RAIO-1118-63021

November 20, 2018

Docket No. 52-048

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

SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 468 (eRAI No. 9420) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 468 (eRAI No. 9420)," dated May 10, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 468 (eRAI No.9420)," dated July 09, 2018

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

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Question from NRC eRAI No. 9420:

- 15-17

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9420

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9420

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Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9420
Date of RAI Issue: 05/10/2018

NRC Question No.: 15-17

Regulatory Basis

General Design Criterion (GDC) 1 in 10 CFR Part 50, Appendix A, requires structures, systems, and components (SSCs) important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. The NRC regulations in 10 CFR 50.2 define safety-related, in part, as SSCs that prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in § 50.34(a)(1) or §100.11 of that chapter, as applicable. In addition, 10 CFR 52.47(a)(2)(iv) provides equivalent siting and safety analysis offsite dose guidelines for new nuclear power plant standard design certifications.

Introduction

In RAI 8744, Question 15.02.08-4, RAI 9205, Question 15-3, and RAI 9237, Question 15.06.03-3 the NRC staff requested the applicant to provide additional information justifying the credit of nonsafety-related components for design basis accident (DBA) mitigation. The applicant's response referred to the guidance in RG 1.206 which specifies that nonsafety-related components may be used as backup protection to mitigate transient or accident conditions; or NUREG-0138 which details the acceptable means by which nonsafety-related components can be credited for DBA mitigation. The staff found the applicant's response generally acceptable; however, the staff also determined that more information is required in order to find that the applicant is appropriately meeting the guidance provided in NUREG-0138, precedence, and overall find that the applicant's FSAR Tier 2, Chapter 15 analyses are in compliance with the applicable regulations.

Discussion

The NRC staff agrees that NUREG-0138 (November 1976), "Staff Discussion of Fifteen Technical Issues Listed in Attachment to November 3, 1976, Memorandum from Director, NRR to NRR Staff," in Issue No. 1, "Treatment of Non-Safety Grade Equipment in Evaluations of Postulated Steam Line Break Accidents," discusses the acceptance of reliance on specific nonsafety-related valves as part of the mitigation of secondary line breaks.

In particular, NUREG-0138 defines the issue as follows:

In evaluating the consequences of postulated breaks of steam lines the current staff position (SRP 10.3) states that the design should preclude the blowdown of more than one steam generator, assuming a concurrent single component failure, and assuming that the turbine stop and control valves remain functional. Provided that these valves and their control systems are designed for closure under the postulated conditions, and because they are high quality components, the staff does not require that they be designed to the requirements for safety-related equipment.

Regarding the reliance on non-safety grade equipment[1] to mitigate steam line break accidents, NUREG-0138 includes the following general NRC staff position:

For loss-of-coolant accidents (LOCA) involving a spontaneous rupture of the primary system boundary, where significant damage to the fuel and a major release of fission products are potential consequences, the most stringent quality and design requirements, including seismic qualification, are imposed on those systems needed to prevent and cope with a LOCA. However, for accidents involving spontaneous failures of secondary system piping not part of the primary system boundary, where the potential consequences are significantly lower, less stringent requirements are imposed on the quality and design of the systems needed to cope with such secondary system ruptures. This approach results, in the staff's judgment, in a proper weighing of consequences and safety requirements in order to assure a balanced level of safety over the entire spectrum of postulated design basis accidents.

In NUREG-0138, the NRC staff discusses the reliance on non-safety grade valves, such as turbine stop, control, and intercept valves to mitigate the consequences of a steam line break. For example, the staff indicates in NUREG-0138 that the continued reliability of these components over the life of the plant is assured by frequent (generally weekly) inservice tests. The staff also states that the NRC conducted a survey of the reliability of these valves at

operating light water reactors. The staff found no control system failures and few incidents where the valves did not fully close. Based on its review, the staff concluded that the reliability of these valves is of the same order of magnitude as that accepted for nuclear safety-grade components. Regarding feedwater isolation, the staff states that the rationale for reliance on "non-safety grade" feedwater components is similar to that presented for steam line valves. In NUREG-0138, the staff states its belief that it is acceptable to rely on these non-safety grade components in the steam and feedwater systems because their design and performance are compatible with the accident conditions for which they are called upon to function.

