RAIO-1217- 57719

December 15, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 265 (eRAI No. 9117) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 265 (eRAI No. 9117)," dated October 17, 2017

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

The Enclosure to this letter contains NuScale's response to the following RAI Questions from NRC eRAI No. 9117:

- 10.04.06-1
- 10.04.06-2
- 10.04.06-3
- 10.04.06-4
- 10.04.06-5
- 10.04.06-6

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 Carrie Fosaaen at 541-452-7126 or at cfosaaen@nuscalepower.com.

Sincerely,

Jennie Wike
Manager, Licensing
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Demetrius Murray, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9117

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9117

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

eRAI No.: 9117
Date of RAI Issue: 10/17/2017

NRC Question No.: 10.04.06-1

Regulatory Basis (applies to all questions in this RAI):

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria (GDC) 14 requires assurance that the **reactor coolant pressure boundary (RCPB) have an extremely low probability of abnormal leakage, rapidly propagating failure, and of gross rupture.** 10 CFR Part 52.47 requires that a standard design certification submitted for approval under 10 CFR Part 52 shall "contain a level of design information sufficient to enable the Commission … to reach a final conclusion on all safety questions associated with the design." As described below the staff finds that the NuScale application does not include necessary information for the staff to reach a safety finding.

DCD Tier 2, FSAR 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°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.

NUREG-0800, "Standard Review Plan [SRP] for Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 10.4.6, "Condensate Cleanup System," Revision 3, states that following the latest version of the Electric Power Research Institute "Pressurized Water Reactor [PWR] Secondary Water Chemistry Guidelines" (EPRI Guidelines), is one way to meet the requirements of GDC 14 with respect to an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture of the RCPB.

After reviewing the proposed secondary water chemistry monitoring parameters found in the NuScale FSAR against the EPRI Guidelines, the NRC staff has the following questions:

a. The "Normal Values" in NuScale Final Safety Analysis Report (FSAR) Table 10.3-3a appear to be incorrect. The "Normal Values" listed in the NuScale FSAR appear to be the values that should not be exceeded during normal operation and would require action to correct (i.e., normal chloride concentration should be below 1000 ppb). Either correct the values or change the heading on the table to show that these values are the limits past which action would be required to correct water chemistry.

b. Hydrazine concentration should be controlled during the initial fill of the steam generator (SG) subsequent to a shutdown. However, this control was not found in the NuScale FSAR. Either include the justification for not controlling hydrazine during initial fill of the SG, or include hydrazine as a parameter in the FSAR for initial fill of the SG.
c. The control parameters and associated limits for RCS > 200ºF to Reactor Critical at <15% Reactor Power Blowdown Sample, cannot be found in the NuScale FSAR. Provide the secondary water chemistry limits for the control parameters at this reactor mode.
d. In the NuScale FSAR, there is no discussion or list of the Action Level limits for any of the control parameters listed in the FSAR Tables 10.3-3a through d. What are the Action Level limits for Action Levels 1, 2, and 3 for the control parameters listed in the NuScale FSAR Tables listed above?
e. In DCD Tier 2, FSAR Section 10.4.6.1 it states that the NuScale design is "consistent" with the GDC. Clarify whether the NuScale design meets GDC 14 and if GDC 14 is part of the licensing basis for the NuScale Condensate Polishing System (CPS) design.

NuScale Response:

Question (a):

FSAR Table 10.3-3a has been corrected to indicate the acceptable operating limits.

Question (b):

New FSAR Table 10.3-3e, Steam Generator Fill water (initial fill subsequent to a shutdown), has been added to the DCA to address the hydrazine requirements for SG initial fill water subsequent to a shutdown.

Question (c):

As noted in FSAR Section 10.4.8, Steam Generator Blowdown System, the NuScale SG design does not use a SG blowdown system. Samples of SG blowdown are not applicable to the design. Samples of the feedwater will be monitored in accordance with Table 10.3-3b, Feedwater Sample (Reactor Coolant System >200ºF to <15% reactor power), to control impurity ingress to the steam generators.

Question (d):

COL action item 10.3-1 requires development of a site specific chemistry program consistent with the current revision of the EPRI PWR Secondary Water Chemistry Guidelines when the

COL is issued. The site specific chemistry program will contain site operating procedures that will define the parameters, frequencies, limits, Action Levels and responses consistent with the current EPRI PWR Secondary Water Chemistry Guidelines.

