14 INITIAL TEST PROGRAM AND INSPECTIONS, ANALYSES, AND ACCEPTANCE CRITERIA

14.1 Introduction

14.2 Initial Plant Test Program - Design Certification and New License Applicants

14.3 Inspections, Tests, Analyses, and Acceptance Criteria

14.3.1 Selection Criteria for DCA Part 2, Tier 1

14.3.1.1 Introduction

Section 14.3 of this safety evaluation report (SER) describes the NRC staff's evaluation of the Design Certification Application (DCA) Part 2, Tier 1 information for the NuScale design. This section also addresses the technical adequacy and completeness of the inspections, tests, analyses, and acceptance criteria (ITAAC) in DCA Part 2, Tier 1, or it references other portions of this SER where the staff evaluates those items. The staff issued requests for additional information (RAIs) to NuScale to resolve staff questions on the information in the DCA submittal. In response to the RAIs, NuScale revised DCA Part 2 to clarify specific information. In this SER section, the staff focuses on how the revised DCA complies with 10 CFR 52.47(b)(1) and conforms with the applicable NRC guidance, rather than discussing each RAI and NuScale response.

The staff is reviewing DCA Part 2, Tier 1, for the type of information and the level of detail discussed in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," issued March 2007, as modified by SECY-19-0034, (dated April 8, 2019) (ADAMS Accession No. ML19080A032). As reflected in SECY-19-0034, the following general principles apply to the review of Tier 1:

1. Tier 1 should include "the top-level design features and performance characteristics" that are "the most significant to safety."
2. Tier 1 descriptions should typically be at a qualitative and functional level of detail.
3. The level of detail is governed by a graded approach based on safety significance.
4. Tier 1 should not include detail that could necessitate NRC approval for departures from the certified design that have minimal safety significance. Nonetheless, Tier 1 should still reflect the specific safety-significant features of the design and not just include general statements that apply to classes of reactors.
5. The acceptance criteria in ITAAC should generally be "objective and unambiguous." This can be accomplished if the acceptance criteria clearly state the functional requirement and Tier 2 describes detailed methodologies and criteria for verifying that the functional requirement has been met.
6. Numeric values in Tier 1 should be minimized. Numeric values could be used for basic design descriptions (e.g., numbers of modules, pumps, or diesel generators) or where a deviation from the value clearly indicates a failure to meet fundamental design criteria. Otherwise, specific numeric values should be only in Tier 2.
7. The use of codes and standards in Tier 1 should be minimized, as discussed in SRP Section 14.3. If a code is referenced in Tier 1, the specific edition, date, etc. should be specified in Tier 2 rather than Tier 1 to provide flexibility.

These principles are largely taken from SRP Section 14.3, but principles 2, 4, and 6 in the list above are from SECY-19-0034. Principles 2, 4, and 6 are intended to lead to a more judicious selection of information to be included in Tier 1. With respect to numeric values, SECY-19-0034 acknowledges that applicants might wish to include numeric values in Tier 1 beyond what the staff now proposes. In such cases the staff stated that it will entertain alternatives to the staff's revised position on numeric values. For example, structural dimensions might be retained in Tier 1 as a design goal, but construction deviations from these values would be allowed if a reconciliation analysis shows that the as-built structure still accomplishes its required functions. Other examples include the use of bounding values or appropriate tolerances.

Because SECY-19-0034 was finalized only shortly before completion of the Phase 2 Chapter 14 SER, the staff and applicant have not yet applied principles 2, 4, and 6 to the NuScale Tier 1 as a whole; this will be addressed before Phase 4 is completed. However, the staff did apply these principles to the NuScale structural integrity review, and even before development of SECY-19-0034, the staff has been taking a more judicious approach to the inclusion of information in the NuScale Tier 1.

The NuScale Tier 1 information includes the following:

- definitions and general provisions
- design descriptions
- ITAAC
- significant site parameters
- significant interface requirements

The applicant intends to have this Tier 1 information certified in a design certification (DC) rulemaking pursuant to Subpart B of 10 CFR Part 52, "Standard Design Certifications." The Tier 1 design descriptions are binding requirements for the life of a facility referencing the certified design.

The Tier 1 design descriptions, interface requirements, and site parameters are derived from Tier 2 information. The staff's review of how the underlying Tier 2 information satisfies the NRC's regulations is documented throughout this SER, and these conclusions also apply to the same information included in Tier 1. Thus, for the Tier 1 design descriptions, interface requirements, and site parameters, the additional staff review is limited to addressing whether Tier 1 includes appropriate information from Tier 2.

The purpose of the ITAAC portion of the Tier 1 information is to verify that a facility referencing the DC has been constructed and will be operated in accordance with the certified design, the Atomic Energy Act of 1954, as amended, and applicable regulations. The principal performance characteristics and safety functions of the structures, systems, and components (SSCs) are verified by the appropriate ITAAC.

14.3.1.2 Summary of Application

DCA Part 2, Tier 1: The Tier 1 information is summarized below.

Definitions and General Provisions: The definitions and general provisions are provided in DCA Part 2, Tier 1, Sections 1.1, "Definitions," and 1.2, "General Provisions."

Design Descriptions: Design descriptions are provided in each subsection of DCA Part 2, Tier 1, Section 2.0, "Unit Specific Structures, Systems, and Components Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria," and Section 3.0, "Shared Structures, Systems, and Components and Non-Structures, Systems, and Components Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria." The unit-specific descriptions in Tier 1, Section 2 apply to each NuScale module, while Tier 1, Section 3 addresses SSCs that support multiple NuScale modules.

ITAAC: The ITAAC are provided in Sections 2.0 and 3.0 of DCA Part 2, Tier 1.

Significant Interface Requirements: The significant interface requirement is described in DCA Part 2, Tier 1, Section 4.0, "Interface Requirements," and is associated with site-specific structures.

Significant Site Parameters: The significant site parameters are provided in DCA Part 2, Tier 1, Section 5.0, "Site Parameters."

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Section 14.3, "Certified Design Material and Inspections, Tests, Analyses, and Acceptance Criteria," discusses the development of Tier 1. DCA Part 2, Tier 2, Section 14.3.2, "Tier 1 Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria First Principles," describes the criteria used to identify the scope of Tier 1 design descriptions and the scope of the ITAAC. DCA Part 2, Tier 2 Section 14.3.3 describes the organization of Tier 1 information. DCA Part 2, Tier 2 Section 14.3.4 provides information on the definitions, general provisions, acronyms, abbreviations, and figures used in Tier 1. DCA Part 2, Tier 2 Sections 14.3.5 and 14.3.6 distinguish between those design descriptions and ITAAC that apply to a specific unit or module versus those that are shared by multiple modules. DCA Part 2, Tier 2 Sections 14.3.7 and 14.3.8 discuss interface requirements and site parameters, respectively.

ITAAC: The ITAAC are provided in Sections 2.0 and 3.0 of the DCA Part 2, Tier 1.

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

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

14.3.1.3 Regulatory Basis

The following NRC regulation contains the relevant requirements for this review:

- 10 CFR 52.47(b)(1), which requires that a DC application include the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will operate in accordance

with the DC, the provisions of the Atomic Energy Act of 1954, as amended (AEA), and the NRC's rules and regulations.

- 10 CFR 52.47(a)(26), which requires that a DC application provide justification that compliance with the interface requirements of 10 CFR 52.47(a)(25) is verifiable through inspections, tests, or analyses. The method to be used for verification of interface requirements must be included as part of the proposed ITAAC required by 10 CFR 52.47(b)(1).

NUREG-0800, SRP Section 14.3, describes the regulatory basis for acceptance of the ITAAC associated with a DC application, as modified by SECY-19-0034. In reviewing the ITAAC, the staff also considered the guidance in NRC Regulatory Issue Summary (RIS) 2008-05, Revision 1, "Lessons Learned to Improve Inspections, Tests, Analyses, and Acceptance Criteria Submittal," dated September 23, 2010. Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants – Light Water Reactor Edition," issued June 2007, provides combined license (COL) applicants referencing a certified design with guidance on the development of site-specific ITAAC and the use of ITAAC contained in a certified design. The DCA Part 2, Tier 1 information provides the principal design bases and design characteristics that are proposed for certification by the 10 CFR Part 52 rulemaking process.

14.3.1.4 Technical Evaluation

14.3.1.4.1 DCA Part 2, Tier 2

The staff notes that significant portions of DCA Tier 2, Section 14.3.2, are extracted from a Nuclear Energy Institute white paper that the NRC has not reviewed or approved. This document was submitted on June 14, 2017, and is titled "First Principles for Use in Developing Design Certification Tier 1 Information and Inspections, Tests, Analyses, and Acceptance Criteria [ITAAC]" (ADAMS Accession No. ML17235A591). It describes "first principles" that are used to determine the scope of Tier 1 design descriptions and ITAAC. The staff explicitly excludes DCA Part 2, Tier 2, Section 14.3.2, from its review of this DCA and does not take a position on the "first principles" described in this section. DCA Part 2, Tier 2, Section 14.3.2 will not be incorporated by reference into a design certification rule for the NuScale design.

DCA Part 2, Tier 2, Section 14.3.1 provides an introduction and lists two COL information items which are discussed below. DCA Part 2, Tier 2, Sections 14.3.3 through 14.3.6 describe the content and organization of Tier 1 information and includes information on the definitions, general provisions, acronyms, abbreviations, and figures used in Tier 1. The staff notes that the applicant organized the Tier 1 design descriptions and ITAAC based on the structures and systems of the NuScale design rather than on the format of the SRP. The staff reviewed the information in these sections and finds it consistent with guidance in SRP Section 14.3 and is acceptable.

14.3.1.4.2 DCA Part 2, Tier 1

14.3.1.4.2.1 Definitions, General Provisions, Design Descriptions, and ITAAC

In accordance with SRP Section 14.3, DCA Part 2, Tier 1, information should identify the principal performance characteristics and safety functions of the standard design. The design information includes design commitments that identify those features and capabilities that are necessary for compliance with the AEA and NRC rules and regulations, and that are to be

verified by ITAAC. As required by 10 CFR 52.47(b)(1), the proposed ITAAC must be necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses (ITA) are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will operate in accordance with the DC, the provisions of the AEA, and the NRC's rules and regulations.

For the ITAAC to be "sufficient" as required by 10 CFR 52.47: (1) the (ITA) must clearly identify those activities necessary to demonstrate that the acceptance criteria (AC) are met; (2) the AC must state clear design or performance objectives demonstrating that the Tier 1 design commitments are satisfied; (3) the ITA and AC must be consistent with each other and the Tier 1 design commitment; (4) the ITAAC must be capable of being performed and satisfied prior to fuel load; and (5) the ITAAC, as a whole, must provide reasonable assurance that, if the ITAAC are satisfied, the facility has been constructed and will be operated in accordance with the DC, the AEA, and the NRC's rules and regulations.

Sections 14.3.2 through 14.3.13 of this SER discuss the technical adequacy of the ITAAC listed in DCA Part 2, Tier 1, Sections 2.0 and 3.0. These SER sections either document the staff's review of the technical adequacy of the ITAAC or identify other sections of the SER where the staff's review is being documented.

As described in Section 17.4, "Reliability Assurance Program," of this SER, the applicant did not propose an ITAAC for the design reliability assurance program (D-RAP). This is not consistent with the NRC's expectations as documented in SRP Section 17.4, Revision 1, "Reliability Assurance Program." However, the NRC is currently reconsidering whether an ITAAC for D-RAP is necessary. The NRC staff has submitted a paper to the Commission proposing that design certification and combined license applicants no longer be expected to submit an ITAAC for the D-RAP (ADAMS Accession No. ML18192B471). The Commission has not yet taken a position on the staff's proposal. If the Commission rejects the staff's proposal, the staff will ask NuScale to amend its application to provide an ITAAC for D-RAP. If the Commission accepts the staff's proposal, then the applicant will not need to take any further action. This issue is tracked as **Open Item 17.4-1.**

The staff conducted a review of DCA Part 2, Tier 1 definitions, general provisions, and ITAAC tables for form and clarity in accordance with the guidance provided in SRP Section 14.3 and RIS 2008-05. The staff issued RAI 9681, Question 14.03.01-1 (ADAMS Accession No. ML19151A027), requesting the applicant make wording changes based on NRC guidance, and lessons learned from plants that are currently under construction that are in the process of implementing ITAAC. This is being tracked as **Open item 14.3.1-1**.

14.3.1.4.2.2 Site Parameters

The staff evaluates Tier 1 site parameters in Chapter 2 of this SER.

14.3.1.4.2.3 Interface Requirements

DCA Part 2, Tier 1 Section 4.1, "Site-Specific Structures," states "[f]ailure of any of the site-specific structures within the scope of the NuScale Power Plant certified design will not cause any of the Seismic Category I structures within the scope of the NuScale Power Plant-certified design to fail." The staff's evaluation of this interface requirement and the basis for the staff's finding that they meet 10 CFR 52.47(a)(25) can be found in Section 3.7.2, "Seismic System Analysis," of this SER. ITAAC Number 7 in DCA Part 2, Tier 1, Table 3.11-2 and ITAAC

Number 5 in DCA Part 2, Tier 1, Table 3.13-1 verify that as-built non-Seismic-Category-I SSCs located where a potential for adverse interaction with a Seismic Category I SSC exists will not impair the ability of the Seismic Category I SSC to perform its safety functions during or following a safe shutdown earthquake (SSE). These ITAAC are evaluated in Section 14.3.2 of this SER. As discussed in SER Section 14.3.2, ITAAC Number 7 in DCA Part 2, Tier 1, Table 3.11-2 is acceptable, but the acceptability of ITAAC Number 5 in DCA Part 2, Tier 1, Table 3.13-1 is **Open Item 14.3.2-2**. Because of this open item, the staff cannot yet find that the provisions of 10 CFR 52.47(a)(26) have been met.

14.3.1.4.2.4 Combined License Information Items

Table 14.3.1-1 lists combined license (COL) information item numbers and descriptions related to this area of the review from DCA Part 2, Tier 2, Table 1.8-2, "Combined License Information Items." COL Item 14.3-1 is evaluated in Section 13.3.5 of this SER. Regarding COL Item 14.3-2 the staff agrees that it is the COL applicant's responsibility to provide the site-specific selection methodology and ITAAC for site-specific SSCs.

Table 14.3.1-1 NuScale Combined License Information Items for Section 14.3.1

Item No.	***Description***	***Tier 2 Section***
14.3-1	A COL applicant that references the NuScale Power Plant design certification will provide the site-specific selection methodology and inspections, tests, analyses, and acceptance criteria for emergency planning.	14.3-1
14.3-2	A COL applicant that references the NuScale Power Plant design certification will provide the site-specific selection methodology and inspections, tests, analyses, and acceptance criteria for structures, systems, and components within their scope.	14.3-1

14.3.1.5 Conclusion

The staff has not developed any conclusions given the open items.

14.3.2 Structural and Systems Engineering - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.2.1 Introduction

NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP) Section 14.3.2, "Structural and Systems Engineering—Inspections, Tests, Analyses, and Acceptance Criteria," issued March 2007, addresses the inspections, tests, analyses, and acceptance criteria (ITAAC) for building structures and structural aspects of major components such as the reactor pressure vessel. This section documents the U.S. Nuclear Regulatory Commission (NRC) staff's review of ITAAC proposed by the applicant in Design Control Application (DCA) Part 2, Tier 1, Section 3.11, "Reactor Building," Section 3.12, "Radioactive Waste Building," and Section 3.13, "Control Building."

14.3.2.2 Summary of Application

DCA Part 2, Tier 1: The applicant provided a summary design description and ITAAC for Reactor Building (Section 3.11), Radioactive Waste Building (Section 3.12), and Control Building (Section 3.13) structures, systems, and components (SSCs) that are common to or shared by all NuScale Power Modules in DCD Tier 1, Section 3.0, "Shared Structures, Systems, and Components and Non-structures, Systems, and Components Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria."

DCA Part 2, Tier 2: In DCD Tier 2, Table 14.3-2, "Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," the applicant provides a background discussion of ITAAC associated with the Tier 1 design commitments for the reactor building, radioactive waste building, and control building.

ITAAC: The following tables in DCA Part 2, Tier 1 summarize the ITAAC applicable to this review area:

- Table 3.11-2, "Reactor Building ITAAC," Numbers 6 and 7
- Table 3.12-2, "Radioactive Waste Building ITAAC," Number 3
- Table 3.13-1, "Control Building ITAAC," Numbers 4 and 5

The staff notes that the control building ITAAC is also applicable to the control building (CRB) tunnel since the CRB tunnel is a part of the CRB structure.

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

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

14.3.2.3 Regulatory Basis

The following NRC regulation contains the relevant requirements for this review:

- Title 10 of the *Code of Federal Regulations* (10 CFR) 52.47(b)(1) requires that a design certification application contains the ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification has been

constructed and will be operated in accordance with the design certification; the provisions of the Atomic Energy Act of 1954, as amended; and NRC rules and regulations.

The applicable acceptance criteria used to meet the above relevant requirements of the NRC regulations is summarized below:

- In a letter dated April 8, 2016, the NRC staff transmitted to NuScale a set of Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) that could be used in its design certification application.

The staff is reviewing DCA Part 2, Tier 1, for the type of information and the level of detail discussed in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," issued March 2007, as modified by SECY-19-0034, (dated April 8, 2019) (ADAMS Accession No. ML19080A032).

14.3.2.4 Technical Evaluation

The staff reviewed the ITAAC information in DCA Part 2, Tier 1 and Tier 2 described above. The staff reviewed the structural design descriptions for reactor, radioactive waste, and control building structures in DCA Part 2, Tier 1 Sections 3.6, 3.11, 3.12 and 3.13, and finds that the level of structural information provided is consistent with that included in the enclosure to SECY-19-0034 covering the level of structural information that should be in Tier 1.

14.3.2.4.1 As-Built Reconciliation

The acceptance criterion in SRP Section 14.3.2.II.11 regarding as-built reconciliation states that ITAAC for safety-related structures should be established "to ensure that the final as-built plant structures are built in accordance with the certified design as required by 10 CFR Part 52, structural analyses should be performed which reconcile the as-built configuration of the plant structures with the structural design bases of the certified design. The structural analyses should be documented in structural analysis reports. Structural analysis reports should be verified in conjunction with ITAAC."

14.3.2.4.2 ITAAC for Structural Integrity of Safety-Related Structures

The staff's review focus is on whether ITAAC confirm that post-construction, the design parameters used in the design certification are not exceeded and that the deviations between the as-built structure and the certified design are reconciled to demonstrate that the deviations from the certified design made during construction are within the design code limits. This provides the staff reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a plant that incorporates the design certification has been constructed and will be operated as required.

The staff's review finds that the structural integrity ITAAC for the reactor building, radioactive waste building, and control building structures are not complete. These ITAAC are identified in DCA, Part 2, Tier 1, as ITAAC Number 6 in Table 3.11-2, ITAAC Number 3 in Table 3.12-2, and ITAAC Number 4 in Table 3.13-1. These ITAAC state that, based on inspection and analysis, a design report will reconcile deviations between the drawings used for construction and as-built conditions to verify that the structure maintains its structural integrity under design basis loads.

However, the application did not provide details regarding reconciling deviations in design-basis loads and as-built configuration and did not state that the design report will document the demand analysis using the same methodology used for the certification. The application did not address the deviations between assumed design loads and as-constructed loads, nor did it address the changes in demand resulting from these deviations. The staff notes that reconciliation of deviations from the design basis structural configuration and design basis loads require a structural response analysis of as-built structure configuration and loads to demonstrate that (1) the structural demand/capacity (D/C) ratio of 1.0 is not exceeded, and (2) in-structure seismic response is accommodated by the approved design seismic response. The staff also reviewed the corresponding discussions of these ITAAC in DCA Part 2, Tier 2, Table 14.3-2. The staff finds that the Tier 1 is based on and consistent with the Tier 2 information, but since these structural integrity ITAAC are incomplete the associated Tier 2 discussions are also incomplete.

The ITAAC for the structural integrity of the reactor, radioactive waste, and control buildings is **Open Item 14.3.2-1**.

14.3.2.4.3 ITAAC for Seismic Interaction of Seismic Category I SSCs / non-Seismic Category I SSCs

The applicant provided ITAAC to verify that as-built non-Seismic-Category-I SSCs located where a potential for adverse interaction with a Seismic Category I SSC exists will not impair the ability of the Seismic Category I SSC to perform its safety functions during or following a safe shutdown earthquake (SSE). These ITAAC are identified in DCA, Part 2, Tier 1, as ITAAC Number 7 in Table 3.11-2, and ITAAC Number 5 in Table 3.13-1 for the reactor building and the control building, respectively. The ITAAC Number 7 in Table 3.11-2, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-2, conform to the Standardized DCA ITAAC design commitments and associated Tier 2 discussion in the NRC's April 8, 2016 letter. Also, the staff finds that the Tier 1 design descriptions and ITAAC are based on and consistent with the Tier 2 material. Therefore, the staff finds the ITAAC Number 7 in Table 3.11-2 for the reactor building sufficient to verify that as-built seismic category I structures are protected from adverse seismic interaction with non-Seismic-Category-I SSCs. However, the staff finds ITAAC Number 5 in Table 3.13-1 insufficient to verify for the control building that as-built seismic category I structures are protected from adverse seismic interaction with non-Seismic-Category-I SSCs. The first bullet of the acceptance criteria for this ITAAC states "[t]he collapse of the non-seismic Category I structure to strike a seismic Category I SSC." This is not an acceptance criterion and uses the term, "collapse," which is ambiguous and undefined. An SSC need not collapse to strike a seismic Category I SSC because it can have adverse interactions with a Seismic Category I SSC due to large deformations without collapsing. In addition, this ITAAC does not conform to the Standardized DCA ITAAC acceptance criteria and associated Tier 2 discussion in the NRC's April 8, 2016 letter. The staff also reviewed the corresponding discussions of this ITAAC in DCA Part 2, Tier 2, Table 14.3-2. The staff finds that the Tier 1 is based on and consistent with the Tier 2 information, but since the ITAAC is insufficient, the associated Tier 2 discussions are also insufficient.

The ITAAC for the seismic interaction of seismic category I SSCs with non-seismic category SSCs of the control building is **Open Item 14.3.2-2**.

14.3.2.5 Combined License Information Items

The applicant did not identify any COL information items associated with ITAAC for the certified reactor building, radioactive waste building, and the control building structures.

14.3.2.6 Conclusion

The staff reviewed building descriptions and the ITAAC for the reactor building, radioactive waste building, and the control building structures in DCA Part 2, Tier 1 Sections 3.6, 3.11, 3.12 and 3.13, and the ITAAC background discussion in DCD Tier 2, Table 14.3.2 to ensure that the final as-built condition of these structures is reconciled to conform to the certified design basis for the structural design. The NRC staff finds that design descriptions for these building structures in DCA Part 2, Tier 1 is consistent with that included in enclosure to SECY-19-0034 covering the level of structural information in Tier 1.

Based on the above open items, the staff cannot conclude that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the NuScale design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, as amended, and NRC rules and regulations.

14.3.3 Piping Systems and Components - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.3.1 Introduction

A design certification (DC) application (DCA) is required by 10 CFR 52.47(b)(1) to contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a facility that incorporates the DC has been constructed and will operate in conformity with the DC; the provisions of the Atomic Energy Act of 1954, as amended (AEA); and the Commission's rules and regulations. ITAAC are identified in DCA Part 2, Tier 1, and this section reviews those ITAAC and the associated Tier 1 design descriptions applicable to piping and components.

14.3.3.2 Summary of Application

DCA Part 2, Tier 1: DCA Part 2, Tier 1 (Revision 2), Sections 2.1, 2.2, 2.8, 3.1, 3.5, 3.6, 3.11, and 3.14 contain piping and vessel related design information and ITAAC.

DCA Part 2, Tier 2: DCA Part 2, Tier 2 (Revision 2), Section 14.3, discusses the organization of DCA Part 2, Tier 1, which includes design descriptions, interface requirements, and site parameters that are derived from Tier 2 information. DCA Part 2, Tier 2, Table 14.3-1, "Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," describes how the module-specific ITAAC will be performed. DCA Part 2, Tier 2, Table 14.3-2, "Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," describes how the shared/common system and non-SSC ITAAC will be performed.

ITAAC: The following DCA Part 2, Tier 1, tables contain the ITAAC applicable to this review area:

- Table 2.1-4, "NuScale Power Module ITAAC," Numbers 1–6
- Table 2.1-4, "NuScale Power Module ITAAC," Numbers 12–15
- Table 2.1-4, "NuScale Power Module ITAAC," Numbers 18–21
- Table 2.2-3, "Chemical and Volume Control System ITAAC," Numbers 1, 2, 3, and 5
- Table 2.8-2, "Equipment Qualification ITAAC," Numbers 1, 3, 6, and 7
- Table 3.1-2, "Control Room Habitability System ITAAC," Numbers 2 and 3
- Table 3.5-1, "Fuel Storage System ITAAC," Number 1
- Table 3.6-2, "Ultimate Heat Sink Piping System ITAAC," Number 1
- Table 3.11-2, "Reactor Building ITAAC," Number 8
- Table 3.14-2, "Equipment Qualification—Shared Equipment ITAAC," Number 1

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

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

14.3.3.3 Regulatory Basis

The following NRC regulation contains the relevant requirement for this review:

- 10 CFR 52.47(b)(1) requires that the DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that if the inspections, tests, and analyses are performed and the acceptance criteria are met, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the AEA, and the Commission's rules and regulations.

The guidance in SRP Section 14.3.3, "Piping Systems and Components—Inspections, Tests, Analyses, and Acceptance Criteria," dated March 2007 lists the acceptance criteria adequate to meet the above requirement and includes review interfaces with other SRP sections.

14.3.3.4 Technical Evaluation

SRP Section 14.3.3 discusses nine specific areas related to piping and components. They are piping stress analysis, pipe break analysis, leak-before-break (LBB) evaluation, as-built reconciliation, piping and component safety classification, fabrication (welding), hydrostatic testing, seismic and dynamic qualification of equipment, and valve qualification. The staff's Tier 1 and Tier 2 technical evaluation of the piping stress analysis, pipe break analysis, LBB analysis, piping and component safety classification, environmental and seismic and dynamic qualification of equipment, and valve qualification is discussed in Sections 3.12, 3.6.2, 3.6.3, 3.2.2, 3.10 and 3.11, and 3.9.6 of this SER, respectively.

The staff issued several requests for additional information (RAIs) to NuScale to resolve staff questions on the information in the original DCA Part 2 submittal. In response to the RAIs, NuScale revised DCA Part 2 to clarify specific information with respect to the ITAAC for structures, systems, and components (SSCs). In this safety evaluation report (SER) section, the staff focuses on how the revised DCA Part 2 complies with 10 CFR 52.47(b)(1) and conforms with the applicable NRC guidance, rather than discussing each RAI and NuScale response.

