8 ELECTRIC POWER

This chapter of the safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission's (NRC) staff (hereafter referred to as "the staff") review of Chapter 8, "Electric Power," of the NuScale Power, LLC (hereafter referred to as "NuScale" or "the applicant"), standard plant design certification application (DCA). This application includes the final safety analysis report (FSAR) for Section 8.1, "Introduction"; Section 8.2, "Offsite Power System"; Section 8.3.1, "Onsite Alternating Current Power Systems"; Section 8.3.2, "Direct Current Power Systems"; and Section 8.4, "Station Blackout." NuScale submitted this DCA for its small modular reactor (SMR) standard plant design.

The staff reviewed the design of the electric power systems that are necessary for the safe design and operation of the plant or whose failure might adversely affect their safety-related or in accordance with the applicable design specific review standards (DSRS) or NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), as applicable, and consistent with the graded review approach described in SER Section 1.9. SER Section 8.1.1 contains the introduction of the DCA review, and Sections 8.1, 8.2, 8.3.1, 8.3.2, and 8.4 contain the staff's technical evaluations and conclusions based on this review.

In this chapter, the staff uses the term "not safety-related" to refer to certain structures, systems and components (SSCs) that do not fall under the definition of "safety-related SSCs" described in 10 CFR 50.2. Some of the SSCs that are not safety-related are considered to be "important to safety" as that term is used in the General Design Criteria listed in Appendix A to 10 CFR Part 50. Class 1E is defined in Institute of Electrical and Electronics Engineers (IEEE) Standard (Std.) 308-2001, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations" as the safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal or that are otherwise essential in preventing significant release of radioactive material to the environment. The staff endorsed IEEE Std. 308-2001 in Regulatory Guide 1.32, "Criteria for Power Systems for Nuclear Power Plants." Furthermore, 10 CFR 50.49(b)(1) has a footnote that states that safety-related electric equipment is referred to as "Class 1E" equipment in IEEE Std. 323–1974, as endorsed in RG 1.89. RG 1.89 indicates that safety-related equipment is known as Class 1E. In this chapter, the staff refers to non-Class 1E as not safety-related.

The electric power system for the NuScale design comprises a non-Class 1E alternating current (AC or ac) power system and a non-Class 1E direct-current (DC or dc) power system. Non-Class 1E and non-risk-significant electric power systems for NuScale include a normal ac and dc power system that supply plant loads during startup and shutdown, normal operation, and off normal conditions. The NuScale design does not depend on and, therefore, does not use or include a Class 1E emergency onsite (ac or dc) power system.

The staff reviewed the non-Class 1E and non-risk-significant electric power systems 1) to verify that their failure will not prevent safe shutdown of the plant or result in an unacceptable release of radioactivity to the environment and 2) for compliance with the applicable requirements and conformance to the applicable guidance.

The SSCs are classified according to nuclear safety classification, seismic category, and quality group. DCA Part 2 Tier 2, Section 3.2, "Classification of Structures, Systems, and Components," discusses the safety and risk-significance of SSCs and provides safety and risk

categorization of SSCs for the NuScale design. Further evaluation of the classification of SSCs are described and evaluated in Section 3.2, and Section 17.4, "Reliability Assurance Program," of this SER. As discussed in Section 3.2 of this report, category "B2" designation is given to SSCs that are determined to be both not safety-related and not risk-significant. DCA Part 2 Tier 2, Table 3.2-1, "Classification of Structures, Systems, and Components," lists the classifications of SSCs. This list identifies the electrical main equipment and auxiliary systems located in various areas of the power plant (i.e., the switchyard, switchgear, batteries and chargers, backup power supplies, grounding, cathodic protection, and other such systems) as category B2. Section 3.2.2, "System Quality Group Classification" and Section 19.1, "Probabilistic Risk Assessment," of this report describe and further evaluate acceptability of the electrical systems' safety-significance and risk significance categorizations.

8.1 Electric Power - Introduction

8.1.1 Introduction

The NuScale power plant standard design is modular with 12 nuclear power modules (NPMs); passive; and has safety-related systems for safe shutdown, core and spent fuel assembly cooling, containment isolation and integrity, and reactor coolant pressure boundary (RCPB) integrity. This design does not depend on onsite or offsite ac or dc electrical power, including that from the transmission grid for safe operation. NuScale has stated in its application that the NuScale power plant design can accommodate a site location where an offsite transmission grid is not available. NuScale also states that its design can support a microgrid consisting of a group of interconnected loads and distributed energy sources that allows the power plant to operate either connected or not connected to a transmission grid. Therefore, instead of the transmission grid as the offsite source of power, the normal source of power is generated from 1 or more of the 12 operating power module main generators (MGs) through connections to the switchyard. In the absence of any power module and any offsite transmission grid, an auxiliary ac power source (AAPS) may also provide power to the plant. The onsite electrical power system includes ac power systems and dc power systems and a backup power supply system (BPSS) consisting of back-up diesel generators and the AAPS.

The SER Sections 8.2, 8.3.1, and 8.3.2 discuss and evaluate the offsite and onsite power systems.

The applicant addressed station blackout (SBO), defined as a complete loss of offsite and onsite ac power with a turbine trip. The NuScale passive plant design does not rely on the use of onsite or offsite ac power for the performance of the safety-related functions for any design-basis event (DBE). SER Section 8.4 discusses and evaluates the SBO condition and mitigation.

8.1.2 Summary of Application

DCA Part 2 Tier 1: DCA Part 2 Tier 1, Chapter 2, "Unit Specific Structures, Systems, and Components (SSCs) Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)," addresses the electrical ITAAC for reactor systems and equipment. Tier 1, Section 2.1, "NuScale Power Module," describes the ITAAC, which are identified in the ITAAC section below.

DCA Part 2 Tier 2: The applicant described the electrical power system in DCA Part 2 Tier 2, Section 8.1, summarized, in part, as follows:

[Offsite Power System:] For the NuScale Power Plant, the offsite power system includes a switchyard and one or more connections to a transmission grid, micro-grid, or dedicated service load. This design does not depend on onsite or offsite AC electrical power, including that from the transmission grid, for safe operation. Therefore, the availability of AC electrical power from an offsite power source does not impact the ability to achieve and maintain safety-related functions.

[Onsite ac and dc Power System:] The onsite electrical power systems include AC power systems and direct current (DC) power systems. Also included is a backup power supply system (BPSS) consisting of diesel generators and an auxiliary AC power source (AAPS).

ITAAC: ITAAC Tier 1, "Certified Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)," Table 2.1-4, "NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria," provides the electrical ITAAC for electrical penetration assemblies (EPAs) and physical separation between Class 1E and non-Class 1E electrical circuits. SER Sections 8.3.1 and 8.3.2 and Chapter 14, "Initial Test Program and Inspections, Tests, Analyses, and Acceptance Criteria," discuss these ITAAC. Tier 1, Table 2.13, "NuScale Power Module Electrical Equipment," lists the NuScale power module electrical equipment. The Table 2.1-4 ITAAC address the physical separation of redundant divisions of the module protection system (MPS) Class 1E instrumentation and control circuits and between Class 1E and non-Class 1E current-carrying circuits. Chapter 7 of this SER discusses the details of the MPS.

Technical Specifications: No technical specifications apply to the onsite ac or dc power system because the NuScale design does not include safety-related Class 1E ac and dc electrical power systems.

8.1.3 Regulatory Basis

The relevant NRC requirements for the offsite and onsite ac and dc power system and the associated acceptance criteria, are summarized below. SRP Section 8.1 and DSRS Section 8.1 provide the review interfaces with other SRP/DSRS sections.

Acceptance criteria are based on meeting the following relevant NRC requirements:

- General Design Criterion (GDC) 2, "Design Basis for Protection against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," as it relates to SSCs of the ac power system being capable of withstanding the effects of natural phenomena without the loss of the capability to perform their safety functions.

- GDC 4, "Environmental and Dynamic Effects Design Basis," as it relates to SSCs of the electric power system being capable of withstanding the effects of missiles and environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

- GDC 5, "Sharing of Structures, Systems and Components," as it relates to the sharing of SSCs of the power systems among nuclear units.

- GDC 17, “Electric Power Systems,” as it relates to the onsite ac power system’s (1) capacity and capability to permit functioning of SSCs important to safety, (2) independence, redundancy, and testability to perform its safety functions assuming a single failure, and (3) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network. (The applicant requested an exemption from this criterion.)

- GDC 18, “Inspection and Testing of Electric Power Systems,” as it relates to inspection and testing of the offsite and onsite power systems. (The applicant requested an exemption from this criterion.)

- GDC 33, “Reactor Coolant Makeup”; GDC 34, “Residual Heat Removal”; GDC 35, “Emergency Core Cooling”; GDC 38, “Containment Heat Removal”; GDC 41, “Containment Atmosphere Cleanup”; and GDC 44, “Cooling Water,” as they relate to the operation of the onsite electric power system in GDC 17 to ensure that the safety functions of the systems described in GDC 34, 35, 38, 41, and 44 are accomplished. (The applicant requested an exemption from electric power provisions in these criteria.)

- GDC 50, “Containment Design Basis,” as it relates to the design of containment electrical penetrations that contain ac and dc power system circuits and the capability of electric penetration assemblies in containment structures to accommodate a loss-of-coolant accident (LOCA) without loss of mechanical integrity and the external circuit protection for such.

- 10 CFR 50.34(f)(2)(v), as it relates to Additional Three Mile Island (TMI) Item I.D.3, “Safety System Status Monitoring.” (The applicant requested an exemption from this criterion.)

- 10 CFR 50.34(f)(2)(xiii), as it relates to Additional TMI Item II.E.3.1, “Emergency Power Supply for Pressurizer Heaters.” (The applicant requested an exemption from this criterion.)

- 10 CFR 50.34(f)(2)(xx), as it relates to Additional TMI Item II.G.1, “Emergency Power for Pressurizer Equipment.” (The applicant requested an exemption from this criterion.)

- 10 CFR 50.55a(h), “Protection and safety systems,” as it relates to the incorporation of Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard (Std.) 603-1991, “Standard Criteria for Safety Systems for Nuclear Power Generating Stations,” including the correction sheet dated January 30, 1995, for protection and safety systems.

- 10 CFR 50.63, “Loss of all alternating current power,” as it relates to the establishment of a reliability program for emergency onsite power sources and the use of the redundancy and reliability of diesel generator units as a factor in limiting the potential for SBO events.

Acceptance criteria that are adequate to meet the above NRC regulatory requirements are available in the following regulatory guidance (RG):

- RG 1.6, “Independence between Redundant Standby (Onsite) Power Sources and between their Distribution Systems,” Regulatory Positions D.1, D.3, and D.4, as they relate to the independence between redundant onsite ac power sources and between their distribution systems.

- RG 1.32, “Criteria for Power Systems for Nuclear Power Plants,” as it relates to the design, operation, and testing of the safety-related portions of the onsite ac power system. RG 1.32 endorses IEEE Std. 308-2001, “IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,” with the exception of the sharing of safety-related ac power systems in multi-unit nuclear power plants (NPPs).

- RG 1.41, “Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments,” as it relates to a suitable test to assure that each redundant on-site power source and its load group can function without any dependence upon any other redundant load group or portion thereof.

- RG 1.53, “Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems,” as it relates to the application of the single-failure criterion.

- RG 1.63, “Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants,” as it relates to the capability of electric penetration assemblies in containment structures to withstand a LOCA without loss of mechanical integrity and the external circuit protection for such penetrations.

- RG 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” as it relates to demonstrating compliance with the NRC regulations as they pertain to electrical systems within the Initial Test Programs for light water-cooled nuclear power plants.

- RG 1.75, “Physical Independence of Electrical Systems,” as it relates to the physical independence of the circuits and electrical equipment that constitute or are associated with the onsite electric power system.

- RG 1.81, “Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants,” as it relates to the sharing of SSCs of the electric power system. Regulatory Position C.1 states that multi-unit sites should not share power systems.

- RG 1.118, “Periodic Testing of Electric Power and Protection Systems,” as it relates to the capability to periodically test the onsite ac power system.

- RG 1.128, “Installation Design and Installation of Vented Lead-Acid Batteries for Nuclear Power Plants,” as it relates to installation design and installation of vented lead-acid storage batteries for NPPs.

- RG 1.129, “Maintenance, Testing, and Replacements of Vented Lead-Acid Batteries for Nuclear Power Plants,” as it relates to the maintenance, testing, and replacement of vented lead-acid storage batteries for NPPs.

- RG 1.153, “Criteria for Safety Systems,” as it relates to the design, reliability, qualification, and testability of the power, instrumentation, and control portions of the safety systems of NPPs, including the application of the single-failure criterion in the onsite ac or dc power system. As endorsed by RG 1.153, IEEE Std. 603-1991

provides a method acceptable to the staff to evaluate all aspects of the electrical portions of the safety-related systems, including basic criteria for addressing single failures. However, 10 CFR 50.55a(h) states that not all plants are required to comply with IEEE Std. 603-1991.

- RG 1.155, "Station Blackout," as it relates to the capability and the capacity of the onsite ac power system for an SBO, including the operation of the alternate ac (AAC) power source(s).

- RG 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants," as it relates to the design, installation, and performance of station grounding systems and surge and lightning protection systems.

- RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," as it relates to power system analytical studies and stability studies to verify the capability of the offsite power systems and their interfaces with the onsite power system

- RG 1.212, "Sizing of Large Lead-Acid Storage Batteries," as it relates to methods and procedures for the sizing of large lead-acid storage batteries for NPPs

- RG 1.218, "Condition-Monitoring Techniques for Electric Cables Used in Nuclear Power Plants," as it relates to condition-monitoring methods and techniques used to monitor the performance of electric cables in NPPs.

- SECY-90-016, "Evolutionary Light Water Reactor Certification Issues and Their Relationship to Current Regulatory Requirements," dated January 12, 1990, as it relates to the use of an AAC and the application of the regulatory treatment of nonsafety systems (RTNSSs) at advanced light-water reactors (ALWRs) that have passive safety systems.

- SECY-91-078, "Chapter 11 of the Electric Power Research Institute's (EPRI's) Requirements Document and Additional Evolutionary Light Water Reactor (LWR) Certification Issues," dated March 25, 1991, as it relates to the inclusion of an alternate power source to loads that are not safety-related at evolutionary plant designs.

- SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs," dated March 28, 1994, as it relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.

- SECY-95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems (RTNSS) in Passive Plant Designs," dated May 22, 1995, as it relates to the policy and technical Issues associated with the RTNSS affecting passive plant designs.

- NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System," as it relates to design vulnerability in electric power systems that involves a loss of offsite power (LOOP) resulting from an open circuit condition.

- NUREG-0737, "Clarification of TMI Action Plan Requirements," issued November 1980, as it relates to TMI Items II.E.3.1 and TMI II.G.1.

- NUREG/CR-0660, “Enhancement of Onsite Diesel Generator Reliability,” issued February 1979.

8.1.4 Technical Evaluation

The staff reviewed NuScale DCA Part 2 Tier 1 and Tier 2 to ensure that the applicant discussed compliance with the regulations in DCA Part 2 Tier 2, Table 8.1-1, “Acceptance Criteria and Guidelines for Electrical Systems,” and DCA Part 2 Tier 2, Table 1.9-3, “Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standards (DSRS),” for the NuScale SMR passive plant design.

In DCA Part 2 Tier 2, Section 8.1.4.3, “Regulatory Requirements and Guidance,” NuScale summarizes the regulatory guidance relevant to electrical systems as applied to the design of a passive SMR design. The applicant requested exemptions from certain regulations and states in its application that these regulations are not applicable to the NuScale passive reactor design. These exemptions are discussed in Part 7 of the NuScale DCA and this section of this chapter.

In DCA Part 2 Tier 2, Table 8.1-1, NuScale summarizes the extent to which NRC requirements and guidance relevant to electrical systems are applied in the design of NuScale electrical systems. In DCA Part 2 Tier 2, Section 1.9, and DCA Part 2 Tier 2, Section 3.1, NuScale also summarizes compliance with NRC requirements and conformance to guidance. In general, electrical systems are designed in accordance with the requirements and guidance, with the exceptions or clarifications provided below, as described in DCA Part 2 Tier 2, Section 8.1.4.3.

DSRS Table 8-1 states that 10 CFR 50.65(a)(4) and RG 1.160, on monitoring the effectiveness of the maintenance at nuclear power plants, apply to the offsite and onsite power systems, as well as equipment used for station blackout. The 10 CFR 50.65(a)(4) assessment is applied to NuScale design electrical system SSCs that (1) are determined to meet the 10 CFR 50.65(b) criteria and (2) are significant to public health and safety based on a risk-informed evaluation process. DCA Part 2 Tier 2, Section 17.6, “Maintenance Rule,” describes the Maintenance Rule (10 CFR 50.65) program. DCA Part 2 Tier 2, Section 19.0.2 states that the results and insights of PRA are a source of information for Maintenance Rule (i.e. 10 CFR 50.65) implementation. The DCA Part 2, Tier 2, Section 17.6, states that a COL applicant that references the NuScale Power Plant design certification will describe the program for monitoring the effectiveness of maintenance required by 10 CFR 50.65. The applicant provided COL Item 17.6-1 to monitor the effectiveness of maintenance as required by 10 CFR 50.65 and discussed in RG 1.160.

The staff’s review and evaluation of initial test programs related to electrical systems is in Chapter 14 of this report. In addition, the staff’s evaluation of ITAAC pertaining to electrical penetrations is in Section 14.3.6 of this report.

8.1.4.1 Compliance with 10 CFR Part 50, Appendix A, GDC 2 and GDC 4

The design of the NuScale onsite ac and onsite dc electrical power systems conforms to GDC 2 and GDC 4, as described in DCA Part 2 Tier 2, Section 8.3.1, “Onsite AC Power System,” and Section 8.3.2, “Onsite DC Power System.” GDC 2 and GDC 4 do not apply to DCA Part 2 Section 8.2 because the offsite power system does not impact power plant systems that are important to safety. With respect to the onsite ac and dc electrical power systems, SER Sections 8.2, 8.3.1, and 8.3.2 discuss the compliance with GDC 2 for protection against natural phenomena such as earthquakes and tornados and GDC 4 for protection against environmental and dynamic effects.

8.1.4.2 Compliance with GDC 5

The design of the NuScale offsite, onsite ac, and onsite dc electrical systems conforms to GDC 5 as described in DCA Part 2 Tier 2, Section 8.2, Section 8.3.1, and Section 8.3.2. GDC 5 requires that SSCs important to safety not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units. DCA Part 2 Tier 2, Section 3.1.1.5, states that the NuScale design conforms to GDC 5. SER Sections 8.2, 8.3.1, 8.3.2, and 8.4 evaluate and discuss this statement.

8.1.4.3 Compliance with GDC 17

As described in DCA Part 2 Tier 2, Section 3.1.2.8, and DCA Part 7, Section 4, the NuScale design supports an exemption from the electric power system requirements of GDC 17. In DCA Part 2 Tier 2, Section 3.1.2.8, the applicant stated that the plant does not rely on electric power to meet specified acceptable fuel design limits or to protect the RCPB as a result of anticipated operational occurrences or postulated accidents. In addition, the availability of electrical power sources does not affect the plant's ability to achieve and maintain safety-related functions. The staff discusses and evaluates this issue in SER Sections 8.2 and 8.3. The applicant requested an exemption from this criterion in DCA Part 7, Section 4, and the staff discusses the exemption request in Section 8.1.5 of this report.