Question (e):

As noted in FSAR Section 10.4.6.3, General Design Criterion 14 was considered in the design of the condensate polishing system. Consistent with GDC 14, the design of the CPS provides the means to maintain acceptable secondary water chemistry as discussed in the EPRI report series, "PWR Secondary Water Chemistry Guidelines."

Impact on DCA:

Table 10.3-3e has been added and Table 10.3-3a has been revised as described in the response above and as shown in the markup provided in this response.

Table 10.3-3a: Steam Generator (Reactor Coolant System ≤ 200°F)

Parameter	Normal Value	Value Necessary Prior to Heatup Above >200°F
pH @ 25°C	≤≥9.8	-
Hydrazine[a], ppm	<≥25	>3 x oOxygen (ppm)
Sodium, ppb	>≤1000	≤100
Chloride, ppb	>≤1000	≤100
Sulfate, ppb	>≤1000	≤100
Diagnostic Parameters		**Analysis Basis**
Nitrogen overpressure, psig		Minimize oxygen ingress to the SGs
Hideout return Analysis (Na, Cl, SO_4, SiO_2, K, Mg, Ca, Al)		Assessment of steam generator impurity deposition

Notes:

a) Alternative oxygen scavenger to hydrazine (if used) must be qualified by the utility prior to use. Revised limits applicable to the hydrazine alternative will be used.

RAI 02.04.13-1, RAI 03.04.02-1, RAI 03.04.02-2, RAI 03.04.02-3, RAI 03.05.01.04-1, RAI 03.05.02-2, RAI-03.06.02-15, RAI 03.07.01-2, RAI 03.07.01-3, RAI 03.07.02-8, RAI 03.07.02-12, RAI 03.09.02-15, RAI 03.09.02-48, RAI 03.09.03-12, RAI 03.09.06-5, RAI 03.09.06-6, RAI 03.09.06-16, RAI 03.09.06-27, RAI 03.11-8, RAI 03.11-14, RAI 03.13-3, RAI 06.04-1, RAI 09.01.02-4, RAI 09.01.05-3, RAI 09.01.05-6, RAI 09.03.02-3, RAI 09.03.02-4, RAI 09.03.02-5, RAI 09.03.02-6, RAI 09.03.02-8, RAI 10.02-1, RAI 10.02-2, RAI 10.03.06-1, RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3, RAI 10.04.10-2, RAI 13.01.01-1, RAI 13.01.01-1S1, RAI 13.02.02-1, RAI 13.03-4, RAI 13.05.02.01-2, RAI 13.05.02.01-2S1, RAI 13.05.02.01-3, RAI 13.05.02.01-3S1, RAI 13.05.02.01-4, RAI 13.05.02.01-4S1, RAI 19-31

Table 1.8-2: Combined License Information Items

Item No.	Description of COL Information Item	Section
COL Item 1.1-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will identify the site-specific plant location.	1.1
COL Item 1.1-2:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will provide the schedules for completion of construction and commercial operation of each power module.	1.1
COL Item 1.4-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will identify the prime agents or contractors for the construction and operation of the nuclear power plant.	1.4
COL Item 1.7-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will provide site-specific diagrams and legends, as applicable.	1.7
COL Item 1.7-2:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will list additional site-specific P&IDs and legends as applicable.	1.7
COL Item 1.8-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will provide a list of departures from the certified design.	1.8
COL Item 1.9-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will review and address the conformance with regulatory criteria in effect six months before the docket date of the COL application for the site-specific portions and operational aspects of the facility design.	1.9
COL Item 1.10-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will evaluate the potential hazards resulting from construction activities of the new NuScale facility to the safety-related and risk significant structures, systems, and components of existing operating unit(s) and newly constructed operating unit(s) at the co-located site per 10 CFR 52.79(a)(31). The evaluation will include identification of any management and administrative controls necessary to eliminate or mitigate the consequences of potential hazards and demonstration that the limiting conditions for operation of an operating unit would not be exceeded. This COL item is not applicable for construction activities (build-out of the facility) at an individual NuScale Power Plant with operating NuScale Power Modules.	1.10
COL Item 2.0-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will demonstrate that site-specific characteristics are bounded by the design parameters specified in Table 2.0-1. If site-specific values are not bounded by the values in Table 2.0-1, the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of its combined license application.	2.0
COL Item 2.1-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will describe the site geographic and demographic characteristics.	2.1
COL Item 2.2-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will describe nearby industrial, transportation, and military facilities. The COL applicant will demonstrate that the design is acceptable for each potential accident, or provide site-specific design alternatives.	2.2
COL Item 2.3-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will describe the site-specific meteorological characteristics for Section 2.3.1 through Section 2.3.5, as applicable.	2.3
COL Item 2.4-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will investigate and describe the site-specific hydrologic characteristics for Section 2.4.1 through Section 2.4.14, as applicable.	2.4