Prior to the submittal of the NuScale application, the NRC staff reviewed the DCA Part 2, Tier 1, material to ensure that it was consistent with the material contained in DCA Part 2, Tier 2, in accordance with Review Procedure 2 of SRP Section 14.3.3. The staff has confirmed that the revised DCA Part 2 is consistent with the guidance in SRP Section 14.3.3. The staff has also reviewed the contents of DCA Part 2, Tier 1 and ensured that it contains the top-level design features expected for the piping and components of the design. These top-level design features include: compliance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code, Section III, protection of safety-related SSCs from dynamic and environmental effects of postulated piping failures, leak-before-break analysis, safety classification, and qualification and testing of equipment.

The NRC staff participated in a joint effort with the Nuclear Energy Institute to develop draft standardized ITAAC and discussed them at a series of public meetings where NuScale personnel were significant participants. The NRC staff shared a draft set of standardized ITAAC

with NuScale in a letter dated April 8, 2016 (ADAMS Accession No. ML16096A132). The agency sent a followup letter on June 21, 2016 (ADAMS Accession No. ML16160A109). NuScale requested a public meeting with the NRC staff on July 20, 2016, to discuss comments on the incorporation of the standardized ITAAC for the NuScale design. Materials from this meeting are available at ADAMS Accession Nos. ML16193A048 and ML16195A391. The staff based its review of NuScale's ITAAC and the supporting discussion in DCA Part 2, Tier 2 Tables 14.3-1 and 14.3-2 on the staff's standardized ITAAC guidance.

It should also be noted that significant portions of Tier 2, Section 14.3.2 of NuScale's application, are extracted from an NEI document that has not been reviewed or approved by the NRC. This document describes "First Principles," that were used by NuScale to determine the scope of DCA Part 2, Tier 1, design descriptions and ITAAC. The NRC review conducted for SRP Section 14.3.3 explicitly does not take a position on these "First Principles," but rather bases its safety findings on the sufficiency of the proposed ITAAC to meet the regulatory requirements of 10 CFR 52.47(b)(1). The philosophy or methodology used to arrive at an acceptable set of ITAAC is not endorsed through this review, only the ITAAC themselves.

14.3.3.4.1 Reactor Vessel Materials

SER Section 5.3.1 discusses the staff's review of reactor vessel materials. In DCA Part 2, Tier 1, Table 2.1-4, ITAAC Number 6, for Charpy testing of reactor pressure vessel beltline material, and ITAAC Number 12, for reactor pressure vessel surveillance capsule holders, follow the standardized ITAAC guidance provided to NuScale. As these ITAAC and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 satisfy the guidance and contain wording previously found acceptable by the NRC staff, these ITAAC and the associated Tier 2 discussion are found to be acceptable.

14.3.3.4.2 Generic Piping Design

14.3.3.4.2.1 Piping Stress Analysis

SER Section 3.12 discusses the staff's review of the piping stress analysis. ITAAC Number 1 in DCA Part 2, Tier 1, Tables 2.1-4, 2.2-3, and 3.6-2 require the ASME BPV Code Class 1, 2 and 3 as-built piping systems to comply with ASME BPV Code, Section III, requirements through the completion of ASME BPV Code, Section III, Design Reports. As noted in the DCA Part 2, Tier 2, Table 14.3-1 discussion for ITAAC Number 1 in DCA Part 2, Tier 1, Table 2.1-4, the ASME BPV Code requires a Design Report for each ASME BPV Code Class 1, 2, and 3 component (including piping systems), in accordance with NCA-3550. This Design Report must be reconciled with the as-built component in accordance with NCA-3554. The applicant's proposed ITAAC and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 for compliance with ASME BPV Code, Section III, are consistent with the standardized ITAAC guidance discussed above. Based on the technical review conducted in Section 3.12 of this SER, which concludes that the piping stress analysis methodologies are consistent with ASME BPV Code, Section III requirements, and based on the applicant's use of proposed ITAAC and associated discussion in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 that are consistent with the standardized ITAAC guidance, the NRC staff finds these ITAAC acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for piping stress analysis.

14.3.3.4.2.2 Pipe Break Analysis

The staff's review of pipe break analysis is discussed in Section 3.6.2 of this SER. As part of this review, a scope issue was noted regarding the ITAAC associated with this review.

The ITAAC for protection of safety-related SSCs from dynamic and environmental effects (DCA Part 2, Tier 1, Table 2.1-4, Number 4) is in the section for the NuScale Power Module. However, this ITAAC did not cover the full scope of the plant area for the certified design where pipe breaks may be postulated. The staff determined that the ITAAC should either be relocated to a broader section of DCA Part 2, Tier 1, or duplicated so as to provide full coverage of the areas requiring analysis for the protection of safety-related SSCs from dynamic and environmental effects.

As part of its review, the staff requested the applicant to ensure the full scope of the plant area was addressed for postulated pipe breaks (ADAMS Accession No. ML17251A862). In its response to RAI 9087, Question 14.03.03-1, dated November 2, 2017 (ADAMS Accession No. ML17306A530), the applicant clarified that the areas covered by DCA Part 2, Tier 1, Table 2.1-4, ITAAC Number 4, were those up to and including the reactor pool bay wall, and those areas beyond the reactor pool bay wall were covered by COL Item 3.6-3. In addition, the applicant proposed a new ITAAC (DCA Part 2, Tier 1, Table 3.11-2, Number 8) to satisfy this COL item. The staff has confirmed that DCA Part 2, Tier 1, includes the new ITAAC, such that the full scope of the plant area for the certified design where pipe breaks may be postulated is now covered by ITAAC. In addition, the applicant revised the DCA to clarify ITAAC Number 4 in DCA Part 2, Tier 1, Table 2.1-4, and ITAAC Number 8 in DCA Part 2, Tier 1, Table 3.11-2.

The applicant's proposed ITAAC, located in ITAAC tables for the NuScale Power Module and the reactor building, and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 for pipe break analysis, are consistent with the standardized ITAAC guidance discussed above. Therefore, based on the technical review conducted in SER Section 3.6.2, which determines the technical adequacy of the applicant's pipe break analysis methodologies, and the applicant's use of proposed ITAAC and associated Tier 2 discussion consistent with the standardized ITAAC guidance discussed above, the staff finds that these ITAAC and associated discussion are acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for pipe break analysis.

14.3.3.4.2.3 Leak-Before-Break Evaluation

The staff's review of LBB analysis is discussed in Section 3.6.3 of this SER. During the course of this review, no ITAAC issues were identified. The applicant's proposed ITAAC for LBB analysis; specifically, ITAAC Number 5 in DCA Part 2, Tier 1, Table 2.1-4, and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 is consistent with the standardized ITAAC guidance discussed above. Therefore, based on the technical review conducted in SER Section 3.6.3, which determines the technical adequacy of the applicant's LBB analysis methodologies, and the applicant's use of proposed ITAAC and associated Tier 2 discussion consistent with the standardized ITAAC guidance discussed above, the staff finds this ITAAC and associated discussion acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for LBB analysis.

14.3.3.4.2.4 As-Built Reconciliation

The topic of as-built reconciliation is covered through ITAAC requiring that as-built ASME BPV Code piping and components meet the requirements of ASME BPV Code, Section III. As noted in the DCA Part 2, Tier 2, Table 14.3-1 discussion for ITAAC Number 1 in DCA Part 2, Tier 1 Table 2.1-4, the ASME BPV Code requires a Design Report for each ASME BPV Code Class 1, 2, and 3 component, in accordance with NCA-3550. This Design Report must be reconciled with the as-built component per NCA-3554. This reconciled Design Report ensures that the as-built design meets the ASME BPV Code requirements, but does not ensure the adequacy of construction activities. ASME BPV Code, Section III, also requires that a Data Report be prepared to verify that the ASME BPV Code requirements are met for the as-built components. A Data Report (which includes the previously mentioned reconciled Design Report) addresses the adequacy of construction for each component and ensures that the as-built component meets the ASME BPV Code requirements.

ITAAC Number 1 in DCA Part 2, Tier 1, Tables 2.1-4, 2.2-3, and 3.6-2 verify compliance with ASME BPV Code, Section III, requirements for ASME BPV Code Class 1, 2, and 3 piping systems through inspection of ASME BPV Code, Section III, Design Reports for as-built piping systems. These ITAAC and the associated Tier 2 discussion are acceptable, as discussed in SER Section 14.3.3.4.2.1. ITAAC Numbers 2 and 3 in DCA Part 2, Tier 1, Table 2.1-4, ITAAC Number 2 in DCA Part 2, Tier 1, Table 2.2-3, and ITAAC Number 1 in DCA Part 2, Tier 1, Table 3.5-1 verify that the ASME BPV Code Class 1, 2, 3, NF, and CS components and interconnecting piping comply with ASME BPV Code, Section III, requirements through the completion of ASME BPV Code, Section III, Data Reports for the ASME BPV Code Class 1, 2, 3, NF, and CS components and interconnecting piping. The applicant's proposed ITAAC and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 for as-built reconciliation are consistent with the standardized ITAAC guidance discussed above. As these ITAAC and associated Tier 2 discussion are aligned with the staff-approved standardized ITAAC guidance for as-built reconciliation for ASME BPV Code, Section III, compliance, the staff finds these ITAAC and associated discussion acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for as-built reconciliation for ASME BPV Code, Section III, components and interconnecting piping, with the exception of DCA Part 2, Tier 1 Section 3.6, which does not include an ITAAC for adequacy of construction activities (Data Report). DCA Part 2, Tier 1 Section 3.6 will be revised as indicated in a letter from NuScale dated April 4, 2019 (ADAMS Accession No, ML19094B587). The staff finds the applicant's proposed changes to be acceptable because they rectify the omission identified by the staff. The proposed changes are being tracked as **Confirmatory Item 14.3.3-1**.

14.3.3.4.3 Verifications of Components and Systems

14.3.3.4.3.1 Piping and Component Safety Classification

The NRC staff's review of piping and component safety classification is discussed in Section 3.2.2 of this SER. The safety classification of piping and components is a topic that is resolved during the design certification phase, with the exception of any site-specific elements, which will be reviewed during the review of a COL application.

Based on the technical review conducted in SER Section 3.2.2, the staff has identified no specific ITAAC that are required for piping and component safety classification in order to meet the requirements of 10 CFR 52.47(b)(1). The safety classifications assigned in the DCA will be

confirmed through the previously mentioned as-built reconciliation ITAAC which will ensure that the as-built piping and components are constructed in accordance with the assigned classifications

14.3.3.4.3.2 Fabrication (Welding)

The topic of welding is covered in this section primarily through compliance with ASME BPV Code requirements. As previously discussed, the ASME BPV Code requires reports verifying that systems and components meet ASME BPV Code requirements, including welding. Because the topic of ASME BPV Code compliance has previously been discussed and found acceptable, there are no additional issues identified for this review area.

14.3.3.4.3.3 Pressure Testing

The staff's review of pressure testing is typically covered through compliance with ASME BPV Code requirements, as the pressure test (typically hydrostatic, but in some cases pneumatic) is a required element of Code compliance. The ASME BPV Code ITAAC proposed by the applicant satisfy the pressure-testing requirement, in that they require that the applicable ASME BPV Code Report demonstrate that the system meets ASME BPV Code requirements, which include pressure testing. Because the topic of ASME BPV Code compliance has previously been discussed and found acceptable, there are no additional issues identified for this review area.

14.3.3.4.3.4 Environmental and Seismic and Dynamic Qualification of Equipment

The staff's review of seismic and dynamic qualification of equipment is discussed in Section 3.10 of this SER. The staff's review of environmental qualification of mechanical and electrical equipment is discussed in Section 3.11 of this SER.

ITAAC Number 1 in DCA Part 2, Tier 1, Table 2.8-2, and ITAAC Number 1 in DCA Part 2, Tier 1, Table 3.14-2, verify the seismic and dynamic qualification of seismic Category I equipment, including its associated supports and anchorages. The scope of these ITAAC is limited to specific SSCs listed in DCA Part 2, Tier 1, Table 2.8-1, "Module Specific Mechanical and Electrical/I&C Equipment," and DCA Part 2, Tier 1, Table 3.14-1, "Mechanical and Electrical/Instrumentation and Controls Shared Equipment." The staff confirmed that the Tier 1 tables contain the required seismic Category I SSCs. The ITAAC and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 ensure that SSCs listed in the Tier 1 tables will be designed and built to the appropriate standard and remain functional during and after the design-basis earthquake. As the proposed ITAAC and associated Tier 2 discussion are consistent with the standardized ITAAC guidance discussed above, and based on the technical review conducted in SER Section 3.10, the staff finds these ITAAC and associated discussion acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for the seismic and dynamic qualification of SSCs.

The applicant proposed ITAAC Number 3 in DCA Part 2, Tier 1, Table 2.8-2, for the environmental qualification of nonmetallic parts, materials, and lubricants used in safety-related mechanical equipment. The proposed ITAAC and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 is consistent with the standardized ITAAC guidance discussed above. Therefore, based on this consistency and the technical review conducted in SER Section 3.11, the staff finds this ITAAC and the associated Tier 2 discussion acceptable for meeting the

requirements of 10 CFR 52.47(b)(1) for the environmental qualification of nonmetallic parts, materials, and lubricants used in safety-related mechanical equipment.

14.3.3.4.3.5 Valve Qualification

The NRC staff's review of valve qualification is discussed in Section 3.9.6 of this SER.

The staff issued RAI 9132, Question 14.03.03-3, dated September 29, 2017 (ADAMS Accession No. ML17272B013), asking the applicant to clarify the implementation of the ITAAC for the qualification and preoperational testing of safety-related valves identified in DCA Part 2, Tier 1, Section 2.1, "NuScale Power Module." On February 7, 2019 (ADAMS Accession No. ML19038A509), NuScale provided a proposed revision to DCA Part 2, Tier 2, Section 3.9, to clarify the qualification and preoperational testing of these safety-related valves. The staff considers the planned clarification of the DCA to be acceptable because the qualification and preoperational testing of safety-related valves will be performed under ASME QME-1-2007 as accepted in RG 1.100, and will meet the requirements of the ASME OM Code as incorporated by reference in 10 CFR 50.55a. Resolution of this issue is being tracked as **Confirmatory Item 14.3.3-2**.

The staff issued RAI 9133, Question 14.03.03-4, dated September 29, 2017 (ADAMS Accession No. ML17272B017), asking the applicant to clarify the implementation of ITAAC Number 3 and 5 for the qualification and preoperational testing of safety-related valves identified in DCA Part 2, Tier 1, Section 2.2, "Chemical and Volume Control System." On February 7, 2019 (ADAMS Accession No. ML19038A516), NuScale provided a proposed revision to DCA Part 2, Tier 2, Section 3.9, to clarify the qualification and preoperational testing of these safety-related valves. The staff considers the planned clarification of the DCA to be acceptable because the qualification and preoperational testing of safety-related valves will be performed under ASME QME-1-2007 as accepted in RG 1.100, and will meet the requirements of the ASME OM Code as incorporated by reference in 10 CFR 50.55a. Resolution of this issue is being tracked as **Confirmatory Item 14.3.3-3**.

Based on the safety significance of the proper performance of power-operated valves, the NRC staff considers the process of demonstrating the functional capability of safety-related power-operated valves in the NuScale Power Plant to be appropriate as a DCA Part 2, Tier 1, requirement that should not be modified without prior NRC review. The staff requested the applicant to specify the process for qualification of safety-related valves (ADAMS Accession No. ML17307A452). In its responses to RAI 9131, Question 14.03.03-6, dated December 27, 2017, and May 24, 2018 (ADAMS Accession Nos. ML17361A136 and ML18144A918), the applicant explained the intent of the term "Qualification Report," as used in ITAAC Number 6 in DCA Part 2, Tier 1, Table 2.8-2; namely, that use of the term "Qualification Report" refers to the ASME QME-1 Qualification Report, as defined in QR-4000 of ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," which requires adherence to the provisions of ASME QME-1-2007 in order to satisfy the report requirements. The staff has confirmed that DCA Part 2, Tier 1 and Tier 2 includes the clarification. The staff finds that the wording of ITAAC Number 6 in DCA Part 2, Tier 1, Table 2.8-2 and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1, is consistent with the standardized ITAAC guidance after incorporation of these changes. Based on this, as well as the technical review in SER Section 3.9.6, the NRC staff finds that ITAAC Number 6 in DCA Part 2, Tier 1, Table 2.8-2, and the associated discussion in DCA Part 2, Tier 2, Table 14.3-1 is acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for the functional qualification of safety-related valves.

The staff reviewed DCA Part 2, Tier 1, Section 2.8, "Equipment Qualification," to ensure it included all applicable safety-related valves and that ITAAC Number 6 in DCA Part 2, Tier 1, Table 2.8-2 for equipment qualification included qualification of safety-related valves in all environments, and their applicable fluid conditions. The proposed ITAAC Number 6 and the associated discussion in DCA Part 2, Table 14.3-1 is consistent with the standardized ITAAC guidance. Because the applicant includes ITAAC and associated Tier 2 discussion, for the equipment qualification of all safety-related valves in all environments and their applicable fluid conditions, that is consistent with the standardized ITAAC guidance, the staff finds the proposed ITAAC and associated discussion sufficient for the equipment qualification of safety-related valves.

NuScale proposed ITAAC for performance testing under preoperational temperature, differential pressure, and flow conditions for the containment system (CNTS) isolation valves (ITAAC Number 13 in DCA Part 2, Tier 1, Table 2.1-4), emergency core cooling system valves (ITAAC Number 14 in Table 2.1-4), DHRS valves (ITAAC Number 15 in Table 2.1-4), CNTS check valves (ITAAC Number 21 in Table 2.1-4), CVCS air-operated valves (ITAAC Number 3 in DCA Part 2, Tier 1, Table 2.2-3), and control room habitability system valves (ITAAC Number 2 in DCA Part 2, Tier 1, Table 3.1-2). The proposed ITAAC and associated discussion in DCA Part 2, Tier 2 Table 14.3-1 and Table 14.3-2 are consistent with the standardized ITAAC guidance for these preoperational tests. Based on this, as well as the technical review in SER Section 3.9.6, the NRC staff finds that the ITAAC and associated Tier 2 discussion listed above are acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for performance testing for valves under preoperational temperature, differential pressure, and flow conditions, subject to the resolution of RAI 9132, Question 14.03.03-3, which the staff is tracking as **Confirmatory Item 14.3.3-2**.

NuScale proposed ITAAC for loss of motive power testing under preoperational temperature, differential pressure, and flow conditions for the CNTS hydraulic-operated valves (ITAAC Number 18 in DCA Part 2, Tier 1, Table 2.1-4), emergency core cooling system reactor recirculation valves and reactor vent valves (ITAAC Number 19 in Table 2.1-4), DHRS hydraulic-operated valves (ITAAC Number 20 in Table 2.1-4), CVCS air-operated valves (ITAAC Number 5 in DCA Part 2, Tier 1, Table 2.2-3), and control room habitability system solenoid-operated valves (ITAAC Number 3 in DCA Part 2, Tier 1, Table 3.1-2). The proposed ITAAC and associated discussion in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 are consistent with the standardized ITAAC guidance for loss of motive power testing. Based on this, as well as the technical review in SER Section 3.9.6, the NRC staff finds that the ITAAC and Tier 2 associated discussion listed above are acceptable for meeting the requirements of 10 CFR 52.47(b)(1) for loss of motive power testing under preoperational temperature, differential pressure, and flow conditions for valves, subject to the resolution of RAI 9132, Question 14.03.03-3, which the staff is tracking as **Confirmatory Item 14.3.3-2**.

NuScale also proposed ITAAC Number 7 in DCA Part 2, Tier 1, Table 2.8-2, to demonstrate the set pressure, capacity, and overpressure design requirements for safety-related relief valves. The proposed ITAAC and associated discussion in DCA Part 2, Tier 2, Table 14.3-1 cover the full scope of safety-related relief valves and are consistent with the standardized ITAAC guidance for ASME BPV Code, Section III, Relief Valve Capacity Qualification. Therefore, the staff finds this ITAAC and the Tier 2 associated discussion acceptable for meeting the requirements of 10 CFR 52.47(b)(1) to demonstrate the set pressure, capacity, and overpressure design requirements for safety-related relief valves.

The proposed ITAAC in DCA Part 2 do not include ITAAC verifying the functional arrangement or installed configuration of the NuScale Power Module or CVCS in DCA Part 2, Tier 1, Sections 2.1 and 2.2, respectively. The NRC staff issued RAI 9135, Question 14.03.03-5, dated September 29, 2017 (ADAMS Accession No. ML17272B029), asking the applicant to include ITAAC to verify the functional arrangement or installed configuration of the previously mentioned systems. The applicant submitted an initial response to RAI 9135, Question 14.03.03-5, on November 21, 2017 (ADAMS Accession No. ML17325B432). The staff evaluated the applicant's supplemental response, dated June 11, 2018 (ADAMS Accession No.ML18162A354). During a public meeting on July 23, 2018 (ADAMS Accession No. ML18234A174), the applicant committed to providing another supplemental response to address this RAI. NuScale submitted this supplemental response on December 20, 2018 (ADAMS Accession No. ML18234A174). On February 6, 2019 (ADAMS Accession No. ML19038A022), the staff held a public meeting with NuScale indicating that NuScale needed to incorporate this ITAAC into DCA Part 2, Tier 1. The staff is tracking the resolution of RAI 9135, Question 14.03.03-5, as an **Open Item 14.3.3-1**.

14.3.3.5 Combined License Information Items

There are no COL items for this section.

14.3.3.6 Conclusion

The NRC staff reviewed the DCA Part 2, Tier 1, information in the NuScale DCA Part 2 in accordance with the guidance in SRP Section 14.3.3. Because of the presence of an open item, the staff cannot reach a safety finding at this time.

14.3.4 Reactor Systems - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.4.1 Introduction

This section of the safety evaluation report (SER) describes the staff's evaluation of information associated with reactor systems in the NuScale Design Certification Application (DCA) Part 2, Tier 1, Chapter 2 and Chapter 3, and DCA Part 2, Tier 2, Section 14.3, "Certified Design Material and Inspections, Tests, Analyses, and Acceptance Criteria." DCA Part 2, Tier 1, Chapter 2, contains design descriptions and associated inspections, tests, analyses, and acceptance criteria (ITAAC) for unit-specific systems that support a single NuScale Power Module (NPM). DCA Part 2, Tier 1, Chapter 3, contains design descriptions and associated ITAAC for systems that support multiple NPMs (shared or common systems). DCA Part 2, Tier 2, Section 14.3, describes NuScale's approach to the development of certified design material in Tier 1, including ITAAC. As required by 10 CFR 52.47(b)(1), the proposed ITAAC must provide reasonable assurance that, if the ITAAC are successfully completed, the facility has been constructed and will be operated in conformance with the design certification (DC), the Atomic Energy Act of 1954, as amended (AEA), and NRC rules and regulations.

14.3.4.2 Summary of Application

DCA Part 2, Tier 1: DCA Part 2, Tier 1, Section 2.1, "NuScale Power Module," Section 2.2, "Chemical and Volume Control System," Section 2.5, "Module Protection System and Safety Display and Indication System," Section 2.7, "Radiation Monitoring – Module Specific," Section 2.8, "Equipment Qualification," and Section 3.5, "Fuel storage System," provide design descriptions related to the reactor system. Top-level design information in DCA Part 2, Tier 1 is extracted from the more detailed design information presented in DCA Part 2, Tier 2. The Tier 1 design description consists of the system description and design commitments. The design features in the design commitments are verified by ITAAC.

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Section 14.3, provides a general description of, and information on, ITAAC for reactor systems. DCA Part 2, Tier 2, Section 14.3, contains information on ITAAC for the plant's reactor systems in Table 14.3-1, "Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," and Table 14.3-2, "Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference."

ITAAC: The applicant provided ITAAC tables for each of the systems listed in DCA Part 2, Tier 1, Chapters 2 and 3, that had Tier 1 design descriptions. ITAAC related to reactor systems are provided in Tier 1 Sections 2.1, 2.5, 2.7, 2.8, and 3.5, and these ITAAC are evaluated elsewhere in this report, as discussed below.

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

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

14.3.4.3 Regulatory Basis

The following NRC regulation contains the relevant requirement for this review:

- 10 CFR 52.47(b)(1) requires that the DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that if the inspections, tests, and analyses are performed and the acceptance criteria are met, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the AEA, and the Commission's rules and regulations.

The guidance in SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," dated March 2007 provides general guidance to the staff responsible for reviewing ITAAC for design certification. This section describes how previous design certification applications had implemented the requirements of Subpart B of 10 CFR Part 52 and, in addition, provides guidance and rationale of what should be included in the Tier 1 design descriptions, figures, and ITAAC for fluid systems.

The guidance in SRP Section 14.3.4, "Reactor Systems—Inspections, Tests, Analyses, and Acceptance Criteria," dated March 2007 lists the acceptance criteria adequate to meet the above requirement and includes review interfaces with other SRP sections. In addition, a letter dated April 8, 2016, from the NRC to NuScale provided a set of Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) that could be used in its design certification application.

14.3.4.4 Technical Evaluation

Except for the Open Items in Sections 14.3.3 and 14.3.6 of this SER related to the as-built reactor systems in DCA Part 2, Tier 1 and Tier 2, the staff makes the following overall conclusions regarding the reactor systems information in Tier 1. Consistent with SRP Section 14.3.4, the Tier 1 design descriptions and ITAAC adequately describe the top-level design features and performance characteristics that are significant to safety. The reactor systems staff reviewed the design description and system ITAAC, to confirm completeness and consistency with the system design basis as described in various DCA Part 2, Tier 2, sections and conclude the Tier 1 design description and ITAAC are based on and consistent with Tier 2 material. The reactor systems ITAAC, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 generally conform to the standardized DCA ITAAC, design commitments, and associated Tier 2 discussions in the NRC's April 8, 2016 letter.

The requirements of 10 CFR 52.47(b)(1) are met, in part, by identifying ITAAC to verify the top-level design features of the reactor systems in the design certification application.

The staff's review of the reactor systems' ITAAC are presented here, listed in order of the associated DCA Part 2, Tier 2, section.

14.3.4.4.1 Control Rod Drive System (DCA Part 2, Tier 2, Section 4.6)

DCA Part 2, Tier 1, Tables 2.1-4 and 2.8-2 provide ITAAC for Control Rod Drive System (CRDS) piping and components as defined in Tables 2.1-1, 2.1-2, 2.1-3 and 2.8-1. The as-built piping and mechanical components must comply with ASME Code, Section III, requirements, and electrical equipment must perform their operational function as described in the ITAAC. DCA Part 2, Tier 1, Table 2.5-7 provides MPS ITAAC for the CRDS related to automatic reactor trip functions, engineered safety functions, and manual switches as defined in Tables 2.5-1, 2.5-3, and 2.5-4. These ITAAC, and the associated Tier 1 design descriptions and Tier 2, Section 14.3 material, are evaluated in other subsections of Section 14.3 of this report.

