RAIO-0717-55011

July 19, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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Rockville, MD 20852-2738

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

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 27 (eRAI No. 8788)," dated May 22, 2017

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

The Enclosure to this letter contains NuScale's response to the following RAI Question from NRC eRAI No. 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
Director, Regulatory Affairs
NuScale Power, LLC

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8788

Enclosure 1:

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

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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:

The containment electrical penetration assembly (EPA) design conforms to GDC 50. In the NuScale design, the EPAs are included in the scope of the containment system. Specifically, the capability of EPAs in containment structures to withstand a loss-of-coolant accident (LOCA) without loss of mechanical integrity in accordance with GDC 50 is part of the containment system design.

The associated FSAR sections were revised to add detail and clarify how the GDC 50 requirements for EPAs are met. FSAR Section 8.3.1.2.5, Electrical Penetration Assemblies, was revised to address the EPA electrical design requirements. FSAR Section 6.2.1.1 was revised to address mechanical integrity requirements. Conforming changes to FSAR Chapter 8 and other FSAR sections that address EPA design were made to describe compliance with GDC 50.

The responses to the four RAI questions are provided below.

Question 1 Response

The containment EPAs conform to GDC 50 as described above and in the revised FSAR sections included in this response.

Question 2 Response

There are two power supply circuits that contain EPAs: Pressurizer Heater Power (CNV15 and CNV16) and CRDM Power (CNV37). Both of these circuits are non-Class 1E. See FSAR Table 6.2-4, Containment Penetrations.

Question 3 Response

There are no safety-related low voltage power circuits (e.g. 480 Vac, 120 Vac, 125 Vdc, 250 Vdc) and no safety-related signal and control power circuits (e.g. 120 Vac, 125 Vdc, 250 Vdc) that penetrate the containment. The cables for Class 1E instrumentation circuits are divisionally routed by separation group through EPAs (CNV17, CNV18, CNV19, CNV20). The applicable circuits are listed below.

Narrow Range RCS Hot Temperature

Wide Range RCS Hot Temperature

Wide Range RCS Cold Temperature

RCS Flow

Pressurizer Pressure

Wide Range RCS Pressure

Pressurizer and RPV Riser Level

Narrow Range Containment Pressure

Containment Water Level

Question 4 Response

All containment EPAs meet the requirements of GDC 50 as described above and in the revised FSAR sections included in this response.

In the course of responding to this question, Nuscale identified a change to Tier 1 Table 2.1-3, NuScale Power Module Electrical Equipment. An evaluation of reactor pressure vessel penetrations RPV 39, 40, 41 and 42 determined that these ASME mechanical components should not be classified as electrical penetrations, and Tier 1 Table 2.1-3 has been revised to delete these items.

Impact on DCA:

Tier 1 Table 2.1-3, Tier 2 FSAR Table 1.9-2, Table 1.9-3, Section 3.1.5.1, Section 6.2.1.1, Table 8.1-1, Section 8.1, and Section 8.3 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 08.01-1

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	~~<~~≤ ~~5~~7
CNTS reactor coolant system injection outboard CIV	CNT-CVC-ISV-0329	Yes	Closed	~~<~~≤ ~~5~~7
CNTS pressurizer spray inboard CIV	CNT-CVC-ISV-0325	Yes	Closed	~~<~~≤ ~~5~~7
CNTS pressurizer spray outboard CIV	CNT-CVC-ISV-0323	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor coolant system discharge inboard CIV	CNT-CVC-ISV-0334	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor coolant system discharge outboard CIV	CNT-CVC-ISV-0336	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor pressure vessel high point degasification inboard CIV	CNT-CVC-ISV-0401	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor pressure vessel high point degasification outboard CIV	CNT-CVC-ISV-0403	Yes	Closed	~~<~~≤ ~~5~~7
CNTS containment evacuation inboard CIV	CNT-CE-ISV-0101	Yes	Closed	~~<~~≤ ~~5~~7
CNTS containment evacuation outboard CIV	CNT-CE-ISV-0102	Yes	Closed	~~<~~≤ ~~5~~7
CNTS flood and drain inboard CIV	CNT-CFD-ISV-0130	Yes	Closed	~~<~~≤ ~~5~~7
CNTS flood and drain outboard CIV	CNT-CFD-ISV-0129	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor component cooling water system supply inboard CIV	CNT-RCCW-ISV-0185	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor component cooling water system supply outboard CIV	CNT-RCCW-ISV-0184	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor component cooling water system return inboard CIV	CNT-RCCW-ISV-0190	Yes	Closed	~~<~~≤ ~~5~~7
CNTS reactor component cooling water system return outboard CIV	CNT-RCCW-ISV-0191	Yes	Closed	~~<~~≤ ~~5~~7
CNTS feedwater #1 CIV	CNT-FW-ISV-1003	Yes	Closed	~~<~~≤ ~~5~~7
CNTS feedwater #2 CIV	CNT-FW-ISV-2003	Yes	Closed	~~<~~≤ ~~5~~7
CNTS main steam #1 CIV	CNT-MS-ISV-1005	Yes	Closed	~~<~~≤ ~~5~~7
CNTS main steam line #1 bypass valve CIV	CNT-MS-ISV-1006	Yes	Closed	~~< 10~~N/A (see Note 1)
CNTS main steam #2 CIV	CNT-MS-ISV-2005	Yes	Closed	~~<~~ ~~5~~7
CNTS main steam line #2 bypass valve CIV	CNT-MS-ISV-2006	Yes	Closed	~~< 10~~N/A (see Note 1)
DHRS actuation valve	DHR-HOV-1002A	Yes	Open	N/A