Table 1.8-2: Combined License Information Items (Continued)

Item No.	Description of COL Information Item	Section
COL Item 9.5-1:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will provide a description of the offsite communication system, how that system interfaces with the onsite communications system, as well as how continuous communications capability is maintained to ensure effective command and control with onsite and offsite resources during both normal and emergency situations.	9.5
COL Item 9.5-2:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will determine the location for the security power equipment within a vital area in accordance with 10 CFR 73.55(e)(9)(vi)(B).	9.5
COL Item 10.2-1:	~~A COL Applicant that references the NuScale Power Plant design certification will identify the specific turbine vendor and provide a description of the turbine and control system design.~~Not used.	10.2
COL Item 10.2-2:	~~A COL Applicant that references the NuScale Power Plant design certification will describe how the functional requirements for turbine overspeed are met for the vendor specific turbine design and will provide a schematic of the turbine control system and protection systems.~~Not used.	10.2
COL Item 10.2-3:	A COL ~~Applicant~~applicant that references the NuScale Power Plant design certification will perform an evaluation of the probability of turbine missile generation. The report provides a calculation of the probability of turbine missile generation using established methods and industry guidance applicable to the fabrication technology employed. The analysis is a comprehensive report containing a description of turbine fabrication methods, material quality and properties, and required maintenance and inspections that addresses: a) the calculated probability of turbine missile generation from material and overspeed related failures based on as-built rotor and blade designs and asbuilt material properties (as determined in certified testing and nondestructive examination). b) maximum anticipated speed resulting from a loss of load, assuming normal control system function without trip. c) overspeed basis and overspeed protection trip setpoints. d) discussion of the design and structural integrity of turbine rotors. e) an analysis of potential degradation mechanisms (e.g., stress corrosion cracking, pitting, low-cycle fatigue, corrosion fatigue, erosion and erosioncorrosion), and any specific maintenance or operating requirements necessary for mitigation. f) material properties (e.g., yield strength, stress-rupture properties, fracture toughness, minimum operating temperature of the high-pressure turbine rotor) and the method of determining those properties. g) required preservice test and inspection procedures and acceptance criteria to support calculated turbine missile probability. h) actual maximum tangential and radial stresses and their locations in the turbine rotor. i) rotor and blade design analyses, including loading combinations, assumptions and warmup time, that demonstrate sufficient safety margin to withstand loadings from postulated overspeed events up to 120 percent of rated speed. j) description of the required inservice inspection and testing program for valves essential to overspeed protection and any inservice tests, inspections, and maintenance activities for the turbine and valve assemblies that are required to support the calculated missile probability, including inspection and test frequencies with technical bases, type of inspection, techniques, areas to be inspected, acceptance criteria, disposition of reportable indications, and corrective actions.	10.2
COL Item 10.3-1:	A COL ~~Applicant~~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 PWR Secondary Water Chemistry Guidelines and NEI 97-06 at the time of the COL application.	10.3

RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3

Table 9.3.2-3: Secondary Sampling System Normal Sample Points

Sample Point	System	Process Fluid Type	Sampling Method	Analysis(1)
Condensate and feedwater system (CFWS) feedwater line to steam generators (SGs)	CFWS	liquid	continuous semi-continuous(2) grab	specific conductivity, cation conductivity, pH, hydrazine, silica, sodium chloride, sulfate pH agent, suspended solids
Condensate pump discharge line	CFWS	liquid	continuous	specific conductivity, cation conductivity, pH, dissolved oxygen
Individual condensate polisher (i.e., demineralizer) outlet	CFWS	liquid	continuous semi-continuous(2)	specific conductivity, cation conductivity, sodium, dissolved oxygen chloride, sulfate, sodium
Main steam system (MSS) line from SG 1	MSS	steam	continuous semi-continuous(2) grab	cation conductivity, specific conductivity chloride, sulfate, sodium
MSS line from SG 2	MSS	steam	continuous semi-continuous(2) grab	cation conductivity, specific conductivity chloride, sulfate, sodium
Main steam bypass line from SG 1 (3)	MSS	liquid	continuous semi-continuous(2) grab	cation conductivity, specific conductivity chloride, sulfate, sodium pH, hydrazine
Main steam bypass line from SG 2 (3)	MSS	liquid	continuous semi-continuous(2) grab	cation conductivity, specific conductivity chloride, sulfate, sodium pH, hydrazine
Auxiliary boiler system (ABS) feedwater line	ABS	liquid	grab	
ABS feedwater line	ABS	liquid	grab	
ABS steam discharge line	ABS	steam	grab	
ABS blowdown lines	ABS	steam	grab	
ABS high pressure boiler condensate collection tank	ABS	liquid	grab	

Notes:
1. Specific analyses, limits, and monitoring frequencies will be specified in plant procedures.
2. Semi-continuous sampling is performed by the applicable ion chromatography analysis unit provided as part of the SSS.
3. Main steam bypass line sample points are intended to be used during wet layup, startup, and shutdown to monitor SG water chemistry.

RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3, RAI 12.03-2, RAI 12.03-3

Table 9.3.2-4: Local Sample Points

Sample Point	System	Process Fluid Type	Sampling Method	Analysis(1)
ABS steam discharge line (downstream of boilers)	ABS	steam	continuous	pH, cation conductivity
ABS feedwater line (at pump discharge)	ABS	liquid	continuous	pH, hydrazine, dissolved oxygen
Boron addition system (BAS) boric acid storage tank	BAS	liquid	grab	
Boric acid batch tanks	BAS	liquid	grab	
Condenser air removal system (CARS) seal water separator tank vent line	CARS	gas	grab	
CES sample vessel liquid discharge line	CES	liquid	grab	
CES particulate, iodine, and noble gas radiation monitoring skid	CES	gas	grab	hydrogen, oxygen, radionuclides
Circulating water system (CWS) cooling tower basin	CWS	liquid	grab	
CFWS high pressure feedwater heater discharge line	CFWS	liquid	continuous grab	dissolved oxygen~~, iron~~ total iron(2)
Main condenser hotwell	CFWS	liquid	continuous grab	sodium, cation conductivity
Combined polisher effluents	CFWS	liquid	grab	
Feedwater discharge from low pressure feedwater heater	CFWS	liquid	grab	
Feedwater discharge from intermediate pressure feedwater heater	CFWS	liquid	grab	
Demineralized water system (DWS) storage tank	DWS	liquid	grab	radionuclides
Gaseous radioactive waste system (GRWS) moisture separator discharge	GRWS	gas	continuous grab	oxygen, hydrogen
GRWS effluent release to plant exhaust	GRWS	gas	continuous grab	oxygen
Liquid radioactive waste system (LRWS) low conductivity waste collection tanks	LRWS	liquid	grab	
Low conductivity waste sample tanks	LRWS	liquid	grab	
Treated liquid waste effluent discharge line	LRWS	liquid	grab	
High conductivity waste collection tanks	LRWS	liquid	grab	
High conductivity waste sample tanks (2 sample points total; one per tank)	LRWS	liquid	grab	
Detergent waste collection tank	LRWS	liquid	grab	
LRWS low conductivity waste process skid effluent line	LRWS	liquid	grab	radionuclides, tritium
High conductivity waste processing skid effluent line	LRWS	liquid	grab	radionuclides, tritium
Upstream of module heatup system (MHS) heat exchangers	MHS	liquid	grab	
Reactor pool cooling system (RPCS) effluent to pool cleanup system	RPCS	liquid	grab	
Spent fuel pool cooling system (SFPCS) effluent to pool cleanup system	SFPCS	liquid	grab	
Pool cleanup system (PCUS) demineralizer influent	PCUS	liquid	grab	
PCUS effluent	PCUS	liquid	grab	

Table 9.3.2-4: Local Sample Points (Continued)