14.3.4.4.2 Overpressure Protection System (DCA Part 2, Tier 2, Section 5.2.2)

DCA Part 2, Tier 1, Tables 2.1-4 and 2.8-2 provide ITAAC for overpressure protection system mechanical and electrical equipment as defined in Tables 2.1-2, 2.1-3 and 2.8-1. The as-built mechanical equipment must comply with ASME Code, Section III, requirements, and electrical equipment must perform their operational function as described in the ITAAC. DCA Part 2, Tier 1, Table 2.5-7 provides MPS ITAAC relating to the overpressure protection system's automatic engineered safety functions and manual switches as defined in Tables 2.5-2 and 2.5-3. These ITAAC, and the associated Tier 1 design descriptions and Tier 2, Section 14.3 material, are evaluated in other subsections of Section 14.3 of this report.

14.3.4.4.3 Decay Heat Removal System (DCA Part 2, Tier 2, Section 5.4.3)

DCA Part 2, Tier 1, Tables 2.1-4 and 2.8-2 provide ITAAC for Decay Heat Removal System (DHRS) piping and mechanical and electrical equipment as defined in Tables 2.1-1, 2.1-2, 2.1-3 and 2.8-1. The as-built piping and mechanical equipment must comply with ASME Code, Section III, requirements, and electrical equipment must perform their operational function as described in the ITAAC. DCA Part 2, Tier 1, Table 2.5-7 provides MPS ITAAC for the DHRS related to the automatic reactor trip functions, engineered safety functions, and manual switches as defined in Tables 2.5-1, 2.5-2, and 2.5-3. These ITAAC, and the associated Tier 1 design descriptions and Tier 2, Section 14.3 material, are evaluated in other subsections of Section 14.3 of this report. ITAAC Number 8 in Table 2.8-2 which verifies that the safety-related DHRS passive condensers have the capacity to transfer their design heat load is evaluated in Section 5.4.3 of this report.

14.3.4.4.4 Reactor Coolant System High-Point Vents (DCA Part 2, Tier 2, Section 5.4.4)

The reactor coolant system does not include a separate safety-related high-point vent capability. However, a non-safety-related high-point degasification line connected to the upper head of the reactor pressure vessel permits venting the pressurizer to the liquid radioactive waste system via the Chemical and Volume Control System (CVCS). DCA Part 2, Tier 1, Tables 2.1-4 and 2.8-2 provide ITAAC for piping and mechanical and electrical equipment as defined in Tables 2.1-1, 2.1-2, 2.1-3 and 2.8-1. The as-built piping and mechanical equipment must comply with ASME Code, Section III, requirements, and electrical equipment must perform their operational function as described in the ITAAC. These ITAAC, and the associated Tier 1 design descriptions and Tier 2, Section 14.3 material, are evaluated in other subsections of Section 14.3 of this report.

14.3.4.4.5 Emergency Core Cooling System (DCA Part 2, Tier 2, Section 6.3)

DCA Part 2, Tier 1, Tables 2.1-4 and 2.8-2 provide ITAAC for Emergency Core Cooling System (ECCS) piping and components as defined in Tables 2.2-2, 2.2-3 and 2.8-1. The as-built mechanical components must comply with ASME Code, Section III, requirements, and electrical equipment must perform their operational function as described in the ITAAC. DCA Part 2, Tier 1, Table 2.5-7 provides MPS ITAAC for the ECCS related to the automatic engineered safety functions and manual switches as defined in Tables 2.5-2 and 2.5-3. These ITAAC, and the associated Tier 1 design descriptions and Tier 2, Section 14.3 material, are evaluated in other subsections of Section 14.3 of this report.

14.3.4.4.6 Chemical and Volume Control System (DCA Part 2, Tier 2, Section 9.3.4)

DCA Part 2, Tier 1, Table 2.2-3, provides ITAAC for Chemical and Volume Control System (CVCS) piping and components as defined in Tables 2.2-1, 2.2-2. The ASME Code Class 3 as-built piping and isolation valves connected to the Reactor Pressure Vessel (RPV) must comply with ASME Code, Section III, requirements. These ITAAC, and the associated Tier 1 design descriptions and Tier 2, Section 14.3 material, are evaluated in other subsections of Section 14.3 of this report.

14.3.4.4.7 Fuel Assembly Design (DCA Part 2, Tier 2, Section 4.2)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Section 2.9 since ITAAC must be satisfied before fuel load, but the fuel assembly design cannot be reasonably verified until fuel load. Therefore, the staff performed an in-depth review of the fuel assembly design in Chapter 4 of this report.

14.3.4.4.8 New and Spent Fuel Storage (DCA Part 2, Tier 2, Section 9.1.2)

The staff reviewed DCA Part 2, Tier 1, Section 3.5, "Fuel Storage System," which contains the specific ITAAC for the fuel storage system. It describes the high-level features of the fuel storage system design and specifies that the fuel storage racks will maintain the k-effective (k_{eff}) in accordance with the limits in 10 CFR 50.68, "Criticality accident requirements." DCA Part 2, Tier 1, Table 3.5-1, specifies the ITAAC for the fuel storage racks. ITAAC Number 2 in Table 3.5-1 related to criticality safety of new and spent fuel storage and handling is evaluated in Section 14.3.7 of this report.

14.3.4.5 Combined License Information Items

The DCA Tier 2, Section 14.3 contains no COL information items related to this area of review.

14.3.4.6 Conclusion

Given the open items identified above, the staff is unable to finalize its conclusions for this section.

14.3.5 Instrumentation and Controls - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.5.1 Introduction

NuScale Power LLC (NuScale) Standard Plant Design Certification Application (DCA), Part 2, Tier 1, contains the following information:

- Tier 1 design descriptions in the form of narrative descriptions, tables, and figures that address the most safety-significant features

- ITAAC (inspections, tests, analyses, and acceptance criteria) Tables, which include Design Commitments, Inspections, Test, Analyses, and Acceptance Criteria

The scope of review for ITAAC related to instrumentation and controls (I&C) includes information presented in DCA Part 2, Tier 2, on unit-specific I&C systems that support a single NuScale Power Module (NPM).

14.3.5.2 Summary of Application

DCA Part 2, Tier 1: The applicant included the following two material categories in Tier 1:

- Tier 1 design descriptions address the most safety-significant features of a system. The design descriptions are in the form of narrative descriptions, tables, and figures and are binding for the lifetime of a facility.

- ITAAC will be used to verify the NuScale as-built features. ITAAC material is in tabular format only and no longer constitute requirements for a licensee after an NRC finding under 10 CFR 52.103(g) that the acceptance criteria are met.

DCA Part 2, Tier 1, provides the design descriptions and ITAAC for those structures, systems, and components (SSCs) that are specific to and support operation of a single NPM, as well as for SSCs that support operation of multiple modules. All of the ITAAC reviewed in this section are unit-specific ITAAC and must be satisfactorily completed for each NPM in a multiunit plant.

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Section 14.3, "Certified Design Material and Inspections, Tests, Analyses, and Acceptance Criteria," states that the design descriptions, interface requirements, and site parameters are derived from Tier 2 information and that Tier 1 information includes the following:

- definitions and general provisions

- design descriptions

- ITAAC

- significant interface requirements

- significant site parameters

A description of how the I&C-related ITAAC are to be performed is in DCA Part 2, Tier 2, Table 14.3-1, “Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference."

ITAAC: The NuScale I&C-related ITAAC are listed in the following DCA Part 2, Tier 1 tables:

- Table 2.5-7, “Module Protection System and Safety Display and Indication System Inspections, Tests, Analyses, and Acceptance Criteria,” Items 1–29
- Table 2.6-1, “Neutron Monitoring Inspections, Tests, Analyses, and Acceptance Criteria,” Items 1–3
- Table 2.1-4, “NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria,” Item 11
- Table 2.8-2, “Equipment Qualification Inspections, Tests, Analyses, and Acceptance Criteria,” Items 4–5

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

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

14.3.5.3 Regulatory Basis

The following NRC regulation contains the relevant requirements for this review:

- 10 CFR 52.47(b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the certified design has been constructed and will be operated in conformity with the certified design, the provisions of the Atomic Energy Act of 1954, as amended, and the Commission’s rules and regulations

The guidance in Section 14.3.5, “Instrumentation and Controls—Inspections, Tests, Analyses, and Acceptance Criteria,” of the design-specific review standard (DSRS) for the NuScale small modular reactor design lists the acceptance criteria that are adequate to meet the above requirements, as well as review interfaces with other standard review plan (SRP)/DSRS sections.

The applicable acceptance criteria used to meet the above relevant requirements of the NRC regulations is summarized below:

- In a letter dated April 8, 2016, the NRC staff transmitted to NuScale a set of Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) that could be used in its design certification application.

14.3.5.4 Technical Evaluation

During public meetings on April 18 and 20, 2017, the NRC staff discussed its initial review of the DCD (Revision 0) with the applicant. Further information on the meeting is provided in the

associated meeting summary dated May 12, 2017 (ADAMS Accession No. ML17130A991). Based on those discussions, the applicant provided clarifications addressing the NRC's concerns described in Item Numbers T1-1 through T1-9 of the meeting summary with no further action required. The NRC staff prepared this SER section based on these discussions and the information provided in DCA Part 2, Tier 1, Sections 2.5 and 2.6, and DCA Part 2, Tier 2, Section 14.3. Additionally, the staff reviewed the ITAAC in Tier 1, Section 2.1, Table 2.1-4, Item 11, and Section 2.8, Table 2.8-2, Items 4 and 5. The staff reviewed this Tier 1 information against the NuScale DSRS Section 14.3.5 acceptance criteria.

Overall Evaluation of I&C-Related Information in Tier 1

Based on the staff's review of the I&C-related information in DCA Part 2, Tier 1 and Tier 2 Chapter 7, the staff makes the following overall conclusions, which apply to the I&C-related information in Tier 1:

Consistent with NuScale DSRS Section 14.3.5, the Tier 1 design descriptions and ITAAC adequately describe the top-level I&C design features and performance characteristics that are significant to safety. For safety-related systems, this included a description of system purpose, safety functions, equipment quality (e.g., meeting the functional requirements of IEEE Std. 603-1991 and the digital system life cycle design process), automatic decision-making and trip logic functions, manual initiation functions, and design features (e.g., system architecture) provided to achieve high functional reliability.

- Consistent with NuScale DSRS Section 14.3.5, the functions and characteristics of other I&C systems important to safety are adequately discussed to the extent that the functions and characteristics are necessary to support remote shutdown, support operator actions or assessment of plant conditions and safety system performance, maintain safety systems in a state that assures their availability during an accident, minimize or mitigate control system failures that would interfere with or cause unnecessary challenges to safety systems, or provide diverse back-up to safety systems.

- Consistent with NuScale DSRS Section 14.3.5, the ITAAC verify the significant features of the I&C systems on which the staff is relying to assure compliance with each NRC requirement identified in DSRS Chapter 7. Tests, analyses, and acceptance criteria associated with each design commitment, when taken together, are sufficient to provide reasonable assurance that the final as-built I&C system fulfills NRC requirements. The sufficiency of the ITAAC are discussed in greater detail below.

- The Tier 1 design descriptions and ITAAC are based on and consistent with the Tier 2 material.

The staff also evaluated whether Tier 1 design descriptions and ITAAC were needed from an I&C perspective for active systems. The passive-designed reactors (like NuScale) use safety systems that employ passive means (natural forces), such as gravity, natural circulation, condensation and evaporation, and stored energy, for accident mitigation. Such designs may also include active systems that provide defense-in-depth capabilities for reactor-coolant makeup and decay heat removal. These active systems would be the first line of defense to reduce challenges to the passive systems in the event of transients or plant upsets. Based on the I&C design information provided in Tier 2 Chapter 7, the staff finds that no active systems

are needed for reactor-coolant makeup or decay heat removal and therefore no Tier 1 design description or ITAAC is required from an I&C perspective.

14.3.5.4.1 Module Protection System and Safety Display and Indication System ITAAC

In DCA Part 2, Tier 1, Table 2.5-7, the applicant provided ITAAC verifying design features for the module protection system (MPS) and its associated components in the safety display and indication system (SDIS) provided in DCA Part 2, Tier 1, Section 2.5.1, "Design Description." Section 2.5.1 states:

> *The MPS is comprised of the reactor trip system (RTS) and the engineered safety features actuation system (ESFAS). The RTS is responsible for monitoring key variables and shutting down the reactor when specified limits are reached. The ESFAS is responsible for monitoring key variables and actuating the engineered safety features (ESF) such as the emergency core cooling system (ECCS) and the decay heat removal system (DHRS) when specified limits are reached.*

These ITAAC, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1, "Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," for ITAAC 02.05.01 through 02.05.29, generally conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016 letter. The staff finds that the ITAAC are sufficient to demonstrate that the MPS and SDIS perform the safety-related and non-safety-related system functions identified in DCA Part 2, Tier 1, Section 2.5.1

The Tier 1 review of the remote shutdown station capabilities is discussed in Section 14.3.9, "Human Factors Engineering – Inspections, Tests, Analyses, and Acceptance Criteria," of this SER.

14.3.5.4.2 Neutron Monitoring System ITAAC

The design description in DCA Part 2, Tier 1, Section 2.6, "Neutron Monitoring System," states the following:

> *The NMS monitors the neutron flux level of the reactor core by detecting neutron leakage from the core. The NMS measures neutron flux as an indication of core power and provides safety-related inputs to the module protection system.*

There are no ITAAC to verify the capability of the as-built NMS to monitor the neutron flux levels in the reactor core because ITAAC must be satisfied prior to initial loading of fuel into the reactor. However, there are ITAAC to appropriately verify physical separation and electrical isolation for NMS Class 1E circuits. The staff finds that the ITAAC in Tier 1, Table 2.6-1, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1 for ITAAC 02.06.01 through 02.06.03, conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016 letter.

Based on the above, the NRC staff finds that the ITAAC for the NMS in DCA Part 2, Tier 1, Section 2.6, comply with 10 CFR 52.47(b)(1).

14.3.5.4.3 NuScale Power Module ITAAC

In DCA Part 2, Tier 1, Section 2.1, "NuScale Power Module," the applicant provided ITAAC to verify physical separation of the redundant divisions of the MPS cables from the NPM disconnect box to the instruments DCA Part 2, Tier 1, Section 2.1.1, "Design Description," states the following:

> *Physical separation exists between the redundant divisions of the MPS Class 1E instrumentation and control current-carrying circuits, and between Class 1E instrumentation and control current-carrying circuits and non-Class 1E instrumentation and current-carrying circuits. The scope of this commitment includes the cables from the NPM disconnect box to the instruments.*

The ITAAC in DCA Part 2, Tier 1, Table 2.1-4, Item 11, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1 for ITAAC 02.01.11, conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016 letter. Therefore, the staff finds that the ITAAC are sufficient to verify physical separation between the redundant divisions of the MPS cables from the NPM disconnect box to the instruments.

Based on the above, the NRC staff finds that the ITAAC for the NPM in DCA Part 2, Tier 1, Table 2.1-4, Item 11, complies with 10 CFR 52.47(b)(1).

14.3.5.4.4 Equipment Qualification ITAAC

The applicant provided ITAAC verifying design features for the safety-related digital I&C in DCA Part 2, Tier 1, Section 2.8, "Equipment Qualification." Section 2.8 states the following:

> *The Class 1E computer-based instrumentation and control systems located in a mild environment withstand design basis mild environmental conditions without loss of safety-related functions.*
>
> *The Class 1E digital equipment performs its safety-related function when subjected to the design basis electromagnetic interference, radio frequency interference, and electrical surges that would exist before, during, and following a DBA.*

The ITAAC in DCA Part 2, Tier 1, Table 2.8-2, Items 4 and 5, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1 for ITAAC Nos. 02.08.04 and 02.08.05, conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016 letter. Therefore, the staff finds the ITAAC are sufficient to verify the qualification of the Class 1E computer-based I&C systems for a mild environment and verify the capability of the Class 1E digital equipment to withstand electromagnetic interference, radio frequency interference, and electrical surge.

Based on the above, the NRC staff finds that the ITAAC for equipment qualification of the safety-related digital I&C in DCA Part 2, Tier 1, Table 2.8-2, Items 4 and 5, comply with 10 CFR 52.47(b)(1).

14.3.5.5 Combined License Information Items

There are no COL information items listed in DCA Part 2 Tier 2, Table 1.8-2, "Combined License Information Items," for this area of review.

14.3.5.6 Conclusion

The NRC staff finds that the DCA Part 2, Tier 1, design descriptions and ITAAC for the I&C system satisfy the requirements in 10 CFR 52.47(b)(1) and meet the relevant DSRS Section 14.3.5 acceptance criteria for Tier 1 design content. The staff also finds that the description of how to complete the I&C ITAAC in DCA Part 2, Tier 2, Table 14.3-1 is acceptable.

14.3.6 Electrical Systems - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.6.1 Introduction

This section of the safety evaluation report (SER) describes the staff's evaluation of information associated with electrical systems in the NuScale Design Certification Application (DCA) Part 2, Tier 1, Chapter 2 and Chapter 3, and DCA Part 2, Tier 2, Section 14.3, "Certified Design Material and ITAAC." DCA Part 2, Tier 1, Chapter 2, contains design descriptions and associated inspections, tests, analyses, and acceptance criteria (ITAAC) for unit-specific systems that support a single NuScale Power Module (NPM). DCA Part 2, Tier 1, Chapter 3, contains design descriptions and associated ITAAC for systems that support multiple NPMs (shared or common systems). DCA Part 2, Tier 2, Section 14.3, describes NuScale's approach to the development of certified design material in Tier 1, including ITAAC. As required by 10 CFR 52.47(b)(1), the proposed ITAAC must provide reasonable assurance that, if the ITAAC are successfully completed, the facility has been constructed and will be operated in conformance with the design certification (DC), the Atomic Energy Act of 1954, as amended (AEA), and NRC rules and regulations.

14.3.6.2 Summary of Application

DCA Part 2, Tier 1: DCA Part 2, Tier 1, Section 2.1, "NuScale Power Module," Section 2.8, "Equipment Qualification," Section 3.8, "Plant Lighting System," and Section 3.14, "Equipment Qualification—Shared Equipment," provide design descriptions related to equipment qualification and the electrical power system. Top-level design information in DCA Part 2, Tier 1, is extracted from the more detailed design information presented in DCA Part 2, Tier 2. The Tier 1 design description consists of the system description and design commitments. The design features in the design commitments are verified by ITAAC.

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Section 14.3, provides a general description of, and information on, ITAAC for electrical systems. DCA Part 2, Tier 2, Section 14.3, contains information on ITAAC for the plant's electrical system, including equipment qualification (EQ), containment electrical penetrations, and plant lighting. Specifically, this discussion is in DCA Part 2, Tier 2, Table 14.3-1, "Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," and Table 14.3-2, "Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference."

ITAAC: The applicant provided ITAAC tables for each of the systems listed in DCA Part 2, Tier 1, Chapters 2 and 3, that had Tier 1 design descriptions. The staff reviewed the ITAAC related to the electrical system listed in the following DCA Part 2, Tier 1, tables:

- Table 2.1-4, "NuScale Power Module ITAAC," Items 10 and 22
- Table 2.8-2, "Equipment Qualification ITAAC," Items 2 and 9
- Table 3.8-1, "Plant Lighting System ITAAC," Items 1–3
- Table 3.14-2, "Equipment Qualification—Shared Equipment ITAAC," Item 2

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

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

14.3.6.3 Regulatory Basis

The following NRC regulations contain the relevant requirements for this review:

- 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the AEA, and the NRC's rules and regulations.

- 10 CFR 50.49, "Environmental qualification of electric equipment important to safety for nuclear power plants," as it relates to the applicant establishing a program for qualifying electrical equipment important to safety located in a harsh environment.

- 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 17, "Electric Power Systems," requires an onsite electric power system and an offsite electric power system to 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. The applicant has requested an exemption from this criterion, which is reviewed in SER Chapter 8. This is currently **Open Item 8.3-1** and the review in this section is subject to this open item.

- GDC 18, “Inspection and Testing of Electric Power Systems,” requires electric power systems important to safety to be designed to permit appropriate periodic inspection 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. The applicant has requested an exemption from this criterion, which is reviewed in SER Chapter 8. This is currently **Open Item 8.3-1** and the review in this section is subject to this open item.

The guidance in SRP Section 14.3.6, “Electrical Systems – [ITAAC],” lists the acceptance criteria adequate to meet the above requirements. Review interfaces with other SRP sections also can be found in SRP Section 14.3.6. SRP Section 14.3.6 refers to SRP Section 14.3, “[ITAAC],” for guidance on the content and format of ITAAC.

The following document provides additional criteria or guidance in support of the SRP acceptance criteria to meet the above requirements:

- Regulatory Guide (RG) 1.206, Revision 0, “Combined License Applications for Nuclear Power Plants,” provides combined license (COL) applicants referencing a certified design with guidance on the development of site-specific ITAAC and the use of ITAAC contained in a certified design.

- In a letter dated April 8, 2016, the NRC staff transmitted to NuScale a set of Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) that could be used in its design certification application.

DCA Part 2, Tier 1, design descriptions and ITAAC design commitments should be based on and consistent with the DCA Part 2, Tier 2, material.

14.3.6.4 Technical Evaluation

The staff reviewed information in DCA Part 2, Tier 1, and DCA Part 2, Tier 2, related to the electrical power system to ensure, in part, that DCA Part 2, Tier 1, contains the top-level, most safety-significant design, fabrication, testing, and performance requirements for SSCs important to safety, consistent with the guidance in SRP Section 14.3. The staff also reviewed the information for conformance with RG 1.206, Sections C.II.1.2.6 and C.II.1-A. The ITAAC review documented in this SER section is limited to the eight ITAAC listed in Section 14.3.6.2 of this SER and the discussion of these ITAAC in DCA Part 2, Tier 2, Section 14.3, Tables 14.3-1 and 14.3-2. The staff reviewed whether meeting the ITAAC verifies that the DCA Part 2, Tier 1, design commitments are met when the plant is built.

14.3.6.4.1 Design Descriptions and ITAAC for Electrical Systems

The staff reviewed the NuScale design to determine whether the applicant established appropriate Tier 1 design commitments for the electrical power system and that they are verified

by ITAAC. The applicant-proposed design descriptions and associated ITAAC for the electrical systems include design aspects related to (1) EQ for seismic and harsh environment, (2) containment electrical penetrations, and (3) lighting, as discussed below.

14.3.6.4.1.1 Equipment Qualification for Seismic and Harsh Environment

Consistent with SRP Section 14.3.6, the ITAAC for EQ for seismic and harsh environments should verify that the seismic design requirement of GDC 2 and the EQ requirements of 10 CFR 50.49 are met. Specifically, the design description should identify that Class 1E (i.e., safety-related) equipment is seismic Category I and electrical equipment located in a harsh environment is qualified to withstand the harsh environment and perform its function. The staff evaluates the seismic design requirement of GDC 2 in Section 14.3.3 of this SER.

The staff reviewed the DCA Part 2, Tier 1, Sections 2.8 and 3.14, design descriptions, which address the most safety-significant features for equipment qualification. Sections 2.8 and 3.14 describes the module specific and shared equipment that would be subject to equipment qualification. The staff determined that Tier 1 design descriptions and ITAAC relating to module-specific and common electrical equipment located in a harsh environment adequately describe the top-level, most safety-significant design features that are based on and consistent with the Tier 2 material.

The staff reviewed DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2, which provides background information associated with the Tier 1 design commitments for ITAAC Nos. 02.08.02, 02.08.09, and 03.14.02, and a discussion of how to complete the ITAAC. The staff determined that this DCA Part 2, Tier 2 information is consistent with the NuScale design and ITAAC in DCA Part 2, Tier 1, and provides appropriate information to implement the ITAAC successfully.

Section 3.11 of this SER contains the staff's evaluation of DCA Part 2, Tier 2, Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," which describes the environmental qualification requirements for electrical and mechanical equipment. In addition, the staff discusses the applicant's approach for conformance to 10 CFR 50.49 pertaining to the environmental qualification of electrical equipment located in a harsh environment and identifies equipment that is within the scope of 10 CFR 50.49.

The staff reviewed ITAAC Nos. 2 and 9 in DCA Part 2 Tier 1, Table 2.8-2, and ITAAC No. 2 in DCA Part 2 Tier 1, Table 3.14-2, which should verify that the Class 1E equipment located in a harsh environment is qualified and meet the EQ requirements of 10 CFR 50.49. These ITAAC, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2, conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016 letter. Therefore, the staff finds that the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.2 Containment Electrical Penetrations

Consistent with SRP Section 14.3.6, the ITAAC for containment electrical penetrations should verify that all the penetrations (both Class 1E and non-Class 1E circuits) are protected against postulated fault currents (that is, currents greater than the continuous current rating) so that the electrical faults do not breach the containment.

Section 8.3.1 of this SER contains the staff's evaluation of DCA Part 2, Tier 2, Section 8.3.1.2.5, "Containment Electrical Penetration Assemblies," which describes the electrical design requirements for electrical penetration assemblies.

The staff reviewed the DCA Part 2, Tier 1, Section 3.1, design descriptions, which address the most safety-significant features of the NuScale Power Module (NPM). This section describes the systems contained within the boundary of the NPM, the safety-related and nonsafety-related functions that are performed by the NPM and verified by the ITAAC. The staff determined that Tier 1 design descriptions and ITAAC relating to containment electrical penetrations adequately describe the top-level, most safety-significant design features that are based on and consistent with the Tier 2 material.

The staff reviewed DCA Part 2, Tier 2, Table 14.3-1, which provides background information associated with the Tier 1 design commitments for ITAAC Nos. 02.01.10 and 02.01.22, and a discussion of how to complete the ITAAC. The staff determined that this DCA Part 2, Tier 2 information is consistent with the NuScale design and ITAAC in DCA Part 2, Tier 1, and provides appropriate information to implement the ITAAC successfully. Additionally, the staff identified editorial errors in DCA Part 2, Tier 2, Table 14.3-1, ITAAC Nos. 02.01.10 and 02.01.22. This is being tracked as **Open Item 14.03.06-1**.