8.1.4.4 Compliance with GDC 18

As described in DCA Part 2 Tier 2, Section 3.1.2.9, and DCA Part 7, Section 4, the NuScale design supports an exemption from the electric power system inspection and testing requirements of GDC 18. The applicant stated that the electric power supply systems in the NuScale design do not contain any safety-related or risk-significant SSCs that are required to meet GDC 18. The staff discusses the exemption request in Section 8.1.5 of this report.

8.1.4.5 Compliance with GDC 33, 34, 35, 38, 41, and 44

In DCA Part 2 Tier 2, Section 8.1.4.3, the applicant stated that the plant design fulfills a NuScale-derived set of principal design criteria in lieu of GDC 33, 34, 35, 38, 41, and 44, as described in DCA Part 2 Tier 2, Section 3.1.4, and supports an exemption from the electric power system requirements in GDC 33, 34, 35, 38, 41, and 44. These principal design criteria do not include provisions related to electric power systems. The request for exemption from complying with GDC 34, GDC 35, GDC 38, GDC 41, and GDC 44 is also described in DCA Part 7, Section 4, and the staff discusses the exemption request in Section 8.1.5 of this report.

8.1.4.6 Compliance with GDC 50

In DCA Part 2 Tier 2, Section 8.1.4.3, the applicant stated that the containment electrical penetration assembly design conforms to GDC 50. The staff describes and evaluates compliance with GDC 50 in SER Sections 8.3.1.4.7 and 3.11.

8.1.4.7 Compliance with 10 CFR 50.34(f)(2)(v)

The design of the NuScale ac and dc electrical systems complies with 10 CFR 50.34(f)(2)(v) (TMI Item I.D.3) requirements associated with automatic indication of bypassed and operable

status safety systems as described in Sections 8.3.1 and 8.3.2. SER Sections 8.3.1 and 8.3.2 describe and evaluate the design's compliance with this regulation.

8.1.4.8 Compliance with 10 CFR 50.34(f)(2)(xiii)

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 requirement in 10 CFR 50.34(f)(2)(xiii) (TMI Item II.E.3.1) to provide pressurizer heater power supply and associated motive and control power interfaces to establish and maintain natural circulation in shutdown conditions. DCA Part 7, Section 12, also describes the exemption from conforming to 10 CFR 50.34(f)(2)(xiii) (TMI Item II.E.3.1). SER Section 5.4.6.3 describes and evaluates the request for exemption from this regulation.

8.1.4.9 Compliance with 10 CFR 50.34(f)(2)(xx)

The NuScale design does not include pressurizer relief valves or pressurizer relief block valves. The NuScale design supports an exemption from the portions of the rule that require vital power buses for pressurizer level indicators, as discussed in DCA, Part 7, Section 11. SER Sections 5.4.6.3 and 8.3.1 discuss and evaluate the request for exemption from this regulation.

8.1.4.10 Compliance with 10 CFR 50.55a(h)

The extent to which the design of NuScale electrical systems complies with 10 CFR 50.55a(h) is described in SER Sections 8.3.1 and 8.3.2. For the NuScale design, the onsite electrical ac and dc power system equipment is not a protection system and does not perform any safety-related functions. Therefore, the system need not comply with 10 CFR 50.55a(h) and IEEE Standard 603-1991. SER Chapter 7 and Sections 8.3.1 and 8.3.2 describe and evaluate compliance with this regulation.

8.1.4.11 Compliance with 10 CFR 50.63

The NuScale power plant design complies with 10 CFR 50.63, which requires a light water reactor to have the capability to withstand an SBO for a specified duration and recover from an SBO, which is defined in 10 CFR 50.2, "Definitions." SER Section 8.4 describes additional details, discusses, and evaluates compliance with 10 CFR 50.63.

8.1.4.12 Conformance to NUREG-0737

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) in Sections 8.1.4.8 and 8.1.4.9 in this report, the NuScale design supports exemptions from these regulations. SER Sections 5.4.6.3, 7.2.13.4.6, "Three Mile Island Action Items," and 8.3.1 evaluate the request for exemption from this regulation.

8.1.4.13 Conformance to NUREG/CR-0660

Portions of NUREG/CR-0660 relevant to the NuScale electrical systems are considered as reference only, consistent with NuScale DSRS Section 8.1. SER Section 19 describes conformance to TMI items, including those addressed in NUREG/CR-0660.

8.1.4.14 Conformance to SECY-90-016

SECY-90-016 pertains to evolutionary ALWR designs and does not directly apply to passive plant designs. As a passive ALWR design, the NuScale electrical system design conforms to the passive plant guidance in SECY-94-084, Section F, "Station Blackout." SER Sections 8.3.1 and 8.3.2 contain the staff's evaluation for this SECY.

8.1.4.15 Conformance to SECY-91-078

SECY-91-078 pertains to evolutionary ALWR designs and is not directly applicable to passive plant designs. As a passive ALWR design, the NuScale electrical system design conforms to the passive plant guidance in SECY-94-084, Section G, "Electrical Distribution." The staff describes and evaluates this in SER Sections 8.2 and 8.4.

8.1.4.16 Conformance to SECY-94-084

The design of NuScale electrical systems conforms to the Commission-approved positions in SECY-94-084, Sections F and G, related to passive plant electrical systems.

The staff describes and evaluates this in SER Sections 8.2 and 8.4.

8.1.4.17 Conformance to SECY-95-132

The evaluation of NuScale electrical systems under the RTNSS process conforms to SECY-94-084, Section A, "Regulatory Treatment of Non-safety Systems," as modified in SECY-95-132 and subsequently established in SRP Section 19.3, "Regulatory Treatment of Non-Safety Systems." The portion of SECY-95-132 that modifies the RTNSS process description in SECY-94-084, Section A, is applied as guidance to the NuScale non-Class 1E electrical systems. Specifically, the evaluation of NuScale electrical systems under the RTNSS process conforms to SECY-95-132, "Response to Staff Requirements Memorandum (SRM) on SECY-94-084" Attachment 1 (Item A). The staff describes and evaluates this issue in SER Sections 8.2 and 8.4.

8.1.5 Technical Evaluation for Exemptions

This section addresses the evaluation associated with exemptions requested for GDCs 17 and 18, and the electric power provisions in GDCs 33, 34, 35, 38, 41, and 44. The technical evaluation of exemptions associated with the requirements for pressurizer heaters in 50.34(f)(2)(xiii) and vital power requirements for pressurizer level instruments in 50.34(f)(2)(xx) are discussed in Sections 5.4.6.3, 7.2.13.4.6 and 8.3.1 of this report.

GDC 17, "Electric Power Systems," requires

> *Electric power systems. An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.*

The onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure.

Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable. Each of these circuits shall be designed to be available in sufficient time following a loss of all onsite alternating current power supplies and the other offsite electric power circuit, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded. One of these circuits shall be designed to be available within a few seconds following a loss-of-coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained.

Provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.

GDC 18, "Inspection and Testing of Electric Power Systems," requires the inspection and testing of the offsite and onsite power systems important to safety and provides that

Electric power systems important to safety shall be designed to permit appropriate periodic inspection and testing and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system, and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

GDC 33—*Reactor coolant makeup* states that

A system to supply reactor coolant makeup for protection against small breaks in the reactor coolant pressure boundary shall be provided. The system safety function shall be to assure that specified acceptable fuel design limits are not exceeded as a result of reactor coolant loss due to leakage from the reactor coolant pressure boundary and rupture of small piping or other small components which are part of the boundary. The system shall be designed to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished using the piping, pumps, and valves used to maintain coolant inventory during normal reactor operation.

GDC 34—*Residual heat removal* states that

A system to remove residual heat shall be provided. The system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded.

Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

GDC 35—*Emergency core cooling* states that

A system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

GDC 38—*Containment heat removal* states that

A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

GDC 41—*Containment atmosphere cleanup* states that

Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for

onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure.

GDC 44—*Cooling water* states that

> *A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.*
>
> *Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.*

NuScale stated in DCA Part 7, Section 4 that an exemption from GDC 17 is requested because there are no safety-related functions in the design that rely on electrical power. NuScale states that the design of the NuScale Power Plant provides passive safety systems and features to accomplish plant safety-related functions without reliance on electrical power, and that the design therefore, meets the underlying purpose of GDC 17 without the need for electric power systems specified in GDC 17. NuScale further states that exemptions from the GDC 18 requirements for inspection and testing of electric power systems and the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44 are requested to address conforming changes, and states that the underlying purpose of these requirements of ensuring sufficient electric power is available to accomplish the safety functions of the respective systems is met without reliance on electric power.

The FSAR Tier 2, Table 1.6-1, "NuScale Referenced Topical Reports," references Topical Report TR 0815-16497-P-A, "Safety Classification of Passive Nuclear Power Plant Electrical Systems," Rev. 1 (ADAMS Accession No. ML18054B606). The purpose of the topical report is to provide conditions of applicability that if met, would justify an applicant's determination that no plant electrical power systems would warrant a Class 1E or safety-related designation. The staff's safety evaluation on the topical report (ADAMS Accession No. ML17170A196) concluded that if a reactor design can meet the conditions of applicability and the augmented design, qualification, and QA provisions, Class 1E power sources would not be necessary. As part of the DCA, in order to demonstrate that no plant electrical power supply system fulfill functions that would warrant a Class IE classification, the applicant must describe how the NuScale design meets:

1) the limitations and conditions described in Topical Report Section A;

2) the conditions of applicability described in Topical Report Section B (Table 3-1, Sections I and II); and

3) the augmented provisions described in Topical Report Section B (Table 3-2).

The staff evaluated the applicability of Topical Report TR 0815-16497-P-A in Section 1.4.2.3, "Applicability of Topical Report TR 0815-16497-P-A, 'Safety Classification of Passive Nuclear Power Plant Electrical Systems'," of this report. The staff concluded that the NuScale design

conforms to 1) the limitations and conditions described in Topical Report Section A, 2) the conditions of applicability described in Topical Report Section B (Table 3-1, Sections I and II), and 3) the augmented provisions described in Topical Report Section B (Table 3-2). As such, since the NuScale design meets the aforementioned attributes of the Topical Report as discussed in Chapter 1 of this report, the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. Hence, the onsite and offsite electric power systems are classified as non-Class 1E systems and electric power is not needed to 1) achieve or maintain safe shutdown, 2) assure specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operation occurrences and 3) during postulated accidents, maintain core cooling, containment integrity, and other vital functions. Further, the onsite and offsite power systems are not needed to permit functioning of SSCs important to safety. Based on the demonstration of the conditions and limitations in the TR and the non-Class 1E classification of the onsite and offsite electric power systems, and on the analysis described below to support the findings required by 10 CFR 50.12, the staff approves the exemption request regarding GDC 17, GDC 18, and the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44.

Evaluation for Meeting the Exemption Criteria of 10 CFR 50.12, Specific Exemptions

Pursuant to 10 CFR 52.7, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 52. As 10 CFR 52.7 further states, the Commission's consideration will be governed by 10 CFR 50.12, "Specific exemptions," which states that an exemption may be granted when: (1) the exemptions are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security; and (2) special circumstances are present. Specifically, 10 CFR 50.12(a)(2) lists six special circumstances for which an exemption may be granted. It is necessary for one of these special circumstances to be present in order for the NRC to consider granting an exemption request.

Authorized by Law

The NRC staff has determined that granting of the applicant's proposed exemptions will not result in a violation of the Atomic Energy Act of 1954, as amended, or the Commission's regulations because, as stated above, 10 CFR Part 52, allows the NRC to grant exemptions. The staff also determined that granting the applicant's proposed exemptions will not result in a violation of the Atomic Energy Act of 1954, as amended, or the Commission's regulations. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that the exemption is authorized by law.

No Undue Risk to Public Health and Safety

The proposed exemptions will not impact the consequences of any design basis event or create new accident precursors. The design does not rely on electric power systems to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that the exemptions pose no undue risk to the public health and safety.

Consistent with Common Defense and Security

The proposed exemptions do not affect design, function, or operation of any structures or plant equipment that are necessary to maintain a safe and secure plant status. In addition, the proposed exemptions do not impact the security power system and have no impact on plant security or safeguards procedures. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that the common defense and security is not impacted by these exemptions.

Special Circumstances

Special circumstances, in accordance with 10 CFR 50.12(a)(2)(ii), are present whenever application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule. GDCs 17 and 18, and the electric power provisions in GDCs 33, 34, 35, 38, 41, and 44 are discussed in Section 8.1.3 of this report. The underlying purpose of the requirement of GDC 17 to provide onsite and offsite electric power systems to the plant is to assure sufficient power to accomplish safety functions.

The underlying purpose of the requirement of GDC 18 to design electric power systems to permit inspection and testing is to assure the capability for periodic inspection and testing of the power systems important to safety that are subject to the requirement of GDC 17. The underlying purpose of the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44 is to assure the safety functions described in each of these GDCs can still be accomplished when the onsite and offsite electric power systems are not available.

The NuScale design does not rely on power to accomplish safety-related or important to safety functions, and therefore the underlying purpose of GDC 17, 18, and the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44 is met without the need for onsite and offsite electric power systems that are important to safety.

Staff finds that the NuScale design meets the underlying purpose of these regulations because the onsite and offsite electric power systems are not classified as Class 1E, the onsite and offsite electric power systems are not needed to permit functioning of SSCs important to safety, and electric power is not needed to 1) achieve or maintain safe shutdown, 2) assure specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operation occurrences and 3) during postulated accidents, maintain core cooling, containment integrity, and other vital functions.

The applicant states in its DCA Part 7 that special circumstances described in 10 CFR 50.12(a)(2)(vi) are present. However, as described in 10 CFR 50.12(a)(2), where the staff finds that special circumstances are present in accordance with 10 CFR 50.12(a)(2)(ii), a staff finding on whether special circumstances are present in accordance with 10 CFR 50.12(a)(2)(vi) is not necessary for the exemption to be granted. Because the staff finds that special circumstances are present in accordance with 10 CFR 50.12(a)(2)(ii), the staff makes no finding regarding the presence of special circumstances described in 10 CFR 50.12(a)(2)(vi).

Conclusion

For the reasons given above, as set forth in 10 CFR 50.12(a), the staff concludes that the proposed exemptions requested in DCA Part 7, Section 4, regarding requirements stated in GDC 17, GDC 18 and the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44 are authorized by law, will not present an undue risk to the public health and safety, and are

consistent with the common defense and security. Also, the special circumstances in 10 CFR 50.12(a)(2)(ii) are present, in that the application of GDCs 17 and 18, and the electric power provisions in GDCs 33, 34, 35, 38, 41, and 44 in the particular circumstances is not necessary to achieve the underlying purpose of these rules. Therefore, the staff concludes that an exemption from the requirements of GDC 17, GDC 18 and the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44 is justified and approved.

8.1.6 Combined License Information Items

There are no COL items for DCA Part 2 Tier 2, Section 8.1. SER Sections 8.2, 8.3.1, 8.3.2, and 8.4 discuss COL items.

8.1.7 Conclusion

As set forth above, the staff has reviewed all of the relevant information that is applicable to the NuScale electric power system design and evaluated its compliance and conformance with the applicable regulatory criteria discussed in Section 8.1.3 of this report. The staff concludes that the applicant has provided sufficient information in the DCD and identified necessary analyses to support the bases for their conclusions.

In addition, the staff concludes that an exemption to the requirements of GDC 17, GDC 18, and the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44 is justified and approved.

8.2 Offsite Power System

8.2.1 Introduction

The DCA Part 2 Tier 2, Section 8.2, states that the passive design of the NuScale power plant does not depend on offsite ac power for safe operation and that the availability of offsite ac electrical power does not affect the ability to achieve and maintain safety-related functions, as discussed in the sections below.

The offsite power system for the NuScale power plant includes a switchyard and one or more connections to a transmission grid, microgrid, or dedicated service load. However, the offsite power system is not needed to achieve and maintain safe shutdown. The objective of the staff's review is to determine whether the offsite power system satisfies the requirements in 10 CFR 50.63; and 10 CFR Part 50, Appendix A, GDC 5 and whether it will perform its design function during all plant operating and accident conditions. In addition, the staff reviewed the technical basis for the applicant's requested exemptions to GDCs 17, 18, 33, 34, 35, 38, 41, and 44.

8.2.2 Summary of Application

DCA Part 2 Tier 1: None.

DCA Part 2 Tier 2: The applicant has provided a Tier 2 system description in Section 8.2, summarized, in part, as follows:

> *The offsite power system provides power from the transmission system through the station switchyard to the electrical distribution systems. The offsite power system includes all transmission lines connected to the switchyard and the switchyard equipment (overhead buses, circuit breakers, and disconnect air*

switches). The interface between the onsite ac power system and offsite power system is the high side (i.e., switchyard side) of the motor-operated disconnect on the high side of the main power transformers (MPTs). The offsite transmission system and connections to the switchyard are site specific. A COL applicant that references the NuScale design certification will provide site-specific information about the offsite transmission system and connections to the switchyard.

Offsite power is a secondary source of power for plant startup or shutdown. In the case that an auxiliary AC power source (AAPS) or turbine generator is not available, an offsite power source can backfeed power through the MPTs for startup and shutdown loads.

ITAAC: There are no ITAAC associated with the offsite power system.

Technical Specifications: There are no technical specifications applicable to the offsite power system.

8.2.3 Regulatory Basis

The DSRS Section 8.2 provides the relevant NRC requirements for the offsite power system and the associated acceptance criteria, as summarized below. DSRS Section 8.2 provides review interfaces with other SRP or DSRS sections.

- 10 CFR Part 50, Appendix A, GDC 2, as it relates to the SSCs of the offsite power system being capable of withstanding the effects of natural phenomena.

- GDC 4, as it relates to protection of the SSCs of the offsite power system from dynamic effects, including the effects of missiles, which may result from equipment failures during normal operation, maintenance, testing, and postulated accidents.

- GDC 5, as it relates to the sharing of SSCs of the preferred power systems, including the switchyard and all circuits from the switchyard to the onsite power distribution systems of each module.

- GDC 17, as it relates to the preferred power system's (1) capacity and capability to permit functioning of SSCs important to safety, (2) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies, (3) physical independence, (4) availability, and (5) capability. (The applicant requested an exemption from this criterion.)

- GDC 18, as it relates to the inspection and testing of the offsite electric power system. (The applicant requested an exemption from this criterion.)

- GDC 33, 34, 35, 38, 41, and 44, as they relate to the operation of the offsite electric power system in GDC 17 to ensure that the safety functions of the systems described in GDC 33, 34, 35, 38, 41, and 44 are accomplished under the assumption of a single failure, where applicable. (The applicant requested exemption from the electric power provisions in these criteria.)

- 10 CFR 50.63, as it relates to the ability for a passive design to cope with an SBO for 72 hours with no operator actions.

The following guidance is available:

- RG 1.32, which endorses IEEE Std. 308-2001, as it relates to the availability and number of immediate access circuits from the transmission network.