Sample Point	System	Process Fluid Type	Sampling Method	Analysis(1)
Pool surge control system (PSCS) tank (at tank discharge line)	PSCS	liquid	grab	
Reactor component cooling water system (RCCWS) common return lines	RCCWS	liquid	grab	radionuclides, tritium
RCCWS drain lines of individual components being cooled	RCCWS	liquid	grab	radionuclides
Radioactive waste drain system (RWDS) sump tanks; one sample point per each sump tank)	RWDS	liquid	grab	
Reactor Building chemical drain tank	RWDS	liquid	grab	
Reactor Building RCCWS drain tank	RWDS	liquid	grab	
Site cooling water system (SCWS) discharge line to central utility building	SCWS	liquid	grab	
SCWS discharge lines to utility water system discharge basin	SCWS	liquid	continuous grab	conductivity, pH, chlorine, and corrosion inhibitors, radionuclides, tritium
SCWS cooling tower basin	SCWS	liquid	continuous grab	pH, total dissolved solids, chlorine radionuclides, tritium
SCWS supply lines to reactor pool cooling heat exchangers	SCWS	liquid	grab	
Upstream of filters on SCWS return lines from reactor pool cooling heat exchangers	SCWS	liquid	grab	
Downstream of filters on SCWS return lines from reactor pool cooling heat exchangers	SCWS	liquid	grab	
SCWS supply lines to SFPC heat exchangers	SCWS	liquid	grab	
Upstream of filters on SCWS return lines from SFPC heat exchangers	SCWS	liquid	grab	
Downstream of filters on SCWS return lines from SFC heat exchangers	SCWS	liquid	grab	
SCWS supply lines from RCCW heat exchangers	SCWS	liquid	grab	
Upstream of filters on SCWS return lines from RCCW heat exchangers	SCWS	liquid	grab	
Downstream of filters on RCCW return lines from reactor pool cooling heat exchangers	SCWS	liquid	grab	
Solid radioactive waste system (SRWS) phase separator tank discharge line to dewatering skid	SRWS	liquid	grab	
Turbine generator system (TGS) gland steam condenser exhaust	TGS	gas	grab	
Utility water system (UWS) discharge basin	UWS	liquid	grab	radionuclides, tritium
Utility water system (UWS) between UWS supply pump header and UWS distribution header	UWS	liquid	grab	radionuclides, tritium

Notes:
1. Specific analyses, limits, and monitoring frequencies will be specified in plant procedures.
2. Total iron is collected using integrated sampling.

in the design of the MSS. Consistent with 10 CFR 52.47(a)(6), the MSS is designed to meet the requirements of 10 CFR 20.1406 as it relates to minimizing contamination of the facility. Further discussion of the facility design features to protect against contamination is provided in Section 12.3.

The requirements of 10 CFR 50.63 were considered in the design of the MSS. The nonsafety-related portion of the MSS is not relied upon to operate in response to an SBO to satisfy 10 CFR 50.63. Rather, the DHRS operates in conjunction with the ultimate heat sink to fulfill the core cooling function in the event of an SBO. Successful operation of the DHRS relies on the safety-related MSIVs, which form part of the DHRS flowpath and pressure boundary. The secondary MSIVs provide backup to the MSIVs, thus are also required to fail closed during an SBO. This functionality is ensured with or without the availability of electrical power. Conformance with 10 CFR 50.63 and the guidelines of Regulatory Guide 1.155 are discussed in Section 8.4.2.

10.3.4 Inspections and Tests

The MSS components are inspected and tested as part of preoperational and startup tests, and are within the scope of the initial test program described in Section 14.2. Nonsafety-related MSS piping and components are inspected and tested in accordance with the requirements of ASME B31.1.

The proposed Inspections, Tests, Analyses, and Acceptance Criteria required by 10 CFR 52.47(b)(1) and 10 CFR 52.80(a) are discussed in Section 14.3.

10.3.5 Water Chemistry

10.3.5.1 Chemistry Control Program

The SG water and feedwater quality requirements are based on current water chemistry technology reflected in EPRI chemistry guidelines (Reference 10.3-1 and Reference 10.3-2) and NEI 97-06 (Reference 10.3-3).

Consistent with this guidance, the secondary water chemistry control program includes control and diagnostic parameters, and associated action limits. Additional control and diagnostic parameters have been included as appropriate based on industry experience and other available information.

The secondary water chemistry control program is implemented by plant operating procedures, which control the recording and management of data, and require appropriate corrective actions in response to abnormal chemistry conditions.

RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3

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 PWR Secondary Water Chemistry Guidelines and NEI 97-06 at the time of the COL application.

10.3.5.1.1 Chemistry Control Objectives and Basis

The objectives of the secondary water chemistry program are:

- to protect the steam generators, turbine, and FWS from general and localized corrosion caused by the ingress of oxygen and other chemical contaminants
- to minimize the metal release rate from the steam-water cycle materials in order to reduce the transport of corrosion products into the steam generators

The secondary chemistry program addresses these objectives by controlling system pH, controlling the amount of oxidants and minimizing the amount of contaminants in the system. Water chemistry recommendations for secondary systems invoke plant and operational philosophies that address the control of corrosion products and dissolved impurities by minimizing potential sources, and by implementing effective monitoring. Secondary system components and piping exposed to wet steam, flashing liquid flow, or turbulent single-phase flow where significant loss of material could occur use corrosion, erosion, and flow-accelerated corrosion (FAC) resistant materials. The degree of resistance of the material to FAC, corrosion, and erosion is consistent with specific conditions of the fluid stream involved.