The staff reviewed ITAAC Items 10 and 22 in DCA Part 2, Tier 1, Table 2.1-4, which verify that the containment electrical penetrations are protected against postulated fault currents. These ITAAC, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1, conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016 letter. Therefore, the staff finds that the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.3 Lighting

Consistent with SRP Section 14.3.6, the ITAAC for lighting should verify the continuity of power sources for plant lighting systems to ensure that portions of the plant lighting remain available during accident scenarios and power failures. The basis for inclusion may be more related to defense in-depth, support function, operating experience, or PRA rather than "accomplishing a direct safety function."

The staff reviewed the DCA Part 2, Tier 1, Section 3.8, design descriptions, which address the most safety-significant features of the plant lighting system (PLS). The PLS is a nonsafety-related system that provides artificial illumination for the entire plant: buildings (interior and exterior), rooms, spaces, and all outdoor areas of the plant. The staff determined that Tier 1 design descriptions and ITAAC adequately describe the top-level, most safety-significant design features that are based on and consistent with the Tier 2 material.

The staff reviewed DCA Part 2, Tier 2, Table 14.3-2, which provides background information associated with the Tier 1 design commitments for ITAAC Nos. 03.08.01, 03.08.02, and 03.08.03, and a discussion of how to complete the ITAAC. The staff determined that this DCA Part 2, Tier 2 information is consistent with the NuScale design and ITAAC in DCA Part 2, Tier 1, and provides appropriate information to implement the ITAAC successfully.

Section 9.5.3 of this SER discusses and evaluates DCA Part 2, Tier 2, Section 9.5.3, "Lighting Systems," to determine whether the plant lighting levels are adequate during all plant operating conditions, and whether the lighting systems can operate without adversely impacting the

operation, control, and maintenance of SSCs. The NuScale plant lighting system includes normal plant lighting, emergency plant lighting, and normal and emergency main control room lighting.

The staff reviewed ITAAC Items 1–3 in DCA Part 2, Tier 1, Table 3.8-1, which verify that portions of the plant lighting remain available during accident scenarios and power failures. These ITAAC, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-2, conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016 letter. Therefore, the staff finds that the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.5 Combined License Information Items

The DCA Tier 2, Section 14.3 contains no COL information items related to the electrical power system.

14.3.6.6 Conclusion

The staff has reviewed all the relevant ITAAC information applicable to the electrical design and evaluated its sufficiency based on whether it demonstrates that the as-constructed plant complies with 10 CFR 50.49 and whether it conforms with relevant NRC guidance in SRP Section 14.3.6. The staff finds that the NuScale Tier 1 ITAAC for electrical systems satisfies SRP Section 14.3.6 and 10 CFR 52.47(b)(1), with the exception of **Open Item 8.3-1**. The Tier 1 design descriptions contain the top level, most safety-significant design features for the electrical system, consistent with SRP Section 14.3.6, with the exception of **Open Item 8.3-1**. The staff also concludes that the information associated with electrical systems in DCA Part 2, Tier 2, Tables 14.3-1 and 14.3-2 are consistent with the NuScale design and ITAAC, with the exception of **Open Item 14.03.06-1**.

14.3.7 Plant Systems - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.7.1 Introduction

In accordance with 10 CFR 52.47(b)(1), a design certification (DC) application (DCA) must contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act of 1954, as amended (AEA), and the NRC's rules and regulations. This SER section addresses ITAAC related to most of the plant systems that are not part of the core reactor systems. The specific areas that this section addresses include those listed below in SER Section 14.3.7.4.

14.3.7.2 Summary of Application

DCA Part 2,Tier 1: The applicant provided the Tier 1 information associated with plant systems in DCA Part 2, Tier 1, Section 2, "Unit-Specific Structures, Systems, and Components Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria," and Section 3, "Shared Structures, Systems, and Components and Non-Structures, Systems, and Components Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria." The unit-specific descriptions in Tier 1, Section 2 apply to each NuScale module, while Tier 1, Section 3 addresses SSCs that support multiple NuScale modules.

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Table 14.3-1, "Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," and Table 14.3-2, " Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," present a matrix that correlates the top-level NuScale design features contained in design commitments with their treatment in Tier 1.

ITAAC: The following DCA Part 2, Tier 1, tables contain the ITAAC applicable to this review area:

- Table 2.1-4, "NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria," Numbers 24–25. These ITAAC were proposed in response to an RAI. The staff's evaluation below includes these additional ITAAC.
- Table 2.3-1, "Containment Evacuation System ITAAC," Numbers 1–2
- Table 3.1-2, "Control Room Habitability System ITAAC," Numbers 1, 4, and 5
- Table 3.2-2, "Normal Control Room Heating Ventilation and Air Conditioning ITAAC," Numbers 1–3
- Table 3.3-1, "Reactor Building Heating Ventilation and Air Conditioning System ITAAC," Numbers 1–3
- Table 3.4-1, "Fuel Handling Equipment System ITAAC," Numbers 1–6

- Table 3.5-1, Fuel Storage System ITAAC," Number 2
- Table 3.6-2, "Ultimate Heat Sink Piping System ITAAC," Number 2
- Table 3.7-1, "Fire Protection System ITAAC," Numbers 1–4
- Table 3.10-1, "Reactor Building Crane ITAAC," Numbers 1–8. In response to an RAI the applicant proposed two additional ITAAC to this table. The staff's evaluation below includes these additional ITAAC.
- Table 3.11-2, "Reactor Building ITAAC," Numbers 1–2
- Table 3.13-1, "Control Building ITAAC," Numbers 1–2

Technical Specifications (TS): There are no TS associated with this area of review.

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

14.3.7.3 Regulatory Basis

The following NRC regulations contain the relevant requirements for this review:

- 10 CFR 52.47(b)(1), which requires that a DCA include the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will operate in accordance with the DC, the AEA, and the NRC's rules and regulations

The guidance in SRP Section 14.3.7, "Plant Systems—Inspections, Tests, Analyses, and Acceptance Criteria," dated March 2007 lists the acceptance criteria adequate to meet the above requirements, as well as review interfaces with other SRP sections. In addition, a letter dated April 8, 2016, from the NRC to NuScale provided a set of Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) that could be used in its design certification application.

14.3.7.4 Technical Evaluation

Based on the staff's review of the information in DCA Part 2, Tier 1 and Tier 2, the staff makes the following overall conclusions regarding the plant systems information in Tier 1. Consistent with SRP Section 14.3.7, the Tier 1 design descriptions and ITAAC adequately describe the top-level design features and performance characteristics that are significant to safety. The safety significance of the plant systems and how they are treated in Tier 1 is discussed in detail below. The staff reviewed the design description, system ITAAC, to confirm completeness and consistency with the system design basis as described in various DCA Part 2, Tier 2, sections and conclude the Tier 1 design description and ITAAC are based on and consistent with Tier 2 material. Tests, analyses, and acceptance criteria associated with each design commitment, when taken together, are sufficient to provide reasonable assurance that the final as-built system fulfills NRC requirements. These ITAAC, along with the corresponding discussions in DCA Part 2, Tier 2, Table 14.3-1 and Table 14.3-2 generally conform to the standardized DCA ITAAC, design commitments, and associated Tier 2 discussions in the NRC's April 8, 2016 letter.

The requirements of 10 CFR 52.47(b)(1) are met, in part, by identifying ITAAC to verify the top-level design features of the plant systems in the design certification application.

The staff's review of the plant systems' ITAAC are presented here, listed in order of the associated DCA Part 2, Tier 2, section.

14.3.7.4.1 Internal Flood Protection for Onsite Equipment Failures (DCA Part 2, Tier 2, Section 3.4.1)

The ITAAC associated with internal flooding barriers in the reactor building (RXB) and control building (CRB) are found in DCA Part 2, Tier 1, Table 3.11-2, Item 2, and Table 3.13-1, Item 2, respectively. These ITAAC ensure barriers, including flood-resistant doors, curbs and sills, walls, watertight penetration seals, and National Electrical Manufacturers Association (NEMA) enclosures exist and are qualified in accordance with the internal flooding analysis to provide confinement so that the impact from an internal flood in the RXB or CRB is contained within the flooding area of origin.

The staff reviewed the proposed ITAAC and finds that they are acceptable because they will confirm that the as-built plant systems have the design characteristics stated in the design description and thus verify the flood protection features assumed in the plant's internal flood analysis. Therefore, these ITAAC are consistent with the guidance found in the SRP and meet the requirements of 10 CFR 52.47(b)(1).

14.3.7.4.2 Internally Generated Missiles (Outside Containment) (DCA Part 2, Tier 2, Section 3.5.1.1)

In DCA Part 2, Tier 2, Section 3.5.1.1, "Internally Generated Missiles (Outside Containment)" the applicant reviewed the RXB and CRB to determine what missile could be generated based on the plant equipment and processes. Based on its review, the applicant determined that due to plant and system design, there are no credible missiles that could affect SSCs important to safety. Upon reviewing Tier 2 Section 3.5.1, the staff agrees with the applicant's assessment; therefore, the staff finds that no ITAAC are necessary to address the missiles evaluated in DCA Part 2, Tier 2, Section 3.5.1.1.

14.3.7.4.3 Internally Generated Missiles (Inside Containment) (DCA Part 2, Tier 2, Section 3.5.1.2)

In DCA Part 2, Tier 2, Section 3.5.1.2, "Internally Generated Missiles (Inside Containment)" it is stated that the NuScale power modules use a steel containment that encapsulates the reactor pressure vessel. The applicant also states that there is no rotating equipment inside containment and all pressurized components are ASME Class 1 or 2 and therefore not credible missile sources. In its review in Section 3.5.1.2 of this SER, the staff concluded that there are no credible missiles inside containment. Therefore, the staff finds that no ITAAC are necessary to address such missiles.

14.3.7.4.4 Missiles Generated by Tornadoes and Extreme Winds (DCA Part 2, Tier 2, Section 3.5.1.4)

In its review of the information in Tier 1, the staff found that ITAAC in Table 3.11-2 and Table 3.13-1 addresses verification that the RXB and CRB have been designed and constructed to withstand the effects of natural phenomena, including missiles from hurricanes, tornados, and

extreme winds. DCA Tier 1, Table 3.11-2, ITAAC 6 verifies RXB structural integrity under design basis loads, which as indicated in DCA Tier 2, Table 14.3-2 includes missile impact loads. DCA Tier 1, Table 3.13-1, ITAAC 4 verifies the CRB structural integrity under design loads at CRB elevation 120'-0" and below. Therefore, the staff finds that these ITAAC address verification that the RXB and CRB have been designed and constructed to withstand missiles from hurricanes, tornados, and extreme winds. These ITAAC are evaluated in SER Section 14.3.2.

14.3.7.4.5 Structures, Systems, and Components To Be Protected from External Missiles (DCA Part 2, Tier 2, Section 3.5.2*)*

In DCA Part 2, Tier 2, Section 3.5.2, "Structures, Systems, and components to be Protected from External Missiles," the applicant stated that all safety-related and risk-significant SSCs that must be protected from external missiles are located inside the seismic Category I RXB and seismic Category I portions of the CRB. In its review of the information in Tier 1, the staff found that ITAAC 6 in DCA Part 2, Tier 1, Table 3.11-2, verifies RXB structural integrity under design basis loads, and ITAAC 4 in DCA Tier 1, Table 3.13-1, verifies CRB structural integrity under design loads at CRB elevation 120'-0" and below. Therefore, the staff finds that these ITAAC address verification that the RXB and CRB have been designed and constructed to withstand the effects of natural phenomena, including missiles from hurricanes, tornados, and extreme winds. These ITAAC are evaluated in SER Section 14.3.2.

14.3.7.4.6 Plant Design for Protection against Postulated Piping Failure in Fluid Systems (DCA Part 2, Tier 2, Section 3.6.1)

DCA Part 2, Tier 1, Section 2.1, "Nuclear Power Module," identifies a design commitment to ensure safety-related SSCs are protected against the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems. ITAAC Number 4 in DCA Part 2, Tier 1, Table 2.1-4, "NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria," requires an inspection and analysis of the as-built high- and moderate-energy piping systems and protective features for the safety-related SSCs to ensure they are installed in accordance with the as-built Pipe Break Hazard Analysis Report and safety-related SSCs are protected against, or are qualified to withstand, the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems. The staff evaluates this ITAAC in SER Section 14.3.3.4.1.2, "Pipe Break Analysis."

14.3.7.4.7 Reactor Coolant Pressure Boundary Leakage Detection (DCA Part 2, Tier 2, Section 5.2.5)

DCA Part 2, Tier 1, Table 2.3-1, includes ITAAC Numbers 1 and 2 for reactor coolant system (RCS) leakage detection. The ITAAC require tests to verify the design of the RCS leakage detection systems. These test include (1) verifying the containment evacuation system (CES) detects a level increase in the CES tank, which correlates to a detection of an unidentified RCS leakage rate of 1 gallon per minute (gpm) within 1 hour, and (2) verifying the CES detects a pressure increase in the CES inlet pressure instrumentation, which correlates to a detection of an unidentified RCS leakage rate of 1 gpm within 1 hour. This is consistent with the guidance in RG 1.45 and the SRP.

The staff reviewed the proposed ITAAC and find that they are consistent with NRC guidance and meet the requirements of 10 CFR 52.47(b)(1).

14.3.7.4.8 New and Spent Fuel Storage (DCA Part 2, Tier 2, Section 9.1.2)

The staff reviewed DCA Part 2, Tier 1, Section 3.5, "Fuel Storage System," which contains the specific ITAAC for the fuel storage system. It describes the high-level features of the fuel storage system design and specifies that the fuel storage racks will maintain the k-effective (k_{eff}) in accordance with the limits in 10 CFR 50.68, "Criticality accident requirements." DCA Part 2, Tier 1, Table 3.5-1, specifies the ITAAC for the fuel storage racks.

The staff has determined that the DCA Part 2, Tier 1, information related to the criticality safety of new and spent fuel storage and handling is commensurate with its safety significance. In addition, the DCA Part 2, Tier 1, information is consistent with the DCA Part 2, Tier 2, information, and can be verified adequately by ITAAC. Therefore, the staff finds the DCA Part 2, Tier 1, information acceptable with respect to criticality safety of new and spent fuel storage and handling.

The ITAAC related to criticality safety of new and spent fuel storage and handling in DCA Part 2, Tier 1 (Table 3.5-1, ITAAC Number 2), includes a design commitment that the fuel storage racks will meet the portion of 10 CFR 50.68(b)(4) applicable when soluble boron is credited. An inspection of the as-built fuel storage racks, their configuration in the spent fuel pool (SFP), and the associated documentation will ensure that the as-built configuration conforms to the design values and their tolerances used in the approved criticality analysis. Furthermore, this ITAAC is consistent with an NRC letter to the applicant containing draft standard ITAAC to be considered for the DCA (ADAMS Accession No. ML16096A121). For these reasons, this ITAAC is acceptable for the criticality safety of new and spent fuel storage and meets 10 CFR 52.47(b)(1).

The SFP is part of the ultimate heat sink (UHS), and drain down prevention is evaluated in Section 14.3.7.4.16, "Ultimate Heat Sink," of this SER.

14.3.7.4.9 Spent Fuel Pool Cooling and Cleanup System (DCA Part 2, Tier 2, Section 9.1.3).

The SFP cooling and cleanup system is not safety related and is not credited for mitigation of any design-basis events. The pool is cooled by passive means using the volume of water in the combined reactor and SFP. ITAAC Number 2 in DCA Part 2, Tier 1, Table 3.6-2 for the UHS addresses verification that sufficient cooling water is available for design-basis events. This ITAAC is discussed in section 14.3.7.4.16 of this report.

14.3.7.4.10 Fuel Handling Equipment (DCA Part 2, Tier 2, Section 9.1.4)

DCA Part 2, Tier 1, Section 3.4, provides a general overview of the fuel handling equipment (FHE) system and the associated ITAAC. The FHE system ITAAC are provided to meet the requirements of 10 CFR 52.47(b)(1) by ensuring that the as-built system complies with the approved system design described in DCA Part 2, Tier 1. DCA Part 2, Tier 1, Table 3.4-1, Numbers 1–6, present the FHE system ITAAC.

The staff reviewed the proposed ITAAC and finds them acceptable because they will verify that that FHE has been constructed in accordance with the American Society of Mechanical Engineers (ASME) NOG-1 code and will have sufficient load-carrying capability and limits on travel to assure that it has been constructed and will be operated in conformity with the design certification.

Based on the above evaluation, the staff finds that the ITAAC are consistent with the guidance found in the SRP and meet the requirements of 10 CFR 52.47(b)(1).

14.3.7.4.11 Overhead Heavy-Load Handling Systems (DCA Part 2, Tier 2, Section 9.1.5)

DCA Part 2, Tier 1, Section 3.10, provides a general overview of reactor building crane (RBC) and the associated ITAAC. The RBC ITAAC are provided to meet the requirements of 10 CFR 52.47(b)(1) and to ensure that the as-built system is in conformity with the approved system design as described in DCA Part 2, Tier 1. DCA Part 2, Tier 1, Table 3.10-1, Numbers 1–8, include the RBC ITAAC.

A critical load handling evolution is defined as the handling of a heavy load where inadvertent operations or equipment malfunctions, separately or in combination, could: cause a release of radioactivity, a criticality accident, inability to cool fuel within the reactor vessel or spent fuel pool or prevent safe shutdown of the reactor. Therefore, design features that reduce the risk of a dropped load event are of safety importance. The "single-failure-proof" design criteria for the OHLHS equipment is a significant design feature to be included in the DCA Part 2, Tier 1. In DCA Part 2, Tier 1, Table 3.10-1, ITAAC Numbers 1, 2, and 3, verify that the reactor building crane main hoist, the two auxiliary hoists, and the wet hoist, respectively, contain single-failure-proof design features. A load test at 125 to 130 percent of the hoists' rated capacity is provided in ITAAC Numbers 4, 5, and 6, respectively, for listed hoists. Also, ITAAC Numbers 7 and 8 require non-destructive examinations of welds on the load-carrying path for these hoists to verify conformance with ASME NOG-1. The staff finds these ITAAC acceptable because they are consistent with the NRC endorsed, ASME NOG-1 provisions for a Type I crane.

On August 3, 2018, the staff issued RAI 9571, Question 14.03.07-1 (ADAMS Accession No. ML18215A464) regarding inconsistencies in the ITAAC associated with the containment system and reactor building crane. In response to RAI 9571, Question 14.03.07-1, dated November 29, 2018 (ADAMS Accession No. ML18333A228), the applicant agreed to add four new ITAAC. Two of these ITAAC will be added to DCA Part 2, Tier 1, Section 3.10, "Reactor Building Crane," for the module lifting adapter (MLA) and the other two ITAAC will be added to DCA Part 2, Tier 1, Section 2.1, "NuScale Power Module," for the NPM lifting fixture. DCA Part 2, Tier 1, Table 3.10-1, ITAAC Number 9, will provide for a load test on the MLA single and dual load-path elements, and ITAAC Number 10 will verify that the MLA contains single-failure-proof design features. The staff finds these ITAAC acceptable and complete because they are consistent with ASME NOG-1 provisions for a Type I crane. DCA Part 2, Tier 1, Table 2.1-4, ITAAC Number 24 will verify that the NPM lifting fixture supports its rated load, and ITAAC Number 25 will verify that it contains single-failure-proof design features. The staff finds these ITAAC acceptable because they are consistent with ANSI-N14.6, "Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 KG) or More." Incorporation of the markup included in the response to RAI 9571, Question 14.03.07-1 is being tracked as **Confirmatory Item 14.3.7-1**.

Based on the above evaluation, the staff finds that the OHLHS ITAAC are consistent with SRP guidance and meet the requirements of 10 CFR 52.47(b)(1).

14.3.7.4.12 Station Service Water System (DCA Part 2, Tier 2, Section 9.2.1)

In DCA Part 2, Tier 2, the applicant indicated that the NuScale Power Plant design does not have a service water system. Therefore, there are no proposed ITAAC designated in DCA

Part 2, Tier 1, Chapters 2.0 or 3.0 for this section, and the staff finds that no ITAAC are necessary for this section.

14.3.7.4.13 Reactor Component Cooling Water System (DCA Part 2, Tier 2, Section 9.2.2)

The staff reviewed the reactor component cooling water system and found that it is not safety related and does not perform any safety-related, risk-significant, or safety-significant functions. Therefore, the staff finds that no ITAAC are necessary for this system.

14.3.7.4.14 Demineralized Water System (DCA Part 2, Tier 2, Section 9.2.3)

The demineralized water system (DWS) is a nonsafety-related system and is not required for mitigation of any design basis events (DBE). While DWS operation is not required or credited in any DBE, in its review of the demineralized water system, the staff noticed that, because the DWS isolation valves limit or prevent boron dilution of the reactor coolant, the DWS isolation valves perform a safety-related function. However, for the NuScale design, the DWS isolation valves are included as part of the chemical and volume control system (CVCS). Design and operation of the demineralized water system isolation valve is covered by the ITAAC in DCA Part 2, Tier 1, Section 2.2, "Chemical and Volume Control System." These ITAAC are evaluated in Section 14.3.3 of this SER. Other than the function identified above, the system is not safety related or risk significant, and the applicant did not credit it for providing a safety-significant function, and therefore, the staff concluded that no additional ITAAC are necessary.

14.3.7.4.15 Potable and Sanitary Water Systems (DCA Part 2, Tier 2, Section 9.2.4)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the potable water system and found that it is not safety related and does not perform any safety-related, risk-significant, or safety-significant functions. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.16 Ultimate Heat Sink (DCA Part 2, Tier 2, Section 9.2.5)

DCA Part 2, Tier 1, Table 3.6-2, provides ITAAC for UHS piping and connections. The ASME Code Class 3 as-built piping system makeup line to the SFP must comply with ASME Code, Section III, requirements. The SFP, refueling pool, reactor pool, and dry dock piping and connections are located to prevent the drain down of the SFP water level below the minimum safety water level.

DCA Part 2, Tier 1, Table 3.6-2, specifies the ITAAC for the UHS. ITAAC Number 2 contains a design commitment that spent fuel pool, refueling pool, reactor pool, and dry dock piping and connections are located to prevent drain down of the SFP and reactor pool water below the minimum safety water level.

The staff reviewed the proposed ITAAC and finds that an inspection will be performed as part of the ITAAC, that will confirm that the as-built plant systems meet the design commitment regarding prevention of drain down of the SFP. For this reason, this ITAAC is acceptable for SFP drain down. The staff finds that the ITAAC is consistent with the SRP guidance and meet the requirements in 10 CFR 52.47(b)(1).

14.3.7.4.17 Condensate Storage Facilities (DCA Part 2, Tier 2, Section 9.2.6)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the condensate storage facilities and found that they are not safety related or risk significant, and the applicant did not credit them for providing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.18 Site Cooling Water System (DCA Part 2, Tier 2, Section 9.2.7)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the site cooling water system and found that it is not safety related or risk significant, and the applicant did not credit it for providing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.19 Chilled Water System (DCA Part 2, Tier 2, Section 9.2.8)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the chilled water system and found that it is not safety related or risk significant, and the applicant did not credit it for providing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.20 Utility Water System (DCA Part 2, Tier 2, Section 9.2.9)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the utility water system and found that it is not safety related or risk significant, and the applicant did not credit it for providing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.21 Compressed Air Systems (DCA Part 2, Tier 2, Section 9.3.1)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the compressed air system and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.22 Equipment and Floor Drain Systems (DCA Part 2, Tier 2, Section 9.3.3)

In DCA Part 2, Tier 1, Table 3.17-2, "Radiation Monitoring Inspections, Tests, Analyses, and Acceptance Criteria for NuScale Power Modules 1-6," and DCA Part 2, Tier 1, Table 3.18-2, "Radiation Monitoring Inspections, Tests, Analysis, and Acceptance Criteria for NuScale Power Modules 7-12," ITAAC 2 and 3 verify that, upon initiation of a high radiation signal, the balance-of-plant drainage system automatically aligns or actuates the identified components to the positions identified in DCA Part 2, Tier 1, Table 3.17-1, "Radiation Monitoring – Automatic Actions for NuScale Power Modules 1 – 6," and DCA Part 2, Tier 1, Table 3.18-1, "Radiation Monitoring – Automatic Actions for NuScale Power Modules 7 – 12," respectively. SER Section 14.3.8 evaluates these ITAAC.

14.3.7.4.23 Fire Protection System (DCA Part 2, Tier 2, Section 9.5.1)

In DCA Part 2, Tier 1, Table 3.7.1, "Fire Protection System Inspections, Tests, Analysis, and Acceptance Criteria," the applicant provided ITAAC verifying the design features for the fire

protection system provided in DCA Part 2, Tier 1, Section 3.7.1, “Design Description.” Section 3.7.1 states:

> The FPS is comprised of the equipment and components that provide early fire detection and suppression to limit the spread of fires. The FPS is a nonsafety-related system that supports up to 12 NuScale Power Modules (NPMs). The FPS equipment is located throughout the plant site.

ITAAC Number 1 verifies that two separate firewater storage tanks provide a dedicated volume of water for firefighting. ITAAC Number 2 verifies that the FPS has a sufficient number of fire pumps to provide the design flow requirements to satisfy the flow demand for the largest sprinkler or deluge system, plus an additional 500 gpm for fire hoses assuming failure of the largest fire pump or loss of off-site power.

ITAAC Number 3 verifies that safe-shutdown can be achieved assuming that all equipment in any one fire area (except for the MCR and under the bioshield) is rendered inoperable by fire damage and that reentry into the fire area for repairs and operator actions is not possible. An alternative shutdown capability that is physically and electrically independent of the MCR exists. Additionally, smoke, hot gases, or fire suppressant cannot migrate from the affected fire area into other fire areas to the extent that they could adversely affect safe-shutdown capabilities, including operator actions.

ITAAC Number 4 verifies that a plant fire hazards analysis considers potential fire hazards and ensures the fire protection features in each fire area are suitable for the hazards.

In DCA Part 2, Tier 1, Table 3.11-2, “Reactor Building Inspections, Tests, Analysis, and Acceptance Criteria,” the applicant provided ITAAC Number 1 verifying that fire and smoke barriers provide confinement so that the impact from internal fires, smoke, hot gases, or fire suppressants is contained within the reactor building fire area of origin.

In DCA Part 2, Tier 1, Table 3.13-1, “Control Building Inspections, Tests, Analysis, and Acceptance Criteria,” the applicant provided ITAAC Number 1 verifying that fire and smoke barriers provide confinement so that the impact from internal fires, smoke, hot gases, or fire suppressants is contained within the control building fire area of origin.

The staff finds that the ITAAC are sufficient to demonstrate that the FPS can perform the non-safety-related functions identified in DCA Part 2 Tier 1 Sections 3.7.1, 3.11.1, and 3.13.1. Based on a graded approach commensurate with the safety significance of the FPS, the staff reviewed the proposed ITAAC and finds that they are consistent with the SRP guidance and meet the regulations contained in 10 CFR 52.47(b)(1).