NUREG-0138 is referenced in other NRC and industry documents discussing reliance on nonsafety-related components as part of the mitigation of accidents. For example, in NUREG-1793 (September 2004), "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," the NRC staff states in Chapter 15, "Transient and Accident Analyses," Section 15.1.2, "Non-Safety-Related Systems Assumed in the Analysis," that crediting nonsafety-related backup systems and components in the design-basis analyses is acceptable for several reasons, including operating data that show that the turbine stop and control valves are reliable, and taking credit for the turbine valves in the design-basis analyses for backup protection is consistent with the staff position stated in NUREG-0138. In a request for additional information dated November 16, 2009 (ADAMS Accession No. ML093140231) regarding a proposed change to Technical Specifications for the auxiliary feedwater system at the Point Beach nuclear power plant, the NRC staff notes that NUREG-0138 allows a licensee to take credit for nonsafety-grade components in the main feedwater line, even though they are not designed seismic Category I, to perform a backup isolation function in certain accident scenarios, because the staff does not require that an earthquake be assumed to occur coincident with the postulated main steamline break. In its November 16, 2009, letter, the NRC staff further indicates that NUREG-0138 prescribes that in order to rely on these nonsafety-grade components, their design and performance must be compatible with the accident conditions for which they are called upon to be credited, and the reliability of these valves is of the same order of magnitude as that accepted for nuclear safety-grade components. In its reply dated December 16, 2009 (ADAMS Accession No. ML093510809), the Point Beach licensee provides information supporting its determination that the design and performance of the main feedwater regulating valves, which would be downgraded to nonsafety-related, will be compatible with the accident conditions for which the valves will be credited. These NRC and licensee documents indicate that the application of NUREG-0138 requires that the nonsafety-related components to be credited for main steam line or feedwater line breaks must be determined to be reliably capable of performing their intended function.

In its response to RAI 8744, Question 15.02.08-4, the NuScale design certification applicant states that the nonsafety-related FW supply check valves to be credited for a line break are listed in FSAR Tier 2, Section 3.2, "Classification of Structures, Systems, and Components," Table 3.2-1 of the same title, with requirements for augmented quality, designed to Seismic Category I and included in the inservice testing program. The NRC staff notes that Table 3.2-1 lists Feedwater Supply Check Valve (without an identifying valve number) as Seismic Category I with "Technical Specification Surveillance for operability and in-service testing" in the "Augmented Design Requirements" column. The "QA Program Applicability" column specifies AQ-S with Note 2 indicating that AQ-S "indicates that the pertinent requirements of 10 CFR 50 Appendix B are applicable to SSC classified as seismic category II in accordance with the quality assurance program."

In its response to RAI 9205, Question 15-3, the applicant provides information on the three nonsafety-related components that are credited in the NuScale Power Module Chapter 15 safety analyses (nonsafety-related feedwater check valves, nonsafety-related feedwater regulating valves, and nonsafety-related secondary (backup) main steam isolation valves (MSIV) and bypass valves). The information provided details the applicant's position on why the crediting of each valve is appropriate for DBA mitigation. As mentioned above, the staff generally finds the applicant's arguments acceptable; however, additional information is required to assure the applicant is appropriately meeting the guidance in NUREG-0138.

In its response to RAI 9237, Question 15.06.03-3, the applicant provided information related to the crediting of the nonsafety-related secondary MSIVs for a steam generator tube failure (SGTF). The response explains that due to the augmented design requirements identified, precedence from prior design certifications, and statements in RG 1.206, it is appropriate to credit the secondary MSIVs to mitigate the effects of an SGTF. However, the staff needs additional information in order to reach a safety finding on the applicant's proposal.

