10 STEAM AND POWER CONVERSION SYSTEM

This chapter of the safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC or Commission) staff (hereinafter referred to as the staff) review of Chapter 10, “Steam and Power Conversion System,” of the NuScale Power, LLC (hereinafter referred to as the applicant) Design Certification Application (DCA), Part 2, “Final Safety Analysis Report (FSAR, hereinafter referred to as DCA, Part 2),” Revision 1.

The steam and power conversion system removes thermal energy from the reactor coolant system and transfers it to the main turbine generator where it is converted into electric energy. The main elements of the steam and power conversion system include the main steam, turbine generator, turbine bypass, main condensers, circulating water, condensate polishing, feedwater treatment, condensate and feedwater, and auxiliary boiler systems. In general, the steam and power conversion system is not safety-related and is not required for safe shutdown. However, the main steam and main feedwater systems have piping that penetrate the containment and components that directly interface with safety-related structures, systems, and components (SSCs). The failure of these components can have an adverse impact on plant safety and the plant’s ability to achieve a safe shutdown. In addition, failure of some system equipment may result in the potential for internal flooding or the creation of missiles that may have the potential to adversely impact SSCs important to safety.

Using a graded approach, the staff review of the steam and power conversion system focused on the safety-related piping and the system components that are part of the main steam and main feedwater systems that support containment isolation and the operation of the safety-related decay heat removal system (DHRS). However, the staff also recognizes, as indicated above, that the failure of some portion of the steam and power conversion system may have the potential to adversely impact SSCs important to safety. Since the steam and power conversion system functions are not relied on to support the safety-related and safe-shutdown aspects of the NuScale plant, the staff reviewed the design to verify that failure of the SSCs that are not safety-related and not risk-significant will not adversely affect the ability of the plant to achieve and maintain safe shutdown or result in excessive releases of radioactivity to the environment.

In addition, although applicants for design certifications are not required to submit plans for an initial test program, RG 1.68, “Initial Test Programs for Water Cooled Nuclear Power Plants,” acknowledges that design certification applicants have previously submitted these plans to assist a future COL applicant referencing the design certification in meeting the requirements of 10 CFR 52.79(a)(28). In each subsection of this chapter, staff listed related tests from the Initial Test Program that were evaluated as part of the design certification review and which are reviewed in Section 14.2 for the Initial Test Program.

10.1 Summary Description

DCA, Part 2, Tier 2, Section 10.1, “Summary Description,” contains an introductory description of the steam and power conversion system and provides summaries of the protective features incorporated in the design of the system. DCA, Part 2, Tier 2, Table 10.1-1, “Major Steam and Power Conversion System Parameters and Turbine-Generator System Design Data,” provides the major system operating parameters at rated thermal power and turbine generator design data. DCA, Part 2, Tier 2, Figure 10.1-1, “Power Conversion System Block Flow Diagram,” provides a high level flow diagram of the system, DCA, Part 2, Tier 2, Figure 10.1-2 “Flow Diagram and Heat Balance Diagram at Rated Power for Steam And Power Conversion System Cycle,” depicts the heat balance of the system at rated power, and DCA, Part 2, Tier 2, Figure 10.1-3 “Flow Diagram and Heat Balance Diagram at Stretch Power (valves wide open) for Steam and Power Conversion System Cycle,” depicts the heat balance at stretch power.

Detailed descriptions of the main elements of the steam and power conversion system are provided in Sections 10.2 through 10.4.11 of the DCA, Part 2. The staff’s review is documented in Sections 10.2 through 10.4.11 of this report.

10.2 Turbine Generator

10.2.1 Introduction

The NuScale power plant is comprised of up to 12 individual NuScale power modules (NPMs), each of which has its own skid-mounted turbine generator and its own turbine control system.

The turbine generator system (TGS) is not a safety-related system. The TGS converts the energy of the steam produced in the steam generators (SGs) into mechanical shaft power and then into electrical energy. The TGS is not credited for mitigation of design basis accidents (DBAs,) and has no safe shutdown functions, but a failure of the TGS may result in the generation of turbine missiles that could potentially adversely affect SSCs that are important to safety.

10.2.2 Summary of Application

DCA, Part 2, Tier 1: There are no entries in DCA, Part 2, Tier 1 for the TGS.

DCA, Part 2, Tier 2: DCA, Part 2, Tier 2, Section 10.2, “Turbine Generator,” provides a complete description of the TGS. Information provided includes the TGS design bases, system descriptions, component descriptions, and TGS control and protection systems, including overspeed protection.

ITAAC: There are no ITAAC specific to the TGS.

Initial Test Program: DCA, Part 2, Tier 2, Section 14.2, "Initial Plant Test Program," Table 14.2-33, "Turbine Generator Test # 33," describes the preoperational test related to the TGS that is being evaluated as part of the design certification review.

Technical Specifications: There are no Technical Specification (TSs) requirements associated with the TGS.

Technical Reports: There are no Technical Reports associated with the turbine generator.

10.2.3 Regulatory Basis

The relevant regulatory requirements for this area of review and the associated acceptance criteria are discussed in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), Section 10.2, "Turbine Generator," Revision 3, and are summarized below. Review interfaces with other SRP sections also can be found in Item I, "Areas of Review," of the SRP Section 10.2.

- Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, "General Design Criterion" (GDC) 4, "Environmental and dynamic effects design bases," as it relates to the protection of SSCs important to safety from the effects of turbine missiles by providing a turbine overspeed protection system (with suitable redundancy) to minimize the probability of generation of turbine missiles.

- 10 CFR 52.47(b)(1), "Contents of applications; technical information," which requires that a 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 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 (AEA) of 1954, as amended, and the NRC's regulations.

10.2.4 Technical Evaluation

Since the TGS is not a safety-related or risk-significant system, the staff conducted its review utilizing the enhanced safety-focus review approach discussed in SRP Introduction Part 2. The inability of the TGS to perform its normal intended function will have no direct effect on plant safety or the ability of the plant to achieve and maintain a safe shutdown condition. Therefore, the staff's review for the TGS focused on how the system design would preclude TGS failure from adversely affecting SSCs important to safety. In particular, how compliance with GDC 4 will be ensured in events in which TGS failures may result in the ejection of turbine missiles due to excessive turbine overspeed.

The staff's evaluation of the turbine generator system is based upon the information provided in the applicant's DCA, Part 2, Revision 1, including Tier 1 and Tier 2. A general description of the TGS is given in DCA, Part 2, Tier 2, Section 10.2.2, "System Description," as well as a simplified piping and instrumentation drawing of the system in DCA, Part 2, Figure 10.2-1, “Turbine Generator System Piping and Instrumentation Diagram,” and TGS design parameters in DCA, Part 2, Tier 2, Table 10.2-1, “Turbine Generator Design Parameters.” The review of the TGS was performed in accordance with guidance in SRP Section 10.2

10.2.4.1 *GDC 4, Dynamic and environmental effects design bases*

Although the TGS is not safety-related, missiles generated by turbine failure can adversely affect the integrity of SSCs important to safety. To satisfy GDC 4, and as discussed in Section 3.5.1.3, “Turbine Missiles,” of this safety evaluation (SE), the main turbine must have a low probability of rotor failure to minimize the likelihood that turbine missiles will affect SSCs important to safety. Alternatively, the applicant may propose to install barriers or take credit for existing structures or features such as barriers, to reduce or eliminate turbine missile hazards to equipment provided the barriers meet acceptance criteria described in SRP Section 3.5.3. The arrangement and the orientation of the TGS relative to these essential SSCs are also to be considered in the overall minimization of turbine missiles.

The staff reviewed Section 3.5.1.3, “Turbine Missiles,” and Section 3.5.2, “Structures, Systems, and Components to be Protected from External Missiles,” of the NuScale Tier 2 DCA, Part 2, to determine if GDC 4 compliance was achieved based on plant layout or the incorporation in the plant design of missile barriers to protect essential SSCs from turbine missiles. The applicant states in DCA, Part 2, Revision 1, Section 3.5.2 that the reactor building (RXB) and control building (CRB) have not been credited to withstand turbine missiles. The applicant also states in DCA, Part 2, Section 3.5.1.3 that

> *(1) the turbine generator rotor shafts are physically oriented such that the RXB and CRB are within the turbine low-trajectory hazard zone and considered to be unfavorably oriented with respect to the NPMs, as defined by RG 1.115, Revision 2;*

and

> *(2) safety-related and risk-significant SSC within the reactor and control building are protected from the effects of turbine missiles by limiting the generation of missiles from the turbine generators to be less than 10^{-5} consistent with Table 1 of RG 1.115.*

This initial approach for protecting SSCs important to safety from turbine missiles would make compliance with GDC 4 dependent on the turbine overspeed control system successfully performing its intended function.

Subsequently, in a letter dated June 25, 2018 (ADAMS Accession No. ML18176A394), the applicant proposed to revise the NuScale DCA, Part 2, to use barriers in lieu of turbine rotor integrity and turbine missile generation probability as the basis for justifying adequate protection from turbine missiles. Since the protection of SSCs from turbine missiles will no longer be dependent on turbine missile generation probability and the overspeed protection system to prevent destructive overspeed conditions, the review of the overspeed protection system as it relates to ensuring compliance with GDC 4 is not necessary. The staff's review of compliance with GDC 4 as it relates to turbine missiles is included in Section 3.5.1.3 of the SER.

Based on the information provided in the DCA, Part 2, and the proposed markup to the DCA, Part 2, provided in the June 25, 2018 letter, the staff finds that the NuScale design is in compliance with GDC 4, with respect to the design and operation of the turbine generator, because all SSCs important to safety are housed in the reactor building and the control building, and the applicant indicates that these buildings are designed to protect against turbine missiles. This is being tracked as **Confirmatory Item 10.2-1**. As stated above, the staff's review of compliance with GDC 4 as it relates to turbine missiles is included in Section 3.5.1.3 of the SER.

10.2.5 Initial Test Program

The preoperational test related to the TGS for design certification is TGS test (#33) which ensures the various design aspects related to the TGS are implemented. This test is performed in accordance with DCA, Part 2, Tier 2, Table 14.2-33. The staff evaluation of the initial test program for the design certification review is documented in Section 14.2 of this report.

10.2.6 ITAAC

There are no ITAAC required for this system. The system is not safety-related and is not required for safe shutdown. Also, the applicant is not crediting aspects of this system to establish compliance with GDC 4. Therefore, the staff finds this acceptable in accordance with 10 CFR 52.47(b)(1).

10.2.7 Technical Specifications

There are no TS requirements associated with the TGS. The system is not safety-related and is not required for safe shutdown; and does not meet a criterion in 10 CFR 50.36 that would require a TS, therefore, the staff finds this acceptable.

10.2.8 Combined License Information Items

There are no COL Items for Section 10.2.

10.2.9 Conclusion

Based on the review of the information that is provided and as discussed above in the technical evaluation section, the staff determined that the applicant has met the requirements of GDC 4 and 10 CFR 52.47(b)(1) for Section 10.2, "Turbine Generator," of the NuScale DCA, Part 2.

10.3 Main Steam Supply System

10.3.1 Main Steam Supply System

10.3.1.1 *Introduction*

The main steam system (MSS) transfers steam produced in the steam generators (SGs) to the TGS. The NuScale design defines the MSS as only the portions from the flanges immediately downstream of the containment system (CNTS) main steam isolation valves (MSIVs) up to the turbine stop valves. Portions of the main steam piping inside containment are identified as part of the SGs, and the portion upstream of the main steam line flange, including the MSIVs and main steam isolation bypass valves (MSIBVs), is identified as part of the CNTS. Regardless of how the NuScale design defines the MSS, the staff performed its review consistent with the system boundaries defined in NuScale design specific review standard (DSRS) 10.3, “Main Steam Supply System.” For the purposes of this review, the staff considers the main steam system to extend from the outlet of the reactor pressure vessel (RPV) steam plenum (on the secondary side of the SGs) up to and including the turbine stop valves. Such system includes the containment isolation valves, connected piping that is 6.4 centimeters (cm) (2.5 inches (in)) in nominal diameter or larger, and the steam line to the decay heat removal system (DHRS) up the DHRS actuation valves.

10.3.1.2 *Summary of Application*

DCA Part 2, Tier 1: The Tier 1 information concerning SSCs associated with the operation of the MSS are found in Tier 1, Section 2.1.1, “Design Description,” Tier 1, Table 2.1-1, “NuScale Power Module Piping Systems,” Tier 1, Table 2.1-2, “NuScale Power Module Mechanical Equipment,” Tier 1, Table 2.1-3, “NuScale Power Module Electrical Equipment,” and Tier 1 Section 2.8, “Equipment Qualification.”

DCA Part 2, Tier 2: DCA Part 2, Tier 2, Section 5.4, “Reactor Coolant System Component and Subsystem Design,” provides a description of the steam supply located inside containment. DCA Part 2, Tier 2, Section 6.2, “Containment Systems,” provides a discussion of steam supply associated with containment isolation. DCA Part 2, Tier 2, Section 10.3, “Main Steam System,” contains MSS design basis, system and component descriptions, as well as, system operation, inspections, and testing.

ITAAC: ITAAC for the portions of the safety-related SSC of the MSS are described in DCA Part 2, Tier 1, Table 2.1-4, “NuScale Power Module Inspections, Tests, Analysis, and Acceptance Criteria,” Table 2.5-7, “Module Protection System and Safety Display and Indication System Inspections, Tests, Analyses, and Acceptance Criteria,” and Table 2.8-2: “Equipment Qualification Inspections, Tests, Analyses, and Acceptance Criteria.”

Technical Specifications: The TSs associated with the MSS are given in DCA Part 2, Tier 2, Chapter 16 “Technical Specifications.”

Technical Reports: There are no Technical Reports associated with the MSS.

10.3.1.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review and the associated acceptance criteria are discussed in NuScale DSRS 10.3, “Main Steam Supply System,” and are summarized below. Review interfaces with other SRP sections also can be found in Item I, “Review Interfaces,” of the DSRS 10.3.

- GDC 2, “Design bases for protection against natural phenomena,” requires that SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

- GDC 4, “Environmental and dynamic effects design basis,” requires that SSCs important to safety be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

- GDC 5, “Sharing of structures, systems and components,” requires that SSCs important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

- 10 CFR 50.63, “Loss of All Alternating Current,” requires that a nuclear power plant have the ability to withstand for a specified duration and recover from a station blackout (SBO) as defined in 10 CFR 50.2.

- 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the AEA, and the NRC’s regulations.

- GDC 34, “Residual heat removal,” requires that a system to remove residual heat be provided.

- 10 CFR 20.1406, “Minimization of Contamination,” as it relates to the design features that will facilitate eventual decommissioning and 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.

10.3.1.4 *Technical Evaluation*

Each NPM has two SGs and a dedicated MSS. Each of the two SGs has two steam lines that combine before exiting containment and ultimately terminate in the turbine generator building at the turbine stop valve. Each steam line is supported by a pipe rack from the reactor building to the turbine generator building. A flow diagram of the system is provided in DCA Part 2, Tier 2, Figure 10.1-1, "Power Conversion System Block Flow Diagram," and Figure 10.3-1, "Main Steam System Piping and Instrumentation Diagram."

A design description of the NuScale MSS is provided in DCA Part 2, Tier 2, Section 10.3.2, "System Description." The primary function of the MSS is to transport steam from the SGs to the turbine generator system. Other functions of the MSS include delivering steam to the gland seal regulator; delivering steam directly to the condenser through turbine bypass; collecting the drainage condensed in the main steam piping and deliver it to the main condenser; and transporting extraction steam from the turbine to the feedwater heaters. The safety-related portions of the MSS are the piping and valves between each RPV and the flange immediately downstream of the MSIVs. The remainder of the MSS including the main turbine generator is not safety-related. Under accident conditions, the CNTS isolates the SGs and the safety-related portion of the system from the portion that is not safety-related.

Safety-related active components in the MSS are designed to be tested during plant operation. DCA Part 2, Tier 2, Section 6.2.1.1.2, "Design Features," states that the containment system components (which include the MSIVs and MSIBVs) are designed such that the American Society for Mechanical Engineers Boiler and Pressure Vessel Codes (ASME BPVC) Section XI inspection requirements for Class 1, Class 2, and Class main condenser (MC) are met including the preservice inspection requirements. DCA Part 2, Tier 2, Section 10.3.4, "Inspections and Tests," states that the portion of the main steam lines that are not safety-related are inspected and tested in accordance with the requirements of ASME B31.1. A description of periodic inservice inspection and inservice testing of ASME Section III, Class 2 and 3 components is provided in DCA Part 2, Tier 2, Section 3.9.6, "Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints," and Section 6.6, "Inservice Inspection and Testing of Class 2 and 3 Systems and Components."

The staff reviewed the NuScale design to ensure appropriate design margins for pressure relief capacity and set points for the secondary system. The applicant stated that overpressure protection of the steam piping is provided by two different methods, depending on location.

The MSS piping downstream of the secondary MSIVs has a design pressure of 1000 psia as indicated in DCA, Part 2, Tier 2, Table 10.3-1, "Main Steam System Design Data (Single NuScale Power Module)." Overpressure protection for this portion of the MSS is provided by two main steam safety valves shown in DCA, Part 2, Tier 2, Figure 10.3-1.

The steam piping between the SG and the secondary MSIVs has a design pressure of 2100 psia as indicated in DCA Part 2, Tier 2, Tables 10.3-1 and 5.4-2. This design pressure is equal to the design pressure of the reactor coolant system (RCS). Due to the thermal coupling between the RCS and SG, the SG pressure is limited by the saturation pressure of the RCS fluid in the downcomer. The saturation pressure of the RCS is limited by the opening set point of the reactor safety valves (RSVs). Through the SG thermal coupling, the SG design pressure, and the RSVs opening set point, the SG ASME service limits are not exceeded due to over pressurization for normal operation or during transients. As described in DCA, Part 2, Tier 2, Section 5.2.2.2, "Design Evaluation," pressure relieving devices are not needed as indicated by ASME BPVC, Section III, Paragraph NB-7120(c) and NC-7120(b). The overpressure protection of the SG described above does not depend on the availability of either train of the decay heat removal system (DHRS).