Copper deposits are a major source of corrosion products in the steam generators in plants with copper alloys in their secondary system. The elimination of copper from the secondary system mitigates copper transport to the steam generators. The use of all ferrous materials allows the implementation of a higher feedwater pH target compared to systems that use copper. The use of a higher feedwater pH reduces iron corrosion and iron transport to the steam generators. Therefore, emphasis is placed on excluding copper and copper alloy pipe, valves, and components from the secondary chemistry environment.

10.3.5.1.2 Water Chemistry Treatment and Monitoring

RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3

The secondary water chemistry control program includes methods of treatment for corrosion control and proposed specification limits such that the barrier between the primary and secondary fluids maintains its integrity during operation (including design basis accidents), maintenance, and testing. Guidelines for secondary side water chemistry are addressed in Table 10.3-3a through Table 10.3-3e~~Table 10.3-3d~~.

An all-volatile treatment amine, such as ammonium hydroxide is added to the feedwater to establish an optimum pH level. Hydrazine is also added to control the residual dissolved oxygen concentration and to maintain a passive protective film of magnetite on carbon steel surfaces.

10.3.5.1.3 Chemistry Sampling

The secondary system for each NPM is designed to allow for chemistry sampling and analysis, both continuous and grab samples, from selected locations to

RAI 10.04.06-1, RAI 10.04.06-2, RAI 10.04.06-3

Table 10.3-3e: Steam Generator Fill Water (initial fill subsequent to a shutdown)

Control Parameter	Normal Value	Frequency
Hydrazine (ppm)[(a)]	>3 times fill water oxygen (ppm)[(b)]	Prior to and/or during the fill

Notes:

a) Deoxygenated condensate is typically used to fill the steam generators following shutdown, feed and bleed operations, or refill operations occurring while the condensate and feedwater system is connected to the module. An alternate source of fill water that is oxygenated may be used to fill the steam generators if actions are taken to minimize oxygen exposure to the SG tubes. These actions may include nitrogen sparging or the treatment of the fill water with an approved oxygen scavenger (e.g., hydrazine). The oxygen scavenger may be added to the fill water or directly to the SG using batch additions prior to recirculation.

b) This value may be determined by calculation or measurement.

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

eRAI No.: 9117
Date of RAI Issue: 10/17/2017

NRC Question No.: 10.04.06-2

DCD Tier 2, FSAR Section 9.3.2, “Process Sampling System,” describes the sampling for liquid and gaseous streams in both the primary and secondary systems. This section also describes the components for monitoring and analyzing the samples.

NUREG-0800, Section 10.4.6, Revision 3,states that the condensate cleanup system should have adequate instrumentation to monitor the effectiveness of the system.

The NRC staff has reviewed FSAR Sections 9.3.2, and 10.4.6, “Condensate Polishing System,” to determine if adequate instrumentation exists to ensure that secondary water chemistry impurity levels can be maintained by the CPS. The staff has the following question:

> FSAR Table 9.3.2-3, “Secondary Sampling System Normal Sample Points,” does not appear to include samples for several constituents (e.g., iron, silica, etc.) listed as control parameters in Section 10.3.5, “Water Chemistry.” Provide the sample points, and frequencies for all secondary water chemistry control parameters. In addition, update the DCD Tier 2 FSAR as necessary to confirm the sampling frequencies and locations are within the values set in the EPRI Guidelines.

NuScale Response:

FSAR Table 9.3.2-3 and Table 9.3.2-4 have been revised to include the additional control parameters with their sample points. Silica is included in FSAR Table 9.3.2-3 under the CFWS sample point for continuous analysis and iron is included in FSAR Table 9.3.2-4 under the CFWS sample point for continuous analysis. The sample frequency for the control and diagnostic parameters will be specified in the secondary chemistry control program per COL Item 10.3-1.

Impact on DCA:

FSAR Table 9.3.2-3 and Table 9.3.2-4 have been revised as described in the response above and as shown in the markup provided with the response to question 10.04.06-1.

NuScale Power

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

eRAI No.: 9117
Date of RAI Issue: 10/17/2017

NRC Question No.: 10.04.06-3

In DCD Tier 2, FSAR Section 10.3.5, the applicant proposed COL Item 10.3-1. This COL Item states that COL applicants referencing the NuScale DCD will provide a site-specific chemistry control program based on the EPRI Guidelines and NEI 97- 6. As noted in SRP Section 10.4.6, the site-specific chemistry control program should be based on the latest revision of the EPRI Guidelines at the time of the COL application. Revise the COL item to state that the site-specific chemistry control program will be developed in accordance with the latest revision of the EPRI Guidelines at the time of the COL application.