- RG 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants.”

- RG 1.155, as it relates to the adequacy of the AAC source and the independence of the AAC power source from the offsite and onsite power systems and sources. New applications must provide an adequate AAC source of diverse design (with respect to ac onsite emergency sources) that is consistent with the guidance in RG 1.155 and capable of powering at least one complete set of normal safe-shutdown loads.

- RG 1.204; IEEE Std. 665-1995, “IEEE Guide for Generating Station Grounding”; IEEE Std. 666-2007, “IEEE Design Guide for Electric Power Service Systems for Generating Stations”; IEEE Std. 1050-2004, “IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations”; and IEEE Std. C62.23-1995, “IEEE Application Guide for Surge Protection of Electric Generating Plants,” as they relate to the design, installation, and performance of station grounding systems and surge and lightning protection systems.

- RG 1.206, as it relates to power system analytical studies and stability studies to verify the capability of the offsite power systems and their interfaces with the onsite power system.

- SECY-91-078, as it relates to the interface between the onsite ac power system and the offsite power system.

- SECY-94-084, as it relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.

- SECY-95-132, as it relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.

- SRP Branch Technical Position (BTP) 8-3, “Stability of Offsite Power Systems,” as it relates to stability studies for the electrical transmission grid that would be used to provide offsite power sources to the plant.

- SRP BTP 8-6, “Adequacy of Station Electric Distribution System Voltages,” as it relates to adverse effects on the Class 1E loads that can be caused by sustained degraded grid voltage conditions when the Class 1E busses are connected to offsite power.

- SRP BTP 8-9, “Open Phase Conditions in Electric Power System,” as it relates to the vulnerability of the electric power system design resulting from open-phase conditions in offsite electric power systems.

8.2.4 Technical Evaluation

8.2.4.1 Compliance with GDC 2 and GDC 4

The GDC 2 states that SSCs important to safety shall be designed to withstand the effects of natural phenomena without loss of capability to perform their safety functions. Thus, GDC 2 requires that the capability for the offsite power system to perform its functions be retained during the most severe natural phenomena that have been historically reported for the site and surrounding area.

The GDC 4 states that SSCs important to safety shall be designed to accommodate the effects of and to be compatible with environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. These SSCs shall be appropriately protected against dynamic effects that may result from equipment failures and from events and conditions from outside the nuclear power unit.

As discussed in DSRS, Table 8.1-1, GDC 2 and GDC 4 do not apply to the offsite power system. Specifically, the offsite power system is not safety-related and does not perform or support an important to safety function. Therefore, GDC 2 and GDC 4 do not apply to the NuScale offsite power system design.

8.2.4.2 Compliance with GDC 5

The GDC 5 requirement relates to the sharing of SSCs of the preferred (offsite) power systems, including the switchyard and all circuits from the switchyard to the onsite power distribution systems of each module.

In DSRS Section 8.2.II it states that the shared switchyard in multimodule plant configurations must meet GDC 5, thereby ensuring that an accident in one module of a multimodule facility can be mitigated using an available complement of mitigative features irrespective of conditions in the other units and without giving rise to conditions unduly adverse to safety in another unit. DSRS Section 8.2.II also states that meeting the requirements of GDC 5 provides assurance that an accident within any one unit of a multiple-module plant may be mitigated, irrespective of conditions in other units, without affecting the overall operability of the offsite power system. The applicant has provided an interface requirement for the offsite system, including the transmission system, main switchyard, and transformer area.

The DCA Part 2 FSAR Tier 2, Section 8.2, includes COL Item 8.2-1, which states that a COL applicant that references the NuScale Power Plant design certification will describe the site-specific switchyard layout and design, including offsite power connections, control and indication, characteristics of circuit breakers and buses, protective relaying, power supplies, lightning and grounding protection equipment, and conformance with GDC 5.

The staff finds this acceptable because COL Item 8.2-1 directs the COL applicant to describe how SSCs from the preferred power systems are shared with the onsite power distribution systems in the site-specific switchyard in order to conform with GDC 5.

8.2.4.3 Compliance with GDC 17

The GDC 17 states that offsite power shall be provided to allow SSCs important to safety to function and that two physically independent circuits shall supply electric power from the transmission network to the onsite distribution system.

The DCA Part 2 Tier 2, Section 8.2.3.2, “Analysis of Offsite Power System Conformance with Regulatory Framework,” states the following:

> *The passive design of the NuScale Power Plant does not rely on onsite AC power and does not require an offsite power system to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences or to maintain core cooling or containment integrity in the event of postulated accidents, as discussed in [DCA Part 2 Tier 2] Section 15.0.0. In addition, the offsite power system is not relied upon to provide power for risk-significant functions.*

The applicant states that offsite power is not required to ensure that specified acceptable fuel design limits and design conditions of the RCPB are not exceeded as a result of anticipated operational occurrences or to maintain core cooling or containment integrity in the event of postulated accidents.

The DCA Part 7 discusses NuScale’s request for exemption from GDC 17. DCA Part 7, Section 4.2.1, “Technical Basis,” states that safety-related functions are achieved and maintained with no reliance on electrical power. Furthermore, DCA Part 2 Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale Topical Report (TR)-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and can be classified as non-Class 1E systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption from GDC 17. Therefore, the staff determined that due to the exemption, the applicant’s design is exempt from the requirements of GDC 17 with respect to the offsite power system.

Although compliance with GDC 17 is not required, the applicant stated in DCA Part 2, Tier 2, Section 8.3.1.1.1 that the EHVS circuit breakers are rated and constructed to meet the requirements of IEEE Std. C37.06, “AC High-Voltage Circuit Breaker on a Symmetrical Current Basis (2009),” and the EHVS generator circuit breakers (GCBs) are rated and constructed to meet the required capabilities of IEEE Std. C37.013-1997, “AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current Basis.” The ratings and required capabilities of the GCBs are the designated limits of operating characteristics based on definite conditions, as defined in IEEE Std. C37.013-1997. The staff determined that (1) the design of the GCB conforms to IEEE Std. C37.013-1997 and (2) the design of the GCB conforms to the guidance in DSRS Section 8.2, Appendix A, “Guidelines for Generator Circuit Breakers/Load Break Switches.”

8.2.4.4 Compliance with GDC 18

GDC 18 discusses the inspection and testing of electric power systems important to safety. DCA Part 2 Tier 2, Section 8.2.3.2, states that the NuScale design supports an exemption from GDC 18.

The DCA Part 7 states that the electric power supply systems do not contain any safety-related or risk-significant SSCs that are required to meet GDC 18 and that the ac and dc power systems are not safety-related and non-Class 1E.

Furthermore, DCA Part 2 Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale topical report (TR)-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are non-Class 1E systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption from GDC 18. Therefore, the staff determined that due to the exemption, the applicant's design is exempt from the testability requirements of GDC 18 with respect to the capability of inspection and testing of the offsite power system and equipment and is acceptable.

8.2.4.5 Compliance with GDC 33, 34, 35, 38, 41, and 44

The GDC 33, 34, 35, 38, 41, and 44 state requirements for safety systems for which access to both offsite and onsite electric power sources must be provided. Compliance with these criteria requires that capability be provided for reactor coolant makeup (GDC 33), residual heat removal (GDC 34), emergency core cooling (GDC 35), containment heat removal (GDC 38), containment atmosphere cleanup (GDC 41), and cooling water for SSCs important to safety (GDC 44). The applicant has requested an exemption to these criteria in DCA Part 7, Sections 4 and 5.

The DSRS Section 8.2 states the following:

> *Passive reactor designs incorporate passive safety-related systems for core cooling and containment integrity and, therefore, do not depend on the electric power grid connection and grid stability for safe operation. They are designed to automatically establish and maintain safe-shutdown conditions after DBEs for the first 72 hours, without operator action, following a loss of both onsite and offsite ac power sources. Consequently, such passive reactor designs are not required to meet the requirements of GDC 33, 34, 35, 38, 41, and 44 for 72 hours.*

The DCA Part 2 Tier 2, Section 8.2, states that the NuScale plant design complies with a set of principal design criteria in lieu of GDC 33, 34, 35, 38, 41, and 44 and that these principal design criteria do not include requirements for electric power systems. DCA Part 2, Tier 2, Section 8.4.2, "SBO Analysis and Results," states that a safe and stable shutdown is automatically achieved and maintained for 72 hours without operator actions.

Furthermore, DCA Part 2 Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption from the electric power provisions of GDC 33, 34, 35, 38, 41, and 44. Therefore, the staff determined that due to the exemption, the applicant is not required to meet the electric power provisions of GDCs 33, 34, 35, 38, 41, and 44.

8.2.4.6 Compliance with 10 CFR 50.63 and Conformance to RG 1.155

The DSRS Section 8.2.II states that compliance with 10 CFR 50.63 requires that each light-water-cooled NPP be able to withstand or cope with (and recover from) an SBO. Furthermore, DSRS Section 8.2.II states that, if a passive design can cope with an SBO for 72 hours with no operator actions and with the use of only the Class 1E dc power,

10 CFR 50.63 is satisfied. RG 1.155 discusses the independence of an alternate ac power source from the offsite and onsite power systems and sources. The staff reviewed the offsite power system to ensure that the failure of the offsite system will not affect the NuScale power plant's ability to cope with an SBO. The DCA Part 2, Tier 2, Section 8.4.2, states that a safe and stable shutdown is automatically achieved and maintained for 72 hours without operator actions. Additionally, the NuScale design has only onsite dc power systems that are non-Class 1E and not safety-related. DCA Part 2, Tier 2, Section 8.1.2.1, states that the non-reliance on AC power eliminates the need for an alternate AC power source to meet the SBO coping requirements. SER Section 8.4 contains the staff evaluation on the capability of withstanding or coping with, and recovering from, an SBO of a specified duration. As described in DCA Part 2, Section 8.4, the NPM design does not rely on the use of onsite or offsite AC power for the performance of safety-related functions during a design basis event. As a result, emergency onsite AC power is not included in the design. The staff finds that the offsite power system is not needed to demonstrate compliance 10 CFR 50.63 and conformance to the guidance in RG 1.155.

8.2.4.7 Compliance with Generic (GL) Letter 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients"

In Generic (GL) Letter 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients," dated February 7, 2007 (ADAMS Accession No. ML070360665) and the associated summary report (ADAMS Accession No. ML082760385), the NRC staff discusses cable failures and finds that (1) the predominant factor contributing to cable failures at NPPs appears to be the presence of water or moisture or exposure of cables to submerged conditions and (2) licensees should have a program for using available diagnostic cable testing methods to assess the cable condition. DSRS Section 8.2 states that operating experience has shown that undetected degradation of underground electric cables caused by protracted exposure to wetted environments or submergence in water could result in multiple equipment failures and cables from independent power sources or different divisions could be affected by the same condition. The applicant provided clarification in letter dated July 24, 2017 (ADAMS Accession No. ML17205A551), that the NuScale design partially conforms to GL 2007-01 and explained that power cables within the scope of DCA Part 2, Tier 2, Chapter 8, do not include cables that connect offsite power to safety buses, cables that connect an emergency diesel generator (EDG) to a safety bus, or cables that provide power to active emergency core cooling systems.

Therefore, the staff determined that due to the exemptions from GDC 17 and GDC 18, the applicant is not required to provide an inspection, monitoring, or testing program for cables that connect offsite power to safety buses, cables that connect an EDG to a safety bus, or cables that provide power to active emergency core cooling systems.

8.2.4.8 Conformance to RG 1.32

The RG 1.32 is related to the criteria for power systems and endorses IEEE Std. 308-2001, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations." IEEE Std. 308-2001 discusses the offsite power system in Section 5.2.3, "Preferred Power Supply," and states that the preferred power supply consists of two or more circuits from the transmission system.

The DCA Part 2 Tier 2, Section 8.2.3.2, states that RG 1.32 does not apply to the offsite power system. The staff agrees with the applicant that RG 1.32 addresses design criteria for safety-related power systems. The NuScale design does not depend on offsite AC power for

safe operation and does not rely on offsite AC power to support any safety-related function. Therefore, the staff finds that RG 1.32 is not applicable to the NuScale design in regard to the offsite power system.

8.2.4.9 Conformance to RG 1.68

The DSRS, Table 8.1-1, "Acceptance Criteria and Guidelines for Electric Power Systems," states that RG 1.68 may be used as guidance for offsite power systems.

The DCA Part 2, Tier 2, Section 8.2, includes COL Item 8.2-3, which states that a COL applicant will describe the testing of the switchyard and the connections to an offsite power system, if provided, consistent with RG 1.68, Revision 4, issued March 2007.

The staff finds that the NuScale design conforms to RG 1.68 because COL Item 8.2-3 directs the COL applicant to describe the testing of the switchyard and the connections to an offsite power system, if provided, consistent with RG 1.68, Revision 4. The staff finds this acceptable.

8.2.4.10 Conformance to RG 1.204

The DSRS Section 8.2 states that adequate provisions are made in the design of the plant and the offsite and onsite power systems for grounding, surge protection, and lightning protection. The reviewer evaluates the plant/station grounding systems, the methods of equipment and structural grounding, ac power system neutral grounding and ground fault current limiting features, surge and lightning protection features for outdoor equipment and circuits, and the measures for isolation of instrumentation grounding systems. RG 1.204; IEEE Std. 665-1995; IEEE Std. 666-1991, "IEEE Design Guide for Electric Power Service Systems for Generating Stations"; IEEE Std. 1050-1996, "IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations"; and IEEE Std. C62.23-1995 provide acceptable guidelines for the design, installation, and performance of station grounding systems and surge and lightning protection systems as discussed in DSRS Section 8.2. DCA Part 2 Tier 2, Table 8.1-1, and Tier 2, Table 1.9-2, "Conformance with Regulatory Guides," states that RG 1.204 does not apply to Tier 2, Section 8.2, on offsite power systems.

The COL Item 8.2-1 in DCA Part 2 Tier 2, Section 8.2.2, "Switchyard," directs a COL applicant that references the NuScale power plant design certification to describe the site-specific switchyard and design, including lightning and grounding equipment. The applicant clarified in letter dated July 24, 2017 (ADAMS Accession No. ML17205A551), that the NuScale design does not rely on an electric power grid connection and grid stability for safe operation and the design of the switchyard and connections would not be required to show compliance with RG 1.204 or industry standards to demonstrate compliance with GDC 17.

Furthermore, DCA Part 2 Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are non-Class 1E systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption request from GDC 17. Therefore, the staff determined that due to the exemption, the guidance in RG 1.204 or the IEEE standards discussed above do not apply to the design of the switchyard and connections.

8.2.4.11 Conformance to RG 1.206 and SRP BTP 8-3

Because the grid is site specific, RG 1.206, Section C.I.1.8 calls for the DCA to include interface requirements for the COL application. COL Item 8.2-1 directs the COL applicant to describe the switchyard layout and design, including offsite power connections. DSRS Section 8.2 states that communications between the NPP and its offsite transmission system operating authorities are implemented to assess whether the offsite power sources are operable; therefore, agreements and protocols between the transmission system operator and NPP should exist. DCA Part 2, Tier 2, Section 8.2.3.1, "Analysis of Grid Stability," includes COL Item 8.2-2, which directs the applicant to perform the grid stability study in accordance with transmission system operator requirements, including communication agreements and protocols. The staff finds this acceptable because the COL item directs the applicant to establish communication agreements and protocols with the transmission system operator. The staff determined that the NuScale DCA directs a COL applicant to provide the necessary interface requirements between the NPP and grid operator; therefore, it conforms to RG 1.206.

Section III.3.F of DSRS Section 8.2 states the following:

> *The results of the grid stability analysis must show that loss of the largest single supply to the grid does not result in the complete loss of preferred power. The analysis should consider the loss, through a single event, of the largest capacity being supplied to the grid, removal of the largest load from the grid, or loss of the most critical transmission line. This could be the total output of the station, the largest station on the grid, or possibly several large stations if these use a common transmission tower, transformer, or a breaker in a remote switchyard or substation.*

The DCA Part 2 Tier 2, Section 8.2.3.1, provides COL Item 8.2-2, which directs a COL applicant to describe the site-specific offsite power connection and grid stability studies, including the effects of grid contingencies such as the loss of the largest operating unit on the grid, the loss of one NuScale power module (at a 50-megawatt (MW) approximate output), and the loss of the full complement of NuScale power modules (up to 12 modules with a total approximate output of 600-MW). The applicant clarified in letter dated June 2, 2017 (ADAMS Accession No. ML17153A335) that the NuScale design does not rely on electric grid connections and grid stability for safe operation. Furthermore, the applicant stated that removal of the largest load from the grid or the loss of the most critical transmission line does not affect safe operation of the facility. DCA Part 2 Tier 2, Section 8.3 states that the NuScale design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale topical report (TR)-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and can be classified as not safety-related systems to be acceptable.

The guidance in RG 1.206, Section C.I.8.2.1 discusses, in part, the equipment that must be considered in the specification of offsite power supplies. COL Item 8.2-1 in DCA Part 2 Tier 2, Section 8.2.2, directs the applicant to provide information on the site-specific switchyard layout and design, including offsite power connections, and it conforms to RG 1.206.

The SRP BTP 8-3 states that the applicant performs stability studies for the electrical transmission grid that would be used to provide the offsite power sources to the plant. DCA Part 2 Tier 2, Section 8.2.3.2, states that the performance of grid stability studies is site-specific and is to be addressed by the COL applicant. The staff determined that COL Item 8.2-2

adequately addresses the grid stability analysis to be performed by the COL applicant and, therefore, determined that it conforms to the intent of SRP BTP 8-3, for a DC applicant.

8.2.4.12 Conformance to SRP BTP 8-6

SRP BTP 8-6 discusses adverse effects on the Class 1E loads that can be caused by sustained degraded grid voltage conditions when the Class 1E buses are connected to offsite power. DCA Part 2 Tier 2, Table 8.1-1, states that SRP BTP 8-6 is not applicable. Further, DCA Part 2 Tier 2, Section 8.2.3.2, states that SRP BTP 8-6 does not apply to the offsite power system. DCA Part 2 Tier 2, Table 8.1-1, indicates that SRP BTP 8-6 does not apply to offsite power systems. In addition, DCA Part 2 Tier 2, Table 1.9-3, references Section 8.2.3 and states that the offsite power system does not supply power to Class 1E loads and does not support safety-related functions. The staff finds SRP BTP 8-6 does not apply to offsite power systems since the offsite power system does not warrant a Class 1E designation and they are not safety-related systems, as discussed in Section 8.1.5 of this report.

8.2.4.13 Conformance to SRP BTP 8-9

On July 27, 2012, the staff issued NRC Bulletin 2012-01 to all holders of operating licenses and COLs requesting information about facilities' electric power system designs. The intended purpose of the bulletin was to affirm that all plants comply with the GDC 17 requirements and to evaluate whether any further regulatory action is warranted to address this design vulnerability. SRP BTP 8-9 discusses the vulnerability of the electric power system design resulting from open phase conditions in offsite electric power systems.