14.3.7.4.24 Turbine Generator (DCA Part 2, Tier 2, Section 10.2)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the turbine generator and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.25 Main Condenser (DCA Part 2, Tier 2, Section 10.4.1)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the main condenser and found that it is not safety related or risk

significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.26 Condenser Air Removal System (DCA Part 2, Tier 2, Section 10.4.2)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the condenser air removal system and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.27 Turbine Gland Sealing System (DCA Part 2, Tier 2, Section 10.4.3)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the turbine gland sealing system and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.28 Turbine Bypass System (DCA Part 2, Tier 2, Section 10.4.4)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the turbine bypass system and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.29 Circulating Water System (DCA Part 2, Tier 2, Section 10.4.5)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the circulating water system and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.30 Condensate and Feedwater System (DCA Part 2, Tier 2, Section 10.4.7)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the condensate and feedwater system and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.31 Auxiliary Boiler System (DCA Part 2, Tier 2, Section 10.4.10)

For this section, there are no proposed ITAAC designated in DCA Part 2, Tier 1, Chapters 2.0 or 3.0. The staff reviewed the auxiliary boiler system and found that it is not safety related or risk significant, and the applicant did not credit it for performing a safety-significant function. Therefore, the staff finds that no ITAAC are necessary for this section.

14.3.7.4.32 Control Room Habitability System (DCA Part 2, Tier 2, Section 6.4)

The staff reviewed the following ITAAC requirements in DCA, Tier 1, Tables 3.1-2, “Control Room Habitability System Inspection, Tests, analyses, and Acceptance Criteria,” ITAAC numbers 1, 4, and 5. ITAAC number 2 and 3 in Table 3.1-2 are evaluated in Section 14.3.3 of this SER.

1. Control room envelope (CRE) air exfiltration test

Tracer gas testing will be performed to verify the CRE leakage rate is not exceeded.

4. CRE heat sink temperature

   Analysis will be performed to show the CRE heat sink passively maintains the temperature of the CRE within an acceptable range for the first 72 hours following a DBA.

5. CRHS positive pressure

   A test will be performed to verify that the CRHS maintains a positive pressure in the MCR relative to adjacent areas while in DBA alignment.

The staff finds that these ITAAC are sufficient to demonstrate that the CRHS can provide clean breathing air to the control room and maintain a positive control room pressure as described in DCA Part 2, Tier 1 Section 3.1. The staff reviewed these proposed ITAAC and finds that they are consistent with SRP Section 14.3.7. Therefore, the ITAAC are acceptable for complying with the requirements of 10 CFR 52.47(b)(1).

14.3.7.4.33 Normal Control Room Heating, Ventilation, and Air Conditioning System (DCA Part 2, Tier 2, Section 9.4.1)

The staff reviewed the following ITAAC in DCA Part 2, Tier 1, Table 3.2-2:

- ITAAC Number 1—Test that the control room heating, ventilation, and air conditioning system (CRVS) air-operated CRE isolation dampers perform their function to fail to the closed position on loss of motive power under design-basis conditions.

- ITAAC Number 2—Test and verify that the CRVS maintains a positive pressure in the CRB relative to the outside environment.

- ITAAC Number 3—Verify that the hydrogen concentration levels in the CRB battery rooms are below 1 percent by volume. This is consistent with Institute of Electrical and Electronics Engineers Standard 484-2002, as revised by Regulatory Guide (RG) 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants," Revision 2, issued February 2007, which states, "the ventilation system shall limit hydrogen accumulation to one percent of the total volume of the battery area."

The staff finds that the ITAAC conform to the guidance for ITAAC verifications in RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," dated June 2007, as applied to the CRVS and, therefore, finds the ITAAC acceptable for complying with the requirements of 10 CFR 52.47(b)(1).

14.3.7.4.34 Reactor Building Heating Ventilation and Air Conditioning System (DCA Part 2, Tier 2, Section 9.4.2)

The staff reviewed the applicant's proposed ITAAC for the Reactor Building Heating Ventilation and Air Conditioning System (RBVS) in DCA Part 2, Tier 1, Table 3.3-1:

- ITAAC Number 1—Test to verify that the RBVS maintains a negative pressure in the RXB relative to the outside environment.

- ITAAC Number 2— Test to verify that the RBVS maintains a negative pressure in the radioactive waste building (RWB) relative to the outside environment.

- ITAAC Number 3— Test to verify that the RBVS maintains the hydrogen concentration levels in the RXB battery rooms containing batteries below 1 percent by volume.

The staff finds the ITAAC acceptance criteria conform to the guidance for ITAAC verifications in RG 1.206 as applied to the RBVS and, therefore, finds the ITAAC requirements acceptable for complying with the requirements of 10 CFR 52.47(b)(1).

14.3.7.4.35 Radioactive Waste Building Ventilation System (DCA Part 2, Tier 2, Section 9.4.3)

DCA Part 2, Tier 1, Section 3.3, "Reactor Building Heating Ventilation and air Conditioning System," includes one ITAAC that addresses verification of the capability of the reactor building HVAC system to maintain a negative pressure in the RWB relative to the outside environment. The staff finds this to be acceptable for the reactor building HVAC system as discussed in SER Section 14.3.7.4.34.

14.3.7.5 Combined License Information Items

There are no COL information items listed in DCA Part 2 Tier 2, Table 1.8-2, "Combined License Information Items," for this area of review.

14.3.7.6 Conclusion

Pending completion of the confirmatory item discussed above, the staff concludes that if the ITAAC for the matters reviewed in this section are performed and the acceptance criteria met, there is reasonable assurance the NuScale standard design nuclear power plant has been constructed and will be operated in accordance with the design certification, the AEA, and NRC rules and regulations in compliance with 10 CFR 52.47(b)(1).

14.3.8 Radiation Protection - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.8.1 Introduction

Standard Review Plan Section 14.3.8, "Radiation Protection - Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)," addresses the review of Tier 1 design information and ITAAC for radiation protection. The staff reviewed the proposed ITAAC to determine whether they are sufficient to verify that a plant that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the AEA, and NRC rules and regulations.

The scope of the radiation protection Tier 1 design and ITAAC review includes the following:

- Radiation shielding provided by structures and components;
- Radiation monitoring systems;
- Ventilation systems (as they relate to radiation protection design features); and
- Design features for radiation protection.

NuScale DCA Part 2, Tier 2, Chapter 11, "Radioactive Waste Management," provides information on effluent releases, public dose, the design of radioactive waste management systems, radioactive waste, and process and effluent monitors. DCA Part 2, Tier 2, Chapter 12, "Radiation Protection," provides information on the radiation protection design features of the NuScale design, in-plant radiation sources, and occupational radiation exposure. Details on compliance with radiation protection regulations (including 10 CFR Part 20, "Standards for Protection Against Radiation," and applicable portions of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants") are discussed in the Chapter 11 and 12 SER sections, which review those DCA Part 2, Tier 2, chapters and will therefore not be discussed in detail in this section. The purpose of this SER section is to document the staff's review of the radiation protection design features and ITAAC provided in DCA Part 2, Tier 1.

14.3.8.2 Summary of Application

DCA Part 2, Tier 1: The sections of DCA Part 2, Tier 1, that contain information related to radiation protection include Section 2.7, "Radiation Monitoring—Module Specific," Section 3.1, "Control Room Habitability," Section 3.3, Reactor Building Heating Ventilation and Air Conditioning System," Section 3.9, "Radiation Monitoring—NuScale Power Modules 1–12," Section 3.11, "Reactor Building," Section 3.12, "Radioactive Waste Building," Section 3.17, "Radiation Monitoring—NuScale Power Modules 1–6," and Section 3.18, "Radiation Monitoring—NuScale Power Modules 7–12."

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Tables 14.3-1 and 14.3-2, provide additional information on performance of the ITAAC. DCA Part 2, Tier 2, Chapter 11, provides design information for the radioactive waste management systems and process and effluent monitors, as well as information on expected effluent releases to the public during normal operations. DCA Part 2, Tier 2, Chapter 12, provides radiation protection design information, including

design-related aspects supporting the NuScale as low as is reasonably achievable (ALARA) and radiation protection programs, information related to in-plant radiation sources, and worker dose assessment. In accordance with SRP Section 14.3.8, DCA Part 2, Tier 1, includes significant radiation protection design information from Tier 2.

ITAAC: The staff reviewed the radiation protection-related ITAAC listed in the following DCA Part 2, Tier 1, tables:

- Table 2.7-2, "Radiation Monitoring—Module-Specific ITAAC," Items 1–4
- Table 3.3-1, "Reactor Building Heating Ventilation and Air Conditioning System Inspections, Tests, Analyses, and Acceptance Criteria," Items 1–2
- Table 3.4-1, "Fuel Handling Equipment System Inspections, Tests, Analyses, and Acceptance Criteria," Item 5
- Table 3.9-2, "Radiation Monitoring—NuScale Power Modules 1–12 ITAAC," Items 1–10
- Table 3.11-2, "Reactor Building Inspections, Tests, Analyses, and Acceptance Criteria," Items 4–5
- Table 3.12-2, "Radioactive Waste Building ITAAC," Items 1–2
- Table 3.17-2, Radiation Monitoring ITAAC for NuScale Power Modules 1–6," Items 1–4.
- Table 3.18-2, "Radiation Monitoring ITAAC for NuScale Power Modules 7–12," Items 1–3

Technical Specifications: There are no technical specifications (TS) reviewed in this section.

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

14.3.8.3 Regulatory Basis

The following NRC regulations contain the relevant requirements for this review:

- 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 19, "Control room," as it relates to the requirement, in part, that adequate radiation protection be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent (TEDE) for the duration of the accident
- GDC 60, "Control of releases of radioactive materials to the environment," as it relates to the radiation monitors used to initiate mitigating actions to prevent a release of radioactive materials into the environment.
- GDC 61, "Fuel storage and handling and radioactivity control," as it relates to the requirement that occupational radiation protection aspects of fuel storage, fuel handling, radioactive waste, and other systems that may contain radioactivity be designed such

that they ensure adequate safety during normal and postulated accident conditions, with suitable shielding and appropriate containment and filtering systems

- GDC 63, “Monitoring fuel and waste storage,” as it relates to the requirement, in part, that appropriate systems be provided for the fuel storage and radioactive waste systems and associated handling areas to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels

- GDC 64, “Monitoring radioactivity releases,” as it relates to the requirement that the containment atmosphere, spaces containing components for recirculation of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs be monitored for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents

- 10 CFR 20.1101, “Radiation protection programs,” as it relates to the requirement that the licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are ALARA

- 10 CFR 20.1201, “Occupational dose limits for adults,” as it relates to the requirement, in part, that with the exception of planned special exposures, the annual occupational dose limit for adults is equal to a TEDE of 5 rem, or the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rem

- 10 CFR 20.1406, “Minimization of contamination,” as it relates to applicants for standard design certifications describing in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste

- 10 CFR 20.1501, “General,” as it relates to the requirement, in part, that licensees make surveys that are reasonable under the circumstances to evaluate the magnitude and extent of radiation levels, the concentrations or quantities of radioactive material, and the potential radiological hazards

- 10 CFR 20.1701, “Use of process or other engineering controls,” as it relates to the requirement that the applicant shall use, to the extent practical, process or other engineering controls to control the concentration of radioactive material in air

- 10 CFR 50.34(f)(2)(xvii), as it relates to the requirement, in part, that instrumentation be provided that can measure, record, and read out in the main control room containment radiation intensity (high level)

- 10 CFR 52.47(b)(1), as it relates to the requirement that the application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in accordance with the design certification; the provisions of the AEA; and NRC rules and regulations

The guidance in SRP Section 14.3.8 refers to SRP Section 14.3. SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," lists the acceptance criteria adequate to meet the above requirements, as well as review interfaces with other SRP sections:

- SRP Section 14.3, Appendix A, "Information on Prior Design Certification Reviews," IV.1.A, "Definitions"
- SRP Section 14.3, Appendix A, Section IV.2, "General Provisions"
- SRP Section 14.3 Appendix A, Section IV.3, "Legend for Figures and Acronyms and Abbreviations"
- SRP Section 14.3, Appendix A, Section IV.4.B, "ITAAC"; defines the three column format and explains ITAAC terminology
- SRP Section 14.3, Appendix C, "Fluid Systems Review Checklist," Section II.C, "Style Guidelines for ITAAC"
- SRP Section 14.3, Appendix C, "Instrumentation and Control Systems Review Checklist," Section III, "Reviewer Check Lists"
- SRP Section 14.3, Appendix D, "ITAAC Entries"

14.3.8.4 Technical Evaluation

The applicant provided design-basis information, including associated tables and figures, in accordance with the selection criteria and methodology for developing DCA Part 2, Tier 1, information as described in DCA Part 2, Tier 2, Section 14.3. The applicant organized the DCA Part 2, Tier 1, information in the systems, structures, and topical areas format shown in the table of contents to DCA Part 2, Tier 1. The staff reviewed the DCA Part 2, Tier 1, information and ITAAC provided by the applicant in accordance with SRP Section 14.3.8. For each of the ITAAC discussed below, the staff reviewed the information contained in DCA Part 2, Tier 2, Tables 14.3-1 and 14.3-2, and verified it contained information consistent with the ITAAC.

14.3.8.4.1 Radiation Shielding

SRP Section 14.3.8 indicates that the criteria in DCA Part 2, Tier 1, should ensure that the radiation shielding design (as provided by the plant structures or by permanent or temporary shielding included in the design) is adequate so that the maximum radiation levels in plant areas are commensurate with the areas' access requirements (and the requirements of 10 CFR Part 20). SRP Section 14.3.8 also specifies that the review should ensure that DCA Part 2, Tier 1, clearly describes the systems, structures, and components (SSCs) that provide a significant radiation protection function, including the key performance characteristics and safety functions of SSCs based on their safety significance.

DCA Part 2, Tier 2, Section 12.3.2, "Shielding," describes some of the design considerations for radiation shielding, such as stating that material used for a significant portion of plant shielding is to be concrete. DCA Part 2, Tier 2, Section 12.3.2.2, "Design Considerations," states that the selection of shielding materials considers the ambient environment and potential degradation mechanisms. The material used for a significant portion of plant shielding is concrete. In addition to concrete, other types of materials such as steel, water, tungsten, and polymer

composites are considered for both permanent and temporary shielding. DCA Part 2, Tier 2, Section 12.3.2.4.3, "Reactor Building," states that cubicle walls are concrete supported by carbon steel plates, called structural steel partition walls. DCA Part 2, Tier 2, Table 12.3-6, "Reactor Building Shield Wall Geometry," provides the nominal thickness of concrete for some of the walls in the reactor building (RXB). DCA Part 2, Tier 2, Table 12.3-8, "Reactor Building Radiation Shield Doors," lists the shielded doors located in the RXB. DCA Part 2 Tier 2, Table 12.3-7, "Radioactive Waste Building Shield Wall Geometry," provides the nominal thickness of concrete for some of the walls in the radioactive waste building (RWB). DCA Part 2, Tier 2, Table 12.3-9, "Radioactive Waste Building Radiation Shield Doors," lists the shielded doors located in the RWB.

The acceptance criteria of Design-Specific Review Standard Section 12.3-12.4, "Radiation Protection Design Features," states that where the applicant's shielding design incorporates material subject to degradation, such as through the effects of radiation (e.g., depletion of boron neutron absorbers), temperature extremes (e.g., degradation of polymer-based materials because of high temperature), density changes (e.g., sagging or settling of shielding material with age), methods should be specified to ensure that occupational radiation exposure (ORE) remains ALARA, and the equipment exposures are maintained in accordance with the provisions of 10 CFR 50.49. It further states that the application should identify the allowable constraints (e.g., minimum cooling air flow, maximum shielding material temperature, and maximum allowable neutron flux) and how those parameters are measured and assessed over the design life of the facility. DCA Part 2, Tier 2, Section 12.3.2.2, states that in addition to concrete, other types of materials such as steel, water, tungsten, and polymer composites are considered for both permanent and temporary shielding. However, DCA Part 2, Tier 2, Section 12.3.2, does not identify any areas of the plant shielding (e.g., penetration shielding around hot pipes) that have limitations associated with the shielding material or for which specific design criteria (e.g., maximum temperature or radiation resistance) are required for the integrity of the shielding to be maintained.

DCA Part 2, Tier 1, Section 3.11, states that the RXB includes radiation shielding barriers for normal operation and postaccident radiation shielding and Table 3.11-1, "Reactor Building Shield Wall Geometry," provides information on the radiation shield walls, floors, and ceilings in the RXB, including the shielding materials and thicknesses. Further, DCA Part 2, Tier 1, Table 3.11-2, contains the ITAAC for the RXB. Specifically, item 4 in Table 3.11-2 provides an ITAAC to verify the thicknesses of the radiation shield barriers identified in Table 3.11-1, and item 5 in Table 3.11-2 provides an ITAAC to verify that radiation attenuating doors for normal operation and for post-accident radiation shielding have a radiation attenuation capability that meets or exceeds that of the wall within which they are installed. DCA Part 2, Tier 1, Section 3.12, states that the RWB includes radiation shielding barriers for normal operation and postaccident radiation shielding and Table 3.12-1, "Radioactive Waste Building Shield Wall Geometry," provides information on the radiation shield walls, floors, and ceilings in the RWB, including the shielding materials and thicknesses. Further, DCA Part 2, Tier 1, Table 3.12-2, contains the ITAAC for the RWB. Specifically, item 1 in Table 3.12-2 and item 2 in Table 3.12-2 provide the radiation shielding barrier ITAAC and radiation attenuation door ITAAC, respectively, using the same format as the analogous ITAAC for the RXB.

The staff reviewed the Tier 1 information on radiation shielding barriers and radiation attenuation doors discussed above. The staff found that the radiation barriers in Tables 3.11-1 and 3.12-1 were acceptable because they described significant radiation barriers in the plant. In addition, the staff found the proposed ITAAC to be acceptable because the ITAAC ensure that

the radiation shielding barriers are as thick or thicker than that provided in Tables 3.11-1 and 3.12-1 and the doors have a radiation attenuation capability that meets or exceeds that of the wall within which they are installed. However, neither DCA Part 2, Tier 1, Section 3.11 nor DCA Part 2, Tier 1, Section 3.12 describes ITAAC provided for verification of the design features (e.g., minimum air flow rate around hot pipes to prevent degradation of concrete, minimum spacing between hot pipes and structural components provided to prevent degradation of materials) provided to ensure the continued integrity of the radiation shielding. Because routine tests or inspections of shielding material are not capable of assessing the degradation (e.g., dehydration of concrete from the high temperature) of the shielding material that may adversely impact its ability to perform under design-basis conditions (i.e., accident or anticipated operational occurrence source terms following design-basis events, such as earthquakes), provision and function of design features for the protection of shielding are important for ensuring the continued integrity of the shielding.

Therefore, on April 2, 2018, the staff issued RAI 9303, Question 12.03-54 (ADAMS Accession No. ML18092B231), asking the applicant to provide additional information about the adequacy of the ITAAC on design features for ensuring the continued integrity of the radiation shielding. In its response dated May 29, 2018 (ADAMS Accession No. ML18149A643), the applicant indicated that it has ITAAC for radiation shielding that ensure the health and safety of workers. The applicant indicated that it would not include protective features for radiation shielding in ITAAC. The staff's primary concern for ensuring the integrity of radiation shielding was ensuring the integrity of the polyethylene bioshield shielding because polyethylene can degrade over time from exposure to radiation and other environmental conditions. The staff issued RAI 9294, Question 12.03-26, on January 26, 2018 (ADAMS Accession No. ML18026A727), asking about the polyethylene shielding, and RAI 9298, Question 12.03-19, on January 26, 2018 (ADAMS Accession No. ML18026A724), specifically with regard to the ITAAC for borated polyethylene. However, as discussed in its response to RAI 9294, Question 12.03-26, dated March 21, 2018 (ADAMS Accession No. ML18080A127), the applicant indicated that polyethylene bioshield shielding is being removed from the NuScale design. Because the polyethylene was no longer part of the design, the staff found it acceptable to not include ITAAC as part of the design to ensure the integrity of the radiation shielding. However, in its response to RAI 9447, Question 03.11-19, dated November 16, 2018 (ADAMS Accession No. ML18320A253), the applicant specified that it again changed the design of the bioshield to include borated polyethylene shielding but did not propose including borated polyethylene in the ITAAC. As a result, the staff is tracking RAI 9298, Question 12.03-19, and RAI 9303, Question 12.03-54, as **Open Items 14.3.8-1** and **14.3.8-2**.

In addition, because the staff was unable to determine whether the ITAAC for radiation shielding encompassed the different types and associated thicknesses of material needed to meet the underlying requirement for shielding, the staff issued RAI 9294, Question 12.03-27, on January 26, 2018 (ADAMS Accession No. ML18026A727), asking the applicant to provide additional information on the ITAAC for radiation shielding. As discussed in its response to RAI 9294, Question 12.03-23, dated March 21, 2018 (ADAMS Accession No. ML18080A127) (see Chapter 12 of this SER), NuScale specified that 20 inches of concrete and steel partition walls within the RXB consist of two one-half-inch steel plates with 19 inches of concrete in between them. The 20-inch concrete and steel composite slabs for floors and ceilings also consist of two one-half-inch steel plates with 19 inches of concrete in between them. The applicant proposed adding footnotes to DCA Part 2, Tier 2, Table 12.3-6, describing the designed thickness of the steel and concrete for the partition walls and composite slabs. The applicant also specified that an additional 1-inch-thick steel plate is modeled to cover the liquid

radioactive waste system (LRWS) ion exchange and charcoal bed cubicle, and an additional 2-inch-thick plate of steel is modeled to cover the drum dryer skid cubicles. In addition, the shielding analysis of the solid radioactive waste system (SRWS) models a 4.5-inch-thick lead shield around the high-integrity container (HIC) in the HIC fill station room. The applicant will revise DCA Part 2, Tier 2, Section 12.3.2.4.4, "Radioactive Waste Building," and Table 12.3-7, to reflect these additional shields.

In accordance with RAI 9294, Question 12.03-23, the applicant proposed in its response to RAI 9294, Question 12.03-27, dated March 21, 2018 (ADAMS Accession No. ML18080A127), to update DCA Part 2, Tier 1, Tables 3.11-1, "Reactor Building Shield Wall Geometry," and 3.12-1, "Radioactive Waste Building Shield Wall Geometry," to provide the same information regarding steel shielding in DCA Part 2, Tier 2. However, the markups did not clearly indicate whether the applicant would provide this shielding in the design or model it in the shielding calculations. In Revision 1 of the response to RAI 9294, Question 12.03-27, dated August 16, 2018 (ADAMS Accession No. ML18228A861), the applicant proposed updates to DCA Part 2, Tier 2, Table 12.3-7, to clarify that the shielding specified above (or an equivalent amount of attenuation to the shielding specified above) will be provided on the LRWS, drum dryer skid cubicles, and HIC. The staff finds the response to RAI 9294, Question 12.03-27, acceptable because the DCA now specifies the steel shielding being credited in the design. As a result, the response to RAI 9294, Question 12.03-27, is **Confirmatory Item 14.3.8-1** pending the incorporation of the proposed changes in a future DCA revision.

14.3.8.4.2 Radiation Protection Features Associated with Fuel Handling and Storage

The majority of occupational radiation exposure typically occurs during refueling outages, with exposure to plant personnel from the movement of irradiated fuel and in-core components being a potentially significant contributor to this dose. Furthermore, the plant should be designed with appropriate radiation protection design features during potential accident conditions, in accordance with 10 CFR Part 50, Appendix A, GDC 61.

DCA Part 2, Tier 1, Table 3.4-1, design commitment and ITAAC 5, requires that the fuel-handling machine travel is limited so that the machine maintains at least 10 feet of water above the top of the fuel assembly when lifted to its maximum height with the pool level at the lower limit of the normal operating low water level. This ITAAC will ensure that personnel are not overexposed from a raised spent fuel assembly and is a design feature provided for maintaining a dose of less than 2.5 millirem (mrem)/hour radiation exposure to operators on the refueling platform in accordance with the American National Standards Institute (ANSI)/American Nuclear Society (ANS)-57.1-1992, "Design Requirements for Light Water Reactor Fuel Handling Systems," and is acceptable. Section 14.3.7 of this SER discusses other fuel-handling equipment system ITAAC.

14.3.8.4.3 Radiation Monitoring

The main purpose of reviewing the process and effluent monitors as part of this SER section is to evaluate the appropriateness of the ITAAC for the main control room monitors. Therefore, while some aspects of the process and effluent monitor Tier 1 information, including ITAAC, are discussed in this section of the SER, other aspects of the process and effluent monitor Tier 1 information, including ITAAC, are reviewed in more detail in Chapter 11, "Radioactive Waste Management," of this SER.

DCA Part 2, Tier 1, Sections 2.7, 3.9, 3.17, and 3.18, include numerous design commitments and ITAAC related to radiation monitoring, which ensure that automatic actuations occur in the event that high radiation levels are detected by certain radiation monitors in order to mitigate a potential unplanned release of radioactivity. In addition, the staff reviewed DCA Part 2, Tier 1, Section 2.5, "Module Protection Systems and Safety Display and Indication System," and ITAAC 25 in Table 2.5-7, "Module Protection Systems and Safety Display and Indication System ITAAC." The design commitment for this ITAAC states, "The PAM Type B and Type C displays are indicated on the SDIS displays in the MCR," and the ITAAC acceptance criteria is, "The PAM Type B and Type C displays listed in Table 2.5-5 are retrieved and displayed on the SDIS displays in the MCR." Since the under-the-bioshield monitors are post-accident monitoring (PAM) Type B and Type C variables, this ITAAC verifies that the under-the-bioshield-area radiation monitor is displayed on the safety display and information system (SDIS) in the main control room (MCR). The staff evaluated this information and concludes that the DCA includes an appropriate ITAAC for the under-the-bioshield radiation monitors. It is consistent with SRP Section 14.3.8 to include ITAAC that provide assurance that the radiation monitors respond and appropriately actuate components to mitigate an unexpected release of radioactive material. As a result, the staff finds these ITAAC to be acceptable.

14.3.8.4.4 Ventilation Systems

The staff reviewed the radiation protection aspects of the NuScale ventilation system ITAAC, as applicable to this section. DCA Part 2, Tier 1, Section 3.3, "Reactor Building Heating Ventilation and Air Conditioning System," provides design commitments and ITAAC specifying that the RXB and RWB ventilation systems will maintain the buildings at a negative pressure relative to the outside air to control airborne activity so that releases of airborne radioactivity from the buildings are minimized. The staff evaluated the information provided by the applicant and finds that the design commitments and ITAAC in Items 1 and 2 in DCA Part 2, Tier 1, Table 3.3-1, to be in accordance with SRP Section 14.3.8, in that the applicant provides ITAAC associated with controlling the release of radioactive material to the public. As a result, the staff finds these ITAAC to be acceptable. Section 14.3.7 of this SER discusses the reactor building heating, ventilation, and air conditioning system (RBVS) ITAAC.

