has been implemented. Consequently, the Alternate AC Power Source is not applicable to the NuScale design.	8.4 19.3

3.1.5 Reactor Containment

3.1.5.1 Criterion 50-Containment Design Basis

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 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 calculation model and input parameters.

Implementation in the NuScale Power Plant Design

The CNV is designed to provide a final barrier against release of fission products while accommodating the calculated pressures and temperatures resulting from any design basis LOCA with sufficient margin such that the design leak rates are not exceeded. The CNV design also takes into consideration the pressures and temperatures associated with combustible gas deflagration. The design includes no internal sub-compartments to eliminate the potential for collection of combustible gases and differential pressures resulting from postulated high-energy pipe breaks within containment.

Conformance or Exception

The NuScale Power Plant design conforms to GDC 50.

Relevant FSAR Chapters and Sections

For further discussion, see the following sections:

Section 3.8.2 Steel Containment

Section 6.2 Containment Systems

RAI 08.01-1, RAI 08.01-1S1

Section 8.3 Containment Electrical Penetration Assemblies

3.1.5.2 Criterion 51-Fracture Prevention of Containment Pressure Boundary

The reactor containment boundary shall be designed with sufficient margin to assure that under operating, maintenance, testing, and postulated accident conditions (1) its ferritic materials behave in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the containment boundary material during

- 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.

RAI 08.01-1S1

3.8.2.1.6 ~~Electrical Penetrations~~Containment Electrical Penetration Assemblies

RAI 08.01-1S1

The CNV has multiple electrical penetrations on the top head. The electrical penetration assembly (EPA) 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~~EPAs ~~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 assemblyEPA 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 08.01-1S1

EPA design, construction, testing, qualification, and installation are in accordance with IEEE Standard 317-1983 as endorsed by Regulatory Guide 1.63. Production and installation testing meet IEEE Standard 317-1983 criteria. This ensures that EPA mechanical integrity is maintained during normal and accident events, which may also include the electrical faulting of a conductor within that EPA. The electrical design and environmental qualification requirements for EPAs are addressed in Section 8.3 and Section 3.11, respectively.

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.

3.8.2.8 References

3.8.2-1 NUREG/CR-6909, "Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials," Draft Report for Comment

3.8.2-2 NUREG/CR 6906, "Containment Integrity Research at Sandia National Laboratories - An Overview," July 2006

RAI 03.09.03-1

3.8.2-3 ~~NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36," July 1980~~ANSI N14.6-1993 "for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More"

3.8.2-4 NuScale Technical Report TR-0716-50424-P, Rev 0, “Combustible Gas Control”

3.8.2-5 ANSYS Computer Program, Release 15.0, October 2013. ANSYS Incorporated, Canonsburg, Pennsylvania

RAI 08.01-1S1

3.8.2-6 IEEE Std. 317-1983, Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generation Stations

RAI 06.02.04-2, RAI 08.01-1S1

Table 3.11-1: List of Environmentally Qualified Electrical/I&C and Mechanical Equipment Located in Harsh Environments

Description(6)	Location(1)	EQ Environment	Qualification Program	PAM(2)	EQ Category(3)	Operating Time
Nuclear Power Module	-					
Containment System (CNT-A013)	-					
I&C ~~Div I Nozzle~~Division I Electrical Penetration Assembly (EPA)	EQ Zone F EQ Zone G	Harsh	Electrical Mechanical	C	A	Extended PAM (100 days)
I&C ~~Div II Nozzle~~Division II Electrical Penetration Assembly (EPA)	EQ Zone F EQ Zone G	Harsh	Electrical Mechanical	C	A	Extended PAM (100 days)
~~PZR Heater Power #1 Nozzle~~PZR Heater Power #1 Nozzle Electrical Penetration Assembly (EPA)	EQ Zone F ~~DCA~~ EQ Zone G	Harsh	Electrical Mechanical	N/A	A	Extended Term (<= 720 hr)
~~PZR Heater Power #2 Nozzle~~PZR Heater Power #2 Nozzle Electrical Penetration Assembly (EPA)	EQ Zone F ~~DCA~~ EQ Zone G	Harsh	Electrical Mechanical	N/A	A	Extended Term (<= 720 hr)
~~I&C Channel A Nozzle~~I&C Channel A Electrical Penetration Assembly (EPA)	EQ Zone F ~~DCA~~ EQ Zone G	Harsh	Electrical Mechanical	C	A	Extended PAM (100 days)
~~I&C Channel B Nozzle~~I&C Channel B Electrical Penetration Assembly (EPA)	EQ Zone F ~~DCA~~ EQ Zone G	Harsh	Electrical Mechanical	C	A	Extended PAM (100 days)
~~I&C Channel C Nozzle~~I&C Channel C Electrical Penetration Assembly (EPA)	EQ Zone F ~~DCA~~ EQ Zone G	Harsh	Electrical Mechanical	C	A	Extended PAM (100 days)
~~I&C Channel D Nozzle~~I&C Channel D Electrical Penetration Assembly (EPA)	EQ Zone F EQ Zone G	Harsh	Electrical Mechanical	C	A	Extended PAM (100 days)
CRD Power Nozzle Electrical Penetration Assembly (EPA)	EQ Zone F EQ Zone G	Harsh	Electrical Mechanical	N/A	A	Extended Term (<= 720 hr)
RPI Group #1 ~~Nozzle~~Electrical Penetration Assembly (EPA)	EQ Zone F EQ Zone G	Harsh	Electrical Mechanical	N/A	A	Extended Term (<= 720 hr)