The MSS operational aspects are provided in DCA Part 2, Tier 2, Section 10.3.2.3, "System Operation," which includes descriptions of plant startup, normal operation, abnormal operations, and shutdown operations. An evaluation of the MSS abnormal and anticipated operational occurrences is described in DCA Part 2, Tier 2, Chapter 15, "Transient and Accident Analyses," of the application where the NuScale responses to postulated accidents are considered, including an evaluation of a main steam line break, feedwater line break, and SG tube rupture (SGTR). Therefore, these events are not addressed in this section of the SER.

An automatic actuation of the DHRS will automatically isolate the main steam isolation and bypass valves. Monitored variables that provide inputs to the DHRS actuation logic are shown on DCA Part 2, Tier 2, Figure 7.1-1I, "ESFAS - Decay Heat Removal System Actuation." In addition, main steam temperature, pressure, radiation, and flow instrumentation are shown on Figure 10.3-1. The staff's evaluation of the instrumentation and controls regarding main steam isolation is included in Chapter 7 of this SER.

In order for the DHRS to function properly the main steam lines are isolated and steam is routed to the DHRS passive condensers. The staff reviewed the capability of the main steam lines to isolate in the event of a postulated break in a main steam line, assuming a single active failure. In the event a MSIV fails to close, the NuScale design incorporates seismic Category I secondary MSIVs and secondary MSIBVs, both of which are not safety-related. Surveillances for operability and in-service testing of the secondary MSIVs are included in Technical Specifications. The staff notes that the treatment of the secondary MSIVs and secondary MSIBVs is consistent with previous staff position on the treatment of equipment that is not safety-related when applying single failure criteria for steam line break accidents as shown in NUREG-0138, "Staff Discussion of Fifteen Technical Issues Listed in Attachment to November 3, 1976, Memorandum from Director, NRR to NRR Staff," (ML13267A423). Therefore, the staff finds this acceptable. The staff evaluation of the DHRS is included in Section 5.4 of this SER.

The DSRS Section 10.3, Subsection III, "Review Procedure," Item 6.C states that the reviewer should verify that MSIVs and other shutoff valves can close against maximum steam flow. The applicant stated that all containment isolation valves, which include the primary side containment isolation valves and the secondary side containment isolation valves are required to isolate their flow path with the required stroke time against the flow generated during line break conditions. These flow rates are derived from high energy line break calculations and safety analysis calculations. DCA Part 2, Tier 2, Section 6.2.4.3, "Design Evaluation," states that MSIVs are capable of stopping fully developed pipe break flow for steam conditions. DCA Part 2, Tier 2, Section 10.3.2.2, "Component Description," states that the secondary MSIVs are capable of closing in steam conditions.

In DCA Part 2, Tier 2, Section 10.3.3, "Safety Evaluation," the applicant provided its evaluation of the MSS and its compliance with the requirements of the GDCs identified in the "Regulatory Basis" for this Section of the SER. Following is the staff's review of these GDC compliances:

10.3.1.4.1 GDC 2, "Design bases for protection against natural phenomena"

Compliance with GDC 2 is based on meeting the requirements related to the SSCs important to safety, which include portions of the MSS, including steam line piping, being designed to withstand the effects of natural phenomena. The staff reviewed DCA Part 2, Tier 2, Sections 5.4, 6.2, and 10.3 to determine whether the portions of the main steam line important to safety are protected against natural phenomena.

DCA Part 2, Tier 2, Figure 10.3-1 indicates that the main steam line, including piping and valves between each steam generator and flange immediately downstream of the MSIVs (identified as removable spool piece in Figure 10.3-1), is located inside the reactor building. In addition, DCA Part 2, Tier 2, Section 6.2.2.3, "Design Evaluation," states that the CNTS (including the MSIVs) is located below grade in the reactor building, which is designed to withstand the effects of natural phenomena hazards such as earthquakes, winds, tornadoes, or floods while protecting the systems inside.

NuScale DSRS Section 10.3, Subsection III, "Review Procedure," Item 4 indicates that the essential portions of the MSS should be designed to Quality Group B or seismic Category I requirements. The staff reviewed DCA, Part 2, Tier 2, Sections 5.4, 6.2, and 10.3 for the identification of the quality group and seismic classification boundaries on system drawings, and piping and instrumentation diagram (P&IDs). The applicant stated that the safety-related portions of the MSS are contained in the CNTS. The division between the safety-related portion of the MSS and the portion of the MSS that is not safety-related occurs on the outlet side of the main steam isolation valves as shown in DCA Part 2, Tier 2, Figure 10.3-1.

10.3.1.4.2 GDC 4, "Environmental and dynamic effects design bases"

The staff reviewed the NuScale design to ensure the functions important to safety will be maintained in the event of adverse environmental phenomena and dynamic effects. DCA Part 2, Tier 2, Section 10.3.3 states portions of the MSS are located in the RXB; thus, internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks do not prevent the MSS from performing its safety function. The portions of the MSS downstream of the MSIVs to the secondary MSIVs are protected from pipe whip and jet impingement forces resulting from breaks in nearby systems (including the MSS of adjacent power modules) by the piping design layout. The portions of the MSS downstream of the MSIVs to the secondary

MSIVs are physically separated from safety-related systems in the RXB by the use of walls and other restraints and have no adverse impacts on safety functions. The staff reviewed the above information and finds that the portions of the main steam lines and MSS that are subject to protection under GDC 4 are located inside the RXB, a seismically Category I structure designed for wind and missile loads, and therefore are acceptable. The staff notes that it cannot conclude that the main steam lines and MSS are protected against turbine missiles. This is addressed by COL Items 3.5-1 and 10.2-3. The staff evaluation of pipe hazard for the main steam lines is included in Section 3.6 of this SER.

The applicant stated that a CNTS failure modes and effects analysis is located in DCA, Part 2, Tier 2, Section 6.2, and in Table 6.2-6 “Failure Modes and Effects Analysis Containment System.” This table assesses the effect of containment isolation valve (including the MSIVs, MSIV bypass valves and FWIVs) failures.

Further, regarding the GDC 4 requirements, the staff reviewed consideration for steam and water hammer effects on the MSS. DCA, Part 2, Tier 2, Section 3.6.3.1.4, “Water Hammer/Steam Hammer,” states water hammer and relief valve discharge loads are considered and their effects minimized in the design of the MSS. Utilizing drain pots, proper line sloping, and drain valves minimize this potential. The dynamic loads such as those caused by MSIV closure or Turbine Stop Valve closure due to water hammer and steam hammer are analyzed and accounted for in the design and analysis of the main steam piping. These design features minimize the likelihood of water and steam hammer; therefore, the staff finds this acceptable.

10.3.1.4.3 GDC 5, “Sharing of structures, systems, and components”

The GDC 5 contains provisions restricting the sharing of structures, systems, and components important to safety between nuclear power units. The applicant stated that each NPM has a dedicated MSS. There are no important to safety components in the MSS that are shared among NPMs; therefore, the loss of components in one MSS does not significantly impair the ability of other NPMs to perform their safety functions. Therefore, the requirements of GDC 5 are met.

10.3.1.4.4 GDC 34, “Residual heat removal”

The DCA, Part 2, Tier 2, Section 3.1.4.5, Criterion 34, “Residual Heat Removal,” states that the power provisions of GDC 34 are not applicable to the NuScale design and the following principle design criteria (PDC) had been adopted:

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

Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that the system safety function can be accomplished, assuming a single failure.

The staff evaluation of PDC 34 is included in Sections 5.4 and 8.3 of this SER. NuScale has requested an exemption from GDC 34, which is subject to Open Item 8.3-1 in section 8.3, “Onsite Power Systems,” of this SER.

The staff reviewed the MSS design against the decay and residual heat removal safety function requirements of PDC 34. The decay and residual heat removal is performed by the DHRS flow path, and containment isolation function of the containment system performed by the MSIVs and the feedwater isolation valves. The secondary MSIVs that are not safety-related downstream of the MSIVs are credited as backup isolation components in the event that an MSIV fails to close, and provides additional assurance that the blowdown of a second steam generator is limited if a steam line were to break upstream of the MSIV.

Based on the information above, the staff finds that the MSS, including the steam lines between the steam generators and disconnect flange, conforms to the requirements of GDC 34 with respect to the system function of transferring residual and sensible heat from the reactor coolant system, assuming a single failure.

However, due to the Open Item 8.3-1 in Section 8.3 of this SER, the staff cannot reach a conclusion regarding GDC 34 requirements with respect to the system function of transferring residual and sensible heat from the reactor coolant system.

10.3.1.4.5 10 CFR 50.63, “Loss of all alternating current power”

The staff reviewed the MSS capability to supply steam to the DHRS for the removal of decay heat during a SBO. Successful operation of the DHRS relies on the MSIVs ability to isolate steam; this forms part of the DHRS flow path and pressure boundary. In addition, secondary MSIVs that are not safety-related are provided as a backup to the MSIVs. Both the MSIVs and secondary MSIVs fail closed during an SBO.

The staff finds this acceptable because the safety-related main steam components are designed such that they perform their safety function and the system has sufficient capability to cope with an SBO. Therefore, the staff concludes the requirements of 10 CFR 50.63 are met. Further staff evaluation of the SBO event is in Section 8.4 of this SER.

10.3.1.4.6 10 CFR 20.1406, Minimization of contamination

10 CFR 20.1406 requires, in part, that each design certification applicant describe how the facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and environment, as well as the generation of radioactive waste. DCA, Part 2, Tier 2, Table 12.3-26, “Regulatory Guide 4.21 Design Features for Main Steam System,” provides a list of the design features specific to the main steam system for the

minimization of contamination. Some examples of this includes the use of corrosion resistant materials, proper chemistry controls, steam line radiation monitors, and collection and control of fluid leaks by the radioactive waste drain system (RWDS) and balance-of-plant drain system (BPDS). Also, a minimum of two barriers are provided between clean systems (non-radioactive systems), such as the nitrogen distribution system and the auxiliary boiler system (ABS), and the MSS to prevent cross-contamination.

The staff reviewed DCA, Part 2, Tier 2, Sections 10.3 and 12.3, "Radiation Protection Design Features," as related to prevention and minimization of the contamination. Because the NuScale DCA, Part 2, design provides adequate measures for early leak detection and controls in the MSS design to minimize contamination as described above, the staff concludes that the system as described in the DCA, Part 2, conforms to 10 CFR 20.1406.

10.3.1.5 *ITAAC*

ITAAC for portions of the safety-related SSC of the MSS are located in DCA, Part 2, Tier 1 Table 2.1-4, "NuScale Power Module Inspections, Tests, Analysis, and Acceptance Criteria," Table 2.5-7, "Module Protection System and Safety Display and Indication System Inspections, Tests, Analyses, and Acceptance Criteria," and Table 2.8-2, "Equipment Qualification Inspections, Tests, Analyses, and Acceptance." The staff reviewed the proposed ITAAC and finds that the DCA, Part 2, Tier 1 information and ITAAC requirements adequately describe the design certification requirements for the MSS. Further, the staff concludes that the ITAAC requirements are sufficient to demonstrate that if the ITAAC are satisfied, the MSS has been constructed and will operate in accordance with the design certification, the provisions of the AEA, and NRC regulations as required by 10 CFR 52.47(b)(1).

A discussion of all NuScale ITAAC is provided in Section 14.3 of this SER.

10.3.1.6 *Technical Specifications*

The staff reviewed DCA, Part 2, Tier 2, Chapter 16, "Technical Specifications," for applicability to the MSS. These technical specifications provide limiting conditions for operation and surveillance requirements for the MSIVs, secondary MSIVs, and associated bypass valves. The staff also reviewed the associated technical specification bases and found the description to be consistent with the DCA, Part 2, Tier 2 description of the components.

The staff concludes that the technical specification appropriately addresses the limiting conditions for operation and surveillance requirements for the MSIVs, secondary MSIVs, and associated bypass valves. The staff evaluation of technical specifications and associated bases are located in Chapter 16 of this report.

10.3.1.7 *Combined License Information Items*

There are no combined license information items associated with the MSS.

10.3.1.8 *Conclusion*

Based on the review above, the staff concludes that the MSS for the NuScale design satisfies the relevant requirements for the MSS as described in the Regulatory Basis of this section, with the exception of GDC 34, which is associated with the pending Open Item 8.3-1 in Chapter 8.3 of this SER.

10.3.6 Steam and Feedwater System Materials

10.3.6.1 *Introduction*

By application dated December 31, 2016, as supplemented by letters dated June 26, 2017 (ML17177A686), October 17, 2017 (ML17290B241), November 22, 2017 (ML17326B393), April 16, 2018 (ML18106A139), and July 3, 2018 (ML18184A597), the applicant submitted the information in DCA, Part 2, Tier 2, Section 10.3.6, which addresses the selection, fabrication methods, and compatibility of materials with the environments of the steam and power conversion systems which include the MSS, condensate and feedwater system (CFWS), TGS, and ABS.

The NRC staff evaluation considered the system design and Code of Construction, materials selection and fabrication, and flow accelerated corrosion (FAC) program of the steam and power conversion systems.

10.3.6.2 *Summary of Application*

DCA Part 2, Tier 1: There is no Tier 1 information related to this section.

DCA Part 2, Tier 2: The MSS is described in DCA Part 2, Tier 2, Section 10.3, and extends from the flange immediately downstream of the safety-related MSIVs to the inlet of the turbine generator vendor package. Furthermore, the extraction steam points from the turbine to the feedwater heaters are also part of the MSS although there is no direct connection to the other MSS piping. The MSS and extraction steam materials are reviewed in this section of the safety evaluation.

The CFWS is described in DCA, Part 2, Tier 2, Section 10.4.7 and extends from the entrance of the MC (Section 10.4.1) to the flange immediately upstream of the SG FWIVs. Other systems that are part of the CFWS are the CPS (Section 10.4.6) and FWTS (Section 10.4.11). However, only the CFWS and the CPS materials are reviewed in this section of the safety evaluation.

The TGS is described in DCA, Part 2, Tier 2, Section 10.2. Other systems that are part of the TGS are the turbine gland sealing system (Section 10.4.3) and turbine bypass system (Section 10.4.4). The TGS and its two subsystems’ materials are reviewed in this section of the safety evaluation.

The ABS is described in DCA, Part 2, Tier 2, Section 10.4.10. The ABS materials are reviewed in this section of the safety evaluation.

DCA, Part 2, Tier 2, Figure 10.1-1, "Power Conversion System Block Flow Diagram," shows the system breaks for the aforementioned steam and power conversion systems. The portions of the CNTS that include the safety-related piping connected to the MSS and CFWS, as well as the MSIVs and the FWIVs, are reviewed in Section 6.1.1 of this safety evaluation. The MSS, CFWS, TGS, ABS and associated subsystems are not safety-related, and do not perform a nuclear safety function.

The staff notes that historically documents such as Generic Letter (GL) 89-08, "Erosion/Corrosion – Induced Pipe Wall Thinning," have referred to FAC as erosion/corrosion. Therefore, FAC and erosion/corrosion are used interchangeably throughout Section 10.3.6 of this SER.

When the staff reviews the next revision of the DCA, the staff will confirm that the applicable information provided in applicant's RAI response letters dated April 16, 2018 (ML18106A139) and July 3, 2018 (ML18184A597) is added to the next revision of the DCA. These are **Confirmatory Items 10.3.6-1 and 10.3.6-2**

The July 3, 2018, applicant's RAI response letter provided to the NRC does not contain the revisions from the previous June 26, 2017, letter. The staff provided feedback on the letter and NuScale stated that the next revision of the DCA will update the COL Item in accordance with the June 26, 2017 letter. The staff is tracking incorporation of this information in the next revision of the DCA as **Confirmatory Item 10.3.6-3.**

System Design and Code of Construction

The MSS, CFWS, TGS, ABS, and associated subsystems are not safety-related and do not perform a nuclear safety function. The quality group for the aforementioned steam and power conversion systems is quality group D, and the piping is designed to ASME B31.1, "Power Piping." The piping materials are also selected to meet ASME B31.1 requirements.

The quality group and seismic design classifications are provided in DCA, Part 2, Tier 2, Table 3.2-1. The staff's review of the adequacy of system quality group and seismic design classification is evaluated in Section 3.2 of this safety evaluation.

Materials Selection and Fabrication

The materials selected for the steam and power conversion systems are generally selected to minimize the impact of FAC. The FAC program itself is discussed later in this section of the safety evaluation.

DCA, Part 2, Tier 2, Section 10.1.2.7 states, "The MSS and feedwater system piping is designed considering the effects of flow-accelerated corrosion and erosion/corrosion. Erosion/corrosion resistant chromium-molybdenum material has been selected for piping downstream of the MSIVs. The feedwater system piping is also designed with chromium-molybdenum to avoid erosion damage." DCA, Part 2, Tier 2, Sections 10.2.3.1, 10.3.5.1.1, 10.4.1.2.2, 10.4.6.2.1, 10.4.7.2.2, and 10.4.7.3, as well as Table 10.4-20, “Auxiliary Boiler System Component Design Parameters,” also discuss either selecting FAC resistant materials or ensuring that a corrosion allowance is included for the steam and power conversion systems.

Flow Accelerated Corrosion

The applicant states that the piping design considerations of the aforementioned steam and power conversion system piping meets the guidance contained in GL 89-08 and Electric Power Research Institute (EPRI) NSAC-202L-R3, “Recommendations for an Effective Flow-Accelerated Corrosion Program,” in order to minimize erosion and corrosion (including FAC). These piping design considerations include:

- material selection;
- limits on flow velocity;
- inspection programs; and
- limits on water chemistry to reduce FAC, corrosion, and erosion of piping and piping components.