Request

For reliance on nonsafety-related components to mitigate a DBA in the NuScale accident analysis, consistent with the guidance in NUREG-0138, the NRC staff requests that the NuScale design certification applicant provide the following information:

(1) Identifying numbers for the applicable nonsafety-related components,

(2) Type of components (e.g., if a check valve, then what type - swing check or nozzle check,

etc.),

(3) Performance history and operating experience for the applicable components and their application in the NuScale design,

(4) Detailed design and qualification requirements to be applied to the components, including the associated electrical design and qualification requirements where it is applicable (i.e., backup isolation valves that require electrical signals to actuate),

(5) Preservice and inservice testing, and Technical Specification requirements to be applied to the components,

(6) Planned modifications to the NuScale Design Certification application, such as Part 2 (FSAR Tier 1 and Tier 2), and Part 4 (Technical Specifications), to specify the design, qualification, ITAAC, preservice and inservice testing, and Technical Specification requirements for the applicable components, and

(7) Clarification of the reference to AQ-S in the QA Program Applicability column in NuScale FSAR Tier 2, Table 3.2-1, for the applicable nonsafety-related valves to be credited.

In addition, for reliance on the nonsafety-related secondary MSIV to mitigate an SGTF event, as required by the definition of safety-related in 10 CFR 50.2, the applicant must ensure that the estimated offsite doses do not exceed the requirements of 10 CFR 52.47(a)(2)(iv) if the secondary MSIV fails to close. Therefore, the applicant is requested to:

(8) Perform an analysis that demonstrates 10 CFR 52.47(a)(2)(iv) criteria are met assuming the secondary MSIV fails to close for the SGTF event.

With regards to the feedwater regulating valve (FRV), which is credited to close within a specified time in the containment response analysis, the imposed closure time in the analysis needs to be clearly reflected in the FSAR. Although Technical Specification Surveillance Requirement 3.7.2.1 indicates a surveillance to verify the closure time is within limits, that value should be specified in the FSAR. Accordingly, in addition to the aforementioned augmented quality considerations, the staff requests that NuScale:

(9) Provide a closure time for the FRV corresponding to that assumed in the analysis in the FSAR.

[1] In the past, mechanical equipment classified as safety-related was referred to as meeting safety-grade qualification requirements, such as seismic, environmental, and functional requirements.

NuScale Response:

NuScale provided a response to the NRC regarding request for additional information (RAI) 9420, question 15-17 on July 9, 2018 (ML18190A509). Subsequently, the NRC and NuScale had public follow-up conference calls on September 4, 2018, September 25, 2018 and October 23, 2018 where the NRC requested additional clarification to the NuScale response to RAI 9420. This supplemental RAI response provides that additional clarification.

In the follow-up public conference calls held with the NRC and NuScale, the NRC stated that additional information is needed to satisfy NUREG-0138 for the nonsafety-related valves discussed under RAI 9420. Specifically, the NRC requested that additional information regarding the valve design be provided so that performance history and operating experience for these valves could be assessed by the NRC.

Based on these discussions, NuScale is providing the following information, subpart numbers correspond to the request numbering included in the RAI:

(3) and (4)

The NuScale design for the non-safety Backup Main Steam Isolation Valves (MSIVs), Backup Main Steam Isolation Bypass Valves (MSIBVs), Backup Feedwater Check Valves (FWCVs) and Feedwater Regulating Valves (FWRVs) are used as backup protection for their safety-related counterparts as described in Section 15.0.0.6.6. These secondary valves are commercially available valves that utilize a proven design and demonstrate reliable operation based on operating experience in comparable systems. Should a design with no previous operating experience be selected, the design may be proven though testing to demonstrate that the valve actuates as expected at operating conditions.

The valve descriptions in the Final Safety Analysis Report (FSAR) have been modified to incorporate the information described above.

(5)

As described in the FSAR section 3.9.6.5, these nonsafety-related valves are included in an augmented valve testing program. These valves are tested to the intent of the American Society of Mechanical Engineers (ASME) OM Code requirements as endorsed by 10 CFR 50.55a(f), or where relief has been granted by the in the NRC in accordance with 10 CFR 50.55a(f). The valve functions and periodic testing requirements are specified in FSAR Table 3.9-17.

