

21 MULTIMODULE DESIGN CONSIDERATIONS

21.0 Introduction

This chapter of the final safety evaluation report (FSER) identifies sections of other chapters of the U.S. Nuclear Regulatory Commission (NRC) staff's (hereinafter referred to as the staff) review of the NuScale Power, LLC (the applicant), Design Certification Application (DCA) Part 2, where interactions of systems shared between multiple NuScale Power Modules (NPMs) of the NuScale Power Plant have been evaluated. The term "NuScale Power Plant" refers to the entire site, including up to 12 NPMs and the associated balance-of-plant support systems and structures. The staff's documentation in this report regarding the interactions of systems shared among multiple NPMs of the NuScale Power Plant is based on Revision 5 of the DCA, dated July 29, 2020 (Agencywide Document Access and Management System (ADAMS), Accession No. ML20225A071). The precise parameter values, as reviewed by the staff in this safety evaluation, are provided by the applicant in the DCA using the English system of measure. Where appropriate, the NRC staff converted these values for presentation in this safety evaluation to the International System (SI) units of measure based on the NRC's standard convention. In these cases, the SI converted value is approximate and is presented first, followed by the applicant-provided parameter value in English units within parentheses. If only one value appears in either SI or English units, it is directly quoted from the DCA and not converted.

In DCA Part 2, Tier 2, Chapter 21, "Multi-Module Design Considerations," the applicant stated that the modular design of the NuScale Power Plant is consistent with Title 10 of the *Code of Federal Regulations* (10 CFR) 52.1, "Definitions," which defines "modular design" as a nuclear power station that consists of two or more essentially identical nuclear reactors (modules) and each module is a separate nuclear reactor capable of being operated independent of the state of completion or operating condition of any other module co-located on the same site, even though the nuclear power station may have some shared or common systems.

In DCA Part 2, Tier 2, Chapter 21, the applicant referred to DCA Part 2, Tier 2, Chapter 1, "Introduction and General Description of the Plant," which states that the NPM is a collection of systems, subsystems, and components that together constitute a modularized nuclear steam supply system. For the purposes of Chapter 21, an NPM is a self-contained nuclear steam supply system composed of a reactor core, a pressurizer, two steam generators integrated within the reactor pressure vessel and housed in a compact steel containment vessel, and its dedicated module-specific safety systems.

The applicant stated that DCA Part 2, Tier 2, Chapter 21, demonstrates that safety-related systems and functions that prevent or mitigate NPM design-basis events are not adversely affected as a result of failures of shared (common) systems or interfaces among NPMs.

21.1 Summary of Application

DCA Part 2, Tier 1: See the information under ITAAC, below.

DCA Part 2, Tier 2: NuScale DCA Part 2, Tier 2, Chapter 21, contains the Tier 2 information.

ITAAC: DCA Part 2, Tier 1, Chapter 3, "Shared Structures, Systems, and Components and Non-Structures, Systems, and Components Design Descriptions and Inspections, Tests,

Analyses, and Acceptance Criteria,” provides the design descriptions for structures, systems, and components (SSCs) and the inspections, tests, analyses, and acceptance criteria (ITAAC) for those SSCs that are common or shared by multiple NPMs. Shared systems in this chapter are either shared by 1–12 NPMs or by 1–6 NPMs as shown in DCA Part 2, Tier 1, Table 3.0-1, “Shared Systems Subject to Inspections, Tests, Analyses, and Acceptance Criteria.” This chapter also includes non-SSC-based design descriptions and ITAAC that are common or shared by multiple NPMs. These ITAAC are evaluated, as applicable, in conjunction with FSER Sections 6.4, “Control Room Habitability,” 7.2.11, “Multi-unit Stations,” 8.3.1, “Alternating Current Power Systems,” 8.3.2, “Direct Current Power Systems,” 9.2.2, “Reactor Component Cooling Water System,” 9.2.3, “Demineralized Water System,” 9.2.4, “Potable and Sanitary Water Systems,” 9.2.5, “Ultimate Heat Sink,” 9.2.7, “Site Cooling Water System,” 9.2.9, “Utility Water Systems,” 9.3.4, “Chemical and Volume Control System,” 9.3.6, “Containment Evacuation System and Containment Flooding and Drain System,” 9.4.1, “Control Room Area Ventilation System,” 9.4.2, “Reactor Building and Spent Fuel Pool Area Ventilation System,” 9.4.3, “9.4.3 Radioactive Waste Building Ventilation System,” 9.4.4, “Turbine Building Ventilation System,” 10.4.5, “Circulating Water System,” 10.4.10, “Auxiliary Boiler System,” 15.0.0, “Classification and Key Assumptions,” 15.0.3, “Radiological Consequences of Design Basis Accidents,” and 19.1.4.9, “Evaluation of Multi-module Risk,” and documented in the applicable sections of FSER Chapter 14, “Initial Test Program and ITAAC-Design Certification,” Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria.”