The applicant states that the steam and power conversion system’s designs and layout will also incorporate provisions to minimize FAC and other flow-induced degradation mechanisms in the high-energy portions of piping that are not safety-related but that could adversely impact safety-related systems.

Erosion and corrosion are also minimized by the implementation of a secondary water chemistry control program, which is described and reviewed in Section 10.4.6 of the SER.

DCA, Part 2, Tier 2, Table 10.3-5, “Power Conversion System Flow-Accelerated Corrosion Program Piping,” provides the list of piping which is within the scope of the FAC program. This table is located in NuScale’s RAI response letter dated April 16, 2018 (ML18106A139) and its inclusion into the next Revision of the DCA is **Confirmatory Item 10.3.6-1**.

COL Item 10.3-2 states that the COL applicant will provide a description of the FAC monitoring program for the aforementioned steam and power conversion systems based on GL 89-08 and the latest revision to EPRI NSAC-202L at the time of the COL application. The COL Item, and revisions, are located in NuScale’s RAI response letter dated April 16, 2018 (ML18106A139) and July 3, 2018 (ML18184A597) and its inclusion into the next Revision of the DCA is being tracked as **Confirmatory Items 10.3.6-1 and 10.3.6-2**.

DCA, Part 2, Tier 2, Section 3.6.3 discusses FAC for the safety-related, stainless steel portions of the main steam and feedwater piping that are inside the CNV and part of the CNTS. This is outside of the scope of DCA, Part 2, Tier 2, Section 10.3.6 and this section of the safety evaluation.

ITAAC: There are no ITAAC related to this section.

Technical Specifications: There are no Technical Specifications related to this section.

Technical Reports: The staff did not review any technical reports related to this section.

10.3.6.3 *Regulatory Basis*

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

- GDC 1, "Quality Standards and Records," and 10 CFR 50.55a require that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

- GDC 35, "Emergency Core Cooling," states that a system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

- 10 CFR Part 50, Appendix B, Criterion XIII, "Handling, Storage and Shipping," requires that measures be established to control the handling, storage, shipping, cleaning, and preservation of materials and equipment to prevent damage or deterioration.

- 10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," requires that power reactor licensees monitor the performance or condition of structures, systems, and components SSCs against licensee-established goals in a manner sufficient to provide reasonable assurance that such SSCs are capable of fulfilling their intended functions.

The guidance in SRP Section 10.3.6, "Steam and Feedwater System Materials," Revision 3, lists the acceptance criteria adequate to meet the above requirements, as well as 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.

- NRC, Generic Letter 89-08, "Erosion/Corrosion- Induced Pipe Wall Thinning," dated May 1989.

- Electric Power Research Institute (EPRI), NSAC-202L-R3, "Recommendations for an Effective Flow-Accelerated Corrosion Program," dated May 2006.

10.3.6.4 *Technical Evaluation*

10.3.6.4.1 System Design and Code of Construction

SRP Section 10.3.6 is based on using ASME Code, Section III, Class 2 and Class 3 components. However, the aforementioned NuScale steam and power conversion systems are designed to ASME B31.1. The selection of ASME B31.1 as the code of construction is consistent with the recommendations in RG 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” for Quality Category D components. The staff’s review of the adequacy of system classifications is evaluated in Section 3.2 of this safety evaluation. Based on the staff’s review of the adequacy of the system classification in Section 3.2 of this safety evaluation, the staff finds the use of ASME B31.1 acceptable for the design of the NuScale steam and power conversion systems.

SRP Section 10.3.6 lists four RGs with the caveat that RG 1.37, “Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants,” was withdrawn and replaced with RG 1.28 “Quality Assurance Program Criteria (Design and Construction).” SRP Section 10.3.6 will be updated at a future time to reflect the new staff guidance.

The following four RGs are listed in the SRP. These four RGs are not listed in DCA, Part 2, Tier 2, Table 1.9-2, “Conformance with Regulatory Guides,” as applicable to DCA, Part 2, Tier 2, Section 10.3.6:

- RG 1.28, “Quality Assurance Program Criteria (Design and Construction),” Rev. 4
- RG 1.50, “Control of Preheat Temperature for Welding of Low-Alloy Steel,” Rev. 1
- RG 1.71, “Welder Qualification for Areas of Limited Accessibility,” Rev. 1
- RG 1.84, “Design, Fabrication, and Materials Code Case Acceptability, ASME Section III,” Rev. 36

DCA, Part 2, Tier 2, Table 1.9-3, “Conformance with NUREG-0800, Standard Review Plan (SRP) and Design Specific Review Standard (DSRS),” summarizes the differences between the DCA and SRP. While DCA, Part 2, Tier 2, Section 1.9 and Section 10.3.6 do not state that any of these RGs are applicable to Section 10.3.6, the staff reviewed the applicability of these RGs based on the NuScale design and alternatives provided in DCA, Part 2, Tier 2, Section 10.3.6 and RAI responses. NuScale provided additional context in the aforementioned RAI response letters.

The staff reviewed the guidance in the SRP related to cleaning and handling of safety-related materials that were historically in RG 1.37 and incorporated in RG 1.28. Since the NuScale steam and power conversion systems are not safety-related, these quality assurance requirements are not applicable. However, contamination originating in the steam and power conversion systems may have an impact on the safety-related portions of the DHRS, CNTS, and SGS. NuScale states that the secondary water chemistry control program, and materials provide protection to the safety-related systems. The staff reviewed the secondary water chemistry control program and safety-related materials in Sections 10.4.6 and 6.1.1 of the SER, respectively.

RG 1.50 and RG 1.71 state that they are only applicable to ASME Code, Section III, Class 1, 2, and 3 components. While the NuScale steam and power conversion systems are not designed to ASME Code Section III, the staff reviewed the guidance of RG 1.50 and RG 1.71 with consideration of the safety significance of the steam and power conversion system, and requirements in ASME B31.1.

The staff compared the RG 1.50 guidance and the ASME B31.1 requirements. The staff found that ASME B31.1 contains requirements related to the regulatory positions in RG 1.50 for preheat temperature, interpass temperature, post weld heat treatment, and production weld temperature monitoring. Therefore, based on the similarity of the ASME B31.1 requirements and the RG 1.50 guidance, and the safety significance of the steam and power conversion systems, the staff finds not applying RG 1.50 to NuScale DCA, Part 2, Tier 2, Section 10.3.6 acceptable.

The staff compared the RG 1.71 guidance and the ASME B31.1 requirements, and the design and safety significance of the aforementioned steam and power conversion systems. RG 1.71 supplements the welder performance qualification requirements in ASME Code Sections III and IX based on welder access and visibility limitations. The steam and power conversion systems use smaller diameter piping and are manufactured as modules which may decrease the number of locations with limited accessibility. ASME B31.1 cites ASME Code Section IX for welder qualification, which has provisions for qualifying welders in special positions. Therefore, based on similarity of the ASME B31.1 requirements and the RG 1.71 guidance, and the design and safety significance of the steam and power conversion systems, the staff finds not applying RG 1.71 to NuScale DCA, Part 2, Tier 2, Section 10.3.6 acceptable.

The aforementioned steam and power conversion systems are designed to ASME B31.1, and not ASME Code, Section III. Since RG 1.84 is only related to ASME Code, Section III Code Cases, the staff finds not committing to RG 1.84 acceptable.

The SRP states that acceptance criteria for nondestructive examination (NDE) of tubular products should follow the relevant paragraphs of Subsections NC and ND of ASME Code Section III. ASME B31.1 states that NDE should be performed in accordance with the requirements in ASME Code Section V. ASME Code Section III also states that NDE should be performed in accordance with the requirements in ASME Code Section V. Additionally, ASME B31.1 has acceptance criteria related to tubular products. Therefore, the staff finds that ASME B31.1 can meet the intent of the SRP related to the NDE acceptance criteria of tubular products in the steam and power conversion systems.

The staff reviewed SRP Section 10.3.6 related to requiring fracture toughness testing. The SRP states that fracture toughness testing is used to meet GDC 35, "Emergency Core Cooling," so that the steam and feedwater system integrity can be maintained to allow the systems to fulfill their safety functions of removing decay heat and supplying steam to engineered safety feature (ESF) pumps. Since the NuScale design does not require the steam and feedwater system to perform a safety function, the staff finds not requiring additional fracture toughness requirements to be acceptable.

10.3.6.4.2 Material Selection and Fabrication

While the specific grades of piping components have not been selected, NuScale stated that the steam and power conversion systems will be constructed with materials that are resistant to FAC such as chrome-molybdenum (Cr-Mo) steel, or include a corrosion allowance. Cr-Mo steels have extensive history in steam and power conversion systems and the material is suitable for steam and elevated temperature water service provided that controls are provided to prevent material degradation. Cr-Mo steels, such as SA-355 Grade P11 or P22, are listed in EPRI NSAC-202L-R3 as FAC resistant alloys. The staff finds NuScale's statements that the steam and power conversion system will be constructed with FAC resistant materials or include a corrosion allowance for the steam and power conversion systems acceptable.

The applicant stated that they will prevent degradation of the steam and power conversion system by controlling the water chemistry. The secondary water chemistry program is evaluated by the staff in Section 10.4.6 of the SER. Since the MSS and CFWS enter the CNV through the CNV Top Head, the MSS and CFWS do not travel through the ultimate heat sink. Therefore, the findings in DCA, Part 2, Tier 2, Section 9.1.3 related to the chemistry control of the ultimate heat sink were not considered in Section 10.3.6 of the safety evaluation.

10.3.6.4.3 Flow Accelerated Corrosion

SRP Section 10.3.6, item III.3 states that EPRI NSAC-202L-Revision 2 is the acceptance criteria for a FAC program. The use of EPRI NSAC-202L-Revision 3 is acceptable because both revisions are endorsed in NUREG-1801, Rev 2, "Generic Aging Lessons Learned (GALL) Report," Section XI.M17, Flow-Accelerated Corrosion."

NuScale states that the piping design of the steam and power conversion system piping meets the guidance of GL 89-08 and EPRI NSAC-202L-R3 to reduce FAC. Therefore, the staff finds meeting the guidance to minimize the occurrence of FAC acceptable.

10.3.6.5 *ITAAC*

There are no ITAAC required for the steam and feedwater system materials. Required ITAAC for the MSS, CFWS, TGS, ABS, and associated subsystems are discussed in this chapter of the SER. Therefore, the staff finds this acceptable in accordance with 10 CFR 52.47(b)(1).

10.3.6.6 *Technical Specifications*

There are no TS requirements associated with the steam and feedwater system materials. Required TS for the MSS, CFWS, TGS, ABS, and associated subsystems are evaluated of the system subsection in this chapter of this report. Therefore, the staff finds this acceptable in accordance with 10 CFR 50.36.

10.3.6.7 *Combined License Information Items*

Item No.	Description	DCA Part 2 Tier 2 Section
COL Item 10.3-2	A COL Applicant that references the NuScale Power Plant design certification will provide a description of the flow-accelerated corrosion monitoring program for the steam and power conversion systems based on Generic Letter 89-08 and the latest revision of the Electric Power Research Institute NSAC-202L at the time of the COL application.	10.3.6

The applicant has proposed one COL item as described in the table above. The COL item describes site-specific features of the FAC program. Additionally, the staff reviewed DCA, Part 2, Tier 2, Table 1.8-2, "Combined License Information Items," which references COL Item 10.3-2. The staff confirmed the consistency of the wording. The COL Item, and revisions, are located in NuScale's RAI response letter dated April 16, 2018 (ML18106A139) and July 3, 2018 (ML18184A597) and its inclusion into the next Revision of the DCA is being tracked as **Confirmatory Items 10.3.6-1 and 10.3.6-2**.

10.3.6.8 *Conclusion*

Based on its review of the information provided by NuScale, and subject to the closure of **Confirmatory Items 10.3.6-1 through 10.3.6-3,** the staff concludes that the NuScale DCA, Part 2 for the materials to be used in the fabrication of the steam and power conversion systems are acceptable and meet the relevant requirements of 10 CFR 50.55a, GDC 1, GDC 35, Appendix B to 10 CFR Part 50, and 10 CFR 50.65.

10.4 Other Features of Steam and Power Conversion System

10.4.1 Main Condensers

10.4.1.1 *Introduction*

The main condenser (MC) is designed and built to condense and deaerate the exhaust from the main turbine and the turbine bypass system (TBS). The components in the MC are not shared among NPMs, and each NPM has an MC, which is part of the CFWS addressed in Section 10.4.7 of this SER.

10.4.1.2 *Summary of Application*

DCA, Part 2, Tier 1: There are no entries in DCA, Part 2, Tier 1 for the MC.

DCA, Part 2, Tier 2: DCA, Part 2, Tier 2, Section 10.4.1, “Main Condenser,” includes the MC system description, as well as relevant information on the MC design, including the design bases, instrumentation, and the inspection and testing program.

ITAAC: No ITAAC are provided in the DCA, Part 2, Tier 1 for the MC.

Initial Test Program: The preoperational test related to the MC being evaluated as part of the design certification review is described in DCA, Part 2, Tier 2, Section 14.2, “Initial Plant Test Program,” Table 14.2-33.

Technical Specifications: There are no proposed TS requirements associated with the MC.

Technical Reports: There are no technical reports related to the MC.

10.4.1.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review and the associated acceptance criteria are given in NUREG-0800, Section 10.4.1, “Main Condensers,” and are summarized below. Review interfaces with other SRP sections are also indicated in SRP Section 10.4.1.

- GDC 4, "Environmental and dynamic effects design basis," as it relates to SSCs important to safety being designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing and postulated accidents, including loss-of-coolant accidents.

- GDC 60, “Control of releases of radioactive materials to the environment,” as it relates to provisions being included in the nuclear power unit design to control suitably the release of radioactive materials in gaseous and liquid effluents during normal operation, including anticipated operational occurrences.

- GDC 64, "Monitoring radioactivity releases," as it relates to provisions being included in the nuclear power unit design for monitoring the effluent discharge paths and the plant environs for radioactivity that may be released from normal operations, including AOOs, and from postulated accidents.

- 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

10.4.1.4 *Technical Evaluation*

The staff reviewed the main condenser system design, described in DCA Part 2, Tier 2, Section 10.4.1, in accordance with guidance in SRP 10.4.1, to ensure compliance with the regulatory requirements listed in Section 10.4.1.3 of this SER.

The staff reviewed the design of the MC for compliance with the requirements of GDC 4. The staff's review was performed to verify that the system was appropriately protected against environmental and dynamic effects or that a failure of the MC and the resulting discharging fluid (i.e., flooding) would not adversely affect safety-related SSCs. In DCA Part 2, Tier 2, Section 10.4.1.1 "Design Basis", the applicant states that the MC serves no safety-related functions, is not credited for mitigation of a design basis accident (DBA), and has no safe shutdown functions. Also, in DCA Part 2, Tier 2, Section 10.4.1.3 "Safety Evaluation" the applicant states that for a failure of the MC hotwell that releases the water inventory, the resulting flooding does not prevent the operation of a safety-related system because no such systems are located in the Turbine Generator Buildings.

The staff review of the information in DCA Part 2, Tier 2, Table 3.2-1 "Classification of structures, systems, and components," and confirmed that no SSCs important to safety were located in or near the Turbine Generator Buildings. Based on its review, the staff found that all SSCs important to safety to be located in the reactor and control buildings. In DCA Part 2, Tier 2, Section 3.4.1.4 "Flooding Outside the Reactor and Control Buildings," the applicant states that the site is graded to transport water away from those buildings, and therefore, failure of equipment outside the CRB and RXB cannot cause internal flooding.

Based on the above review, the staff finds that the main condenser design complies with GDC 4, because the potential flooding due to a failure to the MC does not result in SSCs important to safety being adversely affected.

The staff also reviewed the design of the MC for compliance with the requirements of GDC 60 with respect to control of release of radioactive materials and GDC 64 with respect to the monitoring of radioactive releases. Compliance with GDC 60 and GDC 64 requires provisions be included in the nuclear power unit design to monitor and control suitably the release of radioactive materials during normal operation, including anticipated operational occurrences (AOOs), and postulated accidents. Meeting these requirements provides a level of assurance that the release of radioactive materials in gaseous and liquid effluents from the main condensers during normal operation, including AOOs, and postulated accidents is kept as low as is reasonably achievable, in accordance with 10 CFR Part 50, Appendix I.

In DCA Part 2, Tier 2, Section 10.4.1.3, "Safety Analysis," the applicant states that the MC is anticipated to contain negligible quantities of radioactive contaminants during power operation and during shutdown. To control the releases of radioactive contaminants, the air and non-condensable gases in the condenser are removed by the condenser air removal system (CARS). There is no buildup of non-condensable gases in the MC during normal operations because the liquid ring vacuum pump operates continuously during operation of the MC.

The applicant also states that the CARS has process radiation monitors on the gaseous effluent lines that discharge to atmosphere capable of detecting radioactivity in the gaseous effluent, and that "[l]eakage from the hotwell is collected and retained by a leakage detection system." Also, if required, operators in the main control room have the ability to manually shut down and isolate the CARS in response to an abnormal plant condition. The review of the CARS radiation monitoring instrumentation and sampling system is covered in Section 11.5, "Process and Effluent Radiation Monitoring Instrumentation and Sampling System," of this report.

SRP, Section 10.4.1, "Main Condenser," Subsection II, "Acceptance Criteria," "SRP Acceptance Criteria," Item 1.B, states that acceptance of GDC 60 is also based on mitigating the potential for explosive mixtures to exist in the MC. Because of the non-condensable gas evacuation provided by the CARS, a negligible amount of dissolved oxygen is present in the condensate and MC hotwell inventory; as such the possibility of an explosion is considerably minimized.