(6)

Attached are changes to the FSAR to provide the clarifications requested by the NRC.

(7)

FSAR Table 3.2-1 has been modified to include reference to FSAR sections 3.9.6.5, 15.0.0.6.6 and FSAR Table 3.9-17 to clarify the quality and testing requirements for these secondary isolation valves.

Impact on DCA:

FSAR Table 3.2-1, Sections 10.3, 10.4 and 15.0 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 03.02.01-2, RAI 03.02.01-3, RAI 03.02.02-2, RAI 03.02.02-6, RAI 03.08.02-14, RAI 03.09.02-64, RAI 05.04.02.01-6, RAI 06.02.04-2, RAI 09.01.03-1, RAI 09.02.02-1, RAI 09.02.04-1, RAI 09.02.04-1S1, RAI 09.02.05-1, RAI 09.02.06-1, RAI 09.02.07-4, RAI 09.02.07-5, RAI 09.02.09-2, RAI 09.03.04-5, RAI 09.04.02-1, RAI 09.04.02-1S1, RAI 10.04.07-2, RAI 11.02-1, RAI 15-17, RAI 15-17S1, RAI 19-14

Table 3.2-1: Classification of Structures, Systems, and Components

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	RTNSS Category (A,B,C,D,E)	QA Program Applicability (Note 2)	Augmented Design Requirements (Note 3)	Quality Group / Safety Classification (Ref RG 1.26 or RG 1.143) (Note 4)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 5)
CNTS, Containment System							
All components (except as listed below)	RXB	A1	N/A	Q	None	B	I
• CVC Injection Check Valve • CVC Discharge Excess Flow Check Valve • CVC PZR Spray Check Valve	RXB	B2	None	AQ-S	None	C	I
• CVC Injection & Discharge Nozzles • CVC PZR Spray Nozzle • CVC PZR Spray CIV • CVC RPV High Point Degasification Nozzle • CVC RPV High Point Degasification CIV • RVV & RRV Trip/Reset # 1 & 2 Nozzles • RVV Trip 1 & 2/Reset #3 Nozzles • CVC Injection & Discharge CIVs	RXB	A1	N/A	Q	None	A	I
• NPM Lifting Lugs • Top Support Structure • Top Support Structure Diagonal Lifting Braces	RXB	B1	None	AQ-S	• ANSI/ANS 57.1-1992 • ASME NOG-1 • NUREG-0554	N/A	I
• CNV Fasteners • Hydraulic skid • CNV Seismic Shear Lug • CNV CRDM Support Frame • Containment Pressure Transducer (Narrow Range) • Containment Water Level Sensors (Radar Transceiver) • SG 1 & 2 Steam Temperature Sensors (RTD)	RXB	A1	N/A	Q	None	N/A	I
CNTS CFDS Piping in containment	RXB	B2	None	AQ-S	None	B	II
Piping from (CES, CFDS, FWS, MSS, and RCCWS) CIVs to disconnect flange (outside containment)	RXB	B2	None	AQ-S	None	D	I
CVCS Piping from CIVs to disconnect flange (outside containment)	RXB	B2	None	AQ-S	None	C	I
CIV Close and Open Position Sensors: • CES, Inboard and Outboard • CFDS, Inboard and Outboard • CVCS, Inboard and Outboard PZR Spray Line • CVCS, Inboard and Outboard RCS Discharge • CVCS, Inboard and Outboard RCS Injection • CVCS, Inboard and Outboard RPV High-Point Degasification • FWS, Supply to SGs and DHR HXs FWIV • RCCWS, Inboard and Outboard Return and Supply • SGS, Steam Supply CIV/MSIVs and CIV/MSIV Bypasses	RXB	B2	None	AQ-S	IEEE 497-2002 with CORR 1	N/A	I
Containment Pressure Transducer (Wide Range)	RXB	B2	None	AQ-S	IEEE 497-2002 with CORR 1	N/A	I
• Containment Air Temperature (RTDs) • FW Temperature Transducers	RXB	B2	None	AQ-S	None	N/A	II
SGS, Steam Generator System							
• SG tubes • Feedwater plenums • Steam plenums	RXB	A1	N/A	Q	None	A	I
• SG tube supports • Upper and lower SG supports	RXB	A1	N/A	Q	None	N/A	I