The DCA Part 2 Tier 2, Table 8.1-1, states that SRP BTP 8-9 and NRC Bulletin 2012-01 are guidance for Section 8.2 on open phase conditions in the grid. DCA Part 2 Tier 2, Section 8.2, states that there are no failures of the offsite power system, including open phase conditions or an SBO that will prevent the operation of safety-related functions. Furthermore, DCA Part 2 Tier 2, Section 8.2, states the following:

> *If the offsite power system is supplying power to the onsite AC power system, the electrical isolation between the EDSS and equipment with safety-related functions, which is described in* DCA Part 2 *Tier 2, Section 7.1.2, ensures that the open phase conditions described in SRP BTP 8-9 would not prevent the performance of safety-related functions.*

The DSRS Section 8.2, Section III, Item 3.H, states that (1) no single event, including a single protective relay, interlock, or switchgear failure, in the event of loss of all standby power sources, will prevent the separation of the offsite power system from the onsite distribution system and (2) the offsite power system and standby power supplies should not have common mode failures. In general, a failure modes and effects analysis for the offsite system evaluates the effects of failures, including loss of a relay or switchgear, and an open phase event.

The applicant clarified in letter dated July 24, 2017 (ADAMS Accession No. ML170205A551), that the offsite power system has no risk-significant or safety-related functions, NuScale is requesting an exemption to GDC 17, and ac equipment failure caused by an open phase condition does not prevent the operation of safety-related equipment.

The DCA Part 2 Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale topical report (TR)-0815-16497. The applicability of TR-0815-16497 to

the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption request from GDC 17. Therefore, the staff determined that due to the exemption, SRP BTP 8-9 is not applicable to the NuScale design.

8.2.4.14 Conformance to SECY-91-078, SECY-94-084, and SECY-95-132

The DSRS, Table 8.1-1, states that SECY-94-084 and SECY-95-132 provide guidance that relates to the inclusion of an alternate power source to nonsafety loads at evolutionary plant designs. DSRS Section 8.2.III.3.A states that, for SECY-94-084 and SECY-95-132, the NuScale design review should identify any offsite power requirements to support non-Class 1E, risk-significant active systems identified through the RTNSS process. SER Section 19.3 further discusses and evaluates the RTNSS; no RTNSS SSCs are determined to meet the RTNSS criteria.

The DCA Part 2 Tier 2, Section 8.1.4.3, states that the design of NuScale electrical systems conforms to the Commission-approved positions in SECY-94-084, Section F and Section G, related to passive plant electrical systems. In addition, DCA Part 2 Tier 2, Table 8.1-1, states that SECY-94-084 and SECY-95-132 provide guidance for the offsite power system.

The DCA Part 2, Section 8.2 discusses that, for conformance to SECY-94-084 and SECY-95-132, the offsite power system has no safety-related or risk-significant loads and an AAC source or safety-related EDG is not needed, as consistent with the guidance in the Commission papers.

The DSRS, Table 8.1-1, states that SECY-91-078 is guidance for offsite power systems as it relates to the inclusion of an alternate power source to nonsafety loads at evolutionary plant designs. The applicant stated in DCA Part 2 Tier 2 Table 8.1-1 that SECY-91-078 does not apply to the offsite power system. The staff finds that since NuScale design is a passive plant design and that offsite power can be classified as non-Class 1E systems, as discussed in Section 8.1.5 of this report, SECY 91-078 is not applicable to the NuScale design.

8.2.5 Combined License Information Items

Table 8-1 below lists COL information item numbers and descriptions related to the offsite power system, from DCA Part 2 Tier 2, Table 1.8-2.

Table 8-1: NuScale Combined License Information Items for Section 8.2

Item No.	Description	DCA Tier 2 Section
COL 8.2-1	A COL applicant that references the NuScale power plant design certification will describe the site-specific switchyard layout and design, including offsite power connections, control and indication, characteristics of circuit breakers and buses, protective relaying, power supplies, lightning and grounding protection equipment, and compliance with General Design Criterion 5.	8.2.2
COL 8.2-2	A COL applicant that references the NuScale power plant design certification will describe the site-specific offsite power connection and grid stability studies, including the effects of grid contingencies such as the loss of the largest operating unit on the grid, the loss of	8.2.3.1

	one NuScale power module, and the loss of the full complement of NuScale power modules (up to 12 modules). The study will be performed in accordance with the applicable Federal Energy Regulatory Commission, North American Electric Reliability Corporation, and transmission system operator requirements, including communication agreements and protocols.	
COL 8.2-3	A COL applicant that references the NuScale power plant design certification will describe the testing of the switchyard and the connections to an offsite power system, if provided, consistent with RG 1.68, Revision 4. The testing description will include the details of initial testing associated with degraded offsite power conditions.	8.2.3.2

8.2.6 Conclusion

As set forth above, the staff has reviewed all of the relevant information that is applicable to the NuScale offsite ac power system design and evaluated its compliance with GDC 2, GDC 4, GDC 5, 10 CFR 50.63, and conformance to RGs, standards, and BTPs committed to by the applicant. The staff also assessed the technical basis for the applicant's requested exemptions to GDCs 17, 18, and the electric power provisions of 33, 34, 35, 38, 41, and 44. The staff also reviewed the COL information items in DCA Part 2 Tier 2, Table 1.8-2. The staff concludes that the applicant has provided sufficient information in the DCD and identified necessary analyses to support the bases for their conclusions of their offsite power system design. The staff concludes the design of the NuScale offsite power system design meets the appropriate regulatory requirements listed in DCA Part 2 Tier 2, Section 8.2.3, "Analysis," and shown in the staff's technical evaluations in Section 8.2.4 of this report and COL Information Items in Section 8.2.5 of this report. Additionally, the staff determined that the applicant's design is exempt from the requirements of GDC 17, GDC 18, and the electric power provisions of GDC 33, 34, 35, 38, 41, and 44, with respect to the offsite power system, as discussed in Section 8.1.5 of this report.

8.3 Onsite Power Systems

8.3.1 Alternating Current Power Systems

8.3.1.1 Introduction

The NuScale onsite power system is designed to provide electric power to the plant loads during all modes of plant operation.

The onsite power system power includes ac and dc power systems. This section discusses the ac power system for plant loads, and SER Section 8.3.2 discusses the dc system. The ac power system provides sufficient capacity and capability to ensure that the SSCs perform as intended during all modes of plant operation. NuScale states that the plant safety-related functions are achieved and maintained without reliance on electrical power; therefore, neither the ac nor dc power systems are needed to be safety-related. The objective of the staff review is to determine that the onsite ac power system will perform its design function during all plant operating conditions and that the design establishes non-reliance on electrical power for accident conditions.

8.3.1.2 Summary of Application

DCA Part 2 Tier 1: DCA Part 2 Tier 1, Chapter 2, addresses the electrical ITAAC for reactor systems and equipment. DCA Part 2 Tier 1, Section 2.1, Table 2.1-4, "NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria," provides ITAAC that address the EPA and physical separation of redundant divisions of the MPS Class 1E instrumentation and control circuits and between Class 1E and non-Class 1E current-carrying circuits.

DCA Part 2 Tier 2: DCA Part 2 Tier 2, Section 8.3.1.1, describes an onsite electrical power system, as summarized here, in part:

> *The onsite AC power systems distribute AC power to the onsite DC power systems (through battery chargers) and to the plant AC electrical loads during startup and shutdown, normal operation, and off-normal conditions. The NuScale Power Plant does not use nor include an emergency onsite AC power system. The onsite AC power systems are shared between the NuScale Power Modules (NPMs), and include the following:*
>
> - *normal power system*
> - *13.8 kV and switchyard system (EHVS) with nominal bus voltage of 13.8 kV*
> - *medium voltage AC electrical distribution system (EMVS) with nominal bus voltage of 4.16 kV*
> - *low voltage AC electrical distribution system (ELVS) with nominal bus voltages of 480 V and 120 V*
> - *backup power supply system (BPSS)*
> - *backup diesel generators (BDGs) with nominal output voltage of 480 V*
> - *auxiliary AC power source (AAPS) with nominal output voltage of 13.8 kV.*

ITAAC: There are no ITAAC associated with the performance of the onsite ac systems. However, there are ITAAC associated with the EPAs and cable separation as stated above.

Technical Specifications: There are no technical specifications for the onsite ac power system because this system does not perform a safety function or directly support safety-related SSCs.

8.3.1.3 Regulatory Basis

The DSRS Section 8.3.1 contains the relevant NRC requirements for the onsite ac power system and the associated acceptance criteria, as summarized below. (DSRS Section 8.3.1 also provides review interfaces with other DSRS sections.)

- 10 CFR Part 50, Appendix A, GDC 2, as it relates to the SSCs of the ac power system being capable of withstanding the effects of natural phenomena without the loss of the capability to perform their safety functions.

- 10 CFR Part 50, Appendix A, GDC 4, as it relates to the SSCs of the ac power system being capable of withstanding the effects of missiles and environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

- 10 CFR Part 50, Appendix A, GDC 5, as it relates to the sharing of SSCs of the ac power systems.

- 10 CFR Part 50, Appendix A, GDC 17, as it relates to the onsite ac power system's (1) capacity and capability to permit functioning of SSCs important to safety, (2) independence, redundancy, and testability to perform its safety function assuming a single failure, and (3) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network. (The applicant requested an exemption from this criterion.)

- 10 CFR Part 50, Appendix A, GDC 18, as it relates to inspection and testing of the onsite power systems. (The applicant requested an exemption from this criterion.)

- 10 CFR Part 50, Appendix A, GDC 33, 34, 35, 38, 41, and 44, as they relate to GDC 17 to ensure the accomplishment of the safety functions as described therein. (The applicant requested an exemption from the electric power provisions in these criteria.)

- 10 CFR Part 50, Appendix A, GDC 50, as it relates to the design of containment electrical penetrations that contain circuits of the ac power system and the capability of electric penetration assemblies in containment structures to accommodate a LOCA without loss of mechanical integrity and the external circuit protection for such penetrations.

- 10 CFR 50.34(f)(2)(v), as it relates to Additional Three Mile Island (TMI) Item I.D.3, "Safety System Status Monitoring." (The applicant requested an exemption from this criterion.)

- 10 CFR 50.34(f)(2)(xiii), as it relates to Additional TMI Item II.E.3.1, "Emergency Power Supply for Pressurizer Heaters." (The applicant requested an exemption from this criterion.)

- 10 CFR 50.34(f)(2)(xx), as it relates to Additional TMI Item II.G.1, "Emergency Power for Pressurizer Equipment." (The applicant requested an exemption from this criterion.)

- 10 CFR 50.55a(h), "Protection and safety systems," as it relates to the incorporation of IEEE Std. 603-1991, including the correction sheet, dated January 30, 1995.

The guidance and acceptance criteria for meeting the above regulatory requirements in accordance with the DSRS are as follows:

- RG 1.6, Regulatory Positions D.1, D.3, and D.4, as they relate to the independence between redundant onsite ac power sources and between their distribution systems.

- RG 1.32, as it relates to the design, operation, and testing of the safety-related portions of the onsite ac power system.

- RG 1.53, as it relates to the application of the single -failure criterion.

- RG 1.63, as it relates to the capability of electric penetration assemblies in containment structures to withstand a LOCA without loss of mechanical integrity and the external circuit protection for such penetrations (GDC 50).
- RG 1.68, as it relates to initial test programs for the onsite ac power systems for water-cooled nuclear power plants.
- RG 1.75, as it relates to the physical independence of the circuits and electrical equipment that comprise or are associated with the onsite ac power system.
- RG 1.81, as it relates to the sharing of the SSCs (power sources) of the ac power system.
- RG 1.106, “Thermal Overload Protection for Electrical Motors on Motor -Operated Valves,” as it relates to safety-related MOVs of the onsite ac power system.
- RG 1.118, as it relates to the capability to periodically test the onsite ac power system (GDC 18).
- RG 1.153, as it relates to the design, reliability, qualification, and testability of the power, instrumentation, and control portions of safety systems of nuclear plants, including the application of the single-failure criterion in the onsite dc power system.
- RG 1.155, as it relates to the capability and the capacity of the onsite ac power system for an SBO, including the operation of the AAC power source(s).
- RG 1.204, as it relates to the design, installation, and performance of station grounding systems and surge and lightning protection systems.
- RG 1.206, as it relates to power system analytical studies and stability studies to verify the capability of the offsite power systems and their interfaces with the onsite power system.
- RG 1.218, as it relates to monitoring the condition of cables within the onsite ac power system that have been determined to fall within the scope of the maintenance rule.
- SRP BTP 8-2, which states that EDGs should not be used for peaking service.
- SRP BTP 8-6, as it relates to the analysis, testing, and selection of the undervoltage and degraded voltage setpoints and associated time delays.
- SRP BTP 8-9, as it relates to providing protection to safety-related ac loads in the event of an open phase condition on the high side of a unit auxiliary transformer (UAT).
- SECY-91-078, as it relates to the interface between the onsite ac power system and the offsite power system.
- SECY-94-084, as it relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.
- SECY-95-132, as it relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.

8.3.1.4 Technical Evaluation

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on safety-related AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497, "Safety Classification of Passive Nuclear Power Plant Electrical Systems." By letter dated December 13, 2017, NRC staff informed the applicant of the approval of TR-0815-1649 (ML17340A524). This letter clarified that, if the applicant chooses to incorporate by reference TR-0815-16497 as part of its DCA, it must demonstrate that the reactor design meets all of the conditions of applicability (provided in Table 3-1 of TR-0815-16497) and address five additional conditions imposed by the NRC staff.

The NRC electrical staff conducted an audit (ML17255A899) to verify that the electrical power portions of the design were in accordance with the TR, specifically staff evaluated 1) NuScale's approach on the safety classification of electrical systems, and 2) the design, qualification, and quality assurance provisions that are applied to the DC system (i.e. EDSS). The staff verified that the applicant's function-by-function assessment determined that no electrical power will be required for achieving the safety functions of the reactor during any DBE. Furthermore, the staff verified the methodology and assumptions for the assessment of the safety classification of the EDSS system, the applicability of TR-0815-16497 to the NuScale DCA is evaluated and approved in Chapter 1 of this SER.

The DCA Part 2 Tier 2, Section 8.3.1, describes design parameters for the onsite ac power system. It also provides design information for the power distribution systems that provide ac power to the various ac system electrical loads, including those that support power production and the battery chargers.

The onsite ac power systems distribute ac power to the onsite dc power systems (through battery chargers) and to the plant ac electrical loads during startup and shutdown, normal operation, and off-normal conditions. The onsite ac power systems are shared between the NPMs and include the following:

- 13.8 kV and switchyard system (EHVS) (13.8 kV);
- EMVS (4.16 kV);
- ELVS (480 Volts and 120 Volts);
- backup diesel generators (BDGs) (480 volts); and
- auxiliary ac power source (AAPS) (13.8 kV).

The DCA Part 2, Tier 2, Section 8.3.1.1.1, describes the EHVS, EMVS, and ELVS power distribution systems. The non-Class 1E EHVS provides electrical connections from the turbine generators, the 13.8-kV switchyard system, and AAPS to the onsite power electrical distribution system. The EHVS is a shared system in which four 13.8-kV buses are used for connecting six generators in division I (North Side) of the NPM physical configuration. Division II (South Side) of the NPM physical configuration includes the other six generators.

The DCA Part 2 Tier 2 states that, during normal plant operation, each turbine generator (up to 12 per plant site) supplies power to the 13.8-kV generator buses as shown in DCA Part 2 Tier 2, Figure 8.3-2a and Figure 8.3-2b, "13.8 kV and Switchyard System," through its own dedicated GCB. The offsite power system is connected to the generator buses through the switchyard,

MPTs, and switchyard grid breakers. SER Section 8.2 contains the documentation and the staff's evaluation of this aspect of the design.

The DCA Part 2, Tier 2, Section 8.3.1.1.1, classifies the EMVS as non-Class 1E, and its primary function is to supply 4.16-kV power to plant loads during normal power module operation, including NPM startup and shutdown. There are four ELVS buses, and a UAT connects each EHVS bus to the corresponding low-voltage ELVS bus as depicted in DCA Part 2 Tier 2, Figure 8.3-1, "Station Single Line Diagram." The loads on these EMVS buses serve multiple NPMs, but the NPM-specific loads are not shared between NPMs. Therefore, the staff determined that operational flexibility is provided by the capability to cross-connect the EMVS buses, designed with automatic transfer from one EMVS bus to another EMVS bus for a UAT lockout relay operation or bus undervoltage condition. EMVS buses are also divided into two divisions for operation flexibility.

The non-safety ELVS consists of the onsite electric power distribution circuits that operate at 600 volts or less. The ELVS buses also provide power, through Class 1E isolation devices, to the Class 1E MPS for certain loads such as the circuit breakers connected to the pressurizer heaters. ELVS buses are divided into two divisions.

The detailed distribution of the above-mentioned EHVS, EMVS, and ELVS buses are provided in the single line diagrams in the figures in DCA Part 2 Tier 2, Section 8.3.

In DCA Part 2, Tier 2, Section 8.3.1.1.2, there are two 480-volt BDGs that are connected to ELVS buses. SER Section 8.3.1.4.4 describes and evaluates BDGs, which are non-safety systems.

The DCA Part 2, Tier 2, Section 8.3.1.1.1, discusses island-mode operation. In island mode, the plant turbine generators independently provide power to onsite ac loads. The applicant further stated that the island mode is a non-Class 1E and non-risk-significant design feature that is not credited to meet any regulatory or safety-related criteria. DCA Part 2 Tier 2, Chapter 14.2, provides initial tests on island-mode operation of the plant. Staff did not review island mode since it is not credited to meet any regulatory or safety-related criteria.

The DSRS, Table 8-1, lists GDC, RGs, standards, and SRP BTPs that are generally applicable to electrical power systems of passive reactor designs. The staff has reviewed the following DCA Part 2 information that relates to compliance with requirements applicable to the NuScale onsite ac power system design and conformance to applicable guidance as described below.

8.3.1.4.1 Compliance with GDC 2

The GDC 2 requires that SSCs important to safety be capable of withstanding the effects of natural phenomena without the loss of the capability to perform their safety functions.

The NuScale design is a passive design, and the applicant stated that the onsite ac power sources neither perform nor support any safety-related SSC functions. Accordingly, the applicant stated that there is no need for the onsite ac power system to be qualified to seismic Category I. The applicant further stated that any non-Class 1E SSCs (including electrical components, as applicable) with the potential for adverse seismic interactions are designed to seismic Category II requirements. SER Chapter 3 evaluates seismic qualification.

In DCA Part 2, Tier 2, Section 8.3.1.1, the applicant stated that the onsite AC power systems do not support plant safety-related functions. This position is supported by the application of the

evaluation methodology described in NuScale TR-0815-16497, “Safety Classification of Passive Nuclear Power Plant Electrical Systems.” The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. Therefore, since the onsite ac power system is not safety-related and not important to safety, and with the exception of potential adverse seismic interactions, its failure does not affect the ability of safety-related SSCs to perform their function. The staff finds that application of seismic Category II requirements (as referenced above) to the onsite ac power system is an acceptable means to address adverse seismic interactions. Therefore, the staff finds that the onsite ac power system meets the requirements of GDC 2.

8.3.1.4.2 Compliance with GDC 4

The GDC 4 requires that SSCs important to safety be capable of withstanding the effects of missiles and environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs.