Based on the design information provided in the DCA Part 2, the staff finds that the design satisfies GDC 60 and GDC 64 because gaseous effluents from the MC are processed by the CARS that provides for monitoring and control of the gaseous effluents being released to the atmosphere, and that condenser hotwell leakage is collected and processed by a leakage detection system.

10.4.1.5 *Initial Test Program*

The preoperational test related to the MC for design certification is TGS test (#33), which ensures the various design aspects related to the MC are implemented. This test is performed in accordance with DCA, Part 2, Tier 2, Table 14.2-33. The staff evaluation of the initial test program for the design certification review is documented in Section 14.2 of this report.

10.4.1.6 *ITAAC*

Applicants for standard plant design certification must provide proposed ITAAC necessary to ensure that a plant incorporating the certified design is built and will operate in accordance with

10 CFR 52.47(b)(1). There are no ITAAC required for the MC because it is not safety-related and is not required for safe shutdown. This system is not credited to meet the requirements of GDC 4. Therefore, the staff finds this acceptable in accordance with 10 CFR 52.47(b)(1). ITAAC related to radiation monitoring are discussed in Chapter 11 of the SER.

10.4.1.7 *Technical Specifications*

There are no TS requirements associated with the MC. The system is not safety-related, is not required for safe shutdown, and does not meet a criterion for 10 CFR 50.36 for inclusion in TS. Therefore, the staff finds this acceptable.

10.4.1.8 *Combined License Information Items*

There are no COL Items associated with the MC.

10.4.1.9 *Conclusion*

Based on the review of the MC above, the staff concludes the design is acceptable because it meets the appropriate regulatory requirements as stated under the Regulatory Basis of this section.

10.4.2 Condenser Air Removal System

10.4.2.1 *Introduction*

The staff reviewed DCA Part 2, Tier 2, Section 10.4.2, "Condenser Air Removal System," in accordance with guidance in SRP 10.4.2, "Main Condenser Evacuation System," to ensure the CARS is designed and built to establish and maintain MC vacuum, and to monitor for radioactive material.

10.4.2.2 *Summary of Application*

DCA, Part 2, Tier 1: There are no entries in DCA Part 2, Tier 1 for the CARS.

DCA, Part 2, Tier 2: DCA Part 2, Tier 2, Section 10.4.2 includes the CARS description, as well as relevant information on the CARS design. DCA Part 2, Tier 2, Figure 10.4-2, "Condenser Air Removal System Piping and Instrumentation Diagram," provides a functional arrangement of the CARS. DCA Part 2, Tier 2, Section 11.5.2.1.2, "Condenser Air Removal System," describes the radiation monitoring instrumentation provided at the discharge of the CARS.

ITAAC: No ITAAC are provided in DCA Part 2, Tier 1 for the CARS.

Technical Specifications: There are no proposed TSs associated with the CARS.

Technical Reports: There are no technical reports associated with the CARS.

10.4.2.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review and the associated acceptance criteria are given in SRP 10.4.2 and are summarized below. Review interfaces with other SRP sections are also indicated in SRP 10.4.2, Item I.

- GDC 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to provisions being included in the CARS design to suitably control the releases of radioactive materials in gaseous and liquid effluents during normal operation, including anticipated operational occurrences.

- GDC 64, “Monitoring radioactivity releases,” as it relates to the CARS design for monitoring of releases of radioactive materials to the environment during normal operation, including anticipated operational occurrences and from postulated accidents.

- 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the AEA, and the NRC's regulations.

10.4.2.4 *Technical Evaluation*

The CARS is used to remove air from the MC and, therefore, establishes a vacuum. In order to prevent loss of condenser vacuum, each MC is provided with two 100 percent capacity CARS in parallel. This way, if one system is unavailable due to maintenance or lost during normal operation, the redundant system is started. The CARS are located near each MC in the turbine generator building. The components in the CARS are not shared among other NPMs; therefore, failure of the CARS does not impair the ability of other NPMs to perform their safety functions. A failure of the CARS results in an increase in pressure in the MC to which CARS is connected. The loss of MC vacuum is an AOO and is discussed in DCA, Part 2, Tier 2, Section 15.2.3, “Loss of Condenser Vacuum.”

The staff reviewed DCA Part 2, Tier 2, Section 10.4.2, in accordance with SRP, Section 10.4.2, to ensure compliance with the regulatory requirements listed in Section 10.4.2.3 of this SER.

DCA Part 2, Tier 2, Section 10.4.2.2.3, “System Operation,” provides a general discussion on CARS operation, and DCA Part 2, Tier 2, Section 11.5.2.1.2, provides information on discharge of CARS effluents to the atmosphere and the monitoring and control of those effluents. In DCA Part 2, Tier 2, Section 10.4.2.1, “Design Basis,” the applicant states that the CARS is designed to satisfy GDC 60 and 64 with regard to the control and monitoring of radioactive material releases to the environment.

Upon review of the information in DCA Part 2, Tier 2, Section 11.5.2.1.2, and Table 11.5-1, “Process and Effluent Radiation Monitoring Instrumentation Characteristics,” the staff finds that sufficient monitoring is provided of CARS exhaust to alert system operators of abnormally high levels of radiation in the CARS effluent releases. The applicant states in DCA Part 2, Section 11.5.2.1.2, that “alarm setpoints, control room monitoring capability, and operator response in accordance with site procedures ensures compliance with GDC 60 and 64 and ensures the objectives of 10 CFR 20 and 10 CFR 50 Appendix I are met.” If required, operators in the main control room have the ability to manually shut down and isolate the CARS in response to an abnormal plant condition. The review of the CARS radiation monitoring instrumentation and sampling system is covered in Section 11.5, “Process and Effluent Radiation Monitoring Instrumentation and Sampling System,” of this report.

Based on the above, the staff finds that the sampling and monitoring provisions for the CARS discussed in DCA, Part 2, Tier 2, Section 11.5.2.1.2, meet the requirements of GDC 60 and GDC 64, as they relate to the system design to control and monitor the releases of the radioactive materials to the environment.

In Section 10.4.1.4 of this report, the staff addresses the role of the CARS in minimizing the possibility of an explosion in the MC system because of the continuous non-condensable gas evacuation provided by the CARS, leading to a negligible amount of dissolved oxygen present in the condensate and MC hotwell inventory. As such, the staff finds the CARS plays a key role in the MC design conforming to the requirements of GDC 60.

10.4.2.5 *ITAAC*

Applicants for standard plant design certification must provide proposed ITAAC necessary to ensure that a plant incorporating the certified design is built and will operate in accordance with 10 CFR 52.47(b)(1). There are no ITAAC required for the CARS. The system is not safety-related and was not identified in DCA, Part 2, Tier 2, table 17.4-1 to be risk-significant. Additionally there are no features or functions of the CARS credited for mitigation of design basis events and its operating parameters are not critical to safety analyses.

Compliance with the regulatory basis is based on compliance with 10 CFR 50 Appendix A, GDC 60 and 64. As indicated in DCA, Part 2, Tier 2 Section 11.5.2.1.2, the alarm setpoints, control room monitoring capability, and operator response in accordance with site procedures ensures compliance with GDC 60 and 64.

10.4.2.6 *Technical Specifications*

There are no TS requirements associated with the CARS. The system is not safety-related and is not required for safe shutdown; and does not meet a criterion in 10 CFR 50.36 that would require a TS, therefore, the staff finds this acceptable.

10.4.2.7 *Combined License Information Items*

There are no COL information items associated with the CARS.

10.4.2.8 *Conclusion*

The CARS does not serve any safety-related functions nor is it credited to achieve and maintain safe shutdown conditions. Since the design of the CARS adequately implements the requirements of GDC 60 and 64 for controlling and monitoring of release of radioactive material to the environment, the staff concludes that the applicant has provided reasonable assurance that the CARS will operate as designed and its post-accident failures have no adverse impact on the capability of any safety-related or safe shutdown equipment in the plant to perform their designed functions.

10.4.3 Turbine Gland Sealing System

10.4.3.1 *Introduction*

The staff reviewed DCA, Part 2, Tier 2, Section 10.4.3, in accordance with guidance in SRP, Section 10.4.3. The turbine gland sealing system (TGSS) is designed and built to provide a source of sealing steam to prevent air leakage into the turbine under vacuum and steam leakage out of the turbine under pressure during certain load conditions. The TGSS is part of the turbine generator system (TGS).

10.4.3.2 *Summary of Application*

DCA, Part 2, Tier 1: There are no entries in DCA, Part 2, Tier 1 for the TGSS.

DCA, Part 2, Tier 2: DCA, Part 2, Tier 2, Section 10.4.3, "Turbine Gland Sealing System," includes the TGSS description, as well as relevant information on the TGSS design, including the design bases, instrumentation, and the inspection and testing program. DCA, Part 2, Tier 2, Section 11.5.2.1.3, "Turbine Gland Sealing System," includes a description of the effluent radiation monitoring system for the TGSS.

ITAAC: No ITAAC are provided in the DCA, Part 2, Tier 1 for the TGSS.

Initial Test Program: Preoperational tests related to the TGSS being evaluated as part of the design certification review are described in DCA, Part 2, Tier 2, Section 14.2, "Initial Plant Test Program," Tables 14.2-9 and 14.2-33.

Technical Specifications: There are no proposed TS requirements associated with the TGSS.

Technical Reports: There are no technical reports related to the TGSS.

10.4.3.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review and the associated acceptance criteria are given in NUREG-0800, Section 10.4.3, “Turbine Gland Sealing System,” and are summarized below. Review interfaces with other SRP sections are also indicated in SRP Section 10.4.3.

- GDC 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to the TGSS design for the control of releases of radioactive materials to the environment.
- GDC 64, “Monitoring Radioactivity Releases,” as it relates to the TGSS design for monitoring of releases of radioactive materials to the environment during normal operation, including anticipated operational occurrences and postulated accidents.
- 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the AEA, and the NRC's regulations.

10.4.3.4 *Technical Evaluation*

Sealing steam, supplied from either the auxiliary boiler system or from the main steam system, is distributed to the turbine shaft seals. The gland seal steam prevents the escape of steam from the turbine shaft and casing penetrations and the glands of large turbine valves. At the outer ends of the turbine glands, collection piping routes the mixture of air and excess seal steam to the gland steam condenser. Condensate from the steam-air mixture drains to the MC while non-condensables are vented to the environment. The mixture of non-condensable gases discharged from the gland steam condenser is not normally radioactive; however, in the event of significant primary-to-secondary system leakage due to a steam generator tube failure (SGTF), it is possible to discharge radioactively contaminated gases. The TGSS effluents are monitored by a radiation monitor and grab sample point located on the exhaust line to the gland seal steam vent.

The staff reviewed DCA, Part 2, Tier 2, Section 10.4.3, in accordance with NUREG-0800, Section 10.4.3 to ensure compliance with the regulatory requirements listed in Section 10.4.3.3 of this SER. The applicant stated that the TGSS has no safety-related functions, is not credited for mitigation of a DBA, and has no safe shutdown functions, and therefore, is not required to operate during or after a design basis accident. DCA, Part 2, Tier 2, Section 10.4.3.2.3 provides a general discussion on TGSS operation, and DCA, Part 2, Tier 2, Section 11.5.2.1.3 provides information on discharge of TGSS effluents to the atmosphere and the monitoring and control of those effluents. In DCA, Part 2, Tier 2, Section 10.4.3, “Design Basis,” the applicant states that the TGSS is designed to satisfy GDC 60 and 64 with regard to the control and monitoring of radioactive material releases to the environment.

Upon review of the information in DCA, Part 2, Tier 2, Section 11.5.2.1.3, and Table 11.5-1, "Process and Effluent Radiation Monitoring Instrumentation Characteristics," the staff found that sufficient monitoring is provided of TGSS exhaust to alert system operators of abnormally high levels of radiation in the TGSS effluent releases. The applicant states in DCA, Part 2, Tier 2, Section 11.5.2.1.3, that "system monitoring and operator response in accordance with site procedures ensures that gaseous effluents meet the objectives of 10 CFR 20 and 10 CFR 50 Appendix I prior to being released into the environment, and ensures compliance with GDC 60 and 64." The review of the TGSS radiation monitoring is covered in Section 11.5 of this SER.

Based on the above, the staff finds that the sampling and monitoring provisions for the TGSS discussed in DCA Part 2, Tier 2, Section 11.5.2.1.3, meet the requirements of GDC 60 and GDC 64, as they relate to the system design to control and monitor the releases of the radioactive materials to the environment.

10.4.3.5 *Initial Test Program*

Preoperational tests related to the TGSS for design certification include the ABS test (#9) and TGS test (#33), which ensures the various design aspects related to the TGSS are implemented. These tests are performed in accordance with DCA, Part 2, Tier 2, Tables 14.2-9 and 14.2-33. The staff evaluation of the initial test program for the design certification review is documented in Section 14.2 of this report.

10.4.3.6 *ITAAC*

Applicants for standard plant design certification must provide proposed ITAAC necessary to ensure that a plant incorporating the certified design is built and will operate in accordance with 10 CFR 52.47(b)(1). There are no ITAAC required for the TGSS. The system is not safety-related and is not identified in DCA, Part 2, Tier 2, table 17.4-1 to be risk-significant. Additionally there are no features or functions of the TGSS credited for mitigation of design basis events and its operating parameters are not critical to safety analyses.

The TGSS is designed to support main turbine functional requirements, but has no nuclear safety design basis. Compliance with the regulatory basis is based on compliance with 10 CFR 50, Appendix A, GDC 60 and 64. As indicated in DCA, Part 2, Tier 2 Section 11.5.2.1.3, system monitoring and operator response in accordance with site procedures ensures that gaseous effluents meet the objectives of 10 CFR 20 and 10 CFR 50 Appendix I prior to being released into the environment, and ensures compliance with GDC 60 and 64.

10.4.3.7 *Technical Specifications*

There are no TS requirements associated with the TGSS. The system is not safety-related and is not required for safe shutdown; and does not meet a criterion in 10 CFR 50.36 that would require a TS, therefore, the staff finds this acceptable.

10.4.3.8 *Combined License Information Items*

There are no COL information items associated with the TGSS.

10.4.3.9 *Conclusion*

The staff concludes that the applicant has met the requirements of the applicable regulations as described in the regulatory basis in this Section and provided reasonable assurance that the TGSS will operate as designed and its post-accident failures have no adverse impact on the capability of any safety-related or safe shutdown equipment in the plant to perform their designed functions.

10.4.4 Turbine Bypass System

10.4.4.1 *Introduction*

The staff reviewed DCA, Part 2, Tier 2, Section 10.4.4, in accordance with guidance in SRP 10.4.4. The Turbine Bypass System (TBS) is designed and built to allow passing steam directly from the steam generators to the main condenser in a controlled manner in order to remove heat from a NPM following a reduction or loss of electrical load. The TBS is part of the TGS.

10.4.4.2 *Summary of Application*

DCA, Part 2, Tier 1: There are no entries in DCA, Part 2, Tier 1 for the TBS.

DCA, Part 2, Tier 2: DCA, Part 2, Tier 2, Section 10.4.4, "Turbine Bypass System," includes the TBS description, as well as relevant information on the TBS design, including the design bases, instrumentation, and the inspection and testing program.

ITAAC: No ITAAC are provided in the DCA, Part 2, Tier 1 for the TBS.

Initial Test Program: Preoperational tests related to the TBS being evaluated as part of the design certification review are described in DCA, Part 2, Tier 2, Section 14.2, "Initial Plant Test Program," Tables 14.2-33 and 14.2-70.

Technical Specifications: There are no proposed TS requirements associated with the TBS.

Technical Reports: There are no technical reports related to the TBS.

10.4.4.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review and the associated acceptance criteria are given in SRP, Section 10.4.4, “Turbine Bypass System,” and are summarized below. Review interfaces with other SRP sections are also indicated in SRP Section 10.4.4.

- GDC 4, "Environmental and dynamic effects design basis," as it relates to SSCs important to safety being designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

- 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

10.4.4.4 *Technical Evaluation*

The turbine bypass system allows main steam to flow directly from the steam generators to the main condenser in a controlled manner to remove heat from the NPM following a reduction or loss of electrical load. The TBS has the capacity to bypass the rated power steam flow to the main condenser at full power operation. The TBS total flow capacity, in combination with bypass valve opening time, pressurizer size, and the reactor power control system is sufficient to sustain a rated power normal load rejection (electrical load), without generating a reactor trip, and without requiring actuation of the main steam safety valve.

The staff reviewed DCA, Part 2, Tier 2, Section 10.4.4, in accordance with NUREG-0800, Section 10.4.4 to ensure compliance with the regulatory requirements listed in Section 10.4.4.3 of this SER. The applicant states that the TBS is part of the TGS, has no safety-related function, is not credited for mitigation of a DBA, and has no safe shutdown functions. The applicant also states that the TBS is designed to satisfy GDC 4, and its failure will not affect any SSCs important to safety.

As indicated in DCA, Part 2, Tier 2, Table 3.2-1, the entire system is located inside the turbine building and classified as not safety-related and not risk-significant. The TBS is part of the TGS and, therefore, is also located inside the turbine building. In DCA, Part 2, Tier 2, Section 3.6.2.1.6, the applicant states that there is no essential equipment outside of the reactor or control buildings. As such, the failure of the TBS due to a pipe break or a malfunction of the TBS would not adversely affect SSCs important to safety since none of these are located in the turbine building. For these reasons, the staff agrees that the TBS meets the requirements of GDC 4.