Table 3.11-1: List of Environmentally Qualified Electrical/I&C and Mechanical Equipment Located in Harsh Environments (Continued)

Description(6)	Location(1)	EQ Environment	Qualification Program	PAM(2)	EQ Category(3)	Operating Time
RPI Group #2 ~~Nozzle~~Electrical Penetration Assembly (EPA)	EQ Zone F EQ Zone G	Harsh	Electrical Mechanical	N/A	A	Extended Term (<= 720 hr)
MS #1 CIV (MSIV #1)	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
MS #2 CIV (MSIV #2)	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
MS line #1 Bypass Valve (MSIV Bypass #1)	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
MS line #2 Bypass Valve (MSIV Bypass #2)	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
FW #1 CIV (FWIV #1)	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
FW #2 CIV (FWIV #2)	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
FW line #1 Check Valve	EQ Zone G	Harsh	Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
FW line #2 Check Valve	EQ Zone G	Harsh	Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
CVC Discharge CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
CVC Injection CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
CVC PZR Spray CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
RPV High Point Degas CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
RCCW Supply CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
RCCW Return CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
CE CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)
CFDS CIV	EQ Zone G	Harsh	Electrical Mechanical	N/A	A B	Short Term (<= 1 hr) Extended Term (<= 720 hr)

Table 3.11-1: List of Environmentally Qualified Electrical/I&C and Mechanical Equipment Located in Harsh Environments (Continued)

Description(6)	Location(1)	EQ Environment	Qualification Program	PAM(2)	EQ Category(3)	Operating Time
Reactor Building Crane	EQ Zone H	Harsh	Electrical Mechanical	N/A	B	Extended Term (<= 720 hr)

Notes:

1. Environmental Zone Locations are delineated in Table 3.11-2.
2. PAM Type Variables:
   - Type B: those variables that provide information to indicate whether plant design functions related to safety are being accomplished.
   - Type C: those variables to be monitored to provide information to indicate whether the primary reactor containment, the fuel cladding, or the reactor coolant pressure boundary remain intact and do not have a potential to be breached.
   - Type D: those variables that provide information to indicate the operation of individual safety systems and other systems that perform design functions related to safety. These variables are to help the operator make appropriate decisions in using the individual systems performing design functions related to safety in mitigating the consequences of an accident.
   - For PAM variables that are assigned multiple types (e.g., B, C, D), the indicated type reflects the type that results in the longest operating time requirement.
3. EQ Categories:
   - A Equipment that will experience the environmental conditions of design basis accidents for which it must function to mitigate said accidents, and that will be qualified to demonstrate operability in the accident environment for the time required for accident mitigation with safety margin to failure.
   - B Equipment that will experience the environmental conditions of design basis accidents through which it need not function for mitigation of said accidents, but through which it must not fail in a manner detrimental to plant safety or accident mitigation, and that will be qualified to demonstrate the capability to withstand the accident environment for the time during which it must not fail with safety margin to failure.
4. This listing is based on a single module evaluation and does not consider multi-module interactions because the secondary module(s) effects that may be created by the primary module affected are enveloped by their own qualifications.
5. Refer to Section 6.2.4 for information regarding subcomponents on the hydraulic skid.
6. All commodities will be qualified for the environmental conditions they will be subjected to. Examples of commodity items that may be subject to environmental qualification includes, but are not limited to, equipment items such as cables, connectors, electrical splices, conduit seals, thread sealants, terminal blocks, or lubricants.

power (via inverters) after a loss of power to the battery chargers, after which the on-site standby power sources restore AC power to the EDNS battery chargers.