The NuScale design is a passive design, and the applicant stated that the onsite ac power sources neither perform nor support any safety-related SSC functions. The applicant further stated that non-Class 1E ac power system SSCs are designed to operate within the environmental conditions associated with normal operation, maintenance, and testing. Failure of the onsite ac power system components does not introduce adverse environmental conditions that would affect the ability of any safety-related SSC to perform its intended function.

In DCA Part 2 Tier 2, Section 8.3.1.1, the applicant stated that the loss of electrical load does not require a safety-related response, that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. Since the onsite ac power system is not safety-related, and is not important to safety, it is not required to meet the requirements of GDC 4.

8.3.1.4.3 Compliance with GDC 5

The GDC 5 requires SSCs important to safety to not be shared among other nuclear units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions.

The DCA Part 2, Tier 2, Section 8.3.1.2.7, “Onsite Alternating Current Power System Conformance with Regulatory Framework,” states that failures affecting the onsite ac power systems do not affect the ability to achieve and maintain safety functions for any NPM, including a DBE in one NPM.

The applicant stated that, as described in DCA Part 2, Section 8.1.4.2, the EHVS and EMVS systems are non-Class 1E systems whose functions are not safety-related and not risk significant. Because the onsite power systems are not required nor credited to support DBE mitigation, EHVS failures do not affect the ability to achieve and maintain safety-related functions for any NPM, including a DBE in one NPM, consistent with GDC 5.

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology

described in NuScale TR-0815-16497. The applicability of TR-0815-16497-A to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. The onsite ac power system is not safety-related and although common to all of the NPMs, its loss does not prevent safe shutdown of all the NPMs even if one is undergoing an accident. Therefore, the staff finds that the onsite power system design complies with the requirements of GDC 5 and is acceptable.

8.3.1.4.4 Compliance with GDC 17

The GDC 17 states that ac onsite power shall be provided to permit functioning of SSCs important to safety and electric power from the onsite ac electric power supplies to the onsite distribution system.

The applicant has requested an exemption to GDC 17, as described in DCA Part 7.

The DCA Part 7, Section 4.2.1, states that safety-related functions are achieved and maintained with no reliance on electrical power. Furthermore, DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption request from GDC 17. Therefore, the staff determined that due to the exemption, the applicant's design is exempt from the requirements of GDC 17 with respect to the onsite ac power system.

8.3.1.4.5 Compliance with GDC 18

Compliance with GDC 18 requires that electric power systems important to safety be designed to permit appropriate periodic inspection and testing of key areas and features to assess their continuity and the condition of their components. These systems shall be designed to test periodically (1) the operability and functional performance of the components of the systems, such as onsite dc power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practicable, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

In DCA Part 2, Section 8.3.1.2.7, "Onsite Alternating Current Power System Conformance with Regulatory Framework," the applicant stated the following with regard to GDC 18:

> *[T]he 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.*

It is important to note that although the applicant states in its application that GDC 18 is not applicable as a requirement, the applicant stated in DCA Part 7, Section 4.2.1, states that the NuScale ac and dc power systems are designed to permit periodic inspection and testing to assess the operability and functionality of the systems and the condition of their components for operational, commercial, and plant investment protection purposes. Although not required as a formal GDC, NuScale stated that periodic inspection and testing is performed on the onsite ac

power system for operational, commercial, and plant investment purposes. The staff finds the program as described in FSAR DCA Part 2, Tier *2,* Section 8.3.1.3, "Inspection and Testing," to be acceptable since periodic inspection and testing are performed on the onsite ac system.

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption request from GDC 17 and GDC 18. Therefore, the staff determined that due to the exemption, the applicant's design is exempt from the requirements of GDC 18 with respect to the onsite dc power system.

8.3.1.4.6 Compliance with GDC 33, 34, 35, 38, 41, and 44

The GDC 33, GDC 34, GDC 35, GDC 38, GDC 41, and GDC 44 identify plant safety-related functions, including electric onsite ac power system requirements for those functions. In DCA Part 2 Tier 2, Section 8.3.1.2.7, the applicant stated that the plant design complies with a set of principal design criteria in lieu of these GDC, as described in Tier 2, Section 3.1.4. The principal design criteria do not include requirements for electric power systems. DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. The staff also addresses in Section 8.1.5 of this report the applicant's request for exemption from the electric power provisions of GDC 33, 34, 35, 38, 41, and 44. Based upon the findings with regard to the topical report and the exemption request, the onsite ac power system is a non-Class 1E system and therefore, the electric power provisions of GDC 33, 34, 35, 38, 41, and 44 are not applicable.

8.3.1.4.7 Compliance with GDC 50

Compliance with GDC 50 requires that the reactor containment structure, including access openings, penetrations, and containment heat removal systems, 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 LOCA. Containment electric penetration assemblies (EPAs) must therefore be designed to accommodate, without exceeding their design leakage rate, the calculated pressure and temperature conditions resulting from a LOCA. This criterion applies specifically to ensure the integrity of the EPAs in the event of design-basis LOCA conditions. The focus of the Chapter 8 portion of the review of the EPAs is circuit protection. The staff uses RG 1.63 as a guide to evaluate the circuit protection for the circuits that penetrate containment. The structural integrity and environmental qualification aspects of the EPAs are evaluated in Section 6.2.1 and Section 3.11 respectively of this SER.

In DCA Part 2, Tier 2, Section 8.3.1.2.5, the applicant stated the following with regard to electrical circuits that penetrate the containment:

> *The electrical penetration assemblies are designed in accordance with IEEE Standard 317-1983 (Reference 8.3-25) as endorsed by RG 1.63. 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.

Self-limiting circuits are those circuits that use EPAs, are not equipped with protection devices, and are supported by analysis that has determined that the maximum fault current in these circuits would not damage the penetration if that current was available indefinitely. For these circuits, consideration of special protection devices is not required. For circuits that are not self-limiting, primary and backup protective devices are provided. EPAs are designed to withstand the maximum available fault and overload currents for the time sufficient for operation of backup devices in case of failure of the primary protection devices.

Circuits contained in the following EPAs support safety-related functions, and consistent with IEEE 308-2001 (Reference 8.3-15) are classified as Class 1E: CNV 17, 18, 19, and 20. The circuits in the remaining EPAs do not support safety-related functions and are classified as non-Class 1E. Protection devices for non-Class 1E circuits using EPAs are not required to be treated as Class 1E.

Based upon the staff's review of the above design criteria, the staff finds that the EPA circuit protection is in conformance to the provisions of RG 1.63. Specifically, Class 1E circuits are provided with Class 1E protection, non-Class 1E circuits are provided with non-Class 1E protection and the self-limiting circuits are not provided circuit protection. Therefore, the staff finds that the NuScale EPA design meets the requirements of GDC 50 with respect to circuit protection and is acceptable.

8.3.1.4.8 Compliance with 10 CFR 50.34(f)(2)

Certain regulations at 10 CFR 50.34(f)(2) pertain to additional TMI-related requirements for the onsite electrical power system. 10 CFR 50.34(f)(2)(v) addresses bypass and inoperable status indications to be provided for safety systems. (SER Section 7.2.13 addresses this item.) 10 CFR 50.34(f)(2)(xiii) addresses the power supply and control for the pressurizer heaters and 10 CFR 50.34(f)(2)(xx) addresses the pressurizer relief valves, block valves, and level indicators.

In DCA Part 7, Section 11 and Section 12, the applicant requested an exemption to 10 CFR 50.34(f)(2)(xx). In DCA, Part 7, Section 11.1.1, the applicant made the following statement:

The NuScale Power Plant design does not include pressurizer relief valves or pressurizer block valves; therefore, portions of the rule applicable to such valves are not technically relevant. The underlying purpose of the requirement is to enable natural circulation cooling in a loss of offsite power condition. The NuScale Power Plant design does not rely on pressurizer level indication to achieve and maintain natural circulation in a loss of electrical power condition, and therefore meets the underlying purpose of the rule. NuScale also requests an exemption from the portions of 10 CFR 50.34(f)(2)(xx) requiring power from vital buses and emergency power sources for pressurizer level indication.

Regarding 10 CFR 50.34(f)(2)(xiii), the applicant made the following statement:

The NuScale Power requests an exemption from 10 CFR 50.34(f)(2)(xiii), which requires power supplies for pressurizer heaters and associated motive and

control interfaces to establish and maintain natural circulation in hot shutdown conditions.

The underlying purpose of the requirement is to enable natural circulation cooling in a loss of offsite power condition. The NuScale design does not rely on pressurizer heaters to achieve and maintain natural circulation in a loss of electrical power condition, and therefore meets the underlying purpose of the rule.

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems.

The exemption for 10 CFR 50.34(f)(2)(xx) and 10 CFR 50.34(f)(2)(xiii) is discussed in Section 5.4.6.3 of this report.

8.3.1.4.9 Compliance with 10 CFR 50.55a(h)

Under 10 CFR 50.55a(h), the NRC requires compliance with the relevant positions for plant protection and safety systems for design, reliability, qualification, and testability of the power and instrumentation and control portions of the safety systems outlined in RG 1.153. In DCA Part 2 Tier 2, Section 8.3.1.2.7, the applicant stated with regard to 10 CFR 50.55a(h) that the onsite electrical ac power system equipment with respect to the design of instrumentation and control equipment and circuits is not a protection system and does not perform any safety-related functions. Therefore, NuScale stated in DCA Part 2 Tier 2, Section 8.3.1.2.7 that the system is not required to conform to 10 CFR 50.55a(h) and IEEE Std. 603-1991. SER Section 7.2.13 addresses and provides the staff's evaluation of compliance with 10 CFR 50.55a(h) in regard to monitoring systems.

8.3.1.4.10 Conformance to RG 1.6

RG 1.6 describes an acceptable degree of independence between redundant standby (onsite) power sources and between their distribution systems, as part of compliance with GDC 17. In DCA Part 2 Tier 2, Section 8.3.1.2.7, with regard to conformance to RG 1.6, the applicant stated that the onsite ac electrical power system design does not contain any Class 1E distribution systems. DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As the onsite ac power system is not safety-related, RG 1.6 is not applicable since there are no Class 1E distribution systems that need to be independent from the standby power sources.

8.3.1.4.11 Conformance to RG 1.32

The RG 1.32 pertains to the design, operation, and testing of the safety-related portions of the onsite ac power system. In FSAR DCA Part 2, Tier 2, Section 8.3.1.2.7, the applicant stated with regard to RG 1.32 that the NuScale design uses passive safety systems that do not require ac

electric power to fulfill safety-related functions and that the onsite electric ac power system is non-Class 1E.

The DCA Part 7, Section 4.2.1, states that safety-related functions are achieved and maintained with no reliance on electrical power. Furthermore, DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. The onsite ac power system is not safety-related and therefore, RG 1.32 is not applicable, since RG 1.32 only pertains to the safety-related portions of the onsite ac power system.

8.3.1.4.12 Conformance to RG 1.53

The RG 1.53 pertains to the application of the single-failure criterion. In DCA Part 2, Tier 2, Section 8.3.1.2.7, the applicant stated that the NuScale onsite ac power sources do not perform any safety-related functions; therefore, the application of the single-failure criterion to these systems is not required.

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. the onsite ac power system is a not safety-related and because the single failure criterion is not applied to systems not safety-related, RG 1.53 is not applicable.

8.3.1.4.13 Conformance to RG 1.63

RG 1.63 pertains to the capability of EPAs in containment structures to withstand a LOCA without loss of mechanical integrity and the external circuit protection for such penetrations to meet the requirement of GDC 50. Mechanical integrity during and following a LOCA is addressed in SER Sections 3.11 and 6.2.1.

The staff's evaluation and approval of the EPA circuit protection aspects of the NuScale design is discussed in SER Section 8.3.1.4.7

8.3.1.4.14 Conformance to RG 1.68

The DSRS, Table 8.1-1, states that RG 1.68 may be used as guidance for the initial test program for the onsite power systems. DCA Part 2, Tier 2, Section 8.3.1.2.7, states that preoperational testing of the onsite ac electrical system is performed as part of the initial test program described in DCA Part 2, Tier 2, Section 14.2.12.

The SER Section 14.2 describes and evaluates the initial test program for the onsite ac system.

8.3.1.4.15 Conformance to RG 1.75

The RG 1.75 pertains to the physical independence of the Class 1E circuits and electrical equipment that comprise or are associated with the onsite ac power system. In DCA Part 2, Tier 2, Section 8.3.1.2.7, the applicant stated that the onsite electric ac power systems do not

perform any safety-related functions and do not contain any Class 1E circuits. However, the guidance in RG 1.75 has been incorporated in the design for these non-Class 1E ac onsite power system circuits requiring physical separation from safety circuits throughout the plant. This guidance forms the basis for the design, routing, and modeling of electrical cable trays and raceways.

Although the onsite ac power system neither contains nor supports safety-related SSCs, the applicant has stated that it will use the separation criteria in the RG 1.75 to maintain separation between the non-Class 1E power system and the Class 1E circuits within the MPS. The staff finds this acceptable for the onsite ac power system. SER Chapter 7 evaluates electrical isolation with respect to the MPS.

8.3.1.4.16 Conformance to RG 1.81

The RG 1.81 provides guidance in support of GDC 5 with respect to the sharing of Class 1E power sources within the onsite ac power system. The staff evaluated the DCA Part 2 with respect to RG 1.81 as it relates to the sharing of the ac power sources. The staff concludes in SER Section 8.3.1.4.3 that the onsite ac power system complies with GDC 5 in that there are no Class 1E circuits in the design. Therefore, RG. 1.81 is not applicable to the NuScale design since RG 1.81 pertains to safety-related systems.

8.3.1.4.17 Conformance to RG 1.106

The RG 1.106 provides guidance with respect to thermal overload protection for Class 1E motor-operated valves (MOVs). In DCA Part 2, Tier 2, Section 8.3.1.2.7, the applicant stated that the NuScale design does not include safety-related MOVs. Therefore, the staff determined that this RG is not applicable to the onsite ac power system to power any safety-related MOV as there are no safety-related MOVs.

8.3.1.4.18 Conformance to RG 1.118

The RG 1.118 pertains to the capability to periodically test the safety-related onsite ac power system (GDC 18). In DCA Part 2, Tier 2, Section 8.3.1.2.7, the applicant stated that periodic testing of onsite ac power equipment is described in DCA Part 2 Section 8.3.1.3.

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this conclusion is confirmed by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. Since RG 1.118 pertains to the safety-related onsite ac power system and the NuScale onsite ac power system is a not safety-related, the staff finds that RG 1.118 is not applicable. However, the applicant does apply the periodic testing of the onsite ac power system and the staff finds this acceptable.

8.3.1.4.19 Conformance to RG 1.153

The staff evaluated the DCA Part 2 with respect to RG 1.153 as it relates to the design, reliability, qualification, and testability of the power, instrumentation, and control portions of safety systems of nuclear plants, including the application of the single -failure criterion in the onsite ac power system. As endorsed by RG 1.153, IEEE Std. 603-1991 provides a method acceptable to the staff to evaluate all aspects of the electrical portions of the safety-related systems, including basic

criteria for addressing single failures. In DCA Part 2 Tier 2, Section 8.3.1.2.7, the applicant stated the following with respect to RG 1.153:

> *As described in the discussion of conformance to 10 CFR 50.55a(h), no onsite electrical AC power system equipment is required to conform to 10 CFR 50.55a(h) and IEEE Standard 603-1991.*

The SER Chapter 7 discusses the evaluation of IEEE Std. 603-1991 and 10 CFR 50.55a(h).

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. The onsite ac power system is not safety-related and therefore, the staff finds that RG 1.153 is not applicable since the RG applies only to safety-related systems.

8.3.1.4.20 Conformance to RG 1.155

The RG 1.155 pertains to the capability and the capacity of the onsite ac power system to accommodate an SBO, including the operation of the AAPS power source. SER Section 8.4 contains the staff evaluation of the SBO capability of the AC power system.

8.3.1.4.21 Conformance to RG 1.204

The RG 1.204 endorses IEEE Std. 665-1995 (reaffirmed 2001), IEEE Std. 666-1991 (reaffirmed 1996), IEEE Std. 1050-1996, and IEEE Std. C62.23-1995 (reaffirmed 2001). The applicant stated in DCA Part 2, Tier 2, Section 8.3.1.2.4, “Grounding and Lightning Protection,” that the electrical grounding and lightning protection system is designed in accordance with these standards. The applicant has also provided COL Item 8.3-3, which directs the COL applicant to describe the design of the site-specific plant grounding grid and lightning protection network to ensure its compatibility with the NuScale design. The staff finds this to be in accordance with RG 1.204 and, therefore, acceptable.

8.3.1.4.22 Conformance to RG 1.206

RG 1.206, Section C.I.8.3.1.3, as it pertains to the onsite power system, calls for analytical studies to be performed to verify the capability of these systems. DCA Part 2, Tier 2, Section 8.3.1.2.8, describes various studies including:

- load flow studies and undervoltage/overvoltage protection;
- short-circuit studies;
- equipment sizing studies;
- equipment protection and coordination studies;
- insulation coordination (surge and lightning protection); and
- power quality limits.

In the NuScale design, the electrical power system calculations and distribution system studies used the Electrical Transient Analyzer Program (ETAP) to analyze the ac distribution system for load flow, voltage regulation, motor starting, and short-circuit studies. In DCA Part 2, Tier 2, Section 8.3.1.2.8, the applicant stated that equipment sizing was developed from a load list and subsequently verified using the ETAP power system studies.

In regard to the equipment protection and coordination studies, the applicant stated that the distribution system circuit breakers and fuses are selected to carry design loads and to interrupt overloads and the maximum fault current available at their point of application. Using this selection process, only the protective device nearest the fault operates to isolate the fault or faulted equipment. The staff determined that the applicant developed a load list, performed the power system studies for the plant, and verified the equipment capability for operation with adequate information from the electrical power system studies.

The staff finds that the applicant follows the guidance of RG 1.206 with respect to the onsite electrical power system and finds it acceptable.

8.3.1.4.23 Conformance to RG 1.218

The RG 1.218, “Condition Monitoring Techniques for Electric Cables Used in Nuclear Power Plants,” pertains to monitoring the condition of cables that have been determined to fall within the scope of the Maintenance Rule. SER Section 17.6 provides the staff’s evaluation of Maintenance Rule (10 CFR 50.65).

8.3.1.4.24 Conformance to Branch Technical Positions (BTPs)

The SRP BTP 8-2 states that emergency diesel generator sets should not be used for peaking service. The intent of SRP BTP 8-2 is to ensure that the provision of GDC 17 is met with respect to minimizing the probability of concurrent loss of electrical power sources, which would preclude the use of onsite ac power sources for purposes other than supplying standby power when needed. In DCA Part 2, Tier 2, Section 8.3.1.2.7, the applicant stated that, with the NuScale design being non-reliant on ac power for the performance of safety-related functions, the concurrent loss of onsite and offsite ac power sources would have no significant adverse effect on plant safety. The staff finds that BTP 8-2 is not applicable to the NuScale design since there are no Class 1E power sources or emergency diesel-generator sets.

