NUSCALE POWER™

RAIO-0418-59443

April 09, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 366 (eRAI No. 9292) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 366 (eRAI No. 9292)," dated February 08, 2018

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. 9292:

- 12.03-43
- 12.03-44
- 12.03-45
- 12.03-46
- 12.03-47

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,

Zackary W. Rad
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9292

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9292

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

eRAI No.: 9292
Date of RAI Issue: 02/08/2018

NRC Question No.: 12.03-43

Regulatory Basis

Appendix A to 10 CFR Part 50— "General Design Criteria for Nuclear Power Plants," Criterion (GDC) 61 "Fuel Storage and Handling and Radioactivity Control," requires that new and spent fuel storage facilities include provisions for inspection and the provision for testing are important to verify that there is no corrosion of the spent fuel pool liner.

10 CFR 52.47(a)(6) requires compliance with the requirements of 10 CFR 20.1406 "Minimization of contamination," which requires a description in the DCD how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

10 CFR 20.1406 requires applicants to describe in the application how facility design and procedures for operation 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. The acceptance criteria of NuScale DSRS Section 12.3-12.4, "Radiation Protection Design Features," state that the applicant is to describe how facility design addresses the requirements of 10 CFR 20.1406.

10 CFR 20.1101(b) and 10 CFR 20.1003, require the use of engineering controls to maintain exposures to radiation as far below the dose limits in 10 CFR Part 20 as is practical. The guidance provided in NuScale DSRS Section 12.3-12.4 "Radiation Protection Design Features," and Standard Review Plan (SRP) Section 9.1.2 "New and Spent Fuel Storage," are consistent with and support the review of the design features provided for satisfy these regulatory requirements.

Background

Information contained in DCD Tier 2 Revision 0, and in the response to RAI 8963 Question 03.08.05 Question 23, dated October 17 2017, (RAI-8963-03.08.05-23) indicates that portions of the pool liner may not be covered by the pool leakage detection system (PLDS). Based on the information contained within the RAI response and the DCD, it is not clear to the staff how the applicant intends to meet the regulatory requirements for providing at an early stage of the design, sufficient information that demonstrates the capability of the PLDS to detect low leakage rates from structures containing pool water.

The “Liquid Radioactive Release Task Force Final Report” (ADAMS Accession No. ML062650312,) documents that radioisotopes have been released from spent fuel pools, including fission products. The report further noted that the potential exists for unplanned and unmonitored releases of radioactive liquids to migrate offsite undetected, including those portions of spent fuel pools not visible to operators. Leakage (and the resultant contamination) that enters the ground below the plant may be undetected. Radioactive contamination in groundwater onsite may migrate offsite undetected. One of the main components resulting in ground water contamination identified by the Task Force was leakage from spent fuel pools.

Key Issue 1

The NuScale response states that FSAR Tier 2, Section 9.1.3.2.5 describes the pool leakage detection system (PLDS). Per this section, the PLDS consists of floor leakage channels, perimeter leakage channels, channel drainage lines, leak collection headers, leakage rate measuring lines, and valves. The floor leakage channels are embedded in the concrete beneath the field welded seams of the pool floor liner plates in the UHS pools and the dry dock. A perimeter channel is embedded in concrete at the wall and floor liner joint area. Based on the staff interpretation of this response and information contained in the DCD, it appears that the NuScale design only monitors for leakage from welds located on the base mat and at the juncture of the walls and the base mat.

However, the guidance in SRP Section 9.1.2 does not make a distinction between those sections of the pool liner located on the wall, and those sections of the liner located on the base mat.

The acceptance criteria of DSRS Section 12.3-12.4 states that the acceptability of the design features described in the application will be based on the guidance contained in RG 4.21 and Appendix 12.3-12.4-A “Evaluation and Scoping information for Structures, Systems, and Components 10 CFR 20.1406 Design Review.” Attachment A of DSRS 12.3-12.4 Appendix 12.3-12.4-A, specifically identifies structures, systems and components, such as spent fuel pools, separated from the environment by a single barrier, or with below grade concrete-to-concrete joints (such as the Ultimate Heat Sink pool in the NuScale Reactor Building). Appendix 12.3- 12.4-A Attachment B “Examples of Structures, Systems, and Components for 20.1406 Review,” specifically identifies the spent fuel pool as an area for the staff to review.

Question 1

a. Please discuss how the proposed NuScale design is consistent with the requirements of GDC 61 and 10 CFR 20.1406.
b. Alternatively, revise the DCD to include sufficient information to describe any features to address potential-leakage monitoring for all walls in contact with the pool water, including the Ultimate Heat Sink, the fuel storage area, the dry dock area and the refueling area.

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

The nonsafety-related pool leakage detection system (PLDS) is described in FSAR Sections 9.1.3.2.5, 9.1.3.3, and 9.1.3.3.3. More detailed clarification of the wall fabrication, inspection, and detection is described below to show that the PLDS design is consistent with applicable regulatory guidance and requirements e.g., DSRS 9.1.2, DSRS 9.1.3, GDC 61, and 10 CFR 20.1406.

- Liner section welds that are inspected on both sides will only leak at damaged areas similar to unwelded plate areas. Welding and nondestructive examination (NDE) techniques will be performed to standard industry practices for the pool wall and floor welds. Based on the above argument and comparison with similar designs, areas without welds and areas