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

Technical Reports: There are no technical reports associated with this area of review.

21.2 Technical Evaluation

Table 21-1 below lists the systems shared among multiple NPMs, and the FSER sections where the staff evaluated multimodule aspects of these systems.

Table 21-1 NuScale Standard Design Shared Systems Evaluated by the NRC Staff

No.	System	DCA Part 2 Tier 2	NPMs Supported	FSER Section
1	Radioactive waste building heating, ventilation, and air conditioning (HVAC) system	Table 21-1	12	9.4.3
2	Diesel generator building HVAC system	Table 21-1	12	9.4.4
3	Turbine building HVAC system	Table 21-1	6	9.4.4
4	Annex building HVAC system	Table 21-1	12	9.4.2
5	Containment flooding and drain system	Table 21-2	Two independent subsystems each supporting six NPMs	9.3.6

No.	System	DCA Part 2 Tier 2	NPMs Supported	FSER Section
6	Normal control room HVAC system	Table 21-2	12	9.4.1
7	Reactor building HVAC system	Table 21-2	12	9.4.2
8	Control room habitability system	Table 21-2	12	6.4
9	Boron addition system	Table 21-2	12	9.3.4
10	Reactor component cooling water system	Table 21-2	Two independent subsystems each supporting six NPMs	9.2.2
11	Circulating water system	Table 21-2	Two subsystems each supporting six NPMs	10.4.5
12	Site cooling water system	Table 21-2	12	9.2.7
13	Demineralized water system	Table 21-2	12	9.2.3
14	Auxiliary boiler system	Table 21-2	12	10.4.10
15	Potable water system	Table 21-1	12	9.2.4
16	Ultimate heat sink	Table 21-2	12	9.2.5
17	13.8-kilovolt and switchyard system, medium-voltage alternating current electrical distribution system, low-voltage alternating current electrical distribution system	Table 21-3	12	8.3.1
18	Highly reliable direct current power system common	Table 21-3	12	8.3.2
19	Normal direct current power system	Table 21-3	12	8.3.2
20	Safety display and indication system	Table 21-3	12	7.2.11
21	Plant protection system	Table 21-3	12	7.2.11
22	Plant control system	Table 21-3	12	7.2.11
23	Utility water system	Table 21-1	12	9.2.9
24	Process sampling system	Table 21-2	12	9.3.2
25	Gaseous radioactive waste system	Table 21-2	12	11.3.4
26	Liquid radioactive waste system	Table 21-2	12	11.2.4

No.	System	DCA Part 2 Tier 2	NPMs Supported	FSER Section
27	Fire protection system and fire detection system	Table 21-2	12	9.5.1
28	Nitrogen distribution system	Table 21-2	12	9.3.1
29	Instrument air system	Table 21-2	12	9.3.1
30	Fuel handling equipment	Table 21-2	12 (only one at a time)	9.1.4
31	Module assembly equipment	Table 21-2	12 (only one at a time)	9.1.5

The failure of shared systems that are not safety related is considered within the NuScale transient and accident analyses and is evaluated in FSER Chapter 15, “Transient and Accident Analysis.” The applicant described its categorization and classification of design-basis events, including postulated accidents, in DCA Part 2, Tier 2, Section 15.0.0, “Classification and Key Assumptions.” FSER Section 15.0.0 contains the staff’s review of the categorization and classification of these events.

DCA Part 2, Tier 2, Chapter 21, discusses the suitability of shared components and the design measures taken to ensure these components do not introduce multimodule risks. Specifically, DCA Part 2, Tier 2, Section 21.1.2, “Safety-Related System Protection from Internal Events,” describes the applicant’s determination that an accident in one NPM that results in an accident in another NPM is bounded by analysis and shown to be acceptable. FSER Chapter 15 documents the staff’s evaluation of the design-basis accidents (DBAs). Internal hazards are discussed in FSER Chapter 3, “Design of Structures, Components, Equipment, and Systems.”

The applicant’s radiological consequence analyses evaluate the radiological consequences off site, in the control room, and in the technical support center for the DBAs described in DCA Part 2, Tier 2, Chapter 15. These DBAs are analyzed for a single NPM. FSER Section 15.0.3 contains the staff’s review of the radiological consequences of these events.

The staff discussed multimodule risk, including internal and external events, in FSER Section 19.1.4.9.

21.3 Conclusion

As applicable to NuScale multimodule design considerations and assertions, the staff has documented its findings and conclusions in the FSER sections as discussed above. The staff reviewed information presented in the DCA on the design of the shared systems listed in Table 21-1 of this report.