14.3.8.4.5 Radioactive Waste Systems and Radiation Effluent Monitoring

The areas of review for radioactive waste systems include design objectives, design criteria, identification of all expected releases of radioactive effluents, methods of treatment, methods used in calculating effluent source terms and releases of radioactive materials in the environment, and operational programs in controlling and monitoring effluent releases and for assessing associated doses to members of the public. The radioactive waste systems include LRWS, gaseous radioactive waste system (GRWS), and SRWS. These systems deal with the management of radioactive wastes, as liquid, wet, and dry solids, produced during normal operation and anticipated operational occurrences. SER Sections 11.2, 11.3, and 11.4, respectively, provide the staff's review of these systems. In addition, the reviews include an evaluation of the process and effluent radiological monitoring instrumentation and sampling systems (PERMISS) which are used to monitor liquid and gaseous process streams and effluents and solid wastes generated by these systems. The PERMISS include subsystems used to collect process and effluent samples during normal operation, anticipated operational occurrences, and under postaccident conditions. Section 11.5 of this SER contains the staff's review of the PERMISS.

DCA Part 2, Tier 1, Section 2.7, contains the design commitments and ITAAC related to the PERMISS for the automatic actions of various systems based on radiation monitoring that are module specific. These design commitments and ITAAC require the containment evacuation system (CES) and chemical and volume control system monitors to automatically respond to high-radiation signals and perform the necessary actions. The staff's review determined that the design commitments and ITAAC are acceptable because the ITAAC tests the functions of the CES and chemical and volume control system monitors, as described in DCA Part 2, Tier 1, Table 2.7-1, "Radiation Monitoring – Module-Specific Automatic Actions," to initiate the desired actions on high-radiation signals to demonstrate the monitors' ability to mitigate radioactive releases, as required by the design commitments.

DCA Part 2, Tier 1, Section 3.9, contains the design commitments and ITAAC related to the PERMISS for the automatic actions of various systems based on radiation monitoring that are shared among the 12 NuScale Power Modules (NPMs). These design commitments and ITAAC require that the control room HVAC system (CRVS), control room habitability system (CRHS), RBVS, GRWS, LRWS, auxiliary boiler system (ABS), and pool surge control system (PSCS) monitors automatically respond to high-radiation signals and perform the necessary actions. The staff's review determined that the design commitments and ITAAC are acceptable because the ITAAC test the functions of the CRVS, CRHS, RBVS, GRWS, LRWS, ABS, and the PSCS monitors, as described in DCA Part 2, Tier 1, Table 3.9-1, "Radiation Monitoring – NuScale Power Modules 1-12 Automatic Actions," to initiate the desired actions on high-radiation signals to demonstrate the monitors' ability to mitigate radioactive releases, as required by the design commitments.

DCA Part 2, Tier 1, Section 3.17, contains the design commitments and ITAAC related to the PERMISS for the automatic actions of various systems based on radiation monitoring that are shared among NPMs 1–6. These design commitments and ITAAC require that the containment flooding and drains system (CFDS) and balance-of-plant drains system (BPDS) monitors automatically respond to high-radiation signals and perform the necessary actions. The staff's review determined that the design commitments and ITAAC are acceptable because the ITAAC test the functions of the CFDS and BDPS monitors, as described in DCA Part 2, Tier 1, Table 3.17-1, "Radiation Monitoring – Automatic Actions for NuScale Power Modules 1-6," to initiate the desired actions on high-radiation signals to demonstrate the monitors' ability to mitigate radioactive releases, as required by the design commitments.

DCA Part 2, Tier 1, Section 3.18, contains the design commitments and ITAAC related to the PERMISS for the automatic actions of various systems based on radiation monitoring that are shared among NPMs 7–12. These design commitments and ITAAC require that the CFDS and BPDS monitors automatically respond to high-radiation signals and perform the necessary actions. The staff's review determined that the design commitments and ITAAC are acceptable because the ITAAC test the functions of the CFDA and BDPS monitors, as described in DCA Part 2, Tier 1, Table 3.18-1, "Radiation Monitoring – Automatic Actions for NuScale Power Modules 7-12," to initiate the desired actions on high-radiation signals to demonstrate the monitors' ability to mitigate radioactive releases, as required by the design commitments.

In addition to the above ITAAC documented in NuScale's DCA Part 2, Tier 1, the staff reviewed information related to CES monitoring in relation to the ITAAC in DCA Part 2, Tier 1, Section 2.3, "Containment Evacuation System." In its review of the standard DCA ITAAC that the staff provided in a letter sent to NuScale on April 8, 2016 (ADAMS Accession No. ML16096A132) (2016 ITAAC Letter), the staff identified that the ITAAC related to the test

for the reactor coolant system (RCS) pressure boundary leakage did not include a test for the CES radiation monitor. In RAI 9252, Question 11.05-03, the staff requested the applicant to provide information in the DCA to show that the CES monitor would detect one gpm of leakage within one hour. In its response to RAI 9252, Question 11.05-03, dated May 30, 2018 (ADAMS Accession No. ML18151B062), the applicant highlighted three methods the NuScale design uses to detect leakage: containment pressure, CES sample tank level, and radiation monitoring. The applicant stated that only two methods (containment pressure and CES sample tank level) are used to quantify RCS leakage. The third method, the CES radiation monitoring, is used as indication of RCS leakage on a high-radiation condition but is not used to measure the amount of RCS leakage. Indication and alarms initiated by the radiation monitor prompt operators to quantify RCS leakage using the other two methods.

In addition to the information the applicant provided, the staff reviewed the information in the TS as it relates to TS 3.4.7 for RCS leakage detection. This TS relates to the test for RCS pressure boundary leakage ITAAC because the ITAAC verifies that a NuScale plant is capable of detecting the leakage described in the TS. In review of the response provided by NuScale, the staff observed that the pressure and level methods included two channels provided for each of these methods. In addition, the conditions described by the TS require actions to verify amounts of RCS leakage when one or more of the channel indicators is inoperable. When one of the leakage detection methods has all channels inoperable, these methods must be restored. Based on the number of pressure and level channels available to quantify RCS leakage and the required actions associated with losing RCS leakage indication, the staff has determined that NuScale's position of using the CES radiation monitoring for indication of a leak only, and not quantification, is acceptable. Therefore, an ITAAC to test the CES radiation monitor is unnecessary. The staff considers RAI 9252, Question 11.05-03, closed.

Based on the discussion above, the staff finds the information provided in DCA Part 2, Tier 1, Sections 2.7, 3.9, 3.12, 3.17, and 3.18 is complete and consistent with the plant design basis as described in DCA Part 2, Tier 2, Sections 11.2, "Liquid Waste Management System," 11.3, "Gaseous Waste Management System," 11.4, "Solid Waste Management System," and 11.5, "Process and Effluent Radiation Monitoring Instrumentation and Sampling System." Based on the discussion above, the staff finds that Tier 1 includes the top-level design requirements for the PERMISS and the ITAAC for the PERMISS are acceptable and comply with the requirements of 10 CFR 52.47(b)(1).

14.3.8.4.6 Other Design Features

The staff's 2016 ITAAC Letter included ITAAC for the RWB and radioactive waste systems and components to ensure that the SSCs meet the appropriate design criteria when constructed. DCA Part 2, Tier 1, Section 3.12, contains an ITAAC ensuring that the RWB will be designed as RW-IIa in accordance with Regulatory Guide (RG) 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," but does not contain ITAAC corresponding to Item R07 in the 2016 ITAAC Letter with respect to verifying that the systems and components containing radioactive waste were designed and constructed, consistent with the guidance in RG 1.143, for demonstrating compliance with the provisions of 10 CFR Part 20 related to the protection of the health and safety of members of the public and plant personnel. Item R07 is an "As-Built Inspection and Reconciliation Analysis" ITAAC and is designed to verify that the equipment of the non-Seismic Category I radioactive waste system are "designed and constructed to the standards of RG 1.143 to withstand the design loads without loss of structural integrity."

RG 1.143 Table 1, "Codes and Standards for the Design of SSC in Radwaste Facilities," describes the design codes and standards expected to be met to demonstrate that the health and safety of members of the public and workers at the facility will be protected for the operational conditions described within RG 1.143 Table 2 "Natural Phenomena and Internal/External Man-Induced Hazard Design Criteria for Safety Classification" and Table 3 "Design Load Combinations." Therefore, the staff issued RAI 9303, Question 12.03-52, on April 2, 2018 (ADAMS Accession No. ML18092B231), asking the applicant to provide additional information on the ITAAC for ensuring that the radioactive waste SSCs have been designed and constructed in a manner that protects the health and safety of the public and plant personnel. In its response dated May 29, 2018 (ADAMS Accession No. ML18149A643), the applicant specified that an ITAAC to verify that the NuScale radioactive waste systems are designed and constructed in accordance with RG 1.143 is not necessary for the following reasons:

- *The NuScale radioactive waste systems do not have any safety-related or risk-significant functions.*
- *The NuScale radioactive waste systems do not support the safety or risk-significant functions of another system.*
- *The radioactive waste systems do not contain top-level design features, as described in FSAR Section 14.3.2.1.1, for shielding that protects the health and safety of workers.*
- *The related ITAAC verifies the following top-level design features:*
    - *High-radiation liquid in the LRWS is automatically isolated from the environment by containing the liquid in the LRWS.*
    - *High-radiation gas in the GRWS is automatically isolated from the environment by containing the gas in the GRWS.*
    - *High-radiation gas in the RWB is contained and precluded from leakage to the outside environment by keeping the RWB pressure negative relative to the outside environment.*
    - *The as-built RW-IIa RWB maintains its structural integrity under the design-basis loads.*

However, the ITAAC listed by the applicant do not address the design and installation of the system and components in accordance with RG 1.143; therefore, the staff is currently tracking RAI 9303, Question 12.03-52, as Closed/Unresolved, and issued RAI 9608, Question 14.03.08-1, on October 23, 2018 (ADAMS Accession No. ML18296A234), asking the applicant to provide additional justification for why an ITAAC on the design of the radioactive waste systems is not needed. The initial response to RAI 9608, Question 14.03.08-1 (ADAMS Accession No. ML18354B151) did not include an ITAAC and did not address the staff's concerns. In the supplemental response to RAI 9608, Question 14.03.08-1 (ADAMS Accession No. ML19080A159) the applicant proposed to update Tier 1, Section 3.14, to discuss nonsafety-related, RG 1.143, RW-IIa components associated with processing gaseous radioactive waste. This included updating Table 3.14-1 to list the degasifiers, guard beds, and decay beds, including associated piping and components up to and including the first isolation valves in the table. The applicant proposed adding ITAAC Item 3 to Table 3.14-2, which provides an ITAAC which ensures that a report exists and concludes that the as-built RW-IIa components

associated with processing gaseous radwaste (i.e. the degasifiers and guard and decay beds, including the piping associated with those components, up to and including the first isolation valves) meet the RW-IIa design criteria. Finally, the applicant also proposed to update Tier 2, Table 14.3-2, to provide more detail regarding the basis and scope of the ITAAC. The applicant indicates that the scope of the ITAAC are RW-IIa components associated with processing gaseous radioactive waste.

As such, the staff determined that it was acceptable to only include ITAAC for the specified components and piping because in the event of a structural failure of radwaste components, those are the radwaste components that the staff determined were most likely to result in a significant radiological release to the public and potential uncontrolled occupational dose. The staff determined these components were the most radiologically significant was because: (1) these components were classified as RW-IIa (due to their high radionuclide content) and (2) failure of these components would be most likely to result in an uncontained release.

The staff also considered the need for ITAAC for other radwaste system components and piping. The staff determined that because of the lower radionuclide content of RW-IIc components, ITAAC for those components were not necessary. The staff determined that while the spent resin storage tanks (RW-IIa), phase separator tanks (RW-IIb) and low conductivity waste collection tanks (RW-IIb), and associated components, contained higher quantities of radioactive material, the potential of an uncontrolled release from those components is low because these components contained slurry and/or liquid waste and were located underground in the radwaste building, in their own individual cubicles which are stainless steel-lined up to a cubicle wall height equivalent to the full tank volume. Furthermore, the low conductivity waste collection tanks are designed with the discharge and drain lines at the lowest point of the tank, and the on/off bottom valve is a minimum distance from the tank bottom to optimize drainage and cleaning capability. Therefore, even if these components failed, the radioactive material would be contained mostly within the cubicle where it could be appropriately handled by radiation protection personnel.

Therefore, the staff found the response, including the associated DCA markups and ITAAC, to be acceptable. As a result, RAI 9608, Question 14.03.08-1 is being tracked as **Confirmatory Item 14.3.8-2**, pending the incorporation of the proposed changes into a future revision of the DCA.

14.3.8.5 Combined License Information Items

No COL information items are associated with this section.

14.3.8.6 Conclusion

The applicant provided DCA Part 2, Tier 1 design information and ITAAC for radiation protection SSCs, which it credited for demonstrating that a plant incorporating the NuScale design certification satisfies the relevant requirements of 10 CFR Part 20, 10 CFR Part 50, and 10 CFR Part 52. In addition, the staff reviewed the information contained in DCA Part 2, Tier 2, Tables 14.3-1 and 14.3-2, and verified it contained information consistent with the Tier 1 ITAAC information reviewed in this section.

Given the open items identified above, the staff is unable to finalize its conclusions for this section.

14.3.9 Human Factors Engineering - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.9.1 Introduction

The scope of review for human factors engineering (HFE) ITAAC includes the human factors aspects of the nuclear power plant design for the main control room (MCR) and the remote shutdown facility.

14.3.9.2 Summary of Application

DCA Part 2, Tier 1: The applicant provided design commitments for HFE in DCA Part 2, Tier 1, Section 3.15, "Human Factors Engineering."

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Table 14.3-2, "Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and ITAAC Cross Reference."

ITAAC: The applicant has provided ITAAC for HFE in DCA Part 2, Tier 1, Section 3.15.2, "Inspections, Tests, Analyses, and Acceptance Criteria," Table 3.15-1, "Human Factors Engineering ITAAC."

14.3.9.3 Regulatory Basis

The following NRC regulation contains the relevant requirement for this review:

- 10 CFR 52.47(b)(1) requires that a design certification application (DCA) contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act, and NRC rules and regulations.

The guidance in SRP Section 14.3.9, "Human Factors Engineering — Inspections, Tests, Analyses, and Acceptance Criteria," lists the acceptance criteria that are adequate to meet the above requirement, as well as review interfaces with other SRP sections.

The following document provides additional guidance in support of meeting the above requirement:

- In a letter dated April 8, 2016 (ADAMS Accession No. ML16096A121), the NRC sent the applicant a set of standardized DCA ITAAC that might be applicable to the NuScale design for use in a future design certification application. This letter contains two standardized HFE ITAAC.

14.3.9.4 Technical Evaluation

The staff reviewed DCA Part 2, Tier 1, Revision 1, Section 3.15, and Table 3.15-1, which includes one HFE ITAAC. The applicant's HFE ITAAC is generally consistent with the format of the second standardized HFE ITAAC in the NRC's 2016 letter. The application does not include the first standardized HFE ITAAC for Main Control Room Integrated System Validation (ISV)

because the applicant completed ISV as part of the design certification, making this ITAAC not applicable.

The remaining HFE ITAAC aims to verify that the as-built Main Control Room Human System Interfaces (HSI) are consistent with the HSI resulting from the applicant's HFE design process. The staff reviewed this ITAAC and the discussion of it in DCA Part 2, Tier 2, Table 14.3-2, "Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and ITAAC Cross Reference," and found it was generally consistent with the second standardized HFE ITAAC. However, the staff questioned whether the scope of the ITAAC is sufficient to address the HFE activities that are to be completed by the COL holder during HFE design implementation (DI) and whether the ITAAC acceptance criteria was appropriately worded for a design certification application that does not use design acceptance criteria (DAC). Therefore, the staff issued RAI 9415, Question 18-46 dated April 23, 2018 (ADAMS Accession No. ML18204A190). In its response to RAI 9415, Question 18-46, dated June 21, 2018 (ADAMS Accession No. ML18172A318) the applicant explained the process for design implementation and stated that the ITAAC would not be changed. The staff found that the response did not fully address the issues identified with the DI implementation plan (IP).

On August 7, 2018, and August 21, 2018, the NRC held two public meetings to discuss NuScale's strategy for DI (ADAMS Accession No. ML18235A137). The NRC held a third public meeting on October 17, 2018 (ADAMS Accession No. ML18304A258). NuScale proposed a method for DI in a draft supplemental RAI response that uses an ITAAC and other existing regulatory controls to ensure that a COL applicant adequately performs DI activities. The strategy does not include submitting a results summary report (RSR) as described in Section 12.3, "Applicant Submittals," of NUREG-0711, "Human Factors Engineering Program Review Model," Revision 3. The staff is currently assessing the proposal. Resolution of this issue is important to ensuring that the activities described in the DI IP are performed appropriately by a COL applicant and that there will be sufficient means for the NRC to perform oversight of this work. This is captured in Chapter 18, "Human Factors Engineering," of this SER as **Open Item 18-22**. The staff is engaging the applicant to agree upon an appropriate ITAAC or other suitable strategy for meeting the intended purpose of the RSR.

In accordance with SRP Section 14.3, Tier 1 design information should identify the principal performance characteristics and safety functions of the standard design. The staff reviewed the HFE design description in DCA Part 2, Tier 1, Section 3.15.1, and found that it is consistent with the HFE design process discussed in parts of DCA Part 2, Tier 2, Section 18; however, the Tier 1 information will need to be updated to include a description of the HFE design that results from completion of the Validation and Verification process discussed in Section 18 of this SER. The staff cannot make a determination about the Tier 1 HFE design information until they have completed their review of the applicant's Validation and Verification Results Summary Report, which the applicant submitted on March 18, 2019, (ADAMS Accession No. ML19077A330). The staff is currently reviewing this report. This is captured in Chapter 18, "Human Factors Engineering," of this SER as **Open Item 18-22**.

Review procedures in the Standard Review Plan, Section 14.3.9 (March 2007 revision), direct the staff to ensure the standard ITAAC entries in SRP Section 14.3 Appendix D are included for each plant system that has alarms, controls or displays. Appendix D of SRP Section 14.3 includes ITAAC entries for alarms, controls, or displays in the MCR and the Remote Shutdown Station (RSS). In addition, entries for such ITAAC are included in the standardized ITAAC

contained in the NRC's 2016 letter. Therefore, the staff also reviewed the ITAAC in DCA Part 2, Tier 1, Revision 2, Table 2.5-7, "Module Protection System and Safety Display and Indication System ITAAC," for system-specific displays, controls, and alarms for the MCR and RSS. The staff compared the applicant's ITAAC to the standard ITAAC and found that NuScale did include ITAAC for displays, controls, and alarms in the MCR, which are reviewed in Section 14.3.5 of the SER. However, the applicant did not include ITAAC for the RSS.

In a letter dated March 14, 2019 (ADAMS Accession No. ML19073A331), NuScale requested a partial exemption from GDC 19 and described its intent to replace GDC 19 with a NuScale-specific principal design criterion (PDC) 19. This letter included proposed revisions to DCA Part 2, Tier 2, Section 3.1.2.10, "Criterion 19 – Control Room," which states that the displays, alarms, and controls in the RSS are not credited to meet the criteria of PDC 19 regarding equipment at appropriate locations outside the control room having the capability for safe shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe shutdown. As indicated in the March 14, 2019, letter, NuScale requested an exemption from GDC 19 to depart from the portion of the rule requiring equipment outside the control room with a potential capability for subsequent cold shutdown of the reactor when the control room is evacuated. The SER sections evaluating this exemption request are listed in SER Section 1.14, "Index of Exemptions." The staff also reviewed the March 14, 2019, letter's proposed revision to DCA Part 2, Tier 2, Section 7.1.1.2.3, "Remote Shutdown Station," which states that operators can achieve safe shutdown of the reactors from outside the main control in the Module Protection System (MPS) equipment rooms. DCA Part 2, Tier 1, Revision 2, Table 2.5-7, "Module Protection System and Safety Display and Indication System ITAAC," includes ITAAC to verify this capability. If the exemption request is approved, then the staff could find it acceptable that the applicant has excluded ITAAC for displays alarms and controls in the RSS because there is no manual control of safety-related equipment allowed from the RSS, the RSS is not used to satisfy the remote shutdown capabilities of GDC 19, and the application includes existing ITAAC to verify the remote shutdown capability of the MPS. As stated in the response to RAI 9401, Question 18-34 (ADAMS Accession No. ML18141A661), the displays, controls, and alarms provided in the RSS are identical to the Module Control System and Plant Control System displays in the MCR and include the parameters necessary to monitor safe shutdown of all units. The exemption request is subject to further staff review and the changes to the application for the remote shutdown capability are being tracked as **Open Item 14.3.9-1**.

14.3.9.5 Combined License Information Items

There are no Combined License Information Items associated with this section.

14.3.9.6 Conclusion

No conclusions have been reached due to open items.

14.3.10 Emergency Planning - Inspections, Tests, Analyses, and Acceptance Criteria

The applicant did not provide emergency planning specific ITAAC for the design and specified COL item 14.3-1 for a future combined license applicant to address ITAAC, as listed in SER Section 13.3.5. The acceptability of a future COL applicant's proposed ITAAC will be evaluated as part of the COL application process.

14.3.11 Containment Systems - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.11.1 Introduction

NuScale Design Certification Application (DCA) Part 2, Tier 1 includes the portion of the design-related information that, if acceptable, would be approved, certified, and incorporated by reference into a new design certification rule for the NuScale design. The design descriptions, interface requirements, and site parameters are derived from information in DCA Part 2, Tier 2. NuScale Design Certification Application (DCA) Part 2, Tier 1 also includes ITAAC.

Section 14.3.11 of this report addresses ITAAC related to the containment and associated systems. The scope of "containment systems" encompasses containment design and associated issues, which include containment isolation provisions, containment leakage testing, combustible gas control in containment, and containment heat removal.

The staff reviewed the ITAAC with respect to the containment systems described in DCA Part 2 in accordance with NUREG-0800, Sections 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," and 14.3.11, "Containment Systems—Inspections, Tests, Analyses, and Acceptance Criteria," both issued March 2007. The staff reviewed the proposed ITAAC to determine whether they are necessary and sufficient to provide reasonable assurance that, if the ITAAC are successfully completed, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act of 1954, as amended, and the Commission's rules and regulations.

14.3.11.2 Summary of Application

DCA Part 2, Tier 1: The applicant provided design descriptions for containment systems in DCA Part 2, Tier 1, Section 2.1, "NuScale Power Module." DCA Part 2, Tier 1, Chapter 1, "Introduction," provides definitions, general provisions, and a legend for figures, acronyms, and abbreviations.

The applicant organized its Tier 1 information in a manner similar to that used for the evolutionary designs as described in SRP Section 14.3 and RG 1.206, "Combined License Applications for Nuclear Power Plants," Section C.II.1 dated June 2007. The tabular format and content for the containment system ITAAC follow the NRC-recommended format presented in RG 1.206, Table C.II.1-1. The ITAAC are presented in a three-column table that includes the proposed design commitment to be verified (column 1), the method (the inspections, tests, or analyses) by which the licensee will verify (column 2), and specific acceptance criteria (column 3) that, if met, demonstrate the licensee has met the design commitment in column 1.

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Section 14.3, "Certified Design Material and Inspections, Tests, Analyses, and Acceptance Criteria," states that the design descriptions, interface requirements, and site parameters are derived from Tier 2 information and that Tier 1 information includes the following:

- definitions and general provisions
- design descriptions
- ITAAC

- significant interface requirements
- significant site parameters

A description of how the containment systems ITAAC are to be performed is in DCA Part 2, Tier 2, Table 14.3-1, “Module-Specific Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference."

ITAAC: The following DCA Part 2, Tier 1 tables contain the ITAAC applicable to this review area:

- Table 2.1-4, “NuScale Power Module ITAAC,” Numbers 7–9.
- Table 2.1-4, Number 23.

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

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

14.3.11.3 Regulatory Basis

The following NRC regulations contain the relevant requirements for this review:

- 10 CFR 52.47(b)(1), as it relates to the requirement that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, as amended, and NRC rules and regulations

The guidance in SRP Sections 14.3 and 14.3.11 lists the acceptance criteria adequate to meet the above requirements, as well as review interfaces with other SRP sections. In addition, in a letter dated April 8, 2016, the NRC staff transmitted to NuScale a set of Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) that could be used in its design certification application.

RG 1.206, Section C.II.1.2.11, describes ITAAC development for containment systems and identifies the aspects to be verified through ITAAC. These are related to the containment design and associated issues, such as containment isolation provisions, containment leakage testing, hydrogen generation and control, containment heat removal, and subcompartment analysis.

14.3.11.4 Technical Evaluation

The staff reviewed the system- and nonsystem-based ITAAC in accordance with SRP Sections 14.3 and 14.3.11, particularly the applicable review procedures identified in each SRP Section III, as well as the guidance in RG 1.206, Section C.II.1. The staff examined the ITAAC to ensure that they can be completed by the organization holding the combined license. The staff examined the phrasing and format of the ITAAC to determine if they were consistent (i.e., the Design Commitment; the Inspection, Test, or Analysis; and the Acceptance Criteria are parallel and in agreement). In addition, the staff determined that the DCA Part 2, Tier 1 ITAAC

items were derived from the DCA Part 2, Tier 2 information. NuScale DCA Part 2, Tier 2, Table 14.3-1 provides background information associated with the Tier 1 design commitments and a brief description of how to complete the ITAAC listed above. The staff reviewed the information and finds that it is consistent with the NuScale design and the associated ITAAC.

14.3.11.4.1 Containment Systems Tier 1 ITAAC

The staff used the following SRP sections identified in SRP Section 14.3.11 that have a potential impact on the ITAAC sections related to containment systems:

- SRP Section 14.3 (general guidance on ITAAC)
- SRP Section 14.3.2 (the ability of SSCs to withstand various natural phenomena)
- SRP Section 14.3.3 (piping design)
- SRP Section 14.3.5 (instrumentation and controls)
- SRP Section 14.3.6 (electrical systems and components)
- SRP Chapter 19, "Severe Accidents" (design of the features and functions of SSCs that should be addressed based on severe accident, probabilistic risk assessment, and shutdown safety evaluations)

The staff assessed the containment system ITAAC items associated with the following DCA Part 2, Tier 2, sections in accordance with the applicable procedures and guidance in SRP Sections 14.3 and 14.3.11:

- Section 6.2.4, "Containment Isolation System"
- Section 6.2.6, "Containment Leakage Testing"

14.3.11.4.2 Containment Isolation System ITAAC

The containment system provides for the isolation of process systems that penetrate the containment vessel (CNV). The purpose of containment isolation is to permit the normal or postaccident passage of fluids through the containment boundary, while protecting against the release to the environment of fission products that may be present in the containment atmosphere and fluids as a result of postulated accidents.