The EHVS is designed as a non-Class 1E system whose functions are nonsafety-related and not risk-significant. The EHVS is designed with the capability for the EHVS buses to be connected, through the switchyard, to any onsite main generator for operation in island mode. The EHVS equipment is physically separated from any safety related circuits and is not located near safety-related components.

The EMVS is designed as a non-Class 1E system whose functions are nonsafety-related and not risk-significant. The EMVS circuits are physically separated from safety circuits throughout the plant and EMVS equipment is not located near safety-related components.

The ELVS is designed as a non-Class 1E system whose functions are nonsafety-related and not risk-significant.The ELVS design includes upstream fault protection to the pressurizer heater circuits.

The BPSS is designed to provide electrical power to the NuScale Power Plant when AC power is not available. The BPSS is a non-Class 1E system whose functions are non-safety related and not risk-significant. The AAPS and the BDGs are designed to automatically start on a loss of 13.8 kV bus voltage and to be manually connected to provide backup AC power to the affected loads.

8.1.4.3 Regulatory Requirements and Guidance

Table 8.1-1 summarizes the extent to which Nuclear Regulatory Commission (NRC) requirements and guidance relevant to electrical systems are applied in the design of NuScale electrical systems. Conformance with NRC requirements and guidance also is summarized in Section 1.9 and Section 3.1. In general, electrical systems are designed in accordance with the requirements and guidance with exceptions or clarifications noted below:

- The design of the NuScale offsite, onsite AC, and onsite DC electrical systems conforms to GDC 2, GDC 4, and GDC 5 to the extent described in Section 8.2, Section 8.3.1, and Section 8.3.2. As described in Section 3.1, the NuScale design supports an exemption from GDC 17, GDC 18, and GDC 33.
- The plant design complies with a set of principal design criteria in lieu of GDC 34, 35, 38, 41, and 44, as described in Section 3.1.4. The principal design criteria do not include requirements for electric power systems.

RAI 08.01-1, RAI 08.01-1S1

- ~~The AC and DC electrical power system circuits do not penetrate the containment vessels; therefore, conformance with GDC 50 is not necessary. Components requiring power inside containment are part of the instrumentation and controls systems. See Section 8.3 for details. Conformance to GDC 50 for penetrations is described in Section 3.1.5.1.~~The electrical penetration assembly (EPA) design conforms to GDC 50. Section 8.3.1.2.5 addresses the EPA electrical design

requirements. Sections 3.8.2 and 6.2.1 address the mechanical integrity requirements of GDC 50.

RAI 08.03.02-1

- ~~The design of the NuScale AC and DC electrical systems conforms to 10 CFR 50.34(f)(2)(v) (TMI Item I.D.3) to the extent described in Section 8.3.1 and Section 8.3.2.~~
- The NuScale design does not rely on pressurizer heaters to establish and maintain natural circulation in shutdown conditions. Accordingly, the NuScale design supports an exemption from the 10 CFR 50.34(f)(2)(xiii) (TMI Item II.E.3.1) requirement to provide pressurizer heater power supply and associated motive and control power interfaces to establish and maintain natural circulation in shutdown conditions.
- The NuScale design does not include pressurizer relief valves or pressurizer relief block valves. Therefore, 10 CFR 50.34(f)(2)(xx) (TMI Item II.G.1) requirements to provide emergency power sources and qualified motive and control power connections for such valves are not technically relevant to the NuScale design. The NuScale design supports an exemption from the portions of the rule which require vital power buses for pressurizer level indicators.
- The extent to which the design of NuScale electrical systems conforms to 10 CFR 50.55a(h) is described in Section 8.3.1 and Section 8.3.2.
- The NuScale Power Plant design conforms to the requirements of 10 CFR 50.63 for a light water reactor to have the capability to withstand an SBO for a specified duration and recover from an SBO as defined in 10 CFR 50.2. Additional details regarding conformance with 10 CFR 50.63 are described in Section 8.4.
- The 10 CFR 50.65(a)(4) assessment is applied to NuScale electrical system SSC that (1) are determined to meet the 10 CFR 50.65(b) criteria, and (2) a risk-informed evaluation process has shown to be significant to public health and safety. Section 17.6 describes the maintenance rule (10 CFR 50.65) program.