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-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	CNV8	N/A	N/A	N/A
CNTS instrumentation and controls division II electrical penetration	CNV9	N/A	N/A	N/A
CNTS pressurizer heater power #1electrical penetration	CNV15	N/A	N/A	N/A
CNTS pressurizer heater power #2 electrical penetration	CNV16	N/A	N/A	N/A
CNTS instrumentation and controls channel A electrical penetration	CNV17	N/A	N/A	N/A
CNTS instrumentation and controls channel B electrical penetration	CNV18	N/A	N/A	N/A
CNTS instrumentation and controls channel C electrical penetration	CNV19	N/A	N/A	N/A
CNTS instrumentation and controls channel D electrical penetration	CNV20	N/A	N/A	N/A
CNTS control rod drive system electrical penetration	CNV37	N/A	N/A	N/A
CNTS rod position indication group #1 electrical penetration	CNV38	N/A	N/A	N/A
CNTS rod position indication group #2 electrical penetration	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 08.02-4, RAI 08.02-6

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.	3.11 8.1 8.3.1
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 08.01-1, RAI 08.02-2

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 3.11, Rev. 0: Environmental Qualification of Mechanical and Electrical Equipment	II.1	Application of RG 1.89 for Environmental Qualification Program per 10 CFR 50.49	Partially Conforms	Applicable	See RG 1.89 in Table 1.9-2.	3.11
NSDSRS 3.11, Rev. 0: Environmental Qualification of Mechanical and Electrical Equipment	II.2	Application of Clarification Related to IEEE Std. 323 Criteria	Conforms	Applicable	None.	3.11
NSDSRS 3.11, Rev. 0: Environmental Qualification of Mechanical and Electrical Equipment	II.3	Application of RG 1.63 for Environmental Design and Qualification of Electrical Penetration Assemblies	~~Not Applicable~~Conforms	~~Not~~ Applicable	~~See RG 1.63 in Table 1.9-2.~~The portion of the guidance that endorses IEEE 317-1983 is applicable. See RG 1.63 entry in Table 1.9-2 with respect to the other aspects of RG 1.63.	3.11.2
NSDSRS 3.11, Rev. 0: Environmental Qualification of Mechanical and Electrical Equipment	II.4	Application of RG 1.73 for Environmental Design and Qualification of Class 1E Electric Valve Operators	Conforms	Applicable	None.	3.11.2
NSDSRS 3.11, Rev. 0: Environmental Qualification of Mechanical and Electrical Equipment	II.5	Application of RG 1.89 for Environmental Qualification of Electrical Equipment Important to Safety	Partially Conforms	Applicable	See RG 1.89 in Table 1.9-2.	3.11.2
NSDSRS 3.11, Rev. 0: Environmental Qualification of Mechanical and Electrical Equipment	II.6	Application of RG 1.97 for Environmental Design and Qualification of PostAccident Monitoring Equipment	Partially Conforms	Applicable	See RG 1.97 in Table 1.9-2.	3.11.2
NSDSRS 3.11, Rev. 0: Environmental Qualification of Mechanical and Electrical Equipment	II.7	Application of RG 1.152 for Environmental design and qualification of computer-specific requirements	Conforms	Applicable	None.	3.11

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 8.3.1.	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 8.3.1.	~~8.3.2~~8.1 8.3.1
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

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

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Section 8.3.1 Containment Electrical Penetrations