NuScale DCA Part 2, Tier 1, Section 2.1, specifies ITAAC for containment isolation. DCA Part 2, Tier 1, Figure 2.1-1, "Containment System (Isolation Valves)," shows the functional arrangement of the containment isolation equipment. DCA Part 2, Tier 1, Section 2.1 includes design commitments requiring that containment isolation valve (CIV) closure times limit potential releases of radioactivity, and that the length of piping between the containment penetration and the associated outboard CIVs be minimized. Tables in DCA Part 2, Tier 1, Section 2.1 define the required closure times and piping lengths, and these times and lengths are consistent with DCA Part 2, Tier 2, Section 6.2.4, "Containment Isolation System." Specifically, DCA Part 2, Tier 1, Table 2.1-4, includes ITAAC Number 8 to verify containment isolation valve (CIV) closure times and ITAAC Number 9 to verify the length of piping between each penetration and its associated outboard CIV.

DCA Part 2, Tier 1, Section 2.1.1, "Design Description," describes the containment pressure boundary as a top-level design feature by "providing a barrier to contain, mass, energy, and fission product release." The staff reviewed the information and finds that it is consistent with SRP Section 14.3 because the containment boundary, which includes the containment isolation function, is a top-level design feature based on the safety significance of containment as identified in safety analyses and defense-in-depth considerations.

The staff reviewed the proposed ITAAC requirements specified in DCA Part 2, Tier 1, Section 2.1, Table 2.1-4, ITAAC Numbers 8 and 9, and finds the ITAAC to be consistent with staff guidance contained in SRP Section 14.3.11 and the Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) because the valve closure times limit potential releases of radioactivity and the containment isolation valves outside containment are located as close to containment as practical. Because the ITAAC are consistent with staff guidance, the staff finds that the proposed ITAAC are acceptable and meet the requirements in 10 CFR 52.47(b)(1).

14.3.11.4.3 Containment Leakage Testing ITAAC

DCA Part 2, Tier 1, "Design Description" describes the containment as an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment. This containment design description is acceptable because it meets the criteria for accommodating the pressure and temperature conditions resulting from any loss-of-coolant accident without exceeding the design leakage rate, in accordance with 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," general design criterion (GDC) 50, "Containment Design Basis." This design description contains one of the principal performance characteristics of a leak tight containment. This design description is also consistent with Tier 2, section 6.2.6, "Containment Leakage Testing."

The containment leakage-rate testing is designed to verify the leak-tight integrity of the CNV by showing that leakage will not exceed the allowable leakage rate specified in the technical specifications. The preoperational and periodic containment leakage testing capability for CNV openings (Type B) and CNV piping penetrations (Type C) are designed to meet the leakage acceptance criteria of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors."

The applicant has requested an exemption from the integrated leak-rate test requirements in 10 CFR Part 50, Appendix J, for the CNV (Type A) test. The applicant has also requested an exemption from 10 CFR Part 50, Appendix A, GDC 52, "Capability for Containment Leakage Rate Testing." These exemption requests are under evaluation in Section 6.2.6, "Containment Leakage Testing," of this SER. This is **Open Item 14.3.11-1.**

The CNV serves as an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment. The containment leakage testing program performs the following safety related functions that are verified by ITAAC: Type B tests are intended to detect and measure local leaks for reactor containment penetrations. Type C tests are intended to measure containment isolation valve leakage rates.

The staff reviewed the proposed ITAAC Number 7 in DCA Part 2, Tier 1, Table 2.1-4, which lists the following test and acceptance criteria:

- A leakage test will be performed of the pressure-containing or leakage-limiting boundaries and CIVs.

- The leakage rate for local leak-rate tests (Type B and Type C) for pressure-containing or leakage-limiting boundaries and CIVs meets the requirements of 10 CFR Part 50, Appendix J.

The staff finds that the applicant has adequately identified ITAAC consistent with the requirements for Type B and Type C testing, consistent with the guidance in SRP Section 14.3.11. The acceptability of omitting an ITAAC for an integrated leak-rate test depends on whether the NRC approves NuScale's requested exemptions. This is **Open Item 14.3.11-1**.

Staff has also reviewed the ITAAC Number 23 in DCA Part 2, Tier 1, Table 2.1-4, which lists the following test and acceptance criteria and was proposed by NuScale to support the exemption request:

- A preservice design pressure leakage test of the CNV will be performed.

- No water leakage is observed at CNV bolted flange connections.

This ITAAC is intended to confirm the design of the bolted flanges (Type B penetrations) results in no leakage. The acceptability of this ITAAC depends on whether the NRC approves NuScale's requested exemptions. This is **Open Item 14.3.11-1**.

14.3.11.5 Combined License Information Items

There are no Combined License Information Items associated with this section.

14.3.11.6 Conclusion

Given the open item identified above, the staff is unable to finalize its conclusions for this section.

14.3.12 Physical Security Hardware - Inspections, Tests, Analyses, and Acceptance Criteria

14.3.12.1 Introduction

DCA Part 2, Tier 2, Chapter 14, Section 14.0, “Verification Programs,” describes the verification programs that include ITAAC. DCA Part 2, Tier 2, Chapter 14, Section 14.3, “Certified Design Material and Inspections, Tests, Analyses, and Acceptance Criteria,” describes the methods used to verify the engineered physical security systems, hardware, and features (hereafter referred to as PSS) within the scope of the NuScale standard design. The NuScale application aims to establish standard design elements for multiple security functions that will provide the detection, assessment, communication, delay, and response functions of a physical protection system that will protect against potential acts of radiological sabotage.

The NuScale standard design and the site-specific design of the physical protection system, physical protection programs, management systems, and organization that are described by a COL applicant must collectively demonstrate how a COL applicant will meet the relevant performance and prescriptive requirements of 10 CFR Part 73, “Physical Protection of Plants and Materials.”

Specifically, NuScale provided the design descriptions of engineered physical security systems and credited design features (e.g., structural walls, floors, and ceilings and configurations of nuclear island and structures); descriptions of intended security functions and performance requirements; the design basis for the detailed design; and supporting technical bases that a COL applicant will incorporate by reference as part of its design and licensing bases.

DCA Part 2, Tier 1, Section 3.0, “Shared Structures, Systems, and Components and Non-Structures, Systems, and Components Design Descriptions and Inspections, Tests, Analyses, and Acceptance Criteria,” and Section 3.16.2, “Inspections, Tests, Analyses, and Acceptance Criteria,” describe the ITAAC for PSS. The COL applicant referencing the NuScale standard design is responsible for providing the site-specific portion of the plant systems and describing the ITAAC for the site-specific PSS credited for performing security functions based on the COL applicant’s final design of a physical protection system and security programs.

14.3.12.2 Summary of Application

The sections of DCA Part 2, Tier 1 and Tier 2, noted below and Technical Report (TR)-0416-48929, “NuScale Design of Physical Security Systems,” Revision 1, dated January 8, 2019 (ADAMS Accession No. ML19010A036), describe the PSS and physical security ITAAC for the standard design and how they meet regulatory requirements. In addition, the applicant submitted DCA Part 8, “License Conditions; Inspections, Tests, Analyses & Acceptance Criteria (ITAAC),” which addresses the ITAAC.

DCA Part 2, Tier 1: DCA Part 2, Tier 1, Section 3.16.1, “Design Description,” describes the NuScale standard design commitments for PSS (including designation of vital areas) that provide capabilities for detection, assessment, and delay functions that protect threats up to and including the design-basis threat (DBT) for radiological sabotage and defense in depth through the integration of systems, technologies, and equipment. DCA Part 2, Tier 1, Section 3.16, “Physical Security System,” Table 3.16-1, “Physical Security System Inspections, Tests, Analyses, and Acceptance Criteria,” includes ITAAC for the PSS in the scope of the NuScale

standard design. The table identifies the general design commitments to be verified; the inspections, tests, and analyses (ITAs); and the acceptance criteria.

DCA Part 2, Tier 1, Section 3.0 and Table 3.0-1, "Shared Systems Subject to Inspections, Tests, Analyses, and Acceptance Criteria," identify the systems that support multiple modules and are verified by ITAAC.

DCA Part 2, Tier 1, Section 3.8, "Plant Lighting System," describes normal and emergency lighting systems for illuminations inside buildings. DCA Part 2, Tier 1, Table 3.8-1, "Plant Lighting System Inspections, Tests, Analyses, and Acceptance Criteria," includes the design commitments and ITAAC for plant lighting systems.

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Section 1.2, "General Plant Description," through Section 1.9, "Conformance with Regulatory Criteria," describe the scope of the NuScale standard design. DCA Part 2, Tier 2, Section 1.8, "Interface with Certified Design," addresses the interface requirements between the NuScale Power Plant certified design and site-specific design. DCA Part 2, Tier 2, Figure 1.2-2, "NuScale Function Boundaries," depicts the general boundaries of the structures or components between the certified design and site-specific design. DCA Part 2, Tier 2, Section 1.8.1, "Combined License Information Items," identifies information that must be provided in order to license and operate a site-specific NuScale power plant but is not included in the certified design. DCA Part 2, Tier 2, Table 1.8-2, "Combined License Information Items," describes COL information items that the COL applicant will address. The table includes COL Items 13.6-1 through 13.7-2, which address physical security.

In DCA Part 2, Tier 2, Chapter 1, Section 1.9, "Conformance with Regulatory Criteria," the applicant commits to conformance with the NRC regulatory guides (RGs) and NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP). DCA Part 2, Tier 2, Table 1.9-2, "Conformance with Regulatory Guides," identifies RG 1.206, "Combined License Applications for Nuclear Power Plants." DCA Part 2, Tier 2, Table 1.9-3, "Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standard (DSRS)," identifies SRP Section 14.3.12, "Physical Security Hardware—Inspections, Tests, Analyses, and Acceptance Criteria," Revision 1 for addressing physical security ITAAC.

DCA Part 2, Tier 2, Section 13.6.1, "Physical Security," states the following:

> *The NuScale Power Plant physical security design provides the capabilities to detect, assess, impede, and delay threats up to and including the design basis threat, and to provide for defense-in-depth through the integration of systems, technologies, and equipment. The design of physical security systems within the nuclear island and structures is described in Technical Report (TR) 0416-48929 (Reference 13.6-1), which is incorporated by reference to this FSAR.*

DCA Part 2, Tier 2, Section 14.0, "Verification Programs," describes the verifications that ensure that the as-built facility configuration and operation comply with the approved plant design and applicable regulations. DCA Part 2, Tier 2, Section 14.2, "Initial Plant Test Program," discusses the verification of ITAAC within the scope of the NuScale standard design. Specifically, DCA Part 2, Tier 2, Section 14.2, Table 14.2-68, "Communication System Test # 68"; Table 14.2-73, "Security Access Control Test # 73"; and Table 14.2-74, "Security Detection and Alarm Test # 74," describe the test abstracts used to verify (1) the installation of PSS and shared plant

systems relied on to perform security functions and (2) the design commitments that are the subject of ITAAC.

DCA Part 2, Tier 2, Section 14.3.1, "Introduction," identifies COL Item 14.3-2, which indicates that a COL applicant will provide a site-specific selection methodology and ITAAC for structures, systems, and components (SSCs) within its scope. DCA Part 2, Tier 2, Table 14.3-2, "Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and Components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference," describes physical security ITAAC Nos. 3.16.01 through 3.16.13 that are within the scope of the NuScale standard design.

ITAAC: DCA Part 2, Tier 1, Section 3.16, Table 3.16-1, includes the design commitments and ITAAC for the PSS included in the scope of the NuScale standard design.

Technical Reports: The applicant submitted TR-0416-48929, "NuScale Design of Physical Security Systems," which describes the security considerations in the NuScale standard design and the design bases, analyses, and assumptions for the design of PSS, including plant layout and building configurations, results of evaluations, and identification of vital equipment and areas for the NuScale standard design. The scope of the PSS described in the NuScale standard design is limited to those related to the nuclear islands and structures (i.e., reactor building (RXB), control building (CRB)) that are within the scope of the NuScale standard design. TR-0416-48929 contains Safeguards Information, security-related information, and proprietary information; therefore, it is protected in accordance with 10 CFR 73.21, "Protection of Safeguards Information: Performance requirements," and 10 CFR 2.390, "Public inspections, exemptions, requests for withholding."

14.3.12.3 Regulatory Basis

The following NRC regulations contain the relevant requirements for this review:

- 10 CFR 52.47, "Contents of applications; technical information," requires that information submitted for a design certification (DC) must include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC. 10 CFR 52.47(b)(1) requires the NuScale application to contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a facility that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the provisions of the Atomic Energy Act of 1954, as amended (AEA), and the NRC rules and regulations.

- The NRC security regulations in 10 CFR Part 73 include performance and prescriptive requirements that, when adequately met and implemented, provide protection against acts of radiological sabotage, prevent the theft or diversion of special nuclear material, and protect Safeguards Information.

- In accordance with the requirements of 10 CFR 52.79(a)(35) and 10 CFR 73.55(b), the COL applicant must describe a physical protection system and security organization whose objective will be to provide high assurance that activities involving special nuclear material are not inimical to the common defense and security and do not constitute an unreasonable risk to the public health and safety. A

physical protection system with capabilities to detect, assess, interdict, and neutralize shall be designed to protect against the DBT of radiological sabotage.

- The DBT for radiological sabotage is described in 10 CFR 73.1(a)(1), "Radiological sabotage." The COL applicant must describe how it will meet regulatory requirements and how it will achieve the high-assurance objective for the protection against the DBT of radiological sabotage. The provisions within 10 CFR 73.54, "Protection of digital computer and communication systems and networks"; 10 CFR 73.55, "Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage"; 10 CFR 73.56, "Personnel access authorization requirements for nuclear power plants"; 10 CFR 73.58, "Safety/security interface requirements for nuclear power reactors"; and Appendix B, "General Criteria for Security Personnel," and Appendix C, "Licensee Safeguards Contingency Plans," establish performance and prescriptive requirements that apply to the design of PSS, operational security requirements, management processes, and programs.

- The requirements in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Subpart B, "Standard Design Certifications," regarding certification of design, limit the application of regulatory requirements that are specific to PSS within the scope of the NuScale standard design. According to 10 CFR 52.79, the operational or administrative controls, programs, and processes (e.g., management systems or controls) for security are addressed by the COL applicant and are not within the scope for certification of the NuScale standard design.

- 10 CFR 52.79(a)(28), which requires COL applicants to provide plans for preoperational testing and initial operations.

The guidance in SRP Section 14.3.12, Revision 1, issued May 2010, lists the acceptance criteria that are adequate to meet the above requirements and the review interfaces with other SRP sections.

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

- RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," Revision 3, issued March 2007

- RG 1.206, "Combined License Applications for Nuclear Power Plants (Light-Water Reactor (LWR) Edition)," Revision 0, issued June 2007

The NRC guidance, approaches, and examples described above and in other guidance documents for methods of compliance are not regulatory requirements and are not intended to be all-inclusive. The applicant may use methods or approaches for implementing NRC regulations other than those discussed in agency guidance as long as these measures satisfy the relevant and applicable NRC regulatory requirements.

14.3.12.4 Technical Evaluation

The staff's technical review determined whether the applicant adequately described appropriate ITAs and acceptance criteria verifying the required security functions, and the reliability,

availability, or performance of selected PSS in accordance with 10 CFR 52.47(b)(1). Tier 1 design descriptions adequately describe the top-level physical security features and performance characteristics that are prescribed by regulations. The staff concludes that the Tier 1 design descriptions are based on and consistent with the Tier 2 material.

The PSS described in the NuScale standard design (and those specific to a COL application) must be reliable and available to ensure their performance and to meet their intended security functions. The PSS are required to meet applicable performance and prescriptive requirements in 10 CFR Part 73. The design and technical bases for PSS within the scope of the NuScale DCA are described in DCA Part 2, Tier 2, Section 13.6, "Security," which incorporates by reference TR-0416-48929. These documents provide the system designs and performance requirements that support the identified ITAAC design commitments for verification.

In addition, the NRC staff's review included the following responses that the applicant submitted to address the staff's requests for additional information (RAIs) and the resulting revisions to the DCA Part 2, Tier 1 and Tier 2, and TR-0416-48929:

- NuScale to the NRC, "NuScale Power, LLC, Response to the NRC Request for Additional Information No. 212 (eRAI No. 8902) on the NuScale Design Certification Application," dated October 10, 2017 (ADAMS Accession No. ML17283A273)

- NuScale to the NRC, "NuScale Power, LLC, Response to the NRC Request for Additional Information No. 219 (eRAI No. 8998) on the NuScale Design Certification Application," dated December 8, 2017 (ADAMS Accession No. ML17345A513)

14.3.12.4.1 Design Commitments, Inspections, Tests, Analyses, and Acceptance Criteria

DCA Part 2, Tier 1, Section 3.16.1, describes the system description and design commitments for PSS within the scope of the NuScale design certification. The first column of the table proposes design commitments extracted from the Tier 1 design description that must be verified. The second and third columns identify proposed methods of verifications and acceptance criteria that demonstrate that design commitments are met.

DCA Part 2, Tier 1, Section 3.16.1, describes the design of PSS that detect, assess, and delay intrusion; enable onsite and offsite communications; and assist in the response to protect against the design-basis threat for radiological sabotage. The 13 ITAAC design commitments include those related to vital equipment locations, physical barriers, bullet-resistant structures, physical controls and security measures for vital areas, intrusion detection and assessment systems and subsystems and components, location of the central alarm station (CAS), access controls for vital areas, and communications that meet the requirements of 10 CFR Part 73. DCA Part 2, Tier 1, Table 3.16-1, includes 13 physical security ITAAC. These ITAAC verify the following design commitments for PSS in the scope of the standard NuScale plant, and are consistent with the standard ITAAC in SRP Section 14.3.12:

(1) Vital equipment within the RXB and the CRB will be located in a vital area (Reference: SRP Section 14.3.12, ITAAC No. 1(a)).

(2) Access to vital equipment within the RXB and CRB will require passage through at least two physical barriers (Reference: SRP Section 14.3.12, ITAAC No. 1(b)).

(3) The external walls, doors, ceiling, and floors in the main control room (MCR) and the CAS will be bullet resistant (Reference: SRP Section 14.3.12, ITAAC No. 6).

(4) An access control system will be installed and designed for use by individuals who are authorized access to vital areas within the RXB and the CRB without escort (Reference: SRP Section 14.3.12, ITAAC No. 9).

(5) Unoccupied vital areas within the RXB and the CRB will be designed with locking devices and intrusion detection devices that annunciate in the CAS (Reference: SRP Section 14.3.12, ITAAC No. 10).

(6) The CAS will be located inside the protected area and will be designed so that the interior is not visible from the perimeter of the protected area (Reference: SRP Section 14.3.12, ITAAC No. 11(b)).

(7) Security alarm devices, including transmission lines to annunciators, will be tamper-indicating and self-checking, and alarm annunciation indicates the type of alarm and its location (Reference: SRP Section 14.3.12, ITAAC No. 13(a)).

(8) Intrusion-detection and assessment systems for the RXB and the CRB will be designed to provide visual display and audible annunciation of alarms in the CAS (Reference: SRP Section 14.3.12, ITAAC No. 13(b)).

(9) Intrusion detection systems' recording equipment will record onsite security alarm annunciations, including each alarm, false alarm, alarm check and tamper indication; and the type of alarm, location, alarm circuit, date, and time (Reference: SRP Section 14.3.12, ITAAC No. 14).

(10) Emergency exits in the vital area boundaries within the RXB and the CRB will be alarmed with intrusion detection devices and secured by locking devices that allow prompt egress during an emergency (Reference: SRP Section 14.3.12, ITAAC No. 15).

(11) The CAS will have landline telephone service with the control room and local law enforcement authorities (Reference: SRP Section 14.3.12, ITAAC No. 16(a)).

(12) The CAS will be capable of continuous communication with on-duty security force personnel (Reference: SRP Section 14.3.12, ITAAC No. 16(b)).

(13) Non-portable communications equipment in the CAS will remain operable from an independent power source in the event of the loss of normal power (Reference: SRP Section 14.3.12, ITAAC No. 16(c)).

DCA Part 2, Tier 1, Table 3.16-1, ITAAC Nos. 1–13, identify 13 physical security ITAAC within the scope for the NuScale standard design that conform to SRP Section 14.3.12, Revision 1, as indicated above. The ITAAC descriptions for the PPS within the scope of the NuScale standard design described above are in the standard format (Design Commitment, Inspection, Test, Analysis, and Acceptance Criteria) for ITAAC.

In addition to engineered systems dedicated to providing security functions, the applicant described nonsafety-related plant systems that provide both safety and security functions. DCA

Part 2, Tier 1, Section 3.8, describes the design of the PLS for the RXB and the CRB, which consists of normal and emergency lighting. DCA Part 2, Tier 1 Table 3.8-1 includes ITAAC to verify (1) battery-pack emergency lighting for illumination for post-fire safe shutdown (FSSD) activities outside of the MCR and the remote shutdown station (RSS) where post-FSSD activities are performed; and (2) the normal and emergency (alternating current and direct current) lighting system illumination for operator workstations and auxiliary panels in the MCR and RSS. The PLS provides illumination within the interior of the RXB and the CRB to support security functions and should be verified by PLS ITAAC. The design requirement and physical security ITAAC for illumination of the security isolation zones and exterior areas within the protected areas (standard physical security ITAAC No. 5 in SRP Section 14.3.12) are not within the scope of the NuScale standard design and, therefore, are to be addressed by the COL applicant.

DCA Part 2, Tier 2, Section 13.6, COL Item 13.6-4, is acceptable because it indicates that the COL applicant referencing the NuScale DC will address ITAAC related to the site-specific physical protection systems design.

NuScale TR-0416-48929, Table 5-1, identifies 23 commitments that pertain to the site-specific physical security systems and/or programs that a COL applicant referencing the NuScale certified design will address as COL items identified in DCA Part 2, Tier 2, Section 13.6. TR-0416-48929, Table 5-1, Item Nos. 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 22, and 23, describe the COL applicant's responsibility for the design of security SSCs, parameters for engineered PSS, and configurations for establishing a site-specific physical protection system, for the following:

- location and design details for the secondary alarm station
- physical security barriers outside the RXB and CRB
- isolation zone, protected area, and associated intrusion assessment systems
- vehicle barrier systems
- exterior personnel, vehicle, and material access control portals
- secondary alarm station and main security building
- communication system secondary power supply
- secondary security power system
- bounding minimum safe standoff distance, alarm station survivability, and protection against vehicle bombs
- alarm station functions and redundant capabilities
- detection and assessment functions
- illumination of isolation zones and protected areas

- secondary alarm station communication

- uninterruptable power system and in-line generators or other source of backup power

The staff finds the following:

- DCA Part 2, Tier 1, adequately identifies general design commitments and ITAAC that conform to those described in SRP Section 14.3.12, for vital areas and vital area access controls; bullet-resistant barriers; the central alarm station; the interior intrusion detection and assessment system; alarms, signal displays, and recording; transmission line supervision and monitoring; emergency exit controls; and security communications.

- The applicant has adequately identified other PSS, such as protected area barriers; isolation zones; protected area intrusion detection; engineered access controls for personnel, vehicles and material; and personnel identification systems that are outside the scope of the NuScale standard design and will be addressed by the COL applicant. COL Item 13.6-4 establishes that the descriptions of site-specific PSS design and related ITAAC are to be addressed by the COL applicant that references the NuScale design certification.

- The staff concludes that the security ITAAC described above comply with 10 CFR 52.47(b).

14.3.12.4.2 Verification Program and Processes

DCA Part 2, Tier 2, Section 14.0, "Initial Test Program and Inspections, Tests, Analyses and Acceptance Criteria," indicates that it consists of the initial test programs for the NuScale Power Plant, including ITAAC, and states "[t]he initial test program addresses structures, systems, and components and design features for both the nuclear portion of the facility and the balance-of-plant." The ITAAC are presented in Tier 1. The DCA Part 2, Tier 2, Section 14.2, describes the initial test program (ITP) that is performed during the initial startup of the NuScale plant. The ITP includes test activities that commence with the completion of construction and installation and end with the completion of reactor power ascension testing. The methodology associated with developing ITAAC is described in Section 14.3.

The verification programs include preoperational and startup tests and ITAAC that provide assurance that systems and equipment perform in accordance with their design and in conformity with the final safety analysis report and NRC regulations. The applicant indicated that the COL applicant is responsible for the organization and staffing level necessary for the verification program to perform the ITP and ITAAC. The organization and staff are responsible for planning, executing, and documenting the plant initial testing and related activities and for developing the site-specific organization and staffing level appropriate for its facility. In addition, the COL applicant will develop the management controls (processes and procedures) that include developing site-specific procedures and guidelines for conducting tests; submitting detailed test procedures for NRC review; preparing and planning the conduct of the test program; reviewing, evaluating, and approving test results; and maintaining records of tests.

DCA Part 2, Tier 2, Section 14.2.2, "Organization and Staffing," COL Item 14.2-1, establishes that "[a] COL applicant that references the NuScale Power Plant design certification will describe the site-specific organizations that manage, supervise, or execute the Initial Test

Program, including the associated training requirements." DCA Part 2, Tier 2, Section 14.2.3, "Test Procedures," describes the management controls and processes for the development of the test procedures, which include the following:

- test procedure format, the application of normal and emergency procedures, surveillance procedures, and management review, approval, and control of changes

- procedures that include the test objectives, prerequisites, test method, special precautions, test instrumentation and calibration, environmental conditions for testing, methods to direct and control test performance, evaluation criteria, data requirements, actions for unanticipated error or malfunctions, and remedial actions (i.e., acceptance criteria not met, unexpected, or unanalyzed)

- graded approach to preoperational testing, including the testing of active, nonsafety-related functions that require ITAAC verification (SSCs in Category B1 and Category B2) and those that do not require ITAAC verification

DCA Part 2, Tier 2, Section 14.2.4, "Conduct of the Test Program," includes COL Item 14.2-2, which states the following:

> *A COL applicant that references the NuScale Power Plant design certification is responsible for the development of the Startup Administration Manual that will contain the administrative procedures and requirements that control the activities associated with the Initial Test Program. The COL applicant will provide a milestone for completing the Startup Administrative Manual and making it available for NRC inspection*.