As indicated in DCA, Part 2, Tier 2, Section 10.4.4.1 “Design Bases” the TBS can be used to provide a residual heat removal function for normal NMP shutdown, eliminating the need to rely solely on safety systems or components, however the TBS is not credited for compliance with GDC 34. The decay and residual heat removal safety function per GDC 34 is performed by the decay heat removal system which is a passive design that consist of two independent trains each capable of performing the system safety function in the event of a single failure. The review of the DHRS and compliance with PDC 34 is covered in section 5.4.3 of this SER. Since the DHRS is used to comply with PDC 34, and the TBS is not credited for compliance, the staff finds that GDC 34 is not applicable for this system.

10.4.4.5 *Initial Test Program*

Preoperational tests related to the TBS for design certification includes the TGS test (#33) and hot functional test (#70) which ensure the various design aspects related to the TBS are implemented. These test are performed in accordance with DCA, Part 2, Tier 2, Tables 14.2-33 and 14.2-70. The staff evaluation of the initial test program for the design certification review is documented in Section 14.2 of this report.

10.4.4.6 *ITAAC*

Applicants for standard plant design certification must provide proposed ITAAC necessary to ensure that a plant incorporating the certified design is built and will operate in accordance with 10 CFR 52.47(b)(1). The TBS is not safety-related and was not identified in DCA, Part 2, Tier 2, Table 17.4-1 to be risk-significant. Additionally there are no features or functions of the TBS system credited for mitigation of design basis events and its operating parameters are not critical to safety analyses. Also it is stated in DCA, Part 2, Tier 2, Section 10.4.4.5 that before the TBS is initially placed in service, the turbine bypass valve is tested to verify proper function. Therefore, the staff finds that there are no ITAAC required for the TBS.

10.4.4.7 *Technical Specifications*

There are no TS requirements associated with the CWS. The system is not safety-related and is not required for safe shutdown; and does not meet a criterion in 10 CFR 50.36 that would require a TS, therefore, the staff finds this acceptable.

10.4.4.8 *Combined License Information Items*

There are no COL information items associated with the TBS.

10.4.4.9 *Conclusion*

The TBS does not serve any safety-related functions and is not credited to achieve and maintain safe shutdown conditions. The staff finds that the design of the TBS adequately implements the requirements of GDC 4.

10.4.5 Circulating Water System

10.4.5.1 *Introduction*

The staff reviewed DCA, Part 2, Tier 2, Section 10.4.5, in accordance with SRP, Section 10.4.5, "Circulating Water System." The circulating water system (CWS) is designed and built to facilitate the transfer of heat load from the MC to the cooling towers. The applicant stated that up to six NuScale NPMs share one CWS, with up to two CWS systems per plant.

Portions of the CWS are identified as conceptual design information (CDI) as described in 10 CFR 52.47(a)(24).

10.4.5.2 *Summary of Application*

DCA, Part 2, Tier 1: There are no entries in DCA, Part 2, Tier 1 for the CWS.

DCA, Part 2, Tier 2: DCA, Part 2, Tier 2, Section 10.4.5, "Circulating Water System," includes the CWS description, as well as relevant information on the CWS design, including the design bases, instrumentation, and the inspection and testing program.

ITAAC: No ITAAC are provided in the DCA, Part 2, Tier 1 for the CWS.

Technical Specifications: There are no proposed TS requirements associated with the CWS.

Technical Reports: There are no technical reports related to the CWS.

10.4.5.3 *Regulatory Basis*

The relevant regulatory requirements for this area of review and the associated acceptance criteria are given in NUREG-0800, Section 10.4.5 and are summarized below. Review interfaces with other SRP sections are also indicated in SRP Section 10.4.5.

- GDC 4, as it relates to design provisions provided to accommodate the effects of discharging water that may result from a failure of a component or piping in the CWS.
- GDC 5, as related to sharing of systems and components important to safety such that sharing does not significantly impair their ability to perform required safety functions.
- 10 CFR 52.47(a)(24), which requires that the DCA, Part 2, contain a representative conceptual design for those portions of the plant for which the application does not seek certification, to aid the NRC in its review of the DCA, Part 2, and to permit assessment of the adequacy of the interface requirements in 10 CFR 52.47(a)(25).

- 10 CFR 52.47(a)(25), which requires that the DCA, Part 2, contain interface requirements to be met by those portions of the plant for which the application does not seek certification. These requirements must be sufficiently detailed to allow completion of the DCA, Part 2.

- 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the AEA, and the NRC's regulations.

10.4.5.4 *Technical Evaluation*

The CWS, being the normal heat sink for the NuScale Power Plant, provides a continuous supply of cooling water to the main condensers and rejects heat to the environment. For the 12-NPM design, the CWS is composed of two identical circulating water subsystems, each responsible for delivering cooling water to the main condensers of six condensate and feedwater systems. There is no interconnected piping between the two circulating water subsystems. Three 33 percent capacity circulating water pumps take suction, through a traveling screen, from dedicated CWS pump bays that are connected directly to the cooling tower basin. Continuously moving traveling screens prevent debris from entering the CWS pump bay. The CWS uses a cooling tower arrangement to reject heat to the atmosphere. Each tower is sized to support the full-power operation of up to six NPMs.

In DCA, Part 2, Section 10.4.5.3, "Safety Evaluation," the applicant states that the CWS serves no safety-related functions, is not credited for mitigation of a design basis accident, and has no safe shutdown functions. Furthermore, the applicant also states that "a failure of the CWS that releases the water inventory and the resulting flooding does not prevent the operation of a safety-related system because no such systems are located in the Turbine Generator Buildings (TBGs)." The staff, however, is concerned about flood water from the CWS piping failures, both internally and externally of the TGBs, impacting safety-related or SSCs important to safety elsewhere on site. Therefore, in an RAI 8878 dated July 21, 2017 (ML17202G701), the staff asked the applicant to provide additional information to demonstrate how the NuScale design ensures discharged water from CWS failures are channeled away from all structures/buildings containing safety-related or SSCs important to safety. In the response dated September 19, 2017 (ML17262B208), the applicant states that "the reactor building (RXB) and control building (CRB) are the only safety-related buildings on a NuScale site," and "Section 3.4.1.4 notes that flooding of the RXB or CRB caused by external sources does not occur and that failure of equipment outside the CRB and RXB cannot cause internal flooding." Additionally, the applicant indicated that a COL applicant is required to demonstrate the site is properly graded to prevent localized flooding as discussed in DCA, Part 2, Tier 2, Table 2.0-1, under the Hydrologic Engineering subsection. Based on the above RAI response and upon further review of the referenced section and table, the staff concludes that the applicant adequately addressed the issue related to the potential impact on safety-related or SSCs important to safety due to CWS failures per GDC 4.

Since a single CWS is shared by up to six NPMs, the staff also reviewed the design of the CWS for compliance with the requirements of GDC 5 with respect to shared systems. Compliance with GDC 5 requires provisions be included in the nuclear power unit design to ensure an event with one NPM does not significantly impair any other NPM units' ability to perform their safety functions, including the ability to safely achieve and maintain safe shutdown. The applicant stated in DCA, Part 2, Tier 2, Section 10.4.5.2.3, that although each loop of the CWS is shared by six NPMs, a trip to one of the NPM served by the CWS does not impair the other five NPMs to perform their safety functions. If a CWS were to fail, however, it would require all six NPMs tied to that CWS to be shut down from normal operation.

Since the CWS interfaces with the MC, the staff also reviewed the design of the CWS for compliance with the requirements of GDC 60 and GDC 64 with respect to the control and monitoring of radioactive material releases to the environment. Compliance with GDC 60 and GDC 64 requires provisions be included in the nuclear power unit design to monitor and control suitably the release of radioactive materials during normal operation, including AOOs and from accidents. Meeting these requirements provides a level of assurance that the release of radioactive materials in gaseous and liquid effluents from the CWS during normal operation, including AOOs, is kept as low as is reasonably achievable, in accordance with 10 CFR Part 50, Appendix I. DCA, Part 2, Tier 2, Subsection 10.4.5.3 states that "the CWS is anticipated to contain negligible quantities of radioactive contaminants during power operation and during shutdown." Furthermore, the applicant states that "in the event of a SG tube leak, radioactive fluid would infiltrate the secondary loop, which would be detected in the main steam system (MSS). There would have to be a simultaneous failure of the SG tubes and MC tube leak for radiation to leak into the CWS. However, during normal operation the CWS is kept at higher pressure than the condenser shell side, which keeps the leakage into the condenser rather than to the environment. Grab sample locations are checked and blowdown is monitored for radiation." Based on the above, the staff finds the CWS design is in compliance with GDC 60 and GDC 64, because provisions have been made to reduce the potential release of radioactive material associated with CWS as low as reasonably achievable.

The SRP 10.4.5, Section III.2 states that CWS design should have the capability to detect leaks and to secure the system quickly and effectively. In the review of DCA, Part 2, Tier 2, Section 10.4.5, the staff was unable to find information addressing the CWS capability of detecting and controlling leaks; therefore, the staff issued an RAI 8878 dated July 21, 2017 (ML17202G701) asking the applicant to provide additional information to demonstrate leakage in the CWS can be detected and controlled effectively. In the response dated September 19, 2017 (ML17262B208), the applicant states that "even if CWS leakage were to occur and progress undetected to the level of flooding, since the TB contains no safety-related systems or components there is not a possibility that a safety-related structure, system, or component (SSC) will be affected." The applicant also proposed a revision to DCA, Part 2, Tier 2, Section 10.4.5.3, to state that "large CWS leaks due to pipe failures will be indicated in the control room by a loss of MC vacuum. MC vacuum is a parameter that is monitored during normal operation (Section 10.4.2.2.3).” The staff finds the additional information provided by the applicant in the above RAI response adequately addressed the staff’s concern.

DCA, Part 2, Tier 2, Figure 1.2-3, “Schematic of a Single NuScale Power Module and Associated Secondary Equipment,” identifies several components of the CWS. The staff notes that the cooling tower and its associate pump are identified as CDI. DCA, Part 2, Tier 2, Table 1.8-1, “Summary of NuScale Certified Design Interfaces with Remainder of Plant,” indicates that the cooling towers, pump houses, and associated SSCs (e.g., cooling tower basin, circulating water pumps, cooling tower fans, chemical treatment building, etc.) are CDI. The staff finds that while CDI is necessary to provide context for interface requirements, as specified in 10 CFR 52.47(a)(24) and (a)(25), such information is outside the scope of the certified design, and therefore, not reviewed by the staff as part of this design review. Instead a future COL applicant must provide the necessary plant-specific information related to the conceptual design portion of the system, at which time the staff will perform the review on the site-specific CWS design. The applicant has properly identified CDI design information for the CWS in DCA, Part 2, Tier 2, Table 10.4-9, “Circulating Water System Design Parameters.”

10.4.5.5 *ITAAC*

Applicants for standard plant design certification must provide proposed ITAAC necessary to ensure that a plant incorporating the certified design is built and will operate in accordance with 10 CFR 52.47(b)(1). The CWS system is not safety-related and was not identified in DCA, Part 2, Tier 2, Table 17.4-1 to be risk-significant. Additionally there are no features or functions of the CWS system credited for mitigation of design basis events and its operating parameters are not critical to safety analyses. Therefore, the staff finds that no ITAAC are required for the CWS.

10.4.5.6 *Technical Specifications*

There are no TS requirements associated with the CWS. The system is not safety-related and is not required for safe shutdown; and does not meet a criterion in 10 CFR 50.36 that would require a TS, therefore the staff finds this acceptable.

10.4.5.7 *Combined License Information Items*

There are no COL Items associated with the CWS.

10.4.5.8 *Conclusion*

The CWS does not serve any safety-related functions nor is credited to achieve and maintain safe shutdown conditions. Since the design of the CWS adequately implements the requirements of GDC 4, 5, 60, and 64, the staff concludes that the applicant provided reasonable assurance that the CWS will operate as designed and its post-accident failures have no adverse impact on the capability of any safety-related or safe shutdown equipment in the plant to perform their designed functions.

10.4.6 Condensate Polishing System

10.4.6.1 *Introduction*

The staff reviewed DCA Part 2, Section 10.4.6 in accordance with NUREG-0800, “Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” (SRP) Section 10.4.6, “Condensate Cleanup System,” Revision 3. SRP Section 10.4.6 references SRP Section 5.4.2.1, “Steam Generator Materials and Design,” Revision 4, to provide the specific acceptance criteria to ensure the requirements of GDC 14 are met as they related to PWR secondary water chemistry.

DCA Part 2, Tier 2, Section 10.3.5 describes the secondary water chemistry, but its evaluation is included under Section 10.4.6 of this SER because the CPS is one of the principal means of affecting secondary water chemistry control and the staff has indicated it accordingly in SRP Section 10.4.6.

The Condensate Polishing System (CPS) is designed to clean and treat feedwater in order to remove corrosion products and ionic impurities. The CPS also provides the capacity to treat feedwater during plant startup, and during a condenser leak that may contaminate the CFWS. The CPS provides condensate cleanup capability and maintains condensate quality through filtration and ion exchange. It does not perform a safety-related function. Also discussed in this section is secondary plant water chemistry as described in DCA, Part 2, Tier 2, Section 10.3.5, “Water Chemistry.”

10.4.6.2 *Summary of Application*

DCA, Part 2, Tier 1: No Tier 1 information is provided in the NuScale DCA, Part 2, for this system.

DCA, Part 2, Tier 2: The applicant provided a design description in DCA, Part 2, Tier 2 Section 10.4.6, “Condensate Polishing System,” which is summarized here in part:

- The CPS is designed with two 100 percent redundant mixed-bed deionizers to remove ionic impurities from the condensate and feedwater system during plant startup, operations, and shutdown. The CPS is supported by the condensate polisher resin regeneration system. This restores the resin quality to polisher requirements for reuse. A condensate bypass valve is provided to bypass the condensate purification when not needed. The CPS consists of the following components: two condensate inlet filters, mixed-bed ion exchanger vessels, resin filters, spent-resin tanks, resin supply tanks, resin replacement equipment, and instrumentation.

The DCA, Part 2 states that the secondary water quality requirements are based on the Electric Power Research Institute (EPRI) “Pressurized Water Reactor Secondary Water Chemistry Guidelines,” (EPRI Guidelines) Revision 7, February 17, 2009, as well as NEI 97-06, “Steam Generator Program Guidelines,” Revision 3, dated January 2011. In addition, the DCA, Part 2, provides certain parameters that will be controlled under the secondary water chemistry program as well as the acceptable limits for these parameters. The DCA, Part 2, also describes that an all-volatile treatment amine will be used for pH control, and that hydrazine will be added to scavenge dissolved oxygen. In addition, the DCA, Part 2, provides sampling parameters for the constituents to be monitored. The applicant also provided TS 5.5.5, “Secondary Water Chemistry Program,” to monitor and control the secondary water chemistry.

The CPS is designed to contain two 100 percent flow filters upstream of the condensate polishers. The CPS is also designed to have two 100 percent redundant polisher trains. The condensate polishers are mixed bed deionizers and will provide the capacity needed to maintain the secondary water chemistry requirements in DCA, Part 2, Section 10.3.5. The CPS will contain instrumentation to measure system performance and take samples of the parameters to be monitored.

The CPS components that will be exposed to wet steam, flashing liquid flow, or turbulent single phase flow where significant loss of material could occur will be constructed with corrosion, erosion, and flow-accelerated corrosion resistant materials.

ITAAC: There are no ITAAC specific to the CPS.

Initial Test Program: “Primary and Secondary System Chemistry Test #79,” in DCA, Part 2, Tier 2, Section 14.2, Table 14-79, related to this system is evaluated as part of the certified design review in Section 14.2, “Initial Test Program,” of this report.

Technical Specifications: The proposed TS associated with DCA Part 2, Tier 2, Section 10.4.6, located in DCA, Part 4, TS 5.5.5, “Secondary Water Chemistry Program,” provides program requirements for monitoring secondary water chemistry.

10.4.6.3 *Regulatory Bases*

The relevant requirements of the Commission's regulations for this area of review, and the associated acceptance criteria, are summarized below.

- 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 plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations.

- GDC 14, “Reactor Coolant Pressure Boundary,” in Appendix A to 10 CFR Part 50, requires that the reactor coolant pressure boundary (RCPB) be designed, fabricated, erected, and tested to ensure an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture.

Acceptance criteria adequate to meet the above requirements are given in SRP Section 10.4.6, Branch Technical Position (BTP) 5-1, “Monitoring of Secondary Side Water Chemistry in PWR Steam Generators,” Revision 3, and SRP Section 5.4.2.1.

10.4.6.4 *Technical Evaluation*

10.4.6.4.1 Secondary Water Chemistry

Secondary water chemistry is focused on preventing corrosion in SGs, condensers, piping, and other equipment. Principal parameters that must be controlled are impurity ion concentrations, including sodium (Na+), chloride (Cl-), and sulfate (SO4-2) ions, pH, and dissolved oxygen.

The staff reviewed the information provided in DCA, Part 2, Tier 2, Sections 10.3.5, “Secondary Water Chemistry,” Revision 1 and 10.4.6, “Condensate Polishing System,” Revision 1, as well as the supplemental letter dated December 15, 2017 (ML17349A838), against the requirements of GDC 14. GDC 14 is applicable to the CPS since the system is designed to maintain water quality and to avoid corrosion-induced failure of the RCPB, specifically the SG tubing. As described in SRP Section 10.4.6, an acceptable method of compliance with GDC 14 with respect to an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture of the RCPB is for the applicant to meet the guidelines in the latest version of the EPRI report series, “PWR Secondary Water Chemistry Guidelines” (EPRI Guidelines)(ML11220A116).

The EPRI Guidelines provide several criteria for the secondary water chemistry control program including sampling frequency and other sampling requirements, guidelines for continuously monitoring water chemistry parameters, and operating limits for impurities and additives, as well as associated action responses to be carried out if limits are exceeded. Although the staff does not formally review or issue a SE of the various EPRI water chemistry guidelines (including the PWR Secondary Water Chemistry Guidelines), these guidelines are recognized as representing the industry’s best practices in water chemistry control. Extensive experience in operating reactors has demonstrated that following the EPRI Guidelines minimizes the occurrence of corrosion-related failures. Further, the EPRI Guidelines are periodically revised to reflect evolving knowledge with respect to best practices in chemistry control. Therefore, the staff accepts the use of the EPRI Guidelines as the basis for the NuScale secondary side water chemistry program.