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

6.2 Containment Systems

6.2.1 Containment Functional Design

The containment is an integral part of the NuScale Power Module (NPM) and provides primary containment for the reactor coolant system (RCS). The NuScale containment system (CNTS) includes the containment vessel (CNV), CNV supports, containment isolation valves (CIVs), passive containment isolation barriers, and containment instruments. (See Figure 6.2-1)

6.2.1.1 Containment Structure

6.2.1.1.1 Design Bases

The CNV is an evacuated pressure vessel fabricated from a combination of low alloy steel and austenitic stainless steel that houses, supports, and protects the reactor pressure vessel (RPV) from external hazards and provides a barrier to the release of fission products. The CNV is maintained partially immersed in a below grade, borated-water filled, stainless steel lined, reinforced concrete pool to facilitate heat removal. The CNV is an American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Class MC (steel) containment that is designed, analyzed, fabricated, inspected, tested and stamped as an ASME Code Class 1 pressure vessel.

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~~The CNV is designed to provide a barrier against the release of fission products while accommodating the calculated pressures and temperatures resulting from postulated mass and energy release inside containment with margin such that design leakage rates are not exceeded (General Design Criterion (GDC) 50).~~The CNTS, including the CNV, CIVs, and passive isolation barriers (refer to Section 6.2.4), provide a barrier that can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any LOCA (General Design Criterion (GDC) 50). As a minimum, pressure retaining components that comprise the CNTS have a design pressure of at least 1000 psia and 550 degrees F, which bound the calculated pressure and temperature conditions for any design basis event (DBE). In concert with the containment isolation valves (CIVs) and passive containment isolation barriers (discussed in Section 6.2.4), the CNV serves as a final barrier to the release of radioactivity and radiological contaminants to the environment (GDC 16).

The CNV design specifications also take into consideration the pressures and temperatures associated with combustible gas deflagration. The CNV design includes no internal sub-compartments which eliminates the potential for collection of combustible gases and differential pressures resulting from postulated high-energy pipe breaks within containment.

The CNV is designed to withstand the full spectrum of primary and secondary system mass and energy releases (loss-of-coolant accident (LOCA), valve opening events and non-LOCA) while considering the worst case single active failure and

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.

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- ~~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. Section 6.2.1 addresses the mechanical integrity requirements of GDC 50.

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					
i. 10 CFR 50.34(f)(2)(v)	Additional Three Mile Island (TMI)-related requirements (Item I.D.3)		A	A		

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	
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 8.3.1.
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
n. Regulatory Guide 1.155 - August 1988	Station Blackout		G	G	G	Limited to portions relevant to passive plant designs; see Section 8.4.2
o. Regulatory Guide 1.160 - Revision 3, May 2012	Monitoring the Effectiveness of Maintenance at Nuclear Power Plants		G	G		

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.

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8.3.1.2.5 Containment ~~Vessel~~ Electrical Penetrations

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~~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 capability of EPAs to withstand a loss-of-coolant accident (LOCA) without loss of mechanical integrity in accordance with GDC 50 is addressed in Section 6.2.1.

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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.

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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.

General Design Criterion 17

The NuScale design supports an exemption from GDC 17. The NuScale Power Plant is designed with passive safety-related systems for safe shutdown, core and spent fuel assembly cooling, containment isolation and integrity, and reactor coolant pressure boundary (RCPB) integrity. Electrical power is not relied upon to meet specified acceptable fuel design limits nor to protect the RCPB as a result of anticipated operational occurrences or postulated accidents.

Although not relied on to ensure plant safety-related functions are achieved, the onsite electric AC power systems are designed with reliability considerations, including independence, redundancy, and testability. The onsite AC electrical systems are classified as non-Class1E.

General Design Criterion 18

As described above, the NuScale design supports an exemption from the GDC 17 requirements. Accordingly, the NuScale design supports an exemption from the GDC 18 inspection and testing requirements.

General Design Criterion 33

The NuScale design supports an exemption from GDC 33, as described in Section 3.1.4.

General Design Criteria 34, 35, 38, 41, and 44

The plant design complies with a set of principal design criteria in lieu of these GDC, as described in Section 3.1.4. The principal design criteria do not include requirements for electric power systems.

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General Design Criterion 50

~~The only circuits that penetrate the CNVs are I&C circuits that serve to control power to and operate safety-related and nonsafety-related equipment (e.g., sensors, execute devices, etc.) associated with each NPM as described in Section 7.0.4. There are no on site AC electrical power system cables that penetrate the CNVs.~~The electrical design requirements for electrical penetration assemblies (EPAs) comply with GDC 50 as described in Section 8.3.1.2.5.