The SRP BTP 8-6 discusses that adverse effects on the Class 1E loads can be caused by sustained low grid voltage conditions when the Class 1E buses are connected to offsite power. DCA Part 2, Tier 2, Section 8.3.1.2.7, states that the undervoltage provisions contained in the BTP 8-6 are not relevant to the NuScale design because a loss of voltage or degraded voltage condition on the offsite power system does not adversely affect the performance of plant safety-related functions. DCA Part 7 discusses the exemption to GDC 17. DCA Part 7, Section 4.2.1, states that safety-related functions are achieved and maintained with no reliance on electrical power. Furthermore, DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. The staff finds that BTP 8-6 is not applicable since the onsite ac system is not safety-related and therefore, a loss of voltage or degraded voltage condition would not impact the onsite ac system.

The SRP BTP 8-9 discusses the electric power system design vulnerability due to open phase conditions in offsite electric power systems. The basis for SRP BTP 8-9 is to provide protection to safety-related ac loads in the event of an open phase condition. SER Section 8.2.4.13 describes and evaluates SRP BTP 8-9.

8.3.1.4.25 Conformance to SECY 91-078, SECY-94-084 and SECY-95-132

The SECY-91-078 pertains to the interface between the offsite ac power system and the Class 1E onsite power system. In DCA Part 2, Tier 2, Table 8.1-1, the applicant states this guidance does not apply to the NuScale design. This guidance pertains to GDC 17, and the applicant has requested an exemption to GDC 17, as described in DCA Part 7. DCA Part 7, Section 4.2.1, states that safety-related functions are achieved and maintained with no reliance on electrical power. Furthermore, the applicant states that the "NuScale Power Module design does not rely on electrical power to achieve and maintain safe shutdown, to provide core cooling, to ensure containment vessel isolation and integrity, or to ensure RCPB integrity during and following a design basis event." DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. Since the onsite ac power system is not safety-related, the staff finds that SECY 91-078 is not applicable since SECY 91-078 pertains to the interface between the offsite ac power system and the Class 1E onsite system.

The DSRS, Table 8.1-1, states that SECY-94-084 and SECY-95-132 provide guidance that relates to the inclusion of an alternate power source to loads that are not safety-related at evolutionary plant designs. DSRS Section 8.2.III.3.A states that, for SECY-94-084 and SECY-95-132, the NuScale design review should identify any offsite power requirements to support non-Class 1E, risk-significant- active systems identified through the RTNSS process. SER Section 19.3 further discusses and evaluates the RTNSS; no RTNSS SSCs are determined to meet the RTNSS criteria.

8.3.1.5 Combined License Information Items

Table 8-2 below lists COL information item numbers and descriptions related to the onsite ac power system from DCA Part 2 Tier 2, Table 1.8-2.

Table 8-2: Combined License Information Items for DCA Part 2 Tier 2, Section 8.3.1

Item No.	Description	DCA Part 2 Tier 2 Section
8.3-1	A COL applicant that references the NuScale Power Plant design certification will describe the site-specific location, type, and design of the power source to be used as the auxiliary alternating current power system.	8.3.1.1.2
8.3-2	A COL applicant that references the NuScale Power Plant design certification will describe the design of the site-specific electrical heat tracing system.	8.3.1.2.3

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.	8.3.1.2.4

8.3.1.6 Conclusion

As set forth above, the staff has reviewed all of the relevant information that is applicable to the NuScale onsite ac power system design and evaluated its compliance with GDC 2; GDC 4; GDC 5; requested exemptions to GDC 17 and GDC 18; applicable portions of GDC 33, 34, 35, 38, 41 and 44; GDC 50; 10 CFR 50.34(f)(2); 10 CFR 50.55a(h); and conformance to applicable RGs and standards committed to by the applicant. The staff also reviewed the COL information items in DCA Part 2, Tier 2, Table 1.8-2. The staff concludes that the applicant has provided sufficient information in the DCD and identified necessary analyses to support the bases for their conclusions of their onsite ac power system design. The staff concludes the design of the NuScale onsite ac power system design meets the appropriate regulatory requirements as shown in the staff's technical evaluations in Section 8.3.1.4 and COL Information Items in Section 8.3.1.5 of this SER. Additionally, the staff determined that the applicant's design is exempt from the requirements of GDC 17, GDC 18, and the electric power provisions of GDC 33, 34, 35, 38, 41, and 44, with respect to the onsite AC power system, as discussed in Section 8.1.5 of this report.

8.3.2 Direct Current Power Systems

8.3.2.1 Introduction

The onsite direct current (dc) power systems include the highly reliable dc power system (EDSS) and the normal dc power system (EDNS). The EDSS is a non-Class 1E dc power system to which augmented design, qualification, and quality assurance (QA) provisions are applied. The EDSS comprises two dc subsystems: (1) the EDSS-common (EDSS-C) plant subsystem serves plant common loads that have functions that are not specific to any single NuScale Power Module (NPM) and (2) the EDSS-module-specific (EDSS-MS) plant subsystem consists of up to 12 separate and independent dc electrical power supply systems, one for each NPM. The EDSS-C provides power to plant common loads including the main control room (MCR) emergency lighting and post-accident monitoring information displayed in the MCR. The source of electrical supply to the EDSS-C and EDSS-MS battery chargers is the low-voltage alternating current (ac) electrical distribution system, through the backup diesel generator-backed distribution equipment.

The EDNS is also a non-Class 1E dc power system. The EDNS does not serve any safety-related loads, and it does not have any safety-related functional requirements during plant startup, normal operation, shutdown, or abnormal operation. Therefore, the EDNS is classified as non-Class 1E and non-risk-significant, and as such, the staff did not review the EDNS. The EDNS is shared between the NPMs and provides both dc and ac power (through inverters) to non-Class 1E loads that support functions related to investment protection and power generation (i.e., the loads that are part of the plant permanent nonsafety systems). The EDNS consists of batteries, battery chargers, inverters, voltage regulating transformers, ac panelboards, maintenance bypass switches, dc switchboards, fused transfer switch boxes, battery monitors, surge suppression, associated EDNS protective relays, instrumentation, and EDNS cabling and wiring. The EDNS battery chargers are supplied from the low-voltage ac electrical distribution system.

The objective of the NRC staff review is to determine that the onsite dc power systems satisfy the requirements of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criteria (GDC) 2, 4, 5, 17, and 18 and will perform its design function during all plant operating and accident conditions.

8.3.2.2 Summary of Application

DCA Part 2 Tier 1: None.

DCA Part 2 Tier 2: The applicant has provided a Tier 2 system description in Section 8.3.2 of the application, summarized here in part as follows.

The onsite dc power systems include the following:

- EDSS
- EDNS

ITAAC: There are no ITAAC associated with dc systems.

Technical Specifications: None.

8.3.2.3 Regulatory Basis

Section 8.3.2 of the NuScale, DSRS gives the relevant requirements of the Commission's regulations for the onsite dc power system, and the associated acceptance criteria, as summarized below. (DSRS Section 8.3.2 also gives the review interfaces with other DSRS sections.)

- GDC 2, "Design Basis for Protection against Natural Phenomena," as it relates to structures, systems, and components (SSCs) of the dc power system being capable of withstanding the effects of natural phenomena without the loss of the capability to perform their safety functions.
- GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to SSCs of the dc power system being protected against dynamic effects such as the effects of missiles and to accommodate the effects of environmental conditions and associated with normal operation, maintenance, testing, and postulated accidents.
- GDC 5, "Sharing of Structures, Systems, and Components," as it relates to multi-module sharing of the dc power system SSCs.
- GDC 17, "Electric Power Systems," as it relates to the onsite dc power system's (1) capacity and capability to permit functioning of SSCs important to safety, (2) independence, redundancy, and testability to perform its safety function assuming a single failure, and (3) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network. (The applicant requested an exemption from this criterion.)

- GDC 18, “Inspection and Testing of Electric Power Systems,” as it relates to inspection and testing of the onsite power systems. (The applicant requested an exemption from this criterion.)

- GDC 33, 34, 35, 38, 41, and 44, as they relate to GDC 17, to ensure that the safety functions so described are accomplished. (The applicant requested an exemption from the electric power provisions of these criteria.)

- GDC 50, “Containment Design Basis,” as it relates to the design of containment electrical penetrations containing circuits of the ac and dc power system and the capability of electric penetration assemblies in containment structures to withstand a loss-of-coolant accident (LOCA) without loss of mechanical integrity and the external circuit protection for such penetrations.

- 10 CFR 50.34(f)(2)(v), as it relates to Additional Three Mile Island (TMI) Item I.D.3, “Safety System Status Monitoring.” (The applicant requested an exemption from this criterion.)

- 10 CFR 50.34(f)(2)(xiii), as it relates to Additional TMI Item II.E.3.1, “Emergency Power Supply for Pressurizer Heaters.” (The applicant requested an exemption from this criterion.)

- 10 CFR 50.34(f)(2)(xx), as it relates to Additional TMI Item II.G.1, “Emergency Power for Pressurizer Equipment.” (The applicant requested an exemption from this criterion.)

- 10 CFR 50.55a(h), as it relates to the incorporation of IEEE Std. 603-1991, including the correction sheet dated January 30, 1995).

The NRC has the following guidance and acceptance criteria for meeting the above regulatory requirements, per the DSRS:

- RG 1.6, “Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems,” Regulatory Positions D.1, D.3, and D.4, as they relate to the independence between redundant onsite dc power sources and between their distribution systems.

- RG 1.32, “Criteria for Power Systems for Nuclear Power Plants,” as it relates to the design, operation, and testing of the safety-related portions of the onsite dc power system.

- RG 1.53, “Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems,” as it relates to the application of the single-failure criterion.

- RG 1.63, “Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants,” Revision 3, issued February 1987, as it relates to the capability of electric penetration assemblies in containment structures to withstand a LOCA without loss of mechanical integrity and the external circuit protection for such penetrations (GDC 50).

- RG 1.68, “Initial Test Programs for water-Cooled Nuclear Power Plants,” as it relates to demonstrating compliance with the NRC regulations as they pertain to Initial Test Programs for light water-cooled nuclear power plants.

- RG 1.75, “Criteria for Independence of Electrical Safety Systems,” as it relates to the physical independence of the circuits and electrical equipment that comprise or are associated with the onsite dc power systems.

- RG 1.81, “Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants,” as it relates to the sharing of SSCs (power sources) of the dc power system.

- RG 1.106, “Thermal Overload Protection for Electrical Motors on Motor-Operated Valves,” as it relates to safety-related valves.

- RG 1.118, “Periodic Testing of Electric Power and Protection Systems,” as it relates to the capability to periodically test the onsite ac and dc power systems (GDC 18).

- RG 1.128, “Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants,” as it relates to criteria for vented lead-acid storage batteries.

- RG 1.129, “Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants,” as it relates to criteria for vented lead-acid storage batteries.

- RG 1.153, “Criteria for Safety Systems,” as it relates to the design, reliability, qualification, and testability of the power, instrumentation, and control portions of safety systems of nuclear plants, including the application of the single-failure criterion in the onsite dc power system.

- RG 1.155, “Station Blackout,” as it relates to the capability and the capacity of the onsite dc power system for a station blackout.

- RG 1.212, “Sizing of Large Lead-Acid Storage Batteries,” as it relates to guidance for defining the dc load and size of lead-acid batteries needed to supply the defined load for full-float stationary battery applications to support nuclear power plant operations.

- RG 1.218, “Condition Monitoring Techniques for Electric Cables Used in Nuclear Power Plants,” as it relates to monitoring the condition of cables that have been determined to fall within the scope of the Maintenance Rule.

- SECY-91-078, as it relates to the interface between the onsite ac power system and the offsite power system.

- SECY-94-084, as it relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.

- SECY-95-132, as it relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.

8.3.2.4 Technical Evaluation

The DSRS Section 8.3.2 (ADAMS Accession No. ML15356A552) discusses the relevant requirements of the Commission’s regulations for the onsite dc power systems, and the associated acceptance criteria. The relevant requirements are discussed in Section 8.3.2.2 of

this report. This section discusses how NuScale has met or addressed those regulatory requirements.

8.3.2.4.1 Compliance with GDC 2, "Design Basis for Protection against Natural Phenomena"

Compliance with GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquake, tornado, hurricane, flood, tsunami, or seiche without losing the capability to perform their intended safety functions.

With regard to the dc power system, this criterion requires that the capability for important-to-safety portions of the onsite dc power system to perform its functions must be protected from the most severe natural phenomena that historically have been reported for the site and surrounding area. Therefore, the important-to-safety portions of the dc power system and its components are normally located in Seismic Category I (SC-I) structures that provide protection from the effects of tornadoes, tornado missiles, and floods.

In DCA Part 2 Tier 2, Section 8.3.2.2.2, the applicant stated the following with regard to GDC 2:

> *The EDNS is not required to function in the event of natural phenomena events. The EDNS structures, systems, and components with the potential for adverse seismic interaction with Seismic Category I SSC are designed to Seismic Category II requirements so that their failure does not affect the ability of a safety-related SSC to perform its intended function. The EDSS structures, systems, and components are designed with augmented requirements for protection from the effects of natural phenomena for increased reliability and availability. The EDSS structures, systems, and components are located in the RXB and in areas of the CRB below the 120 ft elevation, which are designed to withstand the effects of and function following natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and externally-generated missiles. The EDSS structures, systems, and components are further augmented by applying design, qualification, and QA provisions typically applied to Class 1E DC power systems using a graded approach. The graded approach is reflected in the EDSS design, qualification, and QA provisions detailed in Reference 8.3-1 [NuScale Power, LLC, "Safety Classification of Passive Nuclear Power Plant Electrical Systems," TR-0815-16497-P, Revision 0]. Specific to seismic phenomena, Reference 8.3-1 includes augmented seismic design and qualification provisions.*

Conformance with TR-0818-16497-P (evaluated in Chapter 1 of this SER) means that the EDSS meets the requirements for SC-I in accordance with IEEE Std. 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," as endorsed with clarification and exception by RG 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," and as specified in Regulatory Position C.5 of RG 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants."

The staff finds that the EDSS complies with GDC 2 as the EDSS components are located in SC-I structures and the EDSS has augmented design requirements for environmental qualification.

8.3.2.4.2 Compliance with GDC 4, "Environmental and Dynamic Effects Design Bases"

Compliance with GDC 4 requires SSCs important to safety (1) to be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents and (2) to be appropriately protected against dynamic effects that may result from equipment failures, including missiles.

In DCA Part 2 Tier 2, Section 8.3.2.2.2, the applicant stated the following with regard to GDC 4:

> *The EDSS design accommodates the effects of environmental conditions by applying augmented provisions for the design, qualification, and QA typically applied to Class 1E DC power systems using a graded approach. The graded approach is reflected in the EDSS design, qualification, and QA provisions detailed in Reference 8.3-1. The codes and standards that are used to implement the EDSS environmental qualifications are described in Reference 8.3-1. The physical locations of the EDSS-MSs and EDSS-C within the Seismic Category I RXB and CRB, respectively, provide the EDSS with protection from dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids.*

According to NuScale's TR-0815-16497-P, the harsh environment is not applicable to the EDSS. The design would meet the same guidance governing environmental qualification for mild environments as that applied to a Class 1E electrical system. The augmented provisions assume that the EDSS will not be located in an area that would experience environmental conditions considered a harsh environment. These systems will be located in a "mild environment" as defined in 10 CFR 50.49(c), such that they would not be subject to the requirements of 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," for harsh environment.

Since the EDSS will be located in a mild environment, and in the SC-I RXB and CRB, the staff has reasonable assurance that the EDSS meets the requirements of GDC 4.

8.3.2.4.3 Compliance with GDC 5, "Sharing of Structures, Systems, and Components"

Compliance with GDC 5 requires that SSCs important to safety not be shared among nuclear power units unless such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

In DCA Part 2 Tier 2, Section 8.3.2.2.2, the applicant stated the following with regard to GDC 5:

> *As shown on [DCA Part 2 Tier 2] Figure 8.3-7a and Figure 8.3-7b, the EDSS-MS is not shared between NPMs thus satisfying the intent of RG 1.81, Position C.1. Specifically, portions of the EDSS that supply electrical power to the MPS are not shared. This is achieved by providing each NPM with a dedicated EDSS-MS.*
>
> *The EDSS includes augmented design provisions for multiple NPMs that prevent sharing of DC power equipment between NPMs that has the potential to result in adverse interactions. The codes and standards that are used to implement these provisions are described in Reference 8.3-1. Sharing of the EDSS-C is shown on [DCA Part 2 Tier 2] Figure 8.3-6. A postulated loss of or power fluctuation on the EDSS-C would not result in adverse interactions between NPMs and would not*

impair the performance of safety-related functions necessary to achieve and maintain safe shutdown in all NPMs.

*As shown on [DCA P*art *2 Tier 2] Figure 8.3-8a through Figure 8.3-8f, the EDNS consists of the EDNSs located throughout the NuScale Power Plant. A failure in these systems does not impair the ability to achieve and maintain NPM safety-related functions.*

Because (1) the EDSS-MS is not shared between NPMs and (2) the loss of the EDSS-C would not result in adverse interactions between NPMs, the staff finds that the EDSS meets the requirements of GDC 5.

8.3.2.4.4 Compliance with GDC 17, "Electric Power Systems"

The GDC 17 states that an onsite power system (both ac and dc) shall be provided to permit the functioning of SSCs important to safety and that it shall have sufficient independence, redundancy and testability, assuming a single failure, to support those SSCs in performing their safety functions. During the review of DCA Part 2 Tier 2, Section 8.3.2, the staff noted that the applicant stated that there is no safety-related ac or dc power required by the NuScale design.

In a letter dated October 18, 2017 (ADAMS Accession No. ML17291B312), the applicant clarified that although the EDSS does not perform safety-related functions, EDSS provides power to safety-related loads that perform safety-related functions. The applicant further explained that in DCA Part 2, Tier 2, Table 8.3-7, the FMEA results demonstrate that EDSS component failures do not prevent safety-related functions from being achieved and maintained. Furthermore, DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER and therefore, the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption from GDC 17. Therefore, the staff determined that due to the exemption, the applicant's design is exempt from the requirements of GDC 17 with respect to the onsite dc power system.

8.3.2.4.5 Compliance with GDC 18, "Inspection and Testing of Electric Power Systems"

Compliance with GDC 18 requires that electric power systems important to safety be designed to permit appropriate periodic inspection and testing of key areas and features to assess their continuity and the condition of their components. These systems shall be designed to test periodically (1) the operability and functional performance of the components of the systems, such as onsite dc power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practicable, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

In DCA Part 2 Section 8.3.2.2.2, "Onsite Direct Current Power System Conformance with Regulatory Framework," the applicant stated the following with regard to GDC 18:

[T]he 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.

It is important to note that although the applicant states in its application that GDC 18 is not applicable as a requirement, DCA Part 7, Section 4.2.1 states that the NuScale ac and dc power systems are designed to permit periodic inspection and testing to assess the operability and functionality of the systems and the condition of their components for operational, commercial, and plant investment protection purposes. The staff finds the program as described in DCA Part 2, Tier 2, Section 8.3.2.3, "Inspection and Testing," to be acceptable since periodic inspection and testing are performed on the EDSS and EDNS systems.

The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption from GDC 17 and GDC 18. Therefore, the applicant's design is exempt from the requirements of GDC 18 with respect to the onsite dc power system.