RAI 08.03.02-1

- ~~NUREG-0718, Revision 1, includes guidance related to TMI Item I.D.3 (codified in 10 CFR 50.34(f)(2)(v)), TMI Item II.E.3.1 (codified in 10 CFR 50.34(f)(2)(xiii)), and TMI Item II.G.1 (codified in 10 CFR 50.34(f)(2)(xx)). The design of the NuScale AC and DC electrical systems conforms to TMI Item I.D.3 to the extent described in Section 8.3.1 and Section 8.3.2.~~
- NUREG-0737 includes guidance related to TMI Item II.E.3.1 (codified in 10 CFR 50.34(f)(2)(xiii)), and TMI Item II.G.1 (codified in 10 CFR 50.34(f)(2)(xx)). As described above for 10 CFR 50.34(f)(2), the NuScale design supports exemptions from these regulations.
- Portions of NUREG/CR-0660 relevant to the NuScale electrical systems are considered as reference only, consistent with NuScale DSRS Section 8.1. Conformance with TMI items, including those addressed in this NUREG, is described in Section 1.9.
- SECY-90-016 pertains to evolutionary advanced light water reactor (ALWR) designs and is not directly applicable to passive plant designs. As a passive ALWR design,

RAI 08.01-1, RAI 08.01-1S1, RAI 08.02-2, RAI 08.02-4, RAI 08.02-6, RAI 08.02-8, RAI 08.03.02-1

Table 8.1-1: Acceptance Criteria and Guidelines for Electric Power Systems

Criteria	Title	Applicable Section (Note 1)				Remarks
		8.2 Offsite Power System	8.3.1 Onsite AC Power System	8.3.2 Onsite DC Power System	8.4 Station Blackout	
1. 10 CFR 50, Appendix A, General Design Criteria for Nuclear Plants						
a. GDC 2	Design bases for protection against natural phenomena		A	A		§8.2 - ADAMS Accession No. ML090260039
b. GDC 4	Environmental and dynamic effects design bases		A	A		§8.2 - ADAMS Accession No. ML090260039
c. GDC 5	Sharing of structures, systems, and components		A	A		§8.2 - ADAMS Accession Nos. ML11133A334 and ML090260039
d. GDC 17	Electric power systems					The NuScale design supports an exemption from GDC 17.
e. GDC 18	Inspection and testing of electric power systems					The NuScale design supports an exemption from GDC 18.
f. GDC 33	Reactor coolant makeup					The NuScale design supports an exemption from GDC 33.
g. GDCs 34, 35, 38, 41, 44	Residual heat removal, emergency core cooling, containment heat removal, containment atmosphere cleanup, cooling water					The plant design complies with a set of principal design in lieu of these GDC, as described in Section 3.1.4.
h. GDC 50	Containment design basis		A	A		~~Containment vessel penetration assemblies are not included in the scope of the onsite electrical power system.~~ ~~Penetration assemblies are part of the containment design.~~The electrical design requirements for electrical penetration assemblies are included in Section 8.3.1.
2. Regulations (10 CFR 50 and 10 CFR 52)						
a. 10 CFR 50.34	Contents of applications; technical information					

Table 8.1-1: Acceptance Criteria and Guidelines for Electric Power Systems (Continued)

Criteria	Title	Applicable Section (Note 1)				Remarks
		8.2 Offsite Power System	8.3.1 Onsite AC Power System	8.3.2 Onsite DC Power System	8.4 Station Blackout	
c. Regulatory Guide 1.47 - Revision 1, February 2010	Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems		~~G~~	~~G~~		~~As it relates to the EDSS; see Section 8.3.2~~This guidance does not apply to the NuScale electric power systems, which are not safety-related.
d. Regulatory Guide 1.53 - Revision 2, November 2003	Application of the Single-Failure Criterion to Safety Systems		G	G		As it relates to the EDSS; see Section 8.3.2
e. Regulatory Guide 1.63 - Revision 3, February 1987	Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants		G	G		The electrical design requirements for electrical penetration assemblies (EPAs) with respect to RG 1.63 are included in Section 8.3.
f. Regulatory Guide 1.68 - Revision 4, June 2013	Initial Test Programs for water-Cooled Nuclear Power Plants	G	G	G		As it relates to the EDSS; see Section 8.3.2. See Section 8.2 as it relates to the offsite power system.
g. Regulatory Guide 1.75 - Revision 3, February 2005	Criteria for Independence of Electrical Safety Systems		G	G		As it relates to the EDSS; see Section 8.3.2
h. Regulatory Guide 1.81 - Revision 1, January 1975	Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants		G	G		No sharing of EDSS-MS, sharing of EDSS-C meets the intent of the guidance; see Section 8.3.2
i. Regulatory Guide 1.106 - Revision 2, February 2012	Thermal Overload Protection for Electric Motors on Motor-Operated Valves					Not applicable; no safety-related MOVs
j. Regulatory Guide 1.118 - Revision 3, April 1995	Periodic Testing of Electric Power and Protection Systems		G	G		As it relates to the EDSS; see Section 8.3.2
k. Regulatory Guide 1.128 Revision 2, February 2007	Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants			G		Applicability as described in Reference 8.3-1 and Section 8.3.2
l. Regulatory Guide 1.129 - Revision 3, September 2013	Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants			G		Applicability as described in Reference 8.3-1 and SSection 8.3.2
m. Regulatory Guide 1.153 - Revision 1, June 1996	Criteria for Safety Systems		G	G		§8.3.2 - Applies to EDSS to the extent described in Reference 8.3-1