10 CFR 50.34(f)(2)(v)

The bypass and inoperable status indications provided for safety systems and conformance with 10 CFR 50.34(f)(2)(v) and RG 1.47, Rev. 1 are further described in Section 7.2.4. General conformance to 10 CFR 50.34(f)(2)(v) is described in Section 1.9.

The NuScale Power Plant design uses passive safety systems that do not require AC electric power to fulfill safety-related functions and the onsite electric AC power systems are nonsafety-related. Therefore, RG 1.32 is not applicable.

Regulatory Guide 1.47, Rev. 1

The onsite AC power system conforms to RG 1.47 to the extent described in the discussion of conformance to 10 CFR 50.34(f)(2)(v) above.

Regulatory Guide 1.53, Rev. 2

The onsite electric AC power systems do not perform any safety-related functions. Therefore, application of the single-failure criterion to these systems is not required.

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Regulatory Guide 1.63, Rev. 3

~~Details regarding conformance with GDC 50 and RG 1.63 are provided in Section 8.1.4.3 and in the discussion of conformance with GDC 50 above.~~The electrical design requirements for electrical penetration assemblies (EPAs) satisfy RG 1.63 as described in Section 8.3.1.2.5.

Regulatory Guide 1.68, Rev. 4

Regulatory Guide 1.68 is implemented using a graded approach to testing in order to provide reasonable assurance, considering the importance to safety of the item, that the item performs satisfactorily while, at the same time, accomplishing the testing in a cost-effective manner. Preoperational testing of the onsite AC electrical system is performed as part of the initial test program described in Section 14.2.12.

Regulatory Guide 1.75, Rev. 3

The onsite electric AC power systems do not perform any safety-related functions and do not contain any Class 1E circuits. However, the RG 1.75 requirements are implemented for these non-safety AC power system circuits by requiring physical separation from safety circuits throughout the plant. This criterion forms the basis for the design, routing, and modeling of electrical cable trays and raceways.

Regulatory Guide 1.81, Rev. 1

With respect to the sharing of AC electrical systems, RG 1.81 applies to multi-unit plants that require emergency AC power for safe shutdown supplied by diesel generators. The NuScale Power Plant does not require electrical power (or operator action) to ensure safe shutdown for a DBE, assuming a single failure and loss of offsite power, for a minimum of 72 hours. Thus, consistent with the Commission policy for passive advanced light water reactor designs, onsite emergency (Class1E) diesel generators are not used in the NuScale Power Plant. Based on the above, RG 1.81 is not relevant to the NuScale AC power systems design.

The NuScale design supports an exemption from GDC 33, as described in Section 3.1.4.

GDC 34, 35, 38, 41 and 44

The plant design complies with a set of principal design criteria in lieu of these GDC, as described in Section 3.1.4. The principal design criteria do not include requirements for electric power systems.

RAI 08.01-1

GDC 50

~~The only circuits that penetrate the CNVs are not within the scope of the NuScale plant electrical systems. These circuits are described in Section 7.0.4 for the I&C systems.~~

~~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 Section 6.2.1.~~The electrical design requirements for electrical penetration assemblies (EPAs) comply with GDC 50 as described in Section 8.3.1.2.5.

10 CFR 50.34(f)(2)(v)

Bypassed or deliberately induced inoperability of the EDSS and EDNS batteries and battery chargers is automatically annunciated in the MCR to indicate the bypassed system or component. The EDSS and EDNS alarms are discussed in Chapter 18. The bypass and inoperable status indications provided for safety systems, and conformance with 10 CFR 50.34(f)(2)(v) and RG 1.47 are further described in Section 7.2.4. General conformance to 10 CFR 50.34(f)(2)(v) is described in Section 1.9.

10 CFR 50.34(f)(2)(xiii)

As described in Section 8.1.4.3, the NuScale design supports an exemption from 10 CFR 50.34(f)(2)(xiii) (TMI Item II.E.3.1) and this requirement is not applicable to the DC systems.

10 CFR 50.34(f)(2)(xx)

As described in Section 8.1.4.3, the NuScale design supports an exemption from the portions of 10 CFR 50.34(f)(2)(xx) that require vital power buses for pressurizer level indicators. This requirement is not applicable to the DC systems.

10 CFR 50.55a(h)

The onsite electrical DC power system equipment is not a protection system and does not perform any safety-related functions. Therefore, the system is not required to conform to 10 CFR 50.55a(h) and IEEE Standard 603-1991 (Reference 8.3-19).