Table 3.2-1: Classification of Structures, Systems, and Components (Continued)

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	RTNSS Category (A,B,C,D,E)	QA Program Applicability (Note 2)	Augmented Design Requirements (Note 3)	Quality Group / Safety Classification (Ref RG 1.26 or RG 1.143) (Note 4)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 5)
[[SCB, Security Buildings (Guardhouse)]]							
• Security Building • Vehicle inspection sally port	Yard	B2	None	None	None	N/A	III
[[ANB, Annex Building]]							
Annex Building	Yard	B2	None	None	None	N/A	III
[[DGB, Diesel Generator Building]]							
Diesel Generator Building	Yard	B2	None	None	None	N/A	III
[[CUB, Central Utility Building]]							
Central Utility Building	Yard	B2	None	None	None	N/A	III
[[FWB, Firewater Building]]							
Firewater Building	Yard	B2	None	None	None	N/A	III
CRB, Control Building							
CRB Structure at EL 120′-0″ and below (except as discussed below).	Yard	A1	N/A	Q	None	N/A	I
• CRB Structure above EL 120′-0″ • Inside the CRB elevator shaft and two stairwells, full height of structure • CRB Fire Protection Vestibule (on East Side of CRB)	Yard	B2	None	AQ-S	None	N/A	II
MEMS, Metrology and Environmental Monitoring System							
All components	Yard, CRB	B2	None	AQ	IEEE 497-2002 with CORR 1	N/A	III
COMS, Communication Systems							
All components	Yard for collection of data CRB for display of results	B2	None	None	None	N/A	III
SMS, Seismic Monitoring System							
All components	RXB, CRB	B2	None	AQ-S	None	N/A	I

Note 1: Acronyms used in this table are listed in Table 1.1-1.

Note 2: QA Program applicability codes are as follows:

- Q = indicates quality assurance requirements of 10 CFR 50 Appendix B are applicable in accordance with the quality assurance program (see Section 17.5).
- AQ = indicates that pertinent augmented quality assurance requirements for non-safety related SSCs are applied to ensure that the function is accomplished when needed based on that functionality's regulatory requirements. Note that in meeting regulatory guidance, codes, and standards, those applicable SSCs may also have quality assurance requirements invoked by said guidance (e.g., RG 1.26, RG 1.143, IEEE 497, RG 1.189).
- AQ-S = indicates that the pertinent requirements of 10 CFR 50 Appendix B are applicable to nonsafety-related SSC classified as Seismic Category I or Seismic Category II in accordance with the quality assurance program.
- None = indicates no specific QA program or augmented quality requirements are applicable.

Note 3: Additional augmented design requirements, such as the application of a Quality Group, radwaste safety, or seismic classification, to nonsafety-related SSC are reflected in the columns Quality Group/Safety Classification and Seismic Classification, where applicable.

Note 4: See Section 3.2.2.1 through Section 3.2.2.4 for the applicable codes and standards for each RG 1.26 Quality Group designation A, B, C, and D. A Quality Group classification per RG 1.26 is not applicable to supports or instrumentation. See Section 3.2.1.4 for a description of RG 1.143 classifications for RW-IIa, RW-IIb, and RW-IIc.

Note 5: Where SSC (or portions 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.

Note 6: Provides nonsafety-related backup isolation to a safety-related isolation device. See FSAR Sections 3.9.6.5, 15.0.0.6.6 and Table 3.9-17.

Note 7: Includes all subcomponents of the reactor vessel internals upper riser assembly with the exception of the bellows lateral seismic restraining structure and bellows vertical expansion structure which are listed separately.