COL Item 8.3-3: A COL applicant that references the NuScale Power Plant design certification will describe the design of the site-specific plant grounding grid and lightning protection network.

The neutral points of the main generators, MPTs, UATs, SSTs, BDGs, and AAPS are connected to the plant grounding grid. The MPTs are solidly grounded on the primary side of the transformer. The UAT secondary winding neutrals are low-resistance grounded through a neutral grounding resistor. The secondary winding neutrals of the SSTs are high-resistance grounded through a neutral grounding resistor. The neutrals of the turbine generators, BDGs, and AAPS are connected to ground in accordance with vendor requirements.

Equipment ground connections are established by bonding equipment enclosures, raceways, metal structures, metallic tanks, and the ground bus of switchgear assemblies, load centers, MCCs, switchboards, panelboards, and control cabinets to the plant grounding grid.

The instrument and computer grounding network provides plant I&C and computer grounding through separate radial grounding systems consisting of isolated instrumentation ground buses and insulated cables. The radial grounding systems are connected to the plant grounding grid at one point only and are insulated from other grounding circuits.

Lightning protection for the plant is accomplished by providing a low-impedance path for the lightning stroke to discharge to the earth directly. The lightning protection network consists of air terminals, interconnecting cables, and downcomers connected directly to the plant ground. The lightning arresters are connected directly to ground in order to provide a low-impedance path to ground for the surges caused or induced by lightning. Surge arrestors are provided to protect the MPTs, UATs, and EMVS switchgear from lightning surges to avoid fire or damage to the plant from a lightning strike.

RAI 08.01-1, RAI 08.01-1S1

8.3.1.2.5 Containment ~~Vessel~~ Electrical Penetration~~s~~ Assemblies

RAI 08.01-1, RAI 08.01-1S1

~~The containment electrical penetrations are a part of the containment system. See Section 6.2.1 for discussion of containment penetrations.~~The NuScale design of electrical penetration assemblies (EPAs) conforms to GDC 50. This section describes the electrical design requirements for EPAs as they relate to compliance with GDC 50. The NuScale containment system, including EPAs, can accommodate the calculated pressure and temperature conditions resulting from a LOCA in accordance with GDC 50 as described in Section 6.2.1. The mechanical design requirements for EPAs are described in Section 3.8.2. The environmental qualification requirements for EPAs are described in Section 3.11.2.

RAI 08.01-1, RAI 08.01-1S1

The electrical penetration assemblies are designed in accordance with IEEE Standard 317-1983 (Reference 8.3-25) as endorsed by RG 1.63. EPAs are designed to withstand the maximum available fault and overload currents for the time sufficient for operation of backup protective devices in case of failure of the primary protective devices. The EPAs are provided with external circuit protection per Section 5.4 of IEEE Standard 741-1997 (Reference 8.3-26), which is consistent with the 1986 version endorsed by RG 1.63, and per IEEE Standard 242-2001 (Reference 8.3-4) with the following clarifications. Coordinated primary and backup protective devices are provided for circuits that are not self-limiting. Self-limiting circuits are not subject to energy levels that could damage the EPA. Primary and backup protective devices that protect non-Class 1E circuits are non-Class 1E. CNV 17, 18, 19, 20, which are listed in Table 6.2-4, Containment Penetrations, contain Class 1E circuits and are therefore designated Class 1E EPAs.