DCA, Part 2, Tier 2 Section 10.3.5, “Water Chemistry,” addresses the water chemistry quality requirements for steam generator water and feedwater. In particular, Tables 10.3-3a, “Steam Generator [SG] (Reactor Coolant System [RCS] ≤ 200^{o}F),” 10.3-3b, “Feedwater Sample

(Reactor Coolant System > 200 °F to <15% reactor power)," 10.3-3c, "Feedwater Sample (≥15% reactor power)," and 10.3-3d, "Condensate Sample (≥15% reactor power)," provide the normal values for certain secondary water chemistry parameters.

The NRC staff reviewed the information provided in DCA, Part 2, Tier 2, Section 10.3.5, "Water Chemistry," to determine if the applicant's proposed secondary water chemistry parameters provide reasonable assurance that the requirements of GDC 14 will be met. The staff compared the parameters monitored, locations of monitoring, and the conditions while monitoring to the values provided in the EPRI Guidelines. Based on this review, the staff has determined the water chemistry parameters provided by the applicant are consistent with the parameters that are given in the EPRI Guidelines. Because the applicant has proposed maintaining secondary water chemistry constituents at values that are within the EPRI Guidelines, the NRC staff has determined that the constituent limits for the NuScale secondary water chemistry are acceptable to provide the necessary purity of the secondary water.

The applicant stated that the COL applicant will be responsible for developing action levels for its site-specific water chemistry control program. The applicant also provided COL Item 10.3-1 which requires the COL applicant to develop a site-specific water chemistry control program based on the latest revision of the EPRI PWR Secondary Water Chemistry Guidelines and NEI 97-06 at the time of the COL application. As part of COL Item 10.3-1 the site-specific water chemistry control program will incorporate the appropriate aspects (i.e. the "Mandatory," "Shall," and "Recommended" elements) of the EPRI Guidelines, including, but not limited to, Action Levels and the associated required actions. This material will be provided as part of the COL Item at the time of the COL application for the NRC staff's review. The staff finds this acceptable because it is appropriate to develop this information as part of a site-specific application. This information will allow the staff to determine whether aspects of the secondary water chemistry control program not contained in the DCA Part 2 such as Action Levels and the associated required actions, meet the EPRI Guidelines.

As stated in DCA, Part 2, Tier 2, Section 10.3.5.1.2, "Water Chemistry Treatment and Monitoring," an all-volatile treatment amine, such as ammonium hydroxide, is used as a pH controller, and hydrazine is added to control dissolved oxygen. The NRC staff finds this acceptable because these chemicals are commonly added to secondary water in order to control pH, and dissolved oxygen. In addition, the use of these treatments is also discussed in the EPRI Guidelines.

In addition to providing suitable water quality to prevent corrosion-induced failure of the RCPB, adequate instrumentation and sampling must be provided to verify the effectiveness of the CPS in order to meet GDC 14 and the guidance of SRP Section 10.4.6. Concentrations are monitored using continuous analyzers (supplemented by grab samples), as described in DCA, Part 2, Tier 2, Section 9.3.2, "Process and Post-Accident Sampling Systems." The continuous monitors identified in this section are consistent with the EPRI Guidelines. The staff finds the instrumentation and sample points provided are acceptable, because they meet those recommended by the EPRI Guidelines.

The staff has determined the monitoring and control of secondary water chemistry is acceptable based on the applicant having met the applicable sections of the EPRI Guidelines, with respect to maintaining acceptable chemistry control for PWR secondary coolant during normal operation and anticipated operational occurrences, thereby reducing the likelihood and magnitude of reactor piping failures and of primary-to-secondary coolant leakage.

10.4.6.4.2 Condensate Cleanup Capacity

In Table 10.4-15, “Condensate Polishing System Instrumentation,” the applicant lists the instrumentation equipment as well as the parameters monitored by the equipment. This table provides monitoring equipment for differential pressure over the CPS filter, a flow meter for CPS inlet flow, and a temperature transmitter to detect the inlet condensate temperature, among other monitoring equipment. SRP Section 10.4.6 recommends that the CPS, “contains adequate instrumentation to monitor the effectiveness of the system.” The NRC staff determined that the instrumentation available to measure pressure drop and flow across the CPS will be able to monitor the CPS filter for potential clogging, or other issues, that could impact the effectiveness of the CPS. In addition, the staff determined that the inlet temperature transmitter would be able to detect if the condensate temperature was hotter than the design temperature of the CPS resin. Combined with the alarms for CPS high inlet temperature, and inlet filter high pressure differential shown in Table 10.4-16, “Condensate Polishing System Alarms,” the staff has reasonable assurance that the monitoring equipment and alarms described will be adequate to monitor the effectiveness of the CPS.

The CPS purifies secondary water by passing it through mixed-resin (cation and anion) deionizers. The CPS has two 100 percent redundant mixed-resin deionizers that have connections for resin transfer, condensate rinse, sampling, and drainage to balance of plant drains. COL Item 10.4-1 states that a COL applicant will determine the size and number of new and spent resin tanks for the CPS. The NRC staff has reasonable assurance that the CPS will have an adequate amount of capacity to maintain secondary water chemistry conditions based on the design capacity of the deionizers. The staff finds the COL Item acceptable because it is appropriate to develop information related to the size and number of resin tanks for the CPS as part of a site-specific application.

In DCA, Part 2, Section 10.4.6, the applicant states that design features will be in place to limit contaminants in the secondary water to allowable values until the CFWS is isolated in the case of a condenser tube leak. Additionally, the applicant has provided the allowable values for the secondary water chemistry constituents in Section 10.3.5, which are consistent with secondary water chemistry parameters in the EPRI Guidelines. The applicant has stated that contaminants resulting from small to moderate leakage will be removed by the condensate polishers. However, if there is a severe main condenser tube leak, it may necessitate a reactor trip and bypass of the CPS in order to prevent contaminants from being transported to the steam generators. These actions combined with the limits set by the secondary water chemistry control program provide the NRC staff reasonable assurance that contaminant concentrations are held to the values in Section 10.3.5 until corrective action is taken.

SRP Section 10.4.6 recommends that the CPS system be connected to radioactive waste disposal systems to allow disposal of spent resin or regenerant solutions when necessary. DCA, Part 2, Tier 2, Section 10.4.6.2.3 states that CPS regenerant waste will be discharged to the Balance-of-Plant Drain System to be monitored for contamination, and DCA, Part 2, Tier 2, Section 11.4.2.2 states that condensate polishing resin may be transferred to the Solid Radioactive Waste System (SRWS) via high integrity containers or other suitable containers. The staff finds this acceptable as the CPS is connected to radioactive waste disposal systems. The staff's evaluations of the Liquid Waste Management System, and the Solid Waste Management System are documented in Sections 11.2, and 11.4 of this report.

10.4.6.4.3 CPS Materials of Construction

In DCA, Part 2, Tier 2, Section 10.4.6.2.1, the applicant states that, "Corrosion, erosion, and flow-accelerated corrosion resistant materials are used for components exposed to wet steam, flashing liquid flow, or turbulent single phase flow where loss of material could occur." The applicant also states that these materials will be used consistent with the specific fluid conditions and that for carbon steel piping used in the CFWS there will be a corrosion allowance. Additionally, the applicant states that the CPS is Quality Group D, ASME B31.1. In ASME B31.1 there are requirements for the design, materials, fabrication, erection, test, inspection, operating, and maintenance of piping systems and associated components.

Because corrosion resistant materials will be used, and because it will be built to standards which provide appropriate guidance for selecting materials of construction, the staff has reasonable assurance the CPS materials of construction will be compatible with the service environment and allow the system to serve its function. Additionally, the water chemistry parameters provided in Section 10.3.5 provide reasonable assurance that the service conditions will help to limit corrosion and preserve the integrity of the materials used to construct the CPS.

10.4.6.5 *ITAAC*

There are no ITAAC for this system. The CPS contributes to compliance with GDC 14 by helping to maintain water chemistry conditions that prevent degradation of the secondary coolant system, which includes the RCPB in the steam generators. The CPS is not part of the RCPB, and therefore does not directly support compliance with GDC 14. Preoperational testing will demonstrate, to the extent practicable, that the CPS meets its performance requirements. Therefore, the staff finds it acceptable that there are no ITAAC for this system, in accordance with 10 CFR 52.47(b)(1).

10.4.6.6 *Initial Test Program*

Preoperational test "Primary and Secondary System Chemistry Test (Test #79)," in DCA, Part 2, Tier 2, Section 14.2, Table 14.2-79, which is related to the CPS, is evaluated as part of the design certification review in Section 14.2, "Initial Test Program" of this report.

10.4.6.7 *Technical Specifications*

DCA Part 2, Tier 2, Chapter 16, "Technical Specifications," contains certain requirements for the NuScale Generic Technical Specifications. However, DCA Part 4, "Generic Technical Specifications," contains the individual technical specifications, including TS 5.5.5, "Secondary Water Chemistry Program." This TS provides an administrative program for the monitoring and control of secondary water chemistry in order to inhibit steam generator tube degradation. The staff reviewed the TS for monitoring controls for the secondary water chemistry program for its applicability to the CPS and secondary water chemistry program.

The staff determined that the TS appropriately addresses control and monitoring of secondary water chemistry through the administrative secondary water chemistry program. The staff evaluation of the Technical Specifications is located in Chapter 16 of this SER.

10.4.6.8 *Table of COL Information Items*

Table 10.4.6-1 lists COL information item numbers and descriptions related to Condensate Polishing System, from DCA, Part 2, Tier 2, Sections 10.3.5.1 and 10.4.6.2.2

NuScale Combined License Information Items for Section 10.4.6

Item No.	Description	DCA, Part 2, Tier 2 Section
COL Item 10.3-1	A COL applicant that references the NuScale Power Plant design certification will provide a site-specific chemistry control program based on the latest revision of the EPRI Pressurized Water Reactor Secondary Water Chemistry Guidelines and Nuclear Energy Institute (NEI) 97-06 at the time of the COL application.	10.3.5.1
COL Item 10.4-1	A COL applicant that references the NuScale Power Plant design certification will determine the size and number of new and spent resin tanks in the condensate polishing system.	10.4.6.2.2

The applicant proposes two COL items as described in the table above. The COL items describe site-specific features of the CPS and the plant secondary water chemistry control program.

10.4.6.9 *Conclusion*

Based on the NRC staff's review of the CPS, the staff has determined that the CPS includes the necessary components and equipment to remove dissolved and suspended impurities from the condensate. Based upon the staff's review of the applicant's proposed design criteria and bases for the CPS and the criteria for operation of the system, the staff concludes that the design of the system is acceptable and meets the applicable requirements as stated in the Regulatory Basis section above. Additional details of the secondary side water chemistry will be provided by the COL applicant as stated in COL Item 10.3-1 and must comply with the latest version of the EPRI Guidelines.

10.4.7 Condensate and Feedwater System

10.4.7.1 *Introduction*

The CFWS provides feedwater at the required temperature, pressure, and flow rate to the SGs. Condensate is pumped from the main condenser hotwell by the condensate pumps, passes through condensate polishing system (CPS), the gland steam condenser, the low- and intermediate-pressure feedwater heaters to the feedwater pumps, and then is pumped through the high-pressure feedwater heaters into the tube side of the helical coil steam generator. Each NPM is supplied with a separate CFWS, not shared with other NPMs.

The NuScale DCA, Part 2, describes the CFWS boundaries as extending from the main condenser to the flange immediately upstream of the steam generator feedwater isolation valve (FWIV). NuScale has not included as part of the CFWS, the portions of the system between the steam generator and the SG feedwater isolation valve (FWIV) which functionally serve as part of the CFWS. In this evaluation of the CFWS, the staff considers the portion of the system from the SG to the SG FWIV as part of the CFWS per guidance in DSRS 10.4.7.

10.4.7.2 *Summary of Application*

DCA, Part 2, Tier 1: The Tier 1 information concerning SSCs associated with the operation of the condensate and feedwater system is found in Tier 1, Table 2.8-1, "Module Specific Mechanical and Electrical/I&C Equipment," under the title, "Condensate and Feedwater System." Design Information is included for the feedwater regulating valve and their position indicating transmitters, and for the feedwater supply check valves.

DCA, Part 2, Tier 2: DCA, Part 2, Tier 2, Section 10.4.7, "Condensate and Feedwater System," provides a complete description of the CFWS. Information provided includes the CFWS design bases, system descriptions, component descriptions, system operation, safety evaluation, and information on inspection and testing of the CFWS.

In DCA, Part 2, Section 10.4.7.2, "System Description," the applicant states that the CFWS is not safety-related and is primarily located within the turbine generator building (TGB) and RXB, with the exception of some piping and the condensate storage tank (CST) located outside. It also states that downstream of the FWIVs, each feedwater line penetrates the containment vessel (CNV) top head through separate CNV feedwater nozzles and that inside the CNV, each feedwater line is divided into two feedwater lines that connect to the respective SG. The redundant decay heat removal system (DHRS) return lines connect to each feedwater line upstream of the junction for the SG inlet lines inside the CNV.

ITAAC: There are no ITAAC for the entire CFWS shown in Tier 1; however, in DCA, Part 2, Tier 1, Section 2.8, “Equipment Qualification,” the applicant proposes ITAAC for the following CFWS equipment: the feedwater supply check valves, the FWIV, and the feedwater regulating valve (FWRV).

Technical Specifications: The TS associated with the CFWS are given in DCA, Part 2, Tier 2, Chapter 16, Section 3.7.2.

Technical Reports: There are no technical reports related to the CFWS.

10.4.7.3 *Regulatory Basis*

The relevant requirements for this area of review and the associated acceptance criteria are given in Section 10.4.7, “Condensate and Feedwater System,” of the NuScale DSRS, and are summarized below. Review interfaces with other SRP sections are also indicated in DSRS Section 10.4.7.

- GDC 2 from 10 CFR 50, Appendix A, as related to important to safety portions of the CFWS designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

- GDC 4 as related to the dynamic effects associated with possible fluid flow instabilities (e.g., water hammer) during normal plant operation, as well as during upset or accident conditions.

- GDC 5 as related to sharing of systems and components important to safety such that sharing does not significantly impair their ability to perform required safety functions.

- GDC 44 as related to:

  - The capability to transfer heat loads from the reactor system to a heat sink under both normal operating and accident conditions.

  - Redundancy of components so that under accident conditions, the safety functions can be performed assuming a single active component failure. (This may be coincident with the loss of offsite power for certain events.)

    - The capability to isolate components, subsystems, or piping if required so that the system safety function will be maintained.

- GDC 45 as related to design provisions to permit periodic in-service inspection of system components and equipment.

- GDC 46 as related to design provisions to permit appropriate functional testing of the system and components to ensure structural integrity and leak-tightness, operability and performance of active components, and capability of the integrated system to function as intended during normal, shutdown, and accident conditions.

- 10 CFR 20.1406, “Minimization of Contamination,” as it relates to the design features that will facilitate eventual decommissioning and 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 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the AEA, and the NRC’s regulations.

10.4.7.4 *Technical Evaluation*

The staff reviewed the CFWS described in the DCA, Part 2, in accordance with the review procedure in DSRS Section 10.4.7, Condensate and Feedwater System,” Revision 0. As indicated in the section 10.4.7.1 above, the applicant’s description of the CFWS boundaries is not consistent with the CFWS boundaries described in DSRS Section 10.4.7. Thus, SSCs that are functionally part of the CFWS are not identified as part of the CFWS in the DCA, Part 2. The staff performed its review based on the system boundaries identified in the DSRS. Use of the DSRS system boundaries ensures that the SSCs that are functionally part of the CFWS and located inside the RXB and containment are properly designed to ensure that they perform their safety-related functions under all normal and accident conditions, and that their failure will not adversely impact other important to safety SSCs. The results of the staff’s review are provided below.

10.4.7.4.1 GDC 2, “Design basis for protection against natural phenomena”

The staff reviewed the CFWS for compliance with the requirements of GDC 2, which are based on adherence to Position C.1 of RG 1.29, “Seismic Design Classification,” for the safety-related portion of the system, and Position C.2 for the portions of the system that are not safety-related.

Regulatory Guide 1.29, Position C.1.f states that the pertinent quality assurance requirements of Appendix B to 10 CFR 50 shall apply to all activities affecting the safety-related function of those portions of the steam and feedwater systems of PWRs extending from and including the secondary side of the steam generator up to and including the outmost containment isolation valves, and connecting piping of a nominal size of 2.5 inches or larger, up to and including the first valve that is either normally closed or capable of automatic closure during all modes of normal operation.

NuScale DCA, Part 2, Section 10.4.7.2, “System Description,” states that the CFWS is not safety-related and is primarily located within the Turbine Generator Building (TGB) and RXB, with the exception of some piping and the condensate storage tank (CST) located outside. Since the CFWS provides feedwater to the steam generators, which are integral to the reactor module, the CFWS penetrates the reactor containment and has piping located inside containment. The applicant states in DCA, Part 2, Section 10.4.7.2.1 that “the containment penetrating systems are divided into three portions: internal to containment, the containment and safety-related isolation valve(s), and the nonsafety-related portion external to the NPM.” The applicant also indicates that the three portions of the system are shown on DCA, Part 2, Tier 2, Figure 10.1-1.

The staff reviewed DCA, Part 2 Figure 10.1-1 and confirm that SSCs important to safety, including the feedwater isolation and check valves as well as the regulating valves and the spool piece from which the system is disconnected from during refueling, are all designed to seismic category I, and thus comply with Position C.1 of RG 1.29.