The portion of the MSS from the outlets of the MSIVs to the first piping restraint downstream of the MSIVs is nonsafety-related, Seismic Category I, and quality group D. The remainder of the MSS is classified as nonsafety-related, non-seismic, and quality group D. Consistent with Regulatory Guide 1.26, these portions are designed in accordance with the provisions of ASME Power Piping Code Section B31.1. Additional detail of the safety, quality, and seismic classification of the MSS components is provided in Section 3.2.

Main Steam Piping

Figure 10.1-1 depicts the MSS boundaries, including interconnections with other systems.

The two steam lines combine to mix and equalize the output of the two SG coils. Flanges immediately downstream of the MSIVs are provided to enable disconnection of the piping from the NPM in preparation for moving the module for refueling or maintenance. Immediately downstream of the flanges, the MSS lines pass through the secondary MSIV and secondary MSIBVs. Ball-joint type flanges are used downstream of the secondary MSIVs to reduce containment vessel nozzle stress.

The steam lines from six NPMs are then routed inside the RXB toward the center of the building and then exit the building above ground. They are supported on a pipe rack between the RXB and the TGB.

In the TGB, the MSS lines are each routed to their separate turbine generator set.

Secondary Main Steam Isolation Valves

Design parameters and associated values for the secondary MSIVs are provided in Table 10.3-1.

RAI 06.02.04-6S1, RAI 15.06.03-2

Each secondary MSIV is provided with two independent actuator control systems to ensure successful performance of the secondary MSIV function, assuming a single failure. In response to a main steam isolation signal, the secondary MSIVs automatically close. The secondary MSIVs are capable of closing in steam conditions.

RAI 15-17S1

The nonsafety-related secondary MSIVs are used for event mitigation as backup protection for the safety-related MSIVs as described in Section 15.0.0.6.6. The secondary MSIV is a commercially available valve that utilizes a proven design and demonstrates reliable operation based on operating experience in steam systems. A design with no previous operating experience may be proven through testing to demonstrate that the valve can reliably close within the required time specified in Table 10.3-1 at full power steam flow and pressure conditions.

RAI 15-17S1

Each secondary MSIV is periodically tested in accordance with the Augmented Valve Testing Program described in FSAR Section 3.9.6.5. These valves are designed with the

capability to periodically test the operability of the valve and associated apparatus, and to determine if valve leakage is within acceptable limits. Each secondary MSIV is seat leakage tested in the forward and reverse flow directions by the valve supplier. ~~Periodic leak testing of each secondary MSIV is performed as described in Section 3.9.~~ Valve functions and periodic testing requirements are specified in FSAR Table 3.9-17.

Secondary Main Steam Isolation Bypass Valves

RAI 15-17S1

Each of the two secondary MSIVs has a bypass valve that may be used for pressure equalization and warming during NPM startup. The secondary MSIBVs are normally closed and are Seismic Category I, quality group D, ASME B31.1 components. An isolation valve is provided to allow secondary MSIV maintenance, and a safety valve is provided on the bypass line for overpressurization protection. The nonsafety-related secondary MSIBVs are used as backup protection for the safety-related MSIBVs as described in Section 15.0.0.6.6. The secondary MSIBV is a commercially available valve that utilizes a proven design and demonstrates reliable operation based on operating experience in steam systems. A less proven design can be utilized with qualification testing to demonstrate that the valve can reliably close within the time specified in Table 10.3-1 at full power steam flow and pressure conditions.

RAI 15-17S1

Each secondary MSIBV is periodically tested in accordance with the Augmented Valve Testing Program described in FSAR section 3.9.6.5. Valve functions and periodic testing requirements are specified in FSAR Table 3.9-17.

Main Steam Safety Valve

The MSS piping is protected from overpressure by the use of 2 MSSVs located in the main steam header at the [[TGB wall]]. The MSSVs exhaust steam to the atmosphere outside the TGB.

Condensate Drains

The main steam piping layout provides for the collection and drainage of condensate to avoid water entrainment. The MSS lines are sloped in the direction of steam flow. Drains are located and sized to allow the removal of water prior to and during initial rolling of the turbine and during MSS shutdown. Condensate from the MSS drains is routed to the main condenser.