RAI 08.01-1

As described in Section 7.1.2, divisional separation for Class 1E circuits is in accordance with IEEE 384-1992 (Reference 8.3-16), which is endorsed by RG 1.75 Revision 3.

8.3.1.2.6 Electrical Equipment Subject to Wetting or Submergence

The onsite AC power system circuits are not routed through the CNVs. Therefore, they are not subjected to wetting or submergence when the CNV contains water or steam.

None of the AC power system power cables provide power to equipment that performs a safety-related function. A loss of, or degraded condition on, the AC power system, including those due to environmental conditions, such as wetted conditions or submergence, would not adversely affect the functionality of accident mitigation systems or nuclear safety.

8.3.1.2.7 Onsite Alternating Current Power System Conformance with Regulatory Framework

This section describes the extent to which the design of the main onsite AC power system, including the EHVS, the EMVS, the ELVS, and the BPSS, conforms to Nuclear Regulatory Commission (NRC) requirements and guidance. As such, the information in this section provides clarification for the associated entries in Table 8.1-1 of Section 8.1.

The applicability of NRC requirements and guidance to DC power systems, including the EDNS and its AC electrical equipment powered by inverters, and the EDSS, is described in Section 8.3.2.2.2.

General Design Criterion 2

The onsite AC power system does not contain any SSC that are required to function in the event of natural phenomena. Nonsafety-related SSC with the potential for adverse seismic interaction with Seismic Category I SSC are designed to Seismic

RAI 08.01-1S1

Table 14.3-1: Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference

ITAAC No.	System	Discussion	DBA	Internal/External Hazard	Radiological	PRA & Severe Accident	FP
02.01.01	NPM	As required by ASME Code Section III NCA-1210, each ASME Code Class 1, 2 and 3 component (including piping systems) of a nuclear power plant requires a Design Report in accordance with NCA-3550. NCA-3551.1 requires that the drawings used for construction be in agreement with the Design Report before it is certified and be identified and described in the Design Report. It is the responsibility of the N Certificate Holder to furnish a Design Report for each component and support, except as provided in NCA-3551.2 and NCA-3551.3. NCA-3551.1 also requires that the Design Report be certified by a registered professional engineer when it is for Class 1 components and supports, Class CS core support structures, Class MC vessels and supports, Class 2 vessels designed to NC-3200 (NC-3131.1), or Class 2 or Class 3 components designed to Service Loadings greater than Design Loadings. A Class 2 Design Report shall be prepared for Class 1 piping NPS 1 or smaller that is designed in accordance with the rules of Subsection NC. NCA-3554 requires that any modification of any document used for construction, from the corresponding document used for design analysis, shall be reconciled with the Design Report. An ITAAC inspection is performed of the NuScale Power Module ASME Code Class 1, 2 and 3 as-built piping system Design Report to verify that the requirements of ASME Code Section III are met.	X				

Table 14.3-1: Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference (Continued)

ITAAC No.	System	Discussion	DBA	Internal/External Hazard	Radiological	PRA & Severe Accident	FP
02.08.09	EQ	Section 3.11, Environmental Qualification of Mechanical and Electrical Equipment, presents information to demonstrate that the CNTS electrical penetration assemblies, including its connection assemblies, located in a harsh environment are qualified by type test or a combination of type test and analysis to perform its safety-related function under design basis harsh environmental conditions, experienced during normal operations, anticipated operational occurrences, DBAs, and post-accident conditions in accordance with 10 CFR 50.49. As defined in IEEE-Std-572-2006, IEEE Standard for Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations, a connection assembly is any connector or termination combined with related cables or wires as an assembly. The qualification method employed for the equipment is the same as the qualification method described for that type of equipment in Section 3.11. The ITAAC verifies that: (1) an equipment qualification record form exists for the CNTS electrical penetration assemblies listed in Tier 1 Table 2.8-1and addresses connection assemblies, (2) the equipment qualification record form concludes that the CNTS electrical penetration assemblies, including its connection assemblies, performs its safety-related function under the environmental conditions specified in Section 3.11 and the equipment qualification record form, and (3) the required post-accident operability time for the CNTS electrical penetration assemblies in the equipment qualification record form is in agreement with Section 3.11. After installation in the plant, an ITAAC inspection is performed to verify that the CNTS electrical penetration assemblies listed in Tier 1 Table 2.8-1, including its connection assemblies, is installed in its design location in a configuration bounded by the equipment qualification record form.	X				