8.3.2.4.6 Compliance with GDC 33, "Reactor Coolant Makeup," GDC 34, "Residual Heat Removal," GDC 35, "Emergency Core Cooling," GDC 38, "Containment Heat Removal," GDC 41, "Containment Atmosphere Cleanup," and GDC 44, "Cooling Water"

The staff evaluated the DCA Part 2 with respect to the operation of the onsite electric power system. GDC 33, "Reactor Coolant Makeup," GDC 34, "Residual Heat Removal," GDC 35, "Emergency Core Cooling," GDC 38, "Containment Heat Removal," GDC 41, "Containment Atmosphere Cleanup," and GDC 44, "Cooling Water," identify plant safety-related functions, including electric power system requirements for those functions. The NuScale design accomplishes the safety-related functions addressed by these GDC via passive systems without reliance on electrical power.

Furthermore, DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale Topical Report (TR)-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. As discussed in Section 8.1.5 of this report, the staff approves the exemption from the electric power provisions of GDC 33, 34, 35, 38, 41, and 44.

8.3.2.4.7 Compliance with GDC 50, "Containment Design Basis"

Compliance with GDC 50 requires that the reactor containment structure, including access openings, penetrations, and containment heat removal systems, 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 LOCA. Containment electric penetrations must therefore be designed to accommodate, without exceeding their design leakage rate, the calculated pressure and

temperature conditions resulting from a LOCA. This criterion applies specifically to ensuring the integrity of containment electrical penetrations in the event of design-basis LOCA conditions. The focus of the Chapter 8 portion of the review of the EPAs is circuit protection. The staff uses RG 1.63 as a guide to evaluate the circuit protection for the circuits that penetrate containment. The structural integrity and environmental qualification aspects of the EPAs is evaluated in Chapter 6 and Chapter 3 respectively of this SER.

Based upon the staff's review of the design criteria, the staff finds that the EPA circuit protection is in conformance to the provisions of RG 1.63. Specifically, Class 1E circuits are provided with Class 1E protection, non-Class 1E circuits are provided are provided with non-Class 1E protection and the self-limiting circuits are not provided circuit protection. Therefore, the staff finds that the NuScale EPA design meets the requirements of GDC 50 with respect to circuit protection and is acceptable.

Circuit protection for the I&C cables is evaluated in Chapter 7 of this SER.

8.3.2.4.8 Compliance with 10 CFR 50.34(f)(2)(v)

The regulation in 10 CFR 50.34(f)(2)(v) states that the applicant shall provide for automatic indication of the bypassed and operable status of safety systems. The staff evaluated the DCA Part 2 with respect to the automatic indication of the bypassed and operable status of safety systems. In the DCA Part 2, Tier 2, Table 8.1-1, the applicant stated that this requirement is not applicable to the NuScale electric power systems, which are not safety-related. SER Section 7.2.13 addresses this item.

10 CFR 50.34(f)(2)(v) and associated guidance apply to safety-related systems and, because the onsite dc systems, EDNS and EDSS are non-Class 1E systems, the staff finds that 10 CFR 50.34(f)(2)(v) and associated guidance are not applicable. The DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems.

8.3.2.4.9 Compliance with 10 CFR 50.55a(h)

The staff evaluated the DCA Part 2, Tier 2, Section 8.3.2.2.2, with respect to the incorporation of IEEE Std. 603-1991. The applicant stated with regard to 10 CFR 50.55a(h) that the onsite electrical dc power system equipment is not part of a protection system and therefore, does not perform any safety-related functions. The staff finds that because the EDSS is not safety-related, the requirements of 10 CFR 50.55a(h) are not applicable. The staff evaluates compliance with 10 CFR 50.55a(h) with respect to monitoring and protection systems in Chapter 7 of this report.

8.3.2.4.10 Conformance to Regulatory Guide 1.6

RG 1.6 describes an acceptable degree of independence between redundant standby (onsite) power sources and between their distribution systems, as part of compliance with GDC 17. Although compliance with GDC 17 is not required, the staff evaluated the DCA Part 2 with respect to RG 1.6 as it relates to the independence between redundant onsite dc power sources and between their distribution systems. In the DCA Part 2 Tier 2, Section 8.3.2.2.2, NuScale stated with regard to RG 1.6 that the EDSS design conforms to the guidance for independence of standby power sources and their distribution systems provided in RG 1.6.

On the basis of the staff's review of the information provided, the staff considers that the description for the independence of standby power sources and their distribution systems is adequate, and therefore, acceptable.

8.3.2.4.11 Conformance to Regulatory Guide 1.32

The staff evaluated the DCA Part 2 with respect to RG 1.32, as it relates to the design, operation, and testing of the safety-related portions of the onsite dc power system. RG 1.32 endorses IEEE Std. 308-2001, "IEEE Standard Criteria for Class IE Power Systems for Nuclear Power Generating Stations." In DCA Part 2 Tier 2, Section 8.3.2.2.2, the applicant stated with regard to RG 1.32 that the EDSS conforms to RG 1.32 and IEEE Std. 308-2001 to the extent described in TR 0815 16497-P-A.

Since in DCA Part 2 Tier 2, Section 8.3.2.2.2 the applicant stated that the EDSS conforms to RG 1.32 and IEEE Std. 308-2001 to the extent described in TR 0815 16497-P-A, the staff finds it acceptable that the NuScale design applies RG 1.32 to the design of the EDSS.

8.3.2.4.12 Conformance to Regulatory Guide 1.53

The staff evaluated the DCA Part 2 with respect to RG 1.53, as it relates to the application of the single-failure criterion to electrical power portions of plant safety systems. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated with regard to RG 1.53 that the EDSS conforms to RG 1.53 and IEEE Std. 379-2000, "IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems," to the extent described in NuScale TR-0815-16497-P-A. In TR 0815 16497-P-A, the applicant described how the requirement of IEEE Std. 308-2001, as endorsed by RG 1.32, will be met.

Since in DCA Part 2 Tier 2, Section 8.3.2.2.2 the applicant stated that the EDSS conforms to RG 1.53 and IEEE Std. 379-2000 to the extent described in TR 0815 16497-P-A, the staff finds it acceptable that the NuScale design applies RG 1.53 to the design of the EDSS.

8.3.2.4.13 Conformance to Regulatory Guide 1.63

The staff evaluated the DCA Part 2 with respect to RG 1.63 as it relates to the capability of electric penetration assemblies in containment structures to withstand a loss-of-coolant accident without loss of mechanical integrity and the external circuit protection for such penetrations. In DCA Part 2 Tier 2, Section 8.3.2.2.2, the applicant stated with regard to RG 1.63 that electrical design requirements for EPAs satisfy RG 1.63, as described in DCA Part 2 Tier 2, Section 8.3.1.2.5. The staff's evaluation and approval of this the EPA circuit protection aspects with regards to conformance to RG 1.63 is in SER Section 8.3.1.4.13.

8.3.2.4.14 Conformance to Regulatory Guide 1.68

The DSRS, Table 8.1-1, states that RG 1.68 may be used as guidance for the initial test program for the onsite dc power systems. DCA Part 2 Tier 2, Section 8.3.2.2.2, states that initial testing of the EDSS conforms to RG 1.68 with clarifications described in Reference 8.3-1 and that the EDSS preoperational testing of the onsite ac electrical system is performed as part of the initial test program described in DCA Part 2, Tier 2, Section 14.2.12.

The SER Section 14.2 describes and evaluates the initial test program for the onsite dc system.

8.3.2.4.15 Conformance to Regulatory Guide 1.75

The staff evaluated the DCA Part 2 with respect to RG 1.75 as it relates to the physical independence of the circuits and electrical equipment that comprise or are associated with the onsite dc power system. RG 1.75 discusses independence of the electrical circuits and does not differentiate between ac and dc power systems. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated with regard to Regulatory Guide 1.75 that the EDSS conforms to RG 1.75 and IEEE Std. 384-1992, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," to the extent described in Reference 8.3-1. In Reference 8.3-1, the applicant stated that IEEE Std. 384-1992, as endorsed by RG 1.75, will be met substantially equivalent to Class 1E, with clarifications. Although the onsite power system neither contains nor supports safety-related SSCs, the applicant stated that the separation criteria contained in RG 1.75 will be used to maintain separation between the non-Class 1E power system and the Class 1E circuits within the MPS. The staff finds this acceptable for the onsite dc power system. The staff evaluates electrical isolation with respect to the MPS in SER Section 7.1.2.4.1.

8.3.2.4.16 Conformance to Regulatory Guide 1.81

The staff evaluated the DCA Part 2 with respect to RG 1.81 as it relates to the sharing of SSCs of the dc power system. Regulatory Position C.1 of RG 1.81 states that multiunit sites should not share dc systems. The staff discusses the applicability of RG 1.81 to the dc systems in SER Section 8.3.2.4.3, with regard to GDC 5.

8.3.2.4.17 Conformance to Regulatory Guide 1.106

RG 1.106 provides guidance with respect to thermal overload protection for Class 1E motor-operated valves. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated that the NuScale design does not include safety-related, motor-operated valves. Therefore, the staff determined that RG 1.106 does not apply to the onsite dc power system, as it has no safety-related motor-operated valves.

8.3.2.4.18 Conformance to Regulatory Guide 1.118

The staff evaluated the DCA Part 2 with respect to RG 1.118 as it relates to the capability to periodically test the onsite dc power system. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated with regard to RG 1.118 that the EDSS conforms to RG 1.118 and IEEE Std. 338-1987, "IEEE Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems," to the extent described in TR 0815 16497-P-A.

Since in DCA Part 2, Tier 2, Section 8.3.2.2.2 the applicant stated that the EDSS conforms to RG 1.118 and IEEE Std. 338-1987 to the extent described in TR 0815 16497-P-A, the staff finds it acceptable that the NuScale design applies RG 1.118 for the design of the EDSS.

8.3.2.4.19 Conformance to Regulatory Guide 1.128

The staff evaluated the DCA Part 2 with respect to RG 1.128 as it relates to the installation of vented lead-acid storage batteries in the onsite dc power system. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated the following with regard to RG 1.128:

> *Regulatory Guide 1.128 endorses IEEE Standard 484-2002 as an acceptable method of demonstrating compliance with NRC regulations relevant to installation design and installation of vented lead-acid (VLA) batteries. As described in [DCA*

Part 2 Tier 2], Section 8.3.2.1, "System Description," the EDSS uses VRLA batteries. Thus, IEEE Standard 1187-2013 is applied rather than IEEE Standard 484-2002. However, the regulatory positions of RG 1.128, although directed toward VLA battery installations, are appropriately considered in the installation design of the VRLA batteries, with exceptions and clarifications described in Reference 8.3-1.

The staff finds RG 1.128 generally not applicable to the EDSS system because RG 1.128 relates to VLA batteries and the NuScale design uses valve-regulated lead-acid (VRLA) batteries. The staff finds that RG 1.128 is met consistent to extent described in TR 0815 16497-P-A, and installation of valve-regulated lead acid batteries is addressed in IEEE Std. 1187, which the applicant is applying to the NuScale design.

8.3.2.4.20 Conformance to Regulatory Guide 1.129

The staff evaluated the DCA Part 2 with respect to RG 1.129 as it relates to maintenance, testing, and replacement of vented lead-acid storage batteries in the onsite dc power system. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated the following with regard to RG 1.129:

Regulatory Guide 1.129 endorses IEEE Standard 450-2010 as an acceptable method of demonstrating compliance with NRC regulations relevant to maintenance, testing, and replacement of VLA batteries. The EDSS uses VRLA batteries and, thus, applies IEEE Standard 1188-2005 with the 2014 amendment rather than IEEE Standard 450-2010. However, the regulatory positions of RG 1.129, although directed toward VLA battery installations, are appropriately considered for the VRLA batteries, with clarification described in Reference 8.3-1.

The staff finds RG 1.129 not generally applicable to the EDSS system because RG 1.129 relates to VLA batteries and the NuScale design uses VRLA batteries. The staff finds that RG 1.129 is met consistent to extent described in TR 0815 16497-P-A, and maintenance, testing, and replacement of valve-regulated lead acid batteries is addressed in IEEE Std. 1188, which the applicant is applying to the NuScale design.

8.3.2.4.21 Conformance to Regulatory Guide 1.153

The staff evaluated the DCA Part 2 with respect to RG 1.153 as it relates to the design, reliability, qualification, and testability of the power, instrumentation, and control portions of safety systems of nuclear plants, including the application of the single-failure criterion in the onsite dc power system. As endorsed by RG 1.153, IEEE Std. 603-1991 provides a method acceptable to the staff to evaluate all aspects of the electrical portions of the safety-related systems, including basic criteria for addressing single failures. In DCA Part 2 Tier 2, Section 8.3.2.2.2, the applicant stated the following with regard to RG 1.153:

The EDSS conforms to 10 CFR 50.55a(h) and IEEE Standard 603-1991 (and hence RG 1.153) to the extent described in Reference 8.3-1.

The staff evaluates the DCA Part 2 with regard to IEEE Std. 603-1991 and 10 CFR 50.55a(h) in Chapter 7 of this report.

Since in DCA Part 2 Tier 2, Section 8.3.2.2.2 the applicant stated that the EDSS conforms to 10 CFR 50.55a(h) and IEEE Standard 603-1991 (and hence RG 1.153) to the extent described in

TR 0815 16497-P-A, the staff finds it acceptable that the NuScale design applies RG 1.153 for the design of the EDSS.

8.3.2.4.22 Conformance to Regulatory Guide 1.155

The RG 1.155 relates to the capability and the capacity of the onsite dc power system for a station blackout. The staff evaluates conformance to RG 1.155 in SER Section 8.4.

8.3.2.4.23 Conformance to Regulatory Guide 1.212 (November 2008)

The staff evaluated the DCA Part 2 with respect to RG 1.212 (November 2008) as it relates to the sizing of large lead-acid storage batteries. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated with regard to RG 1.212 (November 2008) that the EDSS and EDNS batteries are sized in accordance with IEEE Std. 485-1997, as endorsed by RG 1.212 (November 2008). Although the NuScale design uses VRLA batteries, the staff finds that defining the dc load and size of lead-acid batteries is applicable to VRLA batteries, and thus RG 1.212 (November 2008) can be used.

The staff finds the application of IEEE Std. 485-1997 and RG 1.212 (November 2008) for sizing EDSS and EDNS batteries to be acceptable.

8.3.2.4.24 Conformance to Regulatory Guide 1.218

The staff evaluated the DCA Part 2 with respect to RG 1.218 as it relates to the condition monitoring techniques of electric cables within the scope of the Maintenance Rule. In DCA Part 2, Tier 2, Section 8.3.2.2.2, the applicant stated the following with regard to RG 1.218:

> *Regulatory Guide 1.218 provides guidance for monitoring the condition of cables that have been determined to fall within the scope of the maintenance rule (10 CFR 50.65). The development and implementation of the maintenance rule program, including the identification of SSC that require assessment per 10 CFR 50.65(a)(4), is stated in Section 17.6.*

The staff reviewed the strategy for the DC applicant to address the Maintenance Rule requirement (10 CFR 50.65) described in DCA Part 2, Tier 2, Section 17.6. COL Item 17.6-1 states, "A COL applicant that references the NuScale Power Plant design certification will describe the program for monitoring the effectiveness of maintenance required by 10 CFR 50.65." Because the description of a Maintenance Rule program is the COL applicant's responsibility, the staff finds that deferring consideration of the guidance in RG 1.218 to the COL acceptable.

8.3.2.4.25 Conformance to Branch Technical Position 8-4

The staff evaluated the NuScale design with respect to BTP 8-4 regarding the application of the single-failure criterion to manually-controlled electrically-operated valves. In DCA Part 2 Tier 2 Section 8.3.2.2.2, the applicant stated that

> *Branch Technical Position 8-4 establishes the acceptability of disconnecting power to electrical components of a fluid system as one means of designing against a single failure that might cause an undesirable component action. Removal of electric power from safety-related valves is not used in the NuScale Power Plant design as a means of satisfying the single failure criterion. Therefore, this BTP is not applicable to the NuScale design.*

The staff finds that BTP 8-4 is not applicable to the NuScale design since removal of electric power from safety-related valves is not used as a means to meet the single failure criterion.

8.3.2.4.26 Conformance to SECY 91-078, SECY 94-084 and SECY 95-132

The SECY-91-078 pertains to the interface between the offsite ac power system and the Class 1E onsite power system. In DCA Part 2 Tier 2, Table 8.1-1, the applicant states that guidance does not apply to the NuScale design. This guidance pertains to GDC 17, and the applicant has requested an exemption to GDC 17, as described in DCA Part 7. DCA Part 7, Section 4.2.1, states that safety-related functions are achieved and maintained with no reliance on electrical power. Furthermore, the applicant states that the "NuScale Power Module design does not rely on electrical power to achieve and maintain safe shutdown, to provide core cooling, to ensure containment vessel isolation and integrity, or to ensure RCPB integrity during and following a design basis event." DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on ac or dc power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497. The applicability of TR-0815-16497 to the NuScale DCA is discussed in Sections 1.4.2.3 and 8.1.5 of this SER, and the staff finds that the onsite and offsite electric power systems do not warrant a Class 1E designation and they are not safety-related systems. Since the onsite dc power system is not safety-related, and the staff finds that SECY 91-078 is not applicable since SECY 91-078 pertains to the interface between the offsite ac power system and the Class 1E onsite system.

The DSRS, Table 8.1-1, states that SECY 94-084 and SECY 95-132 provide guidance that relates to the inclusion of an alternate power source to loads that are not safety-related at evolutionary plant designs. DSRS Section 8.2.III.3.A states that, for SECY 94-084 and SECY 95-132, the NuScale design review should identify any offsite power requirements to support non-Class 1E, risk significant active systems identified through the RTNSS process. SER Section 19.3 further discusses and evaluates the RTNSS; no SSCs are determined to meet the RTNSS criteria.

8.3.2.5 Combined License Information Items

There are no COL items for DCA Part 2 Tier 2, Section 8.3.2.

8.3.2.6 Conclusion

As set forth above, the staff has reviewed all of the relevant information that is applicable to the NuScale onsite dc power system design and evaluated its compliance with GDC 2; GDC 4; GDC 5; requested exemptions to GDC 17 and GDC 18; applicable portions of GDC 33, 34, 35, 38, 41 and 44; GDC 50; 10 CFR 50.34(f); 10 CFR 50.55a(h); 10 CFR 50.63;, and conformance to applicable RGs and standards committed to by the applicant. The staff concludes that the applicant has provided sufficient information in the DCD and identified necessary analyses to support the bases for their conclusions of their onsite dc power system design. The staff concludes the design of the NuScale onsite dc power system design meets the appropriate regulatory requirements listed in DCA Part 2 Tier 2, Section 8.3.2.2, "Design Evaluation," as shown in the staff's technical evaluations in Section 8.3.2.4 of this report. Additionally, the staff determined that due to the exemptions, the applicant's design is exempt from the requirements of GDC 17, GDC 18, and the electric power provisions of GDC 33, 34, 35, 38, 41, and 44, with respect to the onsite DC power system, as discussed in Section 8.1.5 of this report.