DCA, Part 2, Tier 2, Section 3.2, “Classification of Structures, Systems and Components,” categorizes SSCs based on safety importance and other considerations. The location, safety classification and seismic category for the CFWS are given in DCA, Part 2, Tier 2, Table 3.2-1. All of the CFWS SSCs located in the TGB are listed as nonsafety-related, quality group D, and seismic category III, except for the feedwater regulating valves, feedwater supply check valves and the feedwater regulating valve limit switch, which are seismic category I.

DCA, Part 2, Tier 2, Figure 10.1-1, identifies the feedwater piping from the CIVs to the disconnect flange outside of containment as being seismic category I, and the portion of the system beyond the seismic anchor located at the exit from the reactor building as seismic category III, which the staff finds to in be in compliance with positions C.1 and C2 of RG 1.29.

The feedwater SSCs inside containment includes the feedwater supply to the steam generators and DHRS heat exchangers feedwater isolation valves (FWIVs), and feedwater supply piping inside containment. These SSCs are classified as seismic Category I in Table 3.2-1. In addition the feedwater regulating and feedwater supply check valves located inside the reactor building are also classified as seismic Category I in Table 3.2-1. The classification of these SSCs is consistent with the guidance provided in Position C.1 of RG 1.29, and therefore considered appropriate. Also, the feedwater piping from the CIVs to the seismic anchor located at the exit from the reactor building is seismic category I, and the portion of the system beyond the seismic anchor at the exit from the reactor building is seismic Category III, which the staff finds to be in compliance with positions C.1 and C2 of RG 1.29.

Based on the above discussion, the staff concludes that the CFWS, as described in the DCA, Part 2, complies with the requirements of GDC 2.

10.4.7.4.2 GDC 4," Environmental and dynamic effects design bases

The staff reviewed the condensate and feedwater system for compliance with the requirements of GDC 4, "Environmental and dynamic effects design bases," as related to dynamic effects associated with possible fluid flow instabilities including water hammer and effects of pipe breaks. Compliance with the requirements of GDC 4 is based on identification of SSCs important to safety that need to be protected from dynamic effects, including internally and externally generated missiles, pipe whip and jet impingement due to high and moderate energy missiles and water hammer.

The CFWS containment isolation valves perform the safety-related function of containment isolation. The FWIVs provides for isolation of feedwater and support DHRS operation by providing isolation of DHRS from the CFWS. DCA, Part 2, Tier 2, Section 10.4.7.3 states that GDC 4 was considered in the design and arrangement of the CFWS and that internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks do not prevent the CFWS from performing safety functions. It also states that isolation backup portions of the CFWS are protected from pipe whip and jet impingement forces resulting from breaks in nearby systems (including the CFWS of adjacent NPMs) by the piping design layout and that portions of the CFWS are physically separated from safety-related systems in the RXB and have no adverse impacts on safety functions. The feedwater regulating valves, feedwater supply check valves, feedwater regulating valve accumulators and feedwater regulating valve limit switches are located in the reactor building, which provide protection from externally generated missiles.

The applicant addresses water hammer prevention in DCA, Part 2, Tier 2, Section 10.4.7.3, by stating that the potential for water hammer in the CFWS is minimized by design features such as pipe slope, the use of available drains before startup, and adjustment of valve closure timing. The staff notes that, in addition to design consideration, effective water hammer prevention is accomplished through the combination of design and accompanying maintenance and operation programs to prevent water hammer. The DCA, Part 2, does not include instructions for the COL applicant to develop the operating and maintenance procedures to assure water hammer occurrences are minimized; therefore, the staff requested in RAI 9122, Question 10.04-07-3, that the applicant include a COL item to have the COL applicant address the development of maintenance and operating procedures that address water hammer prevention in the CFWS.

In its response to RAI Question 10.04-07-3, the applicant did not add a COL item to ensure that procedures developed would address water hammer. The applicant instead stated that DCA, Part 2, Tier 2, Section 3.6.3.1.4 indicates that "The feedwater system (FWS) and steam generator (SG) contain design features and operating procedures that minimize the potential for and effect of water hammer," and that "DCA, Part 2, Section 13.5, "Plant Procedures," states that "Administrative and operating procedures are utilized by the operating organization (plant staff) to ensure that routine operating, off-normal, and emergency activities are conducted in a safe manner."

The staff reviewed Section 13.5 of the NuScale DCA, Part 2, Tier 2, and found it did not identify water hammer prevention as an objective for maintenance and operating procedures. The staff also reviewed information referenced in DCA, Part 2, Section 13.5, in particular, RG 1.33, and ANSI/ANS 3.2-12. The regulatory guidance provided in these documents does not specify that water hammer prevention measures are to be included in procedure developed for water systems. Additionally, as indicated in NUREG 0927, "Evaluation of Water Hammer Occurrence in Nuclear Power Plants," Section 2.4.7, "Operating and Maintenance Procedures," the potential for water hammer is generally not considered in either procedure writing or review. Therefore, the applicant's response failed to adequately address the concern raised by Question 10.04-07-3 since it does not specify that maintenance and operation programs for the CFWS are to include water prevention measures.

A discussion of this NuScale RAI response was included as a topic of a June 30, 2018, public teleconference call with NuScale. Based on the teleconference discussion with the applicant, the applicant indicated that they recognized the role that procedures play in ensuring water hammer prevention, but that they felt identifying the need for procedures or specifying the key elements of procedures was not in the scope of the DCA, Part 2,, and that the procedures addressing water hammer would be developed by the COL applicant based on DCA, Part 2, Section 13.5. In response to the teleconference the applicant submitted a letter dated July 10, 2018, (ML18191B262) in which it provided a markup of the DCA, Part 2, that includes additional discussion on the role of maintenance and operating procedures on minimizing the occurrence of water hammer. The inclusion of the markup provided in the letter is Confirmatory Item 10.4.7-1.

The staff recognizes that while the design aspect related to water hammer prevention is reviewed as part of the DCA, Part 2, review, the procedures are in the scope of the COL application. Therefore the site-specific items will be completed in the COL review. Based on the fact that the water hammer prevention review for this DCA, Part 2, review is limited to the design aspects, and the staff finds this RAI question is resolved, and closed, and the design in compliance with GDC 4.

10.4.7.4.3 GDC 5, "Sharing of structures, systems, and components"

The staff reviewed the design of the CFWS for compliance with the requirements of GDC 5 with respect to shared systems among NPMs. Compliance with GDC 5 requires provisions be included in the nuclear power unit design to ensure an event with one NPM does not adversely impact any the ability of the shared systems to perform their safety functions in other NPM units or their ability to safely achieve and maintain safe shutdown. The CFWS is not shared among NPMs; therefore, the failure of CFWS or components in the CFWS will not impair the ability of

SSCs important to safety in other NPMs to perform their safety functions and the requirement of GDC 5 for sharing of systems between units is satisfied.

10.4.7.4.4 GDC 44, "Cooling water"

The staff reviewed the condensate and feedwater system for compliance with the requirements of GDC 44, "Cooling water," as related to the capability to transfer heat from SSCs important to safety to an ultimate heat sink. The DHRS performs this function for the NPM. The feedwater system does have a connection with the decay heat removal system (DHRS), but does not have the safety function to transfer heat under accident conditions and, therefore, GDC 44 is not applicable to the condensate and feedwater system. The description of the DHRS system is in the DCA, Part 2, Tier 2, Section 5.4.3, and the staff's evaluation of the DHRS system is in Section 5.4.4 of this report.

10.4.7.4.5 GDC 45, "Inspection of Cooling Water System" and GDC 46, "Testing of Cooling Water System"

The staff reviewed the CFWS design to ensure design provisions are provided for periodic inspections of systems, components, and equipment, as required by GDC 45, and periodic functional testing of the system and components, as required by GDC 46. Utilizing the enhanced safety-focus review approach the staff's review focused on the SSCs that are functionally part of the CFWS that perform or support feedwater and containment isolation functions. The isolation functions are important to nuclear safety because CFWS isolation is required to establish and maintain the pressure boundary for the DHRS, and thus preserve DHRS inventory and ensure proper operation of the safety-related DHRS.

CFWS components that perform the isolation functions are the FWIV and the feedwater isolation check valves. These valves are considered containment isolation valves and are discussed in Section 6.2 of the DCA, Part 2. The valves are described as being located such that there is sufficient access to allow for in-service inspection, 10 CFR 50, Appendix J, type C testing, and maintenance and repair.

The applicant states in the DCA, Part 2, Section 10.4.7.4 that the CFWS is inspected and tested prior to plant operation and, because the CFWS is in use and the system parameters are monitored during normal plant operation, the satisfactory operation of the system components demonstrates system operability. Because refueling of the plant involves disconnecting the CFWS from the NPM, the staff requested in RAI Question 10.04-07-01 (ML17349B004) dated December 15, 2017, that the applicant clarify if inspection and testing will be performed prior to plant startup after refueling.

In its response to RAI 9122, Question 10.04.07-01 (ML17349B004) dated December 15, 2017, the applicant stated that the CFWS is not a cooling system as described in GDC 44 and that therefore GDC 45 and 46 is not applicable, and indicated that they would remove GDC 45 and 46 applicability from DCA, Part 2, Section 10.4.7. The applicant's response is based, in part, on the applicant defining the boundaries of the feedwater system differently than the way it's defined in guidance (DSRS 10.4.7). In the NuScale DCA, Part 2, the feedwater system SSCs relied on for feedwater system isolation, which is necessary for DHRS operation, were not included as part of the CFWS, thus leaving important to safety SSC generally covered in this system review, out of scope of the system.

The staff believes that because the SSCs that are functionally part of the CFWS are credited for isolating the CFWS and providing and maintaining the pressure boundary, provisions for inspection and testing called for in GDCs 45 and 46 are applicable. The staff discussed its concern about the RAI response with the applicant in a January 31, 2018, public teleconference call with NuScale. During the teleconference, the applicant indicated that the feedwater system components that were used to support containment isolation and feedwater isolation in support of DHRS operation were included in the DCA, Part 2, as part of the containment system, and that information regarding inspection and testing of those SSCs were contained in Chapters 6 and 3 of the DCA, Part 2.

The staff confirmed that the CFWS SSCs were included as part of the inservice testing program in Chapter 3 of the DCA, Part 2. DCA, Part 2, Table 3.9-16 identifies components that are subject to preservice and inservice testing plans. Among the valves that are included for the containment system are the feedwater isolation and the feedwater check valves, and the identified function for the valves are feedwater isolation, containment isolation, and decay heat removal boundary. Since provisions are provided to permit periodic inservice inspection of the feedwater isolation and check valves, and they are included in the inservice test program, as indicated in DCA, Part 2, Table 3.9-16, the staff finds that the NuScale design provides for periodic inspection and testing and therefore addresses the requirements of GDC 45 and 46.

10.4.7.4.6 Compliance with 10 CFR 20.1406

10 CFR 20.1406 requires in part that each design certification applicant describe how the facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, as well as the generation of radioactive waste. Primary-to-secondary leakage through the steam generator tubes has the potential to introduce radioactive material into the CFWS. The applicant states in DCA, Part 2, Tier 2, Section 10.4.7.3, that the CFWS design satisfies the requirements of 10 CFR 20.1406, minimizing the contamination of the facility and the environment in accordance with RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," and 10 CFR 20.1406.

The staff reviewed the design of the CFWS for compliance with the requirements of 10 CFR 20.1406. In DCA, Part 2, Tier 2, Section 10.4.7.3, the applicant states that main steam and condensate monitoring with MSS and CFWS isolation capabilities minimize the contamination and release to the environment and that the CFWS drains to the balance of plant drain system, which discharges to the radioactive waste drain system should the CFWS become contaminated. The staff found that the applicant has also addressed the CFWS design features compliance with Regulatory Guide 4.21 in DCA, Part 2, Tier 2, Table 12.3-18, "Regulatory Guide Features for Condensate and Feedwater System." The general review of NuScale compliance with RG 4.21 is included in Section 12.3 of this report.

Based on the above discussion, the staff concludes that the CFWS, as described in the DCA, Part 2, complies with 10 CFR 20.1406.

10.4.7.5 *ITAAC*

The DCA, Part 2, Tier 1, Section 2.8, "Equipment Qualification," identifies NPM-specific components for which EQ (equipment qualification) applies including "safety-related electrical and mechanical equipment located in harsh environments and digital instrumentation and controls equipment in mild environments." In DCA, Part 2, Tier 1, Table 2.8-1, "Module Specific Mechanical Electrical/I&C Equipment," the applicant identifies the following CFWS equipment: feedwater supply check valves, the FWIV, and the FWRV. DCA, Part 2, Tier 1, Table 2.8-2, "Equipment Qualification Inspection, Tests, Analyses, and Acceptance Criteria," provides the ITAAC for testing/accepting these valves. Based on a graded approach commensurate with the safety significance of the CFWS, the staff reviewed the proposed ITAAC and finds that they 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 built and will be operated in accordance with the design certification, the AEA, and the NRC's regulations as required by 10 CFR 52.47(b)(1).

A discussion of all NuScale ITAAC is provided in Section 14.3 of this SER.

10.4.7.6 *Technical Specifications*

The staff reviewed DCA, Part 2, Tier 2, Chapter 16, Technical Specification 3.7.2, "Feedwater Isolation," for applicability to the CFWS. These technical specifications provide limiting conditions for operation and surveillance requirements for the FWIVs and FWRV. The staff also reviewed the associated technical specification bases and found the description to be consistent with the DCA, Part 2, Tier 2 description of the components.

The staff concludes that Technical Specification 3.7.2 appropriately addresses the limiting conditions for operation and surveillance requirements for the FWIVs and FWRVs. The staff evaluation of technical specifications and associated bases is in Chapter 16 of this report.

10.4.7.7 *Combined License Information Items*

In accordance with DCA, Part 2, Tier 2, Table 1.8-2, and DCA, Part 2, Tier 2, Section 10.4.7, the applicant has not identified any COL information items that are directly applicable to the CFWS.

10.4.7.8 *Conclusion*

The staff finds the condensate and feedwater system design acceptable because it meets applicable regulatory requirements including GDC 2 regarding protection from natural phenomena, GDC 4 regarding protection against missiles and effects of pipe breaks, GDC 5 regarding shared systems, GDC 45 regarding inspections, GDC 46 regarding periodic testing, 10 CFR 20.1406, and 10 CFR 52.47(b)(1) regarding ITAAC.

10.4.8 Steam Generator Blowdown System (PWR)

Not applicable to NuScale design because it does not use a blowdown system.

10.4.9 Auxiliary Feedwater System

The staff reviewed DCA, Part 2, Tier 2, Section 10.4.9, "Auxiliary Feedwater System." This section states:

> *The NuScale Power Plant design neither requires nor uses an auxiliary feedwater system. Therefore, this section is not applicable to the NuScale design.*
>
> *The decay heat removal system (DHRS) (in Section 5.4.3 of DCA, Part 2, Tier 2) performs some functions similar to an auxiliary feedwater system. However, as compared to an auxiliary feedwater system, the DHRS differs substantially in its design, operation, and relationship to the small break loss-of-coolant accident (LOCA) plant response.*

The staff reviewed the NuScale design and confirmed the applicant's statement above.

In a typical U.S. PWR the auxiliary feedwater system supplies emergency feedwater to the secondary side of the SG to remove core decay heat in the case of a loss of normal feedwater. In the NuScale design, if normal feedwater is lost or not available, the DHRS acts like an auxiliary feedwater system, removing residual decay heat from the reactor via the steam generator. Since NuScale utilizes the DHRS to perform the safety-related heat removal function typically performed by the auxiliary feedwater system in PWRs, the staff agrees with the applicant's determination that an auxiliary feedwater system is not required. The DHRS is reviewed in Section 5.4.3 of this report, and no further review is required for this Section 10.4.9, "Auxiliary Feedwater System."

10.4.10 Auxiliary Boiler System

10.4.10.1 *Introduction*

The staff reviewed DCA, Part 2, Tier 2, Section 10.4.10, "Auxiliary Boiler System." There is no specific SRP section applicable for the review of the auxiliary boiler system (ABS). However, the staff appropriately used similar regulatory requirements from similar SRP Chapter 10 systems, such as the Turbine Gland Sealing System and Circulating Water System, among others, for this area of review. The ABS is designed to supply steam to systems where main steam is not available or not preferred. The applicant stated that up to twelve NPMs share one ABS, with one ABS system per plant.

10.4.10.2 *Summary of Application*

DCA, Part 2, Tier 1: There are no entries in DCA, Part 2, Tier 1 for the ABS.

DCA, Part 2, Tier 2: DCA, Part 2, Tier 2, Section 10.4.10 includes the ABS description, as well as relevant information on the ABS design, including the design bases, instrumentation, and the inspection and testing program. DCA, Part 2, Tier 2, Section 11.5.2.2.14, "Auxiliary Boiler System," includes a description of the effluent radiation monitoring system for the ABS.

ITAAC: There are no ITAAC for the ABS system.

Initial Test Program: Preoperational tests related to the ABS being evaluated as part of the design certification review are described in DCA, Part 2, Tier 2, Section 14.2, "Initial Plant Test Program," Tables 14.2-9, 14.2-33, 14.2-70, and 14.2-97.

Technical Specifications: There are no proposed TS requirements associated with the ABS.

Technical Reports: There are no technical reports related to the ABS.

10.4.10.3 *Regulatory Basis*

There is no specific standard review plan (SRP) applicable for the review of the ABS. Therefore, based on similar systems, the staff used the following relevant regulatory requirements for this area of review:

- GDC 2, "Design bases for protection against natural phenomena," as it relates to SSCs important to safety being designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods; this includes consideration of the failure of SSCs that are not safety-related due to natural phenomena such as earthquakes, tornadoes, hurricanes, and floods which could adversely affect SSCs that are important to safety.