10.3.2.3 System Operation

NuScale Power Module and Main Steam System Startup

The MSS startup coincides with startup of the associated NPM. Prior to reactor heat-up, the secondary MSIBVs are opened and the entire MSS is warmed at once. Condenser vacuum is established and MSS heat-up is controlled by turbine bypass (Section 10.4.4) to the main condenser. During plant startup, condensate is generated in the main

RAI 15-17S1

Table 10.3-1: Main Steam System Design Data (Single NuScale Power Module)

Design Parameter	Rated Conditions
Full power steam flow	
Total	532,100 lbm/hr
Design Conditions	
Design pressure upstream/downstream of the secondary MSIVs	2100 psia/ 1000 psia
Design temperature	650 °F
Operating Conditions	
Pressure at rated power	500 psia
Temperature at rated power	575 °F
Secondary Main Steam Isolation Valves	
Number per main steam line	1
Total number of valves / valve type	2/ gate valve
Valve size	12 in.
Design code	ASME B31.1
Seismic Category	I
Actuator System	hydraulic or pneumatic
Closure speed	Within ~~5~~7 seconds
Secondary Main Steam Isolation Bypass Valves	
Number per main steam line	1
Total number of valves	2
Valve size	4 in.
Design code	ASME B31.1
Seismic Category	I
Actuator System	Air operated
Closure speed	Within ~~10~~7 seconds
Main Steam Safety Valves	
Total number of valves	2
Valve size	4 in. (inlet), 6 in. (outlet)
Valve capacity	Greater than 50% of design steam flow

Feedwater heaters preheat the feedwater before returning to the steam generators. This improves the thermodynamic efficiency of the system, reduces plant operating costs, and helps reduce thermal stress on the steam generators.

Condensate is progressively warmed in the tube side of successive FWHs by turbine extraction steam. The FWHs can be isolated and have a full-flow bypass.

Level in each of the FWHs is automatically controlled using a modulating drain control valve on the downstream heater.

Feedwater Heater Vents and Drains

The heater vents and drains subsystem manages the condensing extraction steam flow through the shell side of the FWHs. Cascading drains flow by gravity to the condenser. Drain coolers are used to remove excess heat. Each FWH is individually vented to the condenser.

Feedwater Pumps

Three feedwater pumps are located downstream of the low-pressure feedwater heater (LP-FWH) and the intermediate-pressure FWH (IP-FWH), and upstream of the HP-FWH. Feedwater pump flow is monitored for each pump with minimum flow protection provided through a dedicated recirculation line sized for the pump required minimum flow. The feedwater pumps and pump control system are designed so that the trip of one feedwater pump does not result in a turbine generator trip or reactor trip. Standby feedwater pumps are provided with autostart capability on low pressure or pump trip.

Feedwater Regulating Valves

The FWRVs are used during normal and transient operation to control and equalize feedwater flow to the steam generators. The FWRVs are located in the RXB and are upstream of the FWIVs.

RAI 15.01.01-7

Normal control of the FWRVs is through the MCS. In off-normal conditions the MPS overrides normal control of the valves and can force closure. Each FWRV is designed to fail closed on loss of power or control signal, regardless of the operating mode, and performs a feedwater isolation function as a backup to the FWIV. As such, the FWRVs meet the same flow requirements as the FWIVs.

RAI 15-17S1

The nonsafety-related FWRVs are used for event mitigation as backup protection for the safety-related FWIVs as described in Section 15.0.0.6.6. The FWRV is a commercially available valve that utilizes a proven design and demonstrates reliable operation based on operating experience in feedwater systems. A design with no previous operating experience may be proven through testing to demonstrate that the valve actuates as expected at operating conditions.

RAI 15-17S1

Each secondary FWRV is periodically tested in accordance with the Augmented Valve Testing Program described in FSAR Section 3.9.6.5. Valve functions and periodic testing requirements are specified in FSAR Table 3.9-17.