NuScale Response:

Combined License (COL) Item 10.3-1 has been revised to state that the site-specific chemistry control program will be based on the latest revision of the EPRI Guidelines at the time of the COL application. The words "based on" in COL Item 10.3-1 are consistent with the wording used in FSAR Section 5.2.3.2.1, “Reactor Coolant Chemistry” which was transmitted by letter LO-0817-55223 on August 3, 2017 (Accession No. ML17215A977). The wording "based on" was used in Section 5.2.3.4 of NUREG-2124, Volume 1, "Final Safety Evaluation Report Related to the Combined Licenses for Vogtle Electric Generating Plant, Units 3 and 4."

The context of the wording “based on the latest revision of the EPRI guidelines at the time of the COL application” means that the individual plant will develop a plant specific Strategic Water Chemistry Plan to meet the sole “mandatory” requirement of the EPRI guidelines. In addition, the "shall" monitoring requirements and the "recommended" monitoring requirements (control and diagnostic parameters) will be implemented by plant operating procedures. Deviations to the EPRI guidelines will be addressed as directed by the EPRI Guidelines in Chapter 1 (Reference 10.4-3), which states, “Deviations to mandatory and shall requirements shall be handled in accordance with the guidance in the current revision of the Steam Generator Management Program (SGMP) Administrative Procedures. Additionally, these Guidelines recommend that any exception to a recommended element (see Chapter 8) be documented in the Strategic Water Chemistry Plan (see Section 4.1.1).”

Impact on DCA:

FSAR Section 10.3.5 and FSAR Table 1.8-2 have been revised as described in the response above and as shown in the markup provided with the response to question 10.04.06-1.

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

eRAI No.: 9117
Date of RAI Issue: 10/17/2017

NRC Question No.: 10.04.06-4

NUREG-0800, Section 10.4.6, Revision 3, states that the reviewer should ensure that the CPS has adequate condensate cleanup capacity.

In DCD Tier 2, FSAR Section 10.4.6, a condensate polisher resin regeneration system is briefly discussed. However, there is very limited information on the operation of the system, as well as how it connects to the rest of the CPS. Because the operation of the resin regeneration system impacts the condensate cleanup capacity, the NRC staff requests the following information:

1. A description of the operation of the resin regeneration system (including regenerants used, regeneration capacity, and clarification if the resin is regenerated on site or shipped offsite for regeneration);
2. A diagram that shows where the resin regeneration system connects to the CPS as well as the connection to the balance-of-plant discharge system; and
3. The quantity of resin that can be held in the resin supply tank (i.e., how many days/years/cycles will the supply in the resin supply tank last?).

NuScale Response:

FSAR Section 3.1.2.5 describes how secondary water chemistry is controlled to monitor for chemical species that can affect the reactor coolant pressure boundary (RCPB) integrity. Sampling and analysis of reactor coolant and pool water samples verify that key chemistry parameters are within prescribed limits and that impurities are properly controlled. This provides assurance that corrosion is mitigated and will not adversely affect the RCPB.

FSAR Section 10.3.5.1 contains COL Item 10.3-1, which commits that 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 PWR Secondary Water Chemistry Guidelines and NEI 97-06 at the time of the COL application.

GDC 14, "Reactor Coolant Pressure Boundary," requires that the RCPB shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. SRP 10.4.6, Section II.2, "SRP Acceptance Criteria," states in part that "specific criteria acceptable to meet the requirements of GDC 14 for indirect cycle (pressurized-water reactor (PWR)) plants, SRP Section 5.4.2.1 provides the criteria for acceptable secondary water chemistry. SRP Section 5.4.2.1 refers to the guidelines provided in the latest version in the EPRI report series, "PWR Secondary Water Chemistry Guidelines." In essence, meeting the EPRI guidelines is one way to meet the requirements of GDC 14. The NuScale DCA satisfies GDC 14 through its commitment to a chemistry control program consistent with the latest version of the EPRI report series, "PWR Secondary Water Chemistry Guidelines."

SRP 10.4.6, Section IV indicates that the design of the condensate cleanup system and supporting systems is acceptable and meets the applicable RCPB integrity requirements of GDC 14 based on the applicant having met the latest version in the EPRI report series, "PWR Secondary Water Chemistry Guidelines." COL Item 10.3-1 requires that the 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 PWR Secondary Water Chemistry Guidelines and NEI 97-06 at the time of the COL application.