- GDC 4, "Environmental and dynamic effects design bases," as it relates to SSCs important to safety that shall be appropriately protected against the dynamic effects of external missiles, internal missiles, pipe whip and jet impingement forces associated with pipe break; this includes consideration of a failure of the ABS due to pipe break or malfunction which could adversely affect essential systems or components necessary for safe shutdown or accident prevention or mitigation.

- GDC 5, "Sharing of structures, systems, and components," with respect to shared systems among the NPMs.

- GDC 60, "Control of releases of radioactive materials to the environment," as it relates to the ability of the auxiliary steam system design to control releases of radioactive materials to the environment.

- GDC 64, “Monitoring radioactivity releases,” as it relates to provisions being included in the nuclear power unit design for monitoring the effluent discharge paths and the plant environs for radioactivity that may be released from normal operations, including AOOs, and from postulated accidents.

- 10 CFR 20.1406, “Minimization of Contamination,” as it relates to the design features that 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 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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the AEA, and the NRC’s regulations.

10.4.10.4 *Technical Evaluation*

The ABS is not safety-related. The ABS is a non-seismic system designed to supply steam to systems where main steam is not available or not preferred. The ABS consists of two separate systems. The high-pressure system is dedicated to supplying steam to the module heatup system (MHS) heat exchangers during startup and shutdown. The primary functions of the low-pressure system are to provide steam to the turbine gland seals, to the MC for deaeration, and to the condensate polishing resin regeneration system. The ABS is not credited for mitigation of a DBA, and has no safe shutdown functions.

10.4.10.4.1 GDC 2, “Design Basis for Protection against Natural Phenomena”

Compliance with the requirements of GDC 2 is based on the staff’s determination that the ABS is designed to withstand the effects of postulated natural phenomena, including earthquakes, such that it would not result in the loss of the capability of SSCs important to safety to perform their safety functions. DCA, Part 2, Tier 2, Subsection 10.4.10.3, “Safety Evaluation,” states that the “ABS serves no safety function, is not credited for mitigation of a DBA, and has no safe shutdown functions.” Therefore, acceptance of GDC 2 is based on the design codes and the guidance provided by regulatory position C.2 of RG 1.29, “Seismic Design Classification,” which specifies that failure of systems that are not safety-related should not have an adverse effect on safety-related systems. In DCA, Part 2, Tier 2, Section 10.4.10.2.1, “General Description,” the applicant states that “the ABS is designed to the requirements of Quality Group D and Seismic Category III.” DCA, Part 2, Tier 2, Subsection 10.4.10.3, states that “the portions of the ABS inside the RXB are designed to preclude adverse seismic interactions during and after a safe shutdown earthquake (SSE) consistent with Regulatory Guide 1.29 .The staff also notes, as indicated in Note 5 in Table 3.2-1 of the Revision 1 to the Tier 2 DCA, Part 2, *where SSC (or portion thereof) as determined in the as-built plant which are identified as seismic category III in this table could, as the result of a seismic event, adversely affect seismic category I SSC or result in incapacitating injury to occupants of the control room, they are categorized as seismic category II consistent with Section 3.2.1.2 and analyzed as described in Section 3.7.3.8.*

The staff evaluated the design of the ABS and agrees that the system performs no safety-related function. The portions of the ABS located in the TGB are not in the vicinity of safety-related SSCs, therefore, failure of these system portions would not impact safety-related systems. The portions of the ABS located in the RXB are designed such that failure of the portions would not adversely impact safety-related SSCs. Therefore, the staff finds that the ABS design meets the requirement of GDC 2."

10.4.10.4.2 GDC 4, "Environmental and Dynamic Effects Design Bases"

The staff also performed the review to verify that the system was protected against environmental and dynamic effects or that a failure of the ABS and the resulting discharging fluid (i.e., flooding) would not adversely affect SSCs important to safety per GDC 4. Compliance with the requirements of GDC 4 is based on the determination that failures of the ABS due to pipe break or malfunction would not adversely affect any of the plant's SSCs important to safety. In DCA, Part 2, Tier 2, Section 10.4.10.3, "Safety Evaluation," the applicant states that "a failure of the ABS that releases the water inventory and the resulting flooding does not prevent the operation of a safety-related SSC."

The ABS does not have a safety function and therefore its failure does not prevent the operation of SSCs important to safety from performing their safety functions. The staff's detailed evaluation of flooding prevention can be found in Section 3.4 of this SER. The staff evaluation of the effect of high and moderate energy line breaks are discussed in Section 3.6 of this report. Therefore, the staff finds that the design of the ABS meets the requirements of GDC 4.

10.4.10.4.3 GDC 5, "Sharing of structures, systems, and components"

Since the ABS serves all NPMs, the staff also reviewed the design of the ABS for compliance with the requirements of GDC 5 with respect to shared systems. Compliance with GDC 5 requires that provisions be included in the nuclear power unit design to ensure an event with one NPM does not significantly impair the ability of important to safety SSCs in any other NPM units' to perform their safety functions, including the ability to safely achieve and maintain safe shutdown. The applicant stated in DCA, Part 2, Tier 2, Section 10.4.10.3, that "there are no safety-related components in the ABS that are shared among NPMs; therefore, failure of the ABS does not significantly impair the ability of other NPMs to perform their safety functions."

The staff evaluated the design of the ABS and, as discussed in the previous section, failure of this system would not significantly impair the ability of SSCs important to safety from performing their safety function. Therefore, the staff finds that the ABS design meets the requirements of GDC 5.

10.4.10.4.4 GDC 60, "Control of releases of radioactive materials to the environment," and GDC 64, "Monitoring radioactivity releases,"

The staff also reviewed the design of the ABS for compliance with the requirements of GDC 60 and GDC 64 with respect to control and monitoring of radioactive releases. Compliance with GDC 60 and GDC 64 requires provisions be included in the nuclear power unit design to monitor and control suitably the release of radioactive materials during normal operation, including AOOs and postulated accidents. Meeting these requirements provides a level of assurance that the release of radioactive materials in gaseous and liquid effluents from the ABS during normal operation, including AOOs and postulated accidents, is kept as low as is reasonably achievable, in accordance with 10 CFR Part 50, Appendix I. The ABS, normally a non-radioactive system, provides steam to the MHS which contains radioactive liquid. Therefore, the ABS may potentially contain radioactive effluents.

The ABS description in Tier 2 Section 10.4.10.3, and Section 11.5.2.2.14 indicates that the ABS includes a number of process radiation monitors throughout the system that monitor, identify, and notify the presence of high radiation conditions in the ABS. Upon detecting high radiation conditions, the system initiates an MCR alarm notifying the operators. If radiation is detected in the ABS that is greater than the high-high radiation isolation or if system power is lost, the ABS flash tank pressure regulating valve and the steam supply valves from both boilers isolate.

The staff finds that these features provide adequate monitoring and control of radioactive materials in gaseous and liquid effluents from the ABS, and therefore, the ABS meets the requirements of GDC 60 and 64.

10.4.10.4.5 10 CFR 20.1406, "Minimization of Contamination"

The staff also reviewed the design of the ABS for compliance with the requirements of 10 CFR 20.1406 with respect to minimizing contamination of the facility and the environment. The applicant states in DCA, Part 2, Tier 2, Section 10.4.10.3, that radiation monitoring of the steam and the condensate return from the module heatup system heat exchangers with CVCS isolation capabilities minimizes the contamination and release to the environment should the ABS become contaminated. The staff also found that the ABS includes design features which address the provisions of Regulatory Guide (RG) 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," as described in DCA, Part 2, Tier 2, Table 12.3-14, "Regulatory Guide 4.21 Features for Auxiliary Boiler System." The general review of NuScale conformance with RG 4.21 is provided in Section 12.3 of this report.

Based on the above discussion, the staff concludes that the ABS design complies with 10 CFR 20.1406.

10.4.10.5 *Initial Test Program*

Preoperational tests related to the ABS for design certification include the ABS test (#9), TGS test (#33), the hot functional test (#70), and thermal expansion test (#97), which ensure the various design aspects related to the ABS are implemented. These tests are performed in accordance with DCA, Part 2, Tier 2, Tables 14.2-9, 14.2-33, 14.2-70, and 14.2-97. The staff evaluation of the initial test program for the design certification review is documented in Section 14.2 of this report.

10.4.10.6 *ITAAC*

Applicants for standard plant design certification must provide proposed ITAAC necessary to ensure that a plant incorporating the certified design is built and will operate in accordance with 10 CFR 52.47(b)(1). The ABS system is not safety-related and was not identified in DCA, Part 2, Tier 2, table 17.4-1 to be risk-significant. Additionally there are no features or functions of the ABS system credited for mitigation of design basis events and its operating parameters are not critical to safety analyses. Therefore the staff finds that there are no ITAAC required for the ABS.

10.4.10.7 *Technical Specifications*

There are no TS requirements associated with the ABS. The system is not safety-related and is not required for safe shutdown; and does not meet a criterion in 10 CFR 50.36, therefore the staff finds this acceptable.

10.4.10.8 *Combined License Information Items*

The NRC staff reviewed COL Information Item 10.4-2 and was unclear as to which specific part of the ABS design is to be provided by the COL applicant. Therefore, the staff issued RAI 8905, Question 10.4.10-2, dated July 21, 2017 (ML17202U684) to seek further clarification, and in the respond dated September 18, 2017 (ML17261B280), the applicant stated that only the type of fuel supply for the boiler will be site-specific and be identified by the COL applicant. The staff finds the additional information provided by the applicant including a proposed change to COL Item 10.4-2, in the above RAI response adequately addressed the staff’s concern. The staff also confirmed that the proposed change was incorporated in Revision 1 of the DCA, Part 2,; therefore, RAI 8905, Question 10.4.10-2 is resolved and closed. Table 10.4.10-1 below lists the COL information item number and description related to the ABS.

Table 10.4.10-1 NuScale Combined License Information Items for Section 10.4.10

Item No.	Description	DCA, Part 2, Tier 2 Section
COL 10.4-2	A COL applicant that references the NuScale Power Plant design certification will describe the type of fuel supply for the auxiliary boilers.	10.4.10.2.1

10.4.10.9 *Conclusion*

Based on the review of the information that is provided and as discussed above in the technical evaluation section, the staff determined that the applicant has met the requirements as stated in the Regulatory Basis of this section.

10.4.11 Feedwater Treatment System

10.4.11.1 *Introduction*

The purpose of the FWTS is to maintain secondary water quality in conjunction with the condensate polishing system (CPS) by providing chemical addition and feedwater sampling. This is to control erosion and corrosion by monitoring and maintaining feedwater pH and dissolved oxygen (DO) levels.

10.4.11.2 *Summary of Application*

DCA, Part 2, Tier 1: No Tier 1 information is provided in the NuScale DCA, Part 2, for this system.

DCA, Part 2, Tier 2: The applicant provided a design description in DCA, Part 2, Tier 2, Section 10.4.11, "Feedwater Treatment System," which is summarized here in part:

> *The FWTS is part of the CFWS [Condensate and Feedwater System] described in Section 10.4.7 and is designed to control erosion and corrosion of CFWS components by monitoring and maintaining feedwater pH and dissolved oxygen levels during plant modes except NPM [NuScale Power Module] transport.*
>
> *Two chemical injection points are provided downstream of the CFWS condensate pumps. The FWTS includes separate equipment for pH control and oxygen scavenger injection. The equipment includes tanks, valves, piping, pumps, and instrumentation for each chemical addition.*

The FWTS will have equipment for injecting chemicals to control feedwater potential Hydrogen (pH) that is separate from the equipment to control dissolved oxygen (DO) levels.

Table 10.4-22, "Feedwater Treatment System Operating Parameters," also states that ammonia will be used for pH control, and that hydrazine will be added to scavenge DO.

Acceptable revisions to the DCA, Part 2, were proposed in the clarification call held with the applicant on August 22, 2018 (ML18235A688) and will be incorporated into Revision 2 of the DCA, Part 2. Confirmation of these changes will be tracked as **Confirmatory Item 10.4.11-1**.

ITAAC: There are no ITAAC specific to the FWTS.

Technical Specifications: There are no TS associated with DCA, Part 2, Tier 2, Section 10.4.11.

10.4.11.3 *Regulatory Bases*

The relevant requirements of the Commission's regulations for this area of review, and the associated acceptance criteria, are summarized below.

- 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 plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

- GDC 14, "Reactor Coolant Pressure Boundary [RCPB]," in Appendix A to 10 CFR Part 50, requires that the RCPB be designed, fabricated, erected, and tested to ensure an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture.

10.4.11.4 *Technical Evaluation*

Chemical Injection Capability

The purpose of the FWTS is to help treat, and clean feedwater by providing chemical addition and feedwater sampling. This is done to maintain feedwater pH and DO content.

The staff reviewed the information provided in the DCA, Part 2, Tier 2, Section 10.4.11, "Feedwater Treatment System," in conjunction with the information provided in DCA, Part 2, Tier 2, Sections 10.3.5, "Secondary Water Chemistry," and 10.4.6, "Condensate Polishing System [CPS]," against the requirements of GDC 14. GDC 14 is applicable to the FWTS since the system is designed to help maintain secondary water quality via chemical injection, which in turn helps to avoid erosion/corrosion-induced failure of the RCPB, specifically the steam generator tubing. The FWTS was reviewed in conjunction with the Secondary Water Chemistry and CPS sections of the DCA, Part 2, because these systems and programs work together to maintain secondary water quality, and to help prevent corrosion-induced failure of the RCPB.

The review for Section 10.4.11 focused on the ability of the FWTS to provide the appropriate chemical injection that allows for the control of certain secondary water chemistry parameters. Sections 10.3.5, and 10.4.6 of the DCA, Part 2 describe how maintaining acceptable secondary water chemistry will demonstrate compliance with GDC 14 with respect to corrosion induced failure of the RCPB.

The FWTS provides control of secondary water chemistry to limit erosion and corrosion of components in the CFWS. This is accomplished through monitoring and maintaining feedwater pH and DO levels. The FWTS controls feedwater pH, and DO levels via chemical injection downstream of the CFWS condensate pumps. Hydrazine will be injected to control DO, and ammonia will be injected for pH control. As described in COL Item 10.4-3, a COL applicant that references the NuScale design will provide an analysis that shows the chemical injection equipment is able to satisfy the requirements of the secondary water chemistry program described in Section 10.3.5 of the DCA, Part 2, and that the equipment is compatible with the chemicals used for feedwater injection. The FWTS also interfaces with the process sampling system, as described in Section 9.3.2 of the DCA, Part 2, which monitors feedwater quality. If feedwater quality is outside of the specified secondary water chemistry parameters, the FWTS can provide chemical injections to control secondary water chemistry.

The FWTS is designed to have tanks, pumps, valves, piping, and instrumentation capable to inject the appropriate agents to control feedwater pH and DO levels. The tanks will be constructed of erosion/corrosion resistant materials. The FWTS will be designed to ensure that the size, materials, and capacity of the FWTS satisfies the water quality requirements of the secondary water chemistry program described in Section 10.3.5, and that it is compatible with the chemicals used, as described in COL Item 10.4-3. In addition, the FWTS includes flow control valves, flow elements, and transmitters to control the addition of chemical injection. The FWTS also includes an oxygen analyzer for the feedwater header.

The use of the FWTS to control feedwater pH and DO levels supports the ability of the secondary water chemistry program to maintain appropriate chemistry and reduce the likelihood of corrosion-induced failure of the RCPB. Control of the feedwater pH and DO levels is appropriate to help reduce corrosion in secondary systems, as well as for erosion/corrosion of the secondary systems. In addition, the FWTS contains the appropriate equipment, including the equipment described in COL Item 10.4-3, to meet chemical injection requirements. Therefore, the staff has determined that the FWTS assists the CPS in implementing the secondary water chemistry program and meeting the requirements of GDC 14. The full evaluations for the CPS and secondary water chemistry program are located in the SER evaluations for Section 10.4.6, and 10.3.5, respectively.

10.4.11.5 *ITAAC*

There are no ITAAC for this system. The FWTS contributes to compliance with GDC 14 by helping to maintain water chemistry conditions that prevent degradation of the secondary coolant system, which includes the RCPB in the steam generators. The FWTS is not part of the RCPB, and therefore does not directly support compliance with GDC 14. Therefore, the staff finds it acceptable that there are no ITAAC for this system, in accordance with 10 CFR 52.47(b)(1).

10.4.11.6 *Technical Specifications*

There are no TS associated with DCA, Part 2, Tier 2, Section 10.4.11. The system does not meet the criteria in 10 CFR 50.36 that would require a TS, therefore the staff finds this acceptable.

10.4.11.7 *Combined License Information Items*

Item No.	Description	DCA, Part 2, Tier 2 Section
COL 10.4-3	A COL applicant that references the NuScale Power Plant design certification will provide a secondary water chemistry analysis. This analysis will show that the size, materials, and capacity of the feedwater treatment system equipment and components satisfies the water quality requirements of the secondary water chemistry program described in Section 10.3.5, and that it is compatible with the chemicals used.	10.4.11.2.2

The applicant proposed one COL item as described in the table above. The COL item describes site-specific features of the FWTS and how it satisfies parts of the plant secondary water chemistry control program.

10.4.11.8 *Conclusion*

Based on the staff review of the FWTS, and pending closure of Confirmatory Item 10.4.11-1, the staff has determined that the FWTS is able to support the CPS, and the Secondary Water Chemistry Program in order to maintain acceptable secondary water quality. Based upon the staff review of the applicant’s proposed design criteria and bases for the FWTS and the criteria for operation of the system, the staff concludes that the design of the system is acceptable and meets the applicable requirements of the regulatory bases as discussed above. Additional details of the FWTS will be provided by the COL applicant as stated in COL Item 10.4-3 regarding the sizing, materials, and capacity of the FWTS.