However, the EDSS design is augmented to conform to 10 CFR 50.55a(h) and IEEE Standard 603-1991 to the extent described in Reference 8.3-1. The conformance of the design of I&C equipment and circuits (that are not within the scope of electrical systems) to 10 CFR 50.55a(h) is shown in Table 7.0-1.

10 CFR 50.63

The NuScale Power Plant design conformance with 10 CFR 50.63 is described in Section 8.4.

10 CFR 50.65(a)(4)

The development and implementation 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 stated in Section 17.6.

10 CFR 52.47(b)(1)

See section 14.3 for the methodology related to developing the Inspections, Tests, Analyses, and Acceptance Criteria for DC systems.

Regulatory Guide 1.6 (March 1971)

The EDSS design conforms to the guidance for independence of standby power sources and their distribution systems provided in RG 1.6.

Regulatory Guide 1.32, Rev. 3

The EDSS conforms to RG 1.32 and IEEE Standard 308-2001 to the extent described in Reference 8.3-1.

Regulatory Guide 1.47, Rev. 1

The onsite DC power systems conform to RG 1.47 to the extent described in the discussion of conformance with 10 CFR 50.34(f)(2)(v) above.

Regulatory Guide 1.53, Rev. 2

The EDSS conforms to RG 1.53 and IEEE Standard 379-2000 (Reference 8.3-20) to the extent described in Reference 8.3-1.

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Regulatory Guide 1.63, Rev. 3

~~Details regarding conformance with GDC 50 and RG 1.63 is provided in Section 8.1.4.3 and in the discussion of conformance with GDC 50 above.~~The electrical design requirements for electrical penetration assemblies (EPAs) satisfy RG 1.63 as described in Section 8.3.1.2.5.

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SECY 94-084 and SECY 95-132

FSAR Section 17.4.3 describes the NuScale methodology to establish risk significance of SSC. The NuScale process for evaluating SSC against the RTNSS criteria is described in FSAR Section 19.3. This process did not identify any safety-related or risk-significant functions for the onsite DC power systems.

8.3.2.2.3 Electrical Power System Calculations and Distribution System Studies for Direct Current Systems

The following subsections describe the calculations and studies that were developed for the DC power systems. The calculations were performed using the ETAP computer software (Reference 8.3-11).

Load-Flow and Voltage-Regulation Studies, and Undervoltage and Overvoltage Protection

The DC load-flow analyses were performed for both the EDNS and EDSS to confirm equipment assumptions and select equipment ratings. The margins for load growth were included in the analyses.

The operating voltage range for the EDSS and EDNS was determined by calculation and accommodates equalize charging the batteries at a specified low temperature. The operating voltage range for the EDSS-MS and the EDSS-C 125 Vdc batteries is 105 Vdc to 140 Vdc. The operating voltage range for the EDNS 250 Vdc batteries is 200 Vdc to 280 Vdc, and the operating range for the EDNS 125 Vdc batteries is 100 Vdc to 140 Vdc.

Short-Circuit Studies

Short-circuit analyses are performed for the EDSS-MS, EDSS-C, and the EDNS DC subsystems. These analyses are performed in accordance with IEEE Standard 946-2004 (Reference 8.3-13) methodology and the available short-circuit currents from each battery and connected charger are determined under a worst case short circuit at the battery terminals.

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~~The short-circuit current results are compared to short-circuit current acceptance criteria. Containment electrical penetration assembly overload, short-circuit current capability, and associated overcurrent protection is described in Section 8.3.1.2.5.~~

Equipment Sizing Studies

The DC equipment sizing was developed from a load list and was verified using the ETAP load-flow and short-circuit analysis results. Worst-case loading was determined and the power supply equipment was selected that enveloped the

8.3-22 Institute of Electrical and Electronics Engineers, "IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications," IEEE Standard 484-2002, reaffirmed in 2008, Piscataway, NJ.

8.3-23 Institute of Electrical and Electronics Engineers, "IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V," IEEE Standard C37.06-2009, New York, NY.

8.3-24 Institute of Electrical and Electronics Engineers, "IEEE Standard for AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current Basis - Amendment 1: Supplement for Use with Generators Rated 10-100 MVA," IEEE Standard C37.013a-2007, New York, NY. (Amendment to IEEE Std C37.013-1997).

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8.3-25 Institute of Electrical and Electronics Engineers, "IEEE Standard for Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations," IEEE Standard 317-1983, New York, NY.

RAI 08.01-1

8.3-26 Institute of Electrical and Electronics Engineers, "IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment Nuclear Power Generating Stations," IEEE Standard 741-1997, New York, NY.