The information presented in FSAR Section 10.4.6 and its supporting tables provides sufficient bases for meeting the requirements of GDC 14.

Impact on DCA:

There are no impacts to the DCA as a result of this response.

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

eRAI No.: 9117
Date of RAI Issue: 10/17/2017

NRC Question No.: 10.04.06-5

DCD Tier 2, FSAR Section 10.4.6 describes the components that comprise the CPS. NUREG-0800, Section 10.4.6, Revision 3 states that the materials of construction for the CPS should be compatible with the service environment.

The materials of construction for the CPS were not provided in FSAR Section 10.4.6. Therefore, the NRC staff requests the materials of construction for the components that comprise the CPS in order to verify the materials will be compatible with the service environment.

NuScale Response:

The materials of construction for the CPS are determined during final design. The selection of materials requires collaboration with the CPS vendor(s) during site-specific design.

FSAR Section 3.1.2.5, which addresses how GDC 14 is implemented, indicates that secondary water chemistry is controlled to monitor for chemical species that can affect the RCPB integrity. This provides assurance that corrosion is mitigated and will not adversely affect the RCPB.

SRP 10.4.6, Section IV indicates that the design of the condensate cleanup system and supporting systems is acceptable and meets the applicable RCPB integrity requirements of GDC 14 based on the applicant having met the latest version in the EPRI report series, “PWR Secondary Water Chemistry Guidelines.”

FSAR Section 10.3.5.1 which describes the chemistry control program includes COL Item 10.3-1 which requires that the 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 PWR Secondary Water Chemistry Guidelines and NEI 97-06 at the time of the COL application.

The information presented in FSAR Section 10.4.6 and its supporting tables provides sufficient bases for meeting the requirements of GDC 14.

Impact on DCA:

There are no impacts to the DCA as a result of this response.

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

eRAI No.: 9117
Date of RAI Issue: 10/17/2017

NRC Question No.: 10.04.06-6

NUREG-0800, Section 10.4.6, Revision 3 states that the staff will review the condenser design to ensure that water purity can be maintained until the condensate and feedwater systems (CFWS) can be isolated in the event of a condenser tube leak.

DCD Tier 2, FSAR Section 10.4.6 states that there are design features in place to limit contaminants in the secondary water to allowable values until the CFWS is isolated. In addition, Table 10.4-13, "Condensate Polishing System Operating Parameters," states the operating limits of the CPS for condenser tube leaks. However, the FSAR does not state how long it will take to isolate the CFWS in the event of a condenser tube leak, nor does it state how the increased impurity levels will be managed by the CPS.

1. The NRC staff requests the applicant provide the duration that the CPS can maintain water chemistry with a condenser tube leak, the design features that allow it to do so, and the time it will take to isolate the CFWS in the event of a condenser tube leak. Provide the basis for selecting the leak rates provided in Table 10.4-13 as well as a justification that these leak rates would bound an actual condense tube leak.
2. In addition, the operating limits state that water chemistry can be maintained during an orderly shutdown with a leak rate of 0.1 GPM (for a brackish or seawater plant). Clarify if, for a plant using brackish or seawater, an action statement to shut down the affected nuclear power module would be implemented if a lead of 0.1 GPM occurs.

NuScale Response:

As noted in FSAR Section 10.3.5.2, condenser cooling water in-leakage is one of the sources that may introduce contaminants into the secondary system during operation. FSAR Section 10.3.5.2 states that, "Contaminants that enter the system through condenser tube leaks are detected by continuous process monitoring of the condenser hotwells for cation conductivity and sodium and the condensate pump discharge for straight conductivity, cation conductivity, and dissolved oxygen."

Contaminants from small to moderate leakage are removed by the online condensate polishers. In the event of a severe main condenser tube leak, the reactor may be tripped and the condensate and feedwater system including the CPS can be quickly bypassed from the control room allowing the plant to be safely shut down using the decay heat removal system (DHRS). This will keep contaminants from being fed to the steam generators during the plant shutdown.

Response to part 1):

The leak rates provided in FSAR Table 10.4-13 are based on values for demineralizer/condensate polisher general requirements found in section 4.3.9.1.1 of the EPRI Advanced Nuclear Technology: Advanced Light Water Reactor Utility Requirements Document, Revision 13.

Response to part 2):

The site-specific water chemistry control procedures will contain the action levels and corrective actions up to and including plant shutdown required to address condenser tube leaks. These procedures are developed in accordance with the EPRI PWR Secondary Water Chemistry Guidelines as required by COL Item 10.3-1.

Impact on DCA:

There are no impacts to the DCA as a result of this response.