Feedwater Check Valves

Two check valves are installed in each feedwater line. Both feedwater check valves prevent reverse flow from the steam generators whenever the feedwater system is not in operation and are designed to withstand the forces of closing after a CFWS line rupture.

The first check valve is upstream of and integral with the FWIV, providing backflow prevention. The second is downstream of the FWRV and is provided for secondary backflow prevention.

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The nonsafety-related secondary FW check valves are used for event mitigation as backup protection for the safety-related FW check valves as described in Section 15.0.0.6.6. The secondary FW check valve is a commercially available valve that utilizes a proven design and demonstrates reliable operation based on operating experience in water systems. A design with no previous operating experience may be proven through testing to demonstrate that the valve actuates as expected at operating conditions.

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Each secondary FW check valve is periodically tested in accordance with the Augmented Valve Testing Program described in FSAR Section 3.9.6.5. Valve functions and periodic testing requirements are specified in FSAR Table 3.9-17.

Condensate and Feedwater Piping

The CFWS piping layout between components is shown in Figure 10.1-1. The CFWS and SG design include features that minimize the potential for water hammer and subsequent effects. Additional detail is provided in Section 3.6.3.

The CFWS piping meets ASME B31.1 (Reference 10.4-5) requirements. CFWS piping materials are further described in Section 10.3.6 and descriptions of piping and support design are provided in Section 3.6.

The design of the CFWS incorporates considerations to prevent the occurrence of erosion and corrosion. These considerations include material selection, limits on flow velocity, inspection programs, and limits on water chemistry to reduce FAC, erosion, and corrosion of piping and piping components. See Section 10.3.6 for a discussion of FAC.

Nonsafety-related equipment may be used for event mitigation for the following two circumstances:

- when a detectable and nonconsequential random and independent failure must occur in order to disable the system
- when nonsafety-related components are used as backup protection.

There are three occurrences where nonsafety-related equipment is credited for event mitigation because the nonsafety-related component is used for backup protection. Listed below is the equipment associated with these occurrences. Table 15.0-9 identifies the events in which nonsafety-related equipment is credited for event mitigation.

1) The nonsafety-related secondary main steam isolation valve (MSIV) serves as the backup isolation device to the safety-related MSIV for isolation of the main steam piping penetrating containment when the safety-related MSIV is assumed to fail.

2) The nonsafety-related feedwater regulating valve (FWRV) serves as the backup isolation device to the safety related feedwater isolation valve (FWIV) for isolation of the feedwater system (FWS) piping penetrating the containment when the FWIV is assumed to fail.

3) The nonsafety-related feedwater check valve serves as the backup isolation device to the safety-related feedwater check valve for isolation of the DHRS when reverse flow is experienced during a break in the FWS piping.

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The nonsafety-related secondary main steam bypass isolation valve (MSIBV) serves a similar function. The nonsafety-related MSIBV serves as a backup isolation device to the safety-related MSIBV for isolation of the main steam piping penetrating containment. Since the MSIBVs are only used during initial startup operations (e.g. for heatup the main steam lines) and are closed during power operations, failure of the safety related MSIBV is not considered in safety analyses. In addition, failure of an MSIV bounds MSIBV failure as the MSIV is a larger valve. So the nonsafety-related MSIBV is not credited for event mitigation based on potential failure of the safety-related MSIBVs and for these reasons the nonsafety-related MSIBV is not identified in Table 15.0-9 as nonsafety-related equipment credited for event mitigation.

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Classification information for the secondary MSIVs, MSIBVs, FWRVs, and the nonsafety-related feedwater check valves are listed in Section 3.2, Table 3.2-1. The secondary MSIVs and MSIBVs are described in Section 10.3.2. The FWRVs and nonsafety-related feedwater check valves are described in Section 10.4.7.

The reactor pool liner, described in Section 9.2.5, is a nonsafety-related component of the reactor pool used as the ultimate heat sink (UHS). Section 9.2.5 describes how the pool liner meets the criteria for event mitigation in that water leakage