8.4 Station Blackout

8.4.1 Introduction

In 10 CFR 50.2, "Definitions," an SBO is defined as a complete loss of ac electric power to the essential and nonessential switchgear buses in the nuclear power plant. For the NuScale design, an SBO involves a loss of the offsite electric power system (preferred power system) concurrent with a turbine trip. An SBO does not include loss of available ac power to buses fed by station batteries through inverters or by AAC sources specifically provided for SBO mitigation. The staff's review is to verify that the plant is capable of withstanding and recovering from a complete loss of ac electric power for a minimum of 72 hours, as described in the DCA Part 2. The staff reviewed and evaluated the application to determine its compliance with the requirements of 10 CFR 50.63 and conformance to the applicable guidance.

8.4.2 Summary of Application

DCA Part 2 Tier 1: None.

DCA Part 2 Tier 2: The applicant has provided a Tier 2 system description in Section 8.4, summarized, in part, as follows:

> *The NPM design does not rely on the use of onsite or offsite ac power for the performance of safety-related functions during a DBE. As a result, emergency onsite ac power is not included in the design.*
>
> *The SBO duration for passive plant designs is 72 hours, which is consistent with the NRC's policy provided in SECY-94-084 and SECY-95-132 and the associated staff requirements memorandums. Passive plants are required to demonstrate that safety-related functions can be performed without reliance on ac power for 72 hours after the initiating event. The relevant guidelines of RG 1.155 are applied as they pertain to compliance with 10 CFR 50.63 for the passive NuScale design.*

ITAAC: There are no ITAAC associated with SBO.

Technical Specifications: There are no technical specifications for this area of review.

8.4.3 Regulatory Basis

DSRS Section 8.4 provides the relevant NRC requirements for this area of review and the associated acceptance criteria for NuScale's plant design, as summarized below. DSRS Section 8.4 also provides review interfaces with other SRP or DSRS sections.

The following acceptance criteria are adequate to meet the above requirements:

- 10 CFR 50.63, as it relates to the capability to withstand and recover from an SBO.
- GDC 17, as it relates to the onsite ac power system's (1) capacity and capability to permit functioning of SSCs important to safety, (2) independence, redundancy, and testability to perform its safety function assuming a single failure, and (3) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or

the loss of power from the transmission network. (The applicant requested an exemption from this criterion.)

- GDC 18, as it relates to the inspection and testing of the offsite and onsite power systems (The applicant requested an exemption from this criterion.)

The following documents also provide additional criteria or guidance in support of the DSRS Section 8.4 acceptance criteria to meet the above requirements:

- RG 1.155, as it relates to compliance with 10 CFR 50.63.
- SECY-90-016 and SECY-94-084, as they relate to the use of AAC power sources and the RTNSS process at plants that have passive safety systems.
- RG 1.75, as it relates to the independence of SBO-related power sources and distribution systems between the onsite and offsite ac power systems, especially the isolation capability of the battery chargers for the dc system.

8.4.4 Technical Evaluation

The staff reviewed DCA Part 2 Tier 2 Section 8.4, to determine whether the design is capable of withstanding and recovering from an SBO as required by 10 CFR 50.63. The SBO duration for passive plant designs is 72 hours, which is consistent with the NRC's policy in SECY-94-084 and SECY-95-132 and the associated staff requirements memorandums.

8.4.4.1 Compliance with 10 CFR 50.63 and Conformance to RG 1.155

Under 10 CFR 50.63, the NRC requires that each NPP be capable of withstanding or coping with, and recovering from, an SBO of a specified duration (known as coping duration) and of maintaining adequate core cooling and appropriate containment integrity for the SBO coping duration. RG 1.155 provides guidance for implementing the SBO requirements of 10 CFR 50.63. DSRS Section 8.4 states that, for new ALWR applications, such as the NuScale application, that use passive safety systems and do not include a spare, full-capacity AAC power source for coping with an SBO, (1) all safety-related functions should be performed without relying on ac power for 72 hours after the initiating event and (2) the applicant has implemented, as appropriate, an RTNSS process that conforms to RG 1.206, Section C.IV.9, "Regulatory Treatment of Nonsafety Systems." RG 1.155 and DSRS Section 8.4 describe guidance acceptable to the staff for meeting the requirements of 10 CFR 50.63 that will be applied to the NuScale design. Aspects of the staff's review for compliance with 10 CFR 50.63 are discussed below.

In DCA Part 2 Tier 2, Section 8.4.3, the applicant stated that it evaluated the design adequacy and capability of equipment needed to cope with an SBO for the 72-hour duration of the event and that the evaluation provides reasonable assurance that the required SBO equipment remains operable and that special equipment provisions or operator actions are not necessary to ensure the operability of SBO mitigation equipment for the 72-hour duration.

The RG 1.155, Regulatory Position C.3.2, states that each NPP should be evaluated to determine its capability to withstand and recover from an SBO of the acceptable duration determined for that plant. In order to establish the plant's capability for mitigating an SBO, the staff reviewed the assumptions and summary of the evaluation referenced in DCA Part 2 Tier 2, Section 8.4.3,

The applicant provided clarification in letter dated June 28, 2017 (ML17179A979) that the SBO coping analysis assumption is described in DCA Part 2 Tier 2, Sections 8.4.1 and 8.4.2, and provided a summary of conformance with RG 1.155, Regulatory Position C.3.2, for the NuScale design. The applicant also stated that the coping analysis did not identify any responsibilities for the COL applicant to cope with an SBO.

The staff's review of RG 1.155 conformance is summarized below.

The RG 1.155, Regulatory Position C.3.2.1, states that the SBO evaluation should be performed under the assumption that the SBO event occurs while the reactor is operating at 100-percent rated thermal power and has been at this power level for at least 100 days. The applicant stated in DCA Part 2 Tier 2, Section 8.4.1, that the SBO analysis assumes that a total of 12 NPMs and supporting equipment are initially operating normally at a minimum of 100-percent rated thermal power for 100 days. Therefore, the staff finds that the design conforms to RG 1.155, Regulatory Position C.3.2.1, because the initial assumptions for the SBO analysis include operation at 100-percent power for 100 days.

The RG 1.155, Regulatory Position C.3.2.2, states that the capability of all systems and components necessary to provide core cooling and decay heat removal should be determined. RG 1.155, Position C.3.2.3, states that the ability to maintain an adequate reactor coolant system inventory to ensure that the core is cooled should be evaluated.

The staff notes that the applicant requested an exemption to GDC 33 related to reactor coolant makeup requirements and is evaluated in Section 9.3.4.4.6 of this report. Specifically, the staff states for off-normal transients the safety-related ECCS provides specified acceptable fuel design limit protection by maintaining core inventory and coolability, and concludes the design meets the underlying purpose of GDC 33.

The staff conducted an audit of documents, in part, that supported the applicant's conclusions in the DCA Part 2, Tier 2, Section 8.4.2, as it relates to core cooling under both DHRS and ECCS cooling (ML19151A658). The staff also conducted a follow-on audit to better understand the detailed calculations, analyses, and bases underlying NuScale's SBO transient analysis and thermal-hydraulic parameters for specific time frames during the first 72 hours (Audit Plan-ML18348B076). The staff confirmed that DHRS and ECCS provide adequate core cooling, including during the timeframe prior to ECCS actuation when riser level falls below the DHRS inlet, as described in DCA Part 2, Tier 2, Section 5.4.3, "Decay Heat Removal System."

Section 15.0.6 of this SER evaluates the potential for boron dilution due to boron volatility. Boron plate-out on the upper core internals due to extended ECCS operation without operator action to inject boron via chemical and volume control system (CVCS) could result in a subsequent return to power, which could exacerbate boron redistribution and core dilution over time and challenge core cooling while on extended ECCS operation. This issue is described in Section 15.0.6 of this SER using Chapter 15 methodologies, assumptions and acceptance criteria for long-term cooling. Although all control rods are assumed to insert into the core in response to an SBO, boron plate-out is a physical phenomenon that could potentially cause re-criticality, even with nominal assumptions with no operator action, as discussed in DCA Part 2, Tier 2 Section 15.0.6. Review of the net margin to critical in DCA Part 2, Tier 2, Section 4.3, Table 4.3, "Reactivity Requirements for Long Term Shutdown Capability," which assumes all rods are inserted, demonstrates significant margin to a re-criticality. This subcritical margin provides reasonable assurance that boron plate-out over a 72-hour timeframe will not cause a core re-criticality with all rods fully inserted. Therefore, the staff finds that the design conforms

to RG 1.155, Regulatory Position C.3.2.3, and C.3.2.2 because the DHRS and ECCS are capable of preserving adequate RCS inventory and provide necessary core cooling during SBO conditions. The RG 1.155, Regulatory Position C.3.2.4, states that the design adequacy and capability of equipment needed to cope with an SBO for the required duration and recovery period should be addressed and evaluated as appropriate for the associated environmental conditions. The applicant provided clarification in letter dated June 28, 2017 (ML17179A979) that "an evaluation of the environmental conditions for the actual installed SBO support equipment in its final configuration will be done as part of the detailed design phase using the guidance of NUMARC 87-00 Revision 1, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors."

The applicant further stated that the SBO mitigation equipment that is relied on to meet 10 CFR 50.63 (e.g., decay heat removal system, emergency core cooling system) is passive, safety-related, and already required to be environmentally qualified and meet design basis accident conditions that bound the SBO environment. Therefore, the staff finds that the design conforms to RG 1.155, Regulatory Position C.3.2.4, because the environmental conditions for installed SBO equipment are bounded by the design-basis accident conditions.

The RG 1.155, Regulatory Position C.3.2.4, Subpart 1, states that the potential failures of equipment necessary to cope with the SBO should be considered. The applicant provided clarification in letter dated June 28, 2017 (ML17179A979) that the SBO event does not impose a new or different failure mode on SBO mitigation equipment and that the coping analysis did not identify any failures of SBO mitigation or support equipment. Therefore, the staff finds that the design conforms to RG 1.155, Regulatory Position C.3.2.1, because the potential failures of equipment necessary to cope with the SBO have been considered and the coping analysis did not identify any failures of SBO mitigation or support equipment.

The RG 1.155, Regulatory Position C.3.2.4, Subpart 2, states that potential environmental effects on the operability and reliability of equipment necessary to cope with SBO, including fire protection systems, should be considered. SER Section 8.3.2 reviews the effects of environmental conditions, and SER Chapter 9 evaluates the effects of fire protection systems.

The RG 1.155, Regulatory Position C.3.2.4, Subpart 3, states that potential effects of other hazards, such as weather, on SBO response equipment should be considered. SER Chapter 18 evaluates the effects of other hazards on SBO response equipment.

The RG 1.155, Regulatory Position C.3.2.4, Subpart 4, states that potential habitability concerns for areas requiring operator access should be considered. SER Chapter 18 reviews this subpart.

The RG 1.155, Regulatory Position C.3.2.5, states that available non-Class 1E equipment should be considered to cope with an SBO as long as such equipment meets the recommendations of RG 1.155, Regulatory Positions 3.3.3 and 3.3.4. The staff evaluates this in SER Section 8.3.2.

The RG 1.155, Regulatory Position C.3.2.6, states that consideration should be given to timely operator actions inside or outside the control room that would increase the length of time that the plant can cope with an SBO as long as the applicant can be demonstrate that it can carry out these actions in a timely fashion. SER Chapter 18 evaluates timely operator actions.

The RG 1.155, Regulatory Position C.3.2.7, states that the ability to maintain "appropriate containment integrity" should be addressed. SER Chapter 6 evaluates containment integrity.

In DCA Part 2 Tier 2, Section 8.4.3, the applicant stated that an SBO transient sensitivity case that considered a simultaneous loss of all ac and dc power was evaluated and demonstrated that the NuScale power plant design does not rely on dc power from the EDSS to meet the requirements of 10 CFR 50.63. The SBO transient analysis assumes operation of the EDSS during the event to comply with 10 CFR 50.63 and the applicant stated in DCA Part 2 Tier 2, Section 8.4.3, that dc power from the EDSS is not relied on for the NuScale power plant design to meet the requirements of 10 CFR 50.63 In letter dated June 28, 2017 (ADAMS Accession No. ML17179A979), the applicant clarified that the SBO transient analysis, the analysis of record, assumes operation of the EDSS during the event, which, in part, forms the basis for compliance with 10 CFR 50.63. The applicant further stated that the sensitivity case assumptions are the same as the base case except that there is immediate loss of the EDSS at the outset of the event. The applicant also stated that this sensitivity case represents an additional failure that is outside of the SBO event; is not used to show compliance to 10 CFR 50.63; and, therefore, does not need to be included in the DCA Part 2.

The staff verified (1) the acceptance criteria of an SBO in all 12 modules, (2) the assumptions and methodology used for the evaluation, and (3) the results of the base case and the sensitivity case. The staff accepts the methodology and the assumptions of the SBO transient sensitivity case. Based on the above, staff finds that the applicant has adequately addressed the NuScale design's non-reliance on the EDSS during an SBO, although it is not needed to meet 10 CFR 50.63 requirements.

The staff determined that the applicant demonstrates the capability to achieve and maintain safe shutdown for a minimum of 72 hours. Therefore, the staff finds that the design conforms to the guidance in RG 1.155, Regulatory Position C.3.2, in support of its compliance with 10 CFR 50.63.

The staff also reviewed the DCA Part 2 information on procedures and training to cope with and recover from an SBO. DSRS Section I, Item 3 (page 8.4-2), states that the review should determine that procedures and training conform to the guidance in RG 1.155, Regulatory Position C.3.4, as they pertain to passive plants. RG 1.155 provides guidance on procedures and training for coping with an SBO for the coping duration and for restoring normal long-term cooling. DCA Part 2 Tier 2, Section 8.4.4, "Station Blackout Procedures and Training," states that the SBO procedures and training consider the relevant guidance of RG 1.155 as it pertains to passive plants, and training and procedures to mitigate an SBO event are implemented in accordance with DCA Part 2 Tier 2, Section 13.2, "Training," and Section 13.5, "Plant Procedures." The applicant has COL items for developing (1) the procedures to cope with and recover from an SBO in accordance with COL Item 13.5-2 and (2) the training to cope with an SBO in accordance with COL Item 13.2-1. Therefore, the staff determined that the design conforms to RG 1.155, Regulatory Position C.3.4, because the applicant provided COL items for developing procedures and training and is, therefore, acceptable.

Additionally, the staff reviewed the DCA Part 2 information on quality assurance (QA) and specification guidance for non-Class 1E equipment required to meet 10 CFR 50.63. DSRS Section I, Item 4 (page 8.4-2), states that the review should determine that QA activities and specifications for non-Class 1E equipment used to meet the requirements of 10 CFR 50.63 conform to the recommendations in RG 1.155, Regulatory Position C.3.5, Appendix A.

The DCA Part 2 Tier 2, Section 8.4.3, states that non-Class 1E equipment is not relied on to mitigate an SBO and that there is no SBO mitigation equipment that requires regulatory

oversight under the RTNSSs process, which is described in DCA Part 2 Tier 2, Section 8.1.4.3 and Section 19.3, “Regulatory Treatment of Non-Safety Systems.”

The staff determined that QA activities and specifications for non-Class 1E equipment, required to meet 10 CFR 50.63 and conform to the recommendations in RG 1.155, Regulatory Position C.3.5, and Appendix A to RG 1.155, is not applicable because non-Class 1E equipment is not relied on to mitigate an SBO.

8.4.4.2 Compliance with GDC 17

The GDC 17 states that ac onsite power shall be provided to permit functioning of SSCs important to safety and electric power from the onsite ac electric power supplies to the onsite distribution system.

The DCA Part 7 discusses the exemption to GDC 17. DCA Part 7, Section 4.2.1, states that safety-related functions are achieved and maintained with no reliance on electrical power. Furthermore, DCA Part 2, Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale TR-0815-16497, “Safety Classification of Passive Nuclear Power Plant Electrical Systems.” The applicability of TR-0815-16497 to the NuScale DCA is discussed in Section 8.1.5 of this SER.

8.4.4.3 Compliance with GDC 18

The GDC 18 discusses the inspection and testing of electric power systems important to safety.

In DCA Part 7, the applicant stated that the electric power supply systems do not contain any safety-related or risk-significant SSCs that are required to meet GDC 18 and that the ac and dc power systems are not safety-related and non-Class 1E. Furthermore, DCA Part 2 Tier 2, Section 8.3 states that the design does not rely on AC or DC power systems, and that this position is supported by the application of the evaluation methodology described in NuScale topical report (TR)-0815-16497, “Safety Classification of Passive Nuclear Power Plant Electrical Systems.” The applicability of TR-0815-16497 to the NuScale DCA is discussed in Section 8.1.5 of this SER.

Although the applicant requested an exemption to GDC 18, DCA Part 7, Section 4.2.1, states that the NuScale ac power systems are designed to permit periodic inspection and testing to assess the operability and functionality of the systems and the condition of their components for operational, commercial, and plant investment protection purposes.

8.4.4.4 Conformance to the Guidelines of SECY-90-016 and SECY-94-084

The guidelines and criteria of SECY-90-016, as they relate to the use of AAC power sources, pertain to evolutionary ALWR designs and do not directly apply to passive plant designs.

For meeting the guidelines and criteria of SECY-94-084 as they relate to the RTNSS at plants provided with passive safety systems, the applicant stated in DCA Part 2 Tier 2, Section 8.4.3, that non-Class 1E equipment is not relied on to mitigate an SBO and that there is no SBO mitigation equipment that requires regulatory oversight under the RTNSS process, which is described in DCA Part 2 Tier 2, Section 8.1.4.3, and DCA Part 2 Tier 2, Section 19.3. The staff considers this acceptable because the non-Class 1E equipment is not relied on to mitigate an

SBO; therefore, SECY-90-016 and SECY-94-084 do not apply to the NuScale design for an SBO. The staff further discusses and evaluates this in SER Section 19.3.

8.4.4.5 Conformance to RG 1.75

The guidance in RG 1.75 pertains to the independence of SBO-related power sources and distribution systems between the onsite and offsite ac power systems. In DCA Part 2 Tier 2, Section 8.4, the applicant stated that the NPM design does not rely on the use of onsite or offsite ac power for the performance of safety-related functions for any DBE. Although the SBO-related power sources and distribution systems neither contain nor support safety-related SSCs, the applicant has stated that it will use the separation criteria in RG 1.75 to maintain separation between the non-Class 1E power system and the Class 1E circuits within the MPS. The staff finds this acceptable for the SBO-related power sources. SER Section 7.1.2.4.2 evaluates electrical isolation with respect to the MPS.

8.4.5 Combined License Information Items

There are no COL items provided for this section.

8.4.6 Conclusion

Based on the above review, the staff finds that the NuScale design is acceptable because the applicant demonstrated that safety-related functions can be performed without reliance on ac power for a minimum of 72 hours following an SBO event. This demonstration was performed in a manner consistent with RG 1.155, Regulatory Position C.3.2 and meets the requirements of 10 CFR 50.63. Additionally, the staff determined that the applicant's design is exempt from the requirements of GDC 17, GDC 18, and the electric power provisions of GDC 33, 34, 35, 38, 41, and 44, with respect to station blackout, as discussed in Section 8.1.5 of this report.