The applicant described the administrative controls for verifying ITAAC:

> *Administrative controls are established to ensure that the designated construction-related inspections and tests are completed prior to initiating preoperational testing. In addition, controls are established to ensure completion of preoperational testing prior to initiating startup testing. Administrative controls address adherence to approved test procedures during the conduct of the test program and the methods for effecting changes to approved test procedures.*
>
> *The controls used to ensure that test prerequisites associated with each major phase of testing, as well as individual system or component testing are met, include requirements for performing inspections and checks, identification of test personnel, completing data forms or check sheets, and identification of dates of completion.*
>
> *The controls provided to implement plant modification and repairs ensure that the required modifications and repairs are made. Retesting is conducted following modifications or repairs. Reviews of proposed facility modifications by designated design organizations [are] conducted prior to performing the modification or repair.*
>
> *Controls are established to ensure that retesting that is required for modifications or maintenance remains in compliance with ITAAC commitments. The*

documentation associated with the conduct of the test plan is captured and auditable.

COL Item 14.2-2 establishes the administrative controls to ensure that designated construction-related inspections and tests are completed before initiating preoperational testing through adherence to approved test procedures. The COL applicant will develop a startup administrative manual that contains the administrative procedures and requirements that control the activities associated with implementing the initial test.

COL Item 17.5-1 establishes that "[a] COL applicant that references the NuScale power plant design certification will describe the quality assurance program applicable to site-specific design activities and to the construction and operations phase." NuScale TR-NP-1010-859-NP, "NuScale Topical Report: Quality Assurance Program Description for NuScale Power Plant," (ADAMS Accession No. ML16196A391) dated March 24, 2016, includes quality control for nonsafety-related structures, systems, and components, including those related to security. DCA Part 2, Tier 2, Section 14.2.5, "Review, Evaluation, and Approval of Test Results," and Section 14.2.6, "Test Records," describe administrative controls for the review, approval, closure, and documentation of test activities that verify ITAAC and for the management of unresolved test deficiencies, test closure, and records.

DCA Part 2, Tier 1, Table 3.0-1, identifies PSS as a shared system supporting the NuScale Power Modules (NPMs), for 1-12 NPMs. DCA Part 2, Tier 1, Section 3.0, states "[f]or a multi-module plant, satisfactory completion of a shared ITAAC for the lead module shall constitute satisfactory completion of the shared ITAAC for associated modules. The ITAAC in Sections 3.1 through 3.17 shall only be completed once in conjunction with the ITAAC in Chapter 2 for the first NPM." The applicant indicated that for the physical security ITAAC identified in DCA Part 2, Tier 1, Table 3.16-1 (ITAAC Nos. 1 through 13) because these ITAAC are not NPM specific; instead, they verify engineered SSCs that provide security functions throughout the RXB and/or CRB. The physical security systems are common (shared) systems that support all 12 NPMs and are verified by ITAAC before fuel load for the first NPM. The staff finds this acceptable for the reasons given by the applicant.

The staff finds the following:

- The applicant identified COL information items for establishing the test organization and management controls for the verifications of ITAAC, including those related to physical security. The applicant has established that a COL applicant referencing the NuScale standard design will address management controls needed to implement the verifications of physical security ITAAC, including procedure controls that document preparations, reviews, approvals, closeouts, and records.

- The system test process, as described in DCA Part 2, Tier 2, Sections 14.2 and 14.3, which the COL applicant must establish, if adequately implemented will demonstrate through testing that credited engineered SSCs will perform their intended security functions.

- The staff concludes that the applicant has established, in the NuScale DCA Part 2, the requirements for a COL applicant referencing the NuScale certified design to establish the management systems, processes, and organization that will verify the installation, construction, and performance of PSS through ITAAC.

14.3.12.4.3 Verification Methods for Physical Security ITAAC

DCA Part 2, Tier 1, Section 1.2.4, indicates that the verification (inspections, tests, or analyses) may be performed by more than a single individual or group, implemented through discrete activities separated by time, performed at any time before fuel load (including before the issuance of the COL for those ITAAC that do not require as-built equipment), and performed at locations other than the construction site. Additionally, the applicant indicated that ITAs may be performed as part of other activities, such as construction inspections or preoperational testing, and that the ITAs do not need to be performed as separate or discrete activities.

Performance methodologies for physical security ITAAC are discussed in more detail in DCA Part 2, Tier 2, Sections 14.2 and 14.3. The staff evaluates these methodologies below, in Subsections 14.3.12.4.3.1 through 14.3.12.4.3.4.

14.3.12.4.3.1 Test Abstracts for Physical Security ITAAC

DCA Part 2, Tier 2, Section 14.2.12, "Individual Test Descriptions," describes test abstracts. The applicant stated that "[i]individual test abstracts are provided in Table 14.2-1 through Table 14.2-108. Table 14.2-109 provides a listing of test abstracts. Each abstract identifies each test by title, identifies test objectives, prerequisites, test methods, and acceptance criteria. Detailed preoperational and startup test procedures are developed using these test abstracts." The applicant describes the following test abstracts for verifying PSS within the scope of the NuScale standard design:

- Table 14.2-68, "Communication System Test #68."
- Table 14.2-73, "Security Access Control Test #73."
- Table 14.2-74, "Security Detection and Alarm Test #74."

The physical security ITAAC test abstracts are provided in the same format used for safety-related and other plant system preoperational tests described in DCA Part 2, Tier 2, Section 14.2. The test abstracts provide the framework for the development of detailed procedures for the conduct of the ITAAC.

DCA Part 2, Tier 2, Tables 14.2-73 and 14.2-74, describe test abstracts consisting of objectives, prerequisites, methods (inspection, test, and/or analysis), data requirements, and acceptance criteria for the verification of the following:

- access controls for vital areas
- a numbered photo-identification badge system
- unoccupied vital areas are locked and alarmed, and alarms are annunciated in the CAS
- intrusion detection system (alarm transmission lines and annunciators are tamper-indicating and self-checking, there are visual and audible indications at the CAS, and equipment to record the information associated with the intrusion alarm)

- emergency exit locking, alarm, and prompt egress capabilities
- active intrusion detection systems for vitals areas
- intrusion detection and assessment systems
- intrusion detection devices and locking devices for emergency exits

DCA Part 2, Tier 2, Table 14.2-68, describes test abstracts consisting of objectives, prerequisites, methods (inspection, test, and/or analysis), data requirements, and acceptance criteria for the verification of plant communication systems. The plant communication systems include the plant public address and general alarm, plant radio communication, sound-powered telephone, wireless communication, and conventional telephone, for the CAS. Specific to security communications, verification includes plant radio communication between the CAS and on-duty watchmen, armed security officers, armed responders, and security personnel, and nonportable communication backup power.

The staff evaluated the test abstracts in conjunction with the verification methodologies for the ITAAC in DCA Part 2, Tier 2, Section 14.3. As discussed in below in Subsections 14.3.12.4.3.2 through 14.3.12.4.3.4, the staff finds that the applicant's descriptions of elements of the test abstracts for PSS (i.e., objectives, prerequisites, test methods, data requirements, and acceptance criteria) are adequate. The test abstracts support the DCA Part 2, Tier 1 descriptions of ITAAC for meeting 10 CFR 52.47(b)(1), which requires a DCA to contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that if the inspections, tests, and analyses are performed and the acceptance criteria are met, the facility have been constructed and will be operated in conformity with the design certification, the AEA, and the NRC's rules and regulations. The staff concludes that the test abstracts for PSS conform to guidance in the SRP and adequately describe the framework for developing specific ITAs for verifying the PSS identified as ITAAC within the scope of the NuScale standard design.

14.3.12.4.3.2 Inspections, Tests, and Analyses for Vital Equipment and Vital Areas

DCA Part 2, Tier 1, Table 3.16-1, establishes physical security ITAAC for the design commitments for vital equipment locations, vital areas, and access to vital equipment. DCA Part 2, Tier 2, Sections 14.2 and 14.3 describe the performance of these physical security ITAAC.

DCA Part 2, Tier 2, Table 14.3-2, describes the verification of the physical security ITAAC in DCA Part 2, Tier 1, Table 3.16-1, associated with the vital equipment and vital areas, as follows:

ITAAC No. 1	"An ITAAC inspection is performed of the as built vital equipment to verify that the equipment is located in a vital area."
ITAAC No. 2	"An ITAAC inspection is performed of the as built vital equipment location to verify that access to vital equipment, within the nuclear island and structures, requires passage through at least two physical barriers, or as otherwise identified in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'"
ITAAC No. 3	"A type test, analysis, or a combination of type test and analysis are performed of the bullet-resisting barriers used in the external walls,

doors, ceilings and floors in the MCR and central alarm station. This qualification will demonstrate that the barriers are bullet-resistant, to Underwriters Laboratories Ballistic Standard 752, 'The Standard of Safety for Bullet-Resisting Equipment,' Level 4, or National Institute of Justice Standard 0108.01, 'Ballistic Resistant Protective Materials,' Type III.'"

ITAAC No. 4 "In accordance with Table 14.2-73, a preoperational test demonstrates that the access control system provides authorized access to vital areas, within the nuclear island and structures, only to those individuals with authorization for unescorted access."

ITAAC No. 5 "In accordance with Table 14.2-74, a preoperational test, inspection, or a combination of test and inspection demonstrates that unoccupied vital areas, within the nuclear island and structures, are locked and alarmed and intrusion is detected and annunciated in the central alarm station as described in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'"

ITAAC No. 6 "An ITAAC inspection is performed of the as built central alarm station to verify that it is located inside the protected area and the interior is not visible from the protected area perimeter."

ITAAC No. 10 "In accordance with Table 14.2-74, a preoperational test, inspection, or a combination of test and inspection demonstrates that emergency exits through the vital area boundaries, within the nuclear island and structures, are alarmed with intrusion detection devices and secured by locking devices that allow egress during an emergency as described in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'"

The objective for ITAAC No. 1 is to demonstrate that vital equipment is located within the vital areas protected in accordance with regulatory requirements. The methods described in DCA Part 2, Tier 2, Table 14.3-2, include inspections to locate vital equipment and verify that access to each component met the stated objective.

The list of vital equipment in TR-0416-48929 is information that is needed for verification of physical security ITAAC No. 2. The design commitment of this ITAAC states that "[a]ccess to vital equipment requires passage through at least two physical barriers." The discussion of this ITAAC in Tier 2, Table 14.3-2 includes this statement but goes on to state "or as otherwise identified in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'" During an April 15, 2019, public meeting (ADAMS Accession No. ML19106A045), the staff discussed with the applicant this discrepancy between Tier 1 and Tier 2 information. During this meeting, the applicant stated that it intends to revise Tier 2, Table 14.3-2 to remove the phrase "or as otherwise identified in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'" DCA Part 2, Tier 2, Table 14.3-2 will be revised as indicated in a letter from NuScale dated April 24, 2019 (ADAMS Accession No. ML19114A552). The staff finds the applicant's proposed changes to be acceptable because the Tier 1 information would be consistent with Tier 2. The proposed changes are being tracked as **Confirmatory Item 14.3.12-1**.

The verification of physical security ITAAC No. 3 includes the type test, analysis, or combination thereof that demonstrate that the structural construction of the MCR and the CAS are bullet resistant. DCA Part 2, Tier 2, Table 14.3-2, describes the inspection to verify physical security ITAAC No. 6 for the CAS. The objective is to verify that the location of the CAS meets the regulatory requirements for the CAS to be inside the protected area and for the interior of the alarm station to not be visible from the perimeter of the protected area. An inspection is the method used to determine that the CAS is designated a vital area and is not visible from outside the protected area.

DCA Part 2, Tier 2, Section 14.2, Table 14.2-73, describes the test abstract for physical security ITAAC No. 4 for verifying the access control system with a numbered photo-identification badge system, which will control access to vital areas within the RXB and the CRB to authorized personnel. A preoperational test demonstrates that the access control system provides authorized access to vital areas, within the nuclear island and structures, only to those individuals with authorization for unescorted access.

DCA, Part 2, Tier 2, Section 14.2, Table 14.2-74, describes the test abstract for physical security ITAAC No. 5 for locked and alarmed access into vital areas. The objective is to determine that vital area personnel access barriers are locked and alarmed, unauthorized access is detected, and alarms at the central alarm station annunciate upon an intrusion into a vital area. The verifications methods include testing the unauthorized opening of each vital area access door to verify that an intrusion alarm is generated; verifying that alarms are detected by the alarm annunciator computers and displays in the CAS; verifying audible and visual alarm annunciation in the CAS; and verifying recording of alarm information. The test and inspection verifications apply to all vital areas, which are alarmed with intrusion detection systems, and demonstrate that activated intrusion detection systems annunciate in the CAS in the event of an unauthorized and attempted access of an unoccupied vital area.

In addition, the applicant described the verification of vital area emergency exits for the RXB and the CRB for physical security ITAAC No. 10. The test abstract indicates that the objective is to verify that each of the emergency exits from the vital areas have installed locking devices, which will allow emergency egress, and installed alarms that will notify the CAS operator that the door has been opened. The verification methods include inspections and tests of alarm initiation and indication and tests of locking devices. The tests operate the emergency egress locking mechanism in the vital area, verify that an alarm is generated when the door is opened, and that the alarmed information is displayed at the CAS.

The acceptance criteria identified for the physical security ITAAC related to the vital areas are the successful inspections and tests that verify locking, intrusion detection, and alarms in accordance with the requirements of 10 CFR 73.55(e)(9)(i) through (iii) and 10 CFR 73.55(e)(8)(iii).

The staff finds that the applicant has provided adequate descriptions of the objectives, prerequisites, methods, and acceptance criteria that support the identified ITAAC related to the vital equipment and vital areas and emergency exit controls for the vital areas in DCA Part 2, Tier 1, Section 13.6, “Design Description,” and Table 3.16-1.

14.3.12.4.3.3 Inspections, Tests, and Analyses for Alarms, System Supervision, Assessment, and Records

DCA Part 2, Tier 2, Table 14.3-2, describes the physical security ITAAC for intrusion detection, assessment, and alarms as follows:

ITAAC No. 7 "In accordance with Table 14.2-74, a preoperational test demonstrates that: (1) alarm annunciation indicates the type of alarm and location, (2) security alarm devices, including transmission lines to annunciators, are tamper-indicating and self-checking, and (3) an automatic indication is provided when failure of the alarm system or a component occurs or when the system is on standby power."

ITAAC No. 8 "In accordance with Table 14.2-74, a preoperational test demonstrates that the intrusion detection and assessment system, within the nuclear island and structures, provides visual and audible annunciation of alarms in the central alarm station."

ITAAC No. 9 "In accordance with Table 14.2-74, a preoperational test demonstrates that the intrusion detection and assessment system, within the nuclear island and structures, records each onsite security alarm annunciation, including each alarm, false alarm, alarm check, and tamper indication that identifies the type of alarm, location, alarm circuit, date, and time."

DCA Part 2, Tier 2, Table 14.2-74, describes the test abstract for ITAAC No. 7 for security alarms and tamper indications and system supervision of security alarm devices and transmission lines. The stated objectives are consistent with ITAAC No. 7, and the test methods verify the performance of security alarm annunciation, that alarm devices and transmission lines are tamper-indicating and self-checking, and that an automatic indication is provided of failure of the alarm system or a component when the system is on standby power. The acceptance criteria are in accordance with the requirements of 10 CFR 73.55(i)(3)(iv) through 73.55(i)(3)(v). The staff concludes that the test procedure adequately verifies ITAAC No. 7.

DCA Part 2, Tier 2, Table 14.2-74, describes the test abstract for ITAAC Nos. 8 and 9 for intrusion and assessment systems and alarm recording equipment. The objectives are to verify that intrusion detection and assessment system provides visual and audible alarm annunciation of alarms in the CAS records each alarm. The test methods include the testing of intrusion detection systems, security alarm annunciation and recording in the CAS as described in TR-0416-48929.

The tests of the intrusion detection system include verifying system tamper indication, component failure for all devices and transmission lines, backup power, and intrusion alarms. The test abstract establishes the following acceptance criteria for the intrusion detection system: (1) alarm annunciation is received in the CAS, indicating type and location of the alarm; (2) audible and visual alarms are received in the CAS; and (3) the intrusion detection system records each alarm, including location of the alarm, type of alarm, alarm circuit, date, and time. Physical security ITAAC No. 8 and ITAAC No. 9 verify that security alarms have visual and audible features that indicate the types of alarms and their locations in accordance with the requirements of 10 CFR 73.55(i)(3)(i) through 10 CFR 73.55(i)(3)(iii) and that a record of the

types of alarms, locations of alarms, alarm circuit, dates, time, and alarm status is maintained in accordance with 10 CFR 73.55(i)(4)(ii)(H). The acceptance criteria identified for the ITAAC related to the CAS are successful inspections and tests that verify alarm indications capabilities in accordance with 10 CFR 73.55(i)(2) for the CAS (one of two required alarm stations). This ITAAC does not cover the secondary alarm station because the COL applicant would be responsible for establishing the secondary alarm station and any associated ITAAC.

The staff finds that the applicant has provided adequate descriptions to support the identified ITAAC related to security alarm, system supervision, assessment, and intrusion detection system records in DCA Part 2, Tier 1, Section 3.16 and Table 3.16-1.

14.3.12.4.3.4 Inspections, Tests, and Analyses for Security Communications

DCA Part 2, Tier 2, Table 14.3-2, describes the following preoperational inspections and tests that demonstrate the systems physical security functions for ITAAC Nos. 11, 12, and 13:

ITAAC No. 11 "In accordance with Table 14.2-68, a preoperational test, inspection, or a combination of test and inspection demonstrates that the central alarm station is equipped with conventional landline telephone service with the MCR and with local law enforcement authorities as described in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'"

ITAAC No. 12 "In accordance with Table 14.2-68, a preoperational test, inspection, or a combination of test and inspection demonstrates that the central alarm station is capable of continuous communication with on-duty security force personnel as described in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'"

ITAAC No. 13 "In accordance with Table 14.2-68, a preoperational test, inspection, or a combination of test and inspection demonstrates that nonportable communications equipment in the central alarm station remains operable (without disruption) from an independent power source in the event of loss of normal power as described in Technical Report TR-0416-48929, 'NuScale Design of Physical Security Systems.'"

DCA Part 2, Tier 2, Table 14.2-68, describes the test abstract that addresses physical security ITAAC Nos. 11, 12, and 13 for verifying the capabilities and performance of communication systems to support security requirements. The prerequisites include the complete installation of plant communication systems and components for the public address system, plant telephone system, and wireless communication system and the complete installation of operational communications equipment in the CAS and the MCR.

The test methods include tests of the communications systems to verify the availability of the public address system, plant telephone system, voice communications with offsite local law enforcement authorities, wireless communications system (radios), and the nonportable security communication system. The tests verify communications between the CAS and the MCR, test the portable radio system and backup plant system between the CAS and security personnel, and verify the continuity of communications capabilities on the secondary power supply in the event of loss of normal power. The test methods include verifying the capabilities of the

communication systems to provide open and cleared communications that can be heard by plant personnel in areas where they are located. Testing includes the use of conventional (landline) telephone services to communicate between the CAS and the MCR and between the CAS and the local law enforcement authorities. The applicant indicated that dedicated security communication systems and plant communication systems are independent of each other. DCA Part 2, Tier 2, Table 14.2-68, addresses the verification of physical security ITAAC Nos. 11, 12, and 13 and the verification of the designs and installation of plant communication systems addressed in DCA Part 2, Tier 2, Section 9.5, "Other Auxiliary Systems." The acceptance criteria identified for the physical security ITAAC are in accordance with 10 CFR 73.55(j)(3), 10 CFR 73.55(j)(4)(i) through (4)(ii), and 10 CFR 73.55(j)(5).

The staff finds that the applicant has provided adequate descriptions of the objectives, verification methods, and acceptance criteria that support the identified physical security ITAAC related to security communications in DCA Part 2, Tier 1, Section 3.16.

14.3.12.5 Combined License Information Items

Item No.	Description	DCA Part 2, Tier 2 Section
COL Item 13.6-4	A COL applicant that references the NuScale Power Plant design certification will provide inspections, tests, analyses, and acceptance criteria for site-specific physical security structures, systems, and components (SSC).	13.6

The staff finds this COL item acceptable for the reasons given above.

14.3.12.6 Conclusion

Pending completion of the confirmatory item discussed above, the staff finds the following:

- The applicant has proposed and adequately described attributes for physical security ITAAC verification.

- The applicant has identified an appropriate and reasonable set of design commitments, test methods (inspections, tests, or analyses), and acceptance criteria for certification of the NuScale standard design in compliance with 10 CFR 52.47(b)(1).

- The applicant has provided adequate descriptions of elements of the test abstracts and inspections and analyses for verifying PSS (i.e., objectives, prerequisites, test methods, data requirements, and acceptance criteria) that support the DCA Part 2, Tier 1, descriptions of physical security ITAAC to meet the regulatory requirement of 10 CFR 52.47(b)(1).

- The applicant has identified appropriate descriptions for tests, inspections, and analyses that establish the framework for developing the detailed procedures for the conduct of the ITAAC, with the exception of the open item identified above.

- The applicant has provided adequate descriptions of requirements (i.e., COL Information Item 13.6-4) that indicate that a COL applicant referencing the NuScale standard design will describe the ITAAC for PSS that are outside the scope of the NuScale DC**.**

Pending completion of the confirmatory item discussed above, the staff concludes that the applicant has met 10 CFR 52.47, which requires information submitted for a DC to include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC. The applicant has met 10 CFR 52.47(b)(1), which requires the NuScale DCA to contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a facility that incorporates the design certification has been constructed and will be operated in accordance with the design certification, the AEA, and NRC rules and regulations. The staff concludes that the applicant has provided sufficient information in the ITP for the physical security test abstracts to satisfy 10 CFR 52.79(a)(28).

14.3.13 External Flooding Protection- Inspections, Tests, Analyses, and Acceptance Criteria

14.3.13.1 Introduction

NuScale Power LLC (NuScale) Standard Plant Design Certification Application (DCA), Part 2, Tier 1, contains the following information:

- Tier 1 design descriptions in the form of narrative descriptions, tables, and figures that address the most safety-significant features
- ITAAC (inspections, tests, analyses, and acceptance criteria) Tables, which include Design Commitments that are verified by Inspections, Test, Analyses, and Acceptance Criteria (ITAAC)

The scope of review for ITAAC related to external flooding protection includes information presented in DCA Part 2, Tier 2, on systems that support multiple NuScale Power Modules (NPMs).

14.3.13.2 Summary of Application

DCA Part 2, Tier 1: The applicant included the following two material categories in Tier 1:

- Tier 1 design descriptions address the most safety-significant features of a system. The design descriptions are in the form of narrative descriptions, tables, and figures and are binding for the lifetime of a facility.
- ITAAC will be used to verify the NuScale as-built features. ITAAC material is in tabular format only and no longer constitute requirements for a licensee after an NRC finding under 10 CFR 52.103(g) that the acceptance criteria are met.

DCA Part 2, Tier 1, provides the design descriptions and ITAAC for those structures, systems, and components (SSCs) that are specific to and support operation of a single NPM, as well as for SSCs that support operation of multiple modules.

This SER section reviews design descriptions and ITAAC in Tier 1, Sections 3.11 and 3.13, for external flooding protection for the reactor building (RXB) and the control building (CRB).

DCA Part 2, Tier 2: A description of how the external flooding protection ITAAC are to be performed is in DCA Part 2, Tier 2, Table 14.3-2, “Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference."

ITAAC: The NuScale external flooding protection ITAAC are listed in the following DCA Part 2, Tier 1 tables:

- Table 3.11-2, “Reactor Building Inspections, Tests, Analyses, and Acceptance Criteria,” Item 3
- Table 3.13-1, “Control Building Inspections, Tests, Analyses, and Acceptance Criteria,” Item 3

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

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

14.3.13.3 Regulatory Basis

The following NRC regulation contains the relevant requirements for this review:

- 10 CFR 52.47(b)(1), which requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the certified design has been constructed and will be operated in conformity with the certified design, the provisions of the Atomic Energy Act of 1954, as amended, and the Commission's rules and regulations.

The applicable acceptance criteria used to meet the above relevant requirements of the NRC regulations is summarized below:

- In a letter dated April 8, 2016, the NRC staff transmitted to NuScale a set of Standardized DCA ITAAC (ADAMS Accession No. ML16096A132) that could be used in its design certification application.

14.3.13.4 Technical Evaluation

Based on the staff's review of the external flooding related information in DCA Part 2, Tier 1 and Tier 2, Chapter 2, the staff concludes that Tier 1 design descriptions and ITAAC adequately describe the top-level design features and performance characteristics that are significant to safety because these features and characteristics appropriately require that the RXB and the CRB are protected from external flooding, as discussed below. Also, the staff concludes that the Tier 1 design descriptions and ITAAC are based on and consistent with the Tier 2 material.

For the RXB, DCA Part 2, Tier 1, Section 3.11.1, "Design Description" states:

> *The RXB supports the following systems by housing and providing structural support:*
>
> − *NuScale Power Module*
>
> − *chemical and volume control system (CVCS)*
>
> − *ultimate heat sink*
>
> − *module protection system*
>
> − *nuclear monitoring system*

For the CRB, DCA Part 2, Tier 1, Section 3.13.1, "Design Description" states, "[T]he CRB supports the module protection system by housing and providing structural support."

The Tier 1 design commitments for the RXB and CRB require that these seismic Category I structures be protected from external flooding to prevent flooding ingress from affecting the

SSCs important to safety. The ITAAC associated with these design commitments require an inspection of the as-built RXB and CRB structures to ensure that the floor elevations at the ground entrances are higher than the maximum external flood elevation.

ITAAC Number 3 in Table 3.11-2 and ITAAC Number 3 in Table 3.13-1, along with their corresponding Tier 1 design commitments and discussions in DCA Part 2, Tier 2, Table 14.3-2, conform to the Standardized DCA ITAAC, design commitments, and associated Tier 2 discussion in the NRC's April 8, 2016, letter. The staff finds that the Tier 1 design descriptions require, and the ITAAC are sufficient to demonstrate, that the RXB and CRB safety-related SSCs are adequately protected from external flooding. Based on the above, the NRC staff finds that these ITAAC comply with 10 CFR 52.47(b)(1), and that the associated Tier 1 design descriptions and Tier 2 discussion are acceptable.

14.3.13.5 Combined License Information Items

There are no COL information items listed in DCA Part 2 Tier 2, Table 1.8-2, "Combined License Information Items," for this area of review.

14.3.13.6 Conclusion

The NRC staff finds that the DCA Part 2, Tier 1, ITAAC for external flooding protection satisfy the requirements in 10 CFR 52.47(b)(1) and that the Tier 1 design descriptions conform to NRC guidance. The staff also finds that the description of how to complete these ITAAC in DCA Part 2, Tier 2, Table 14.3-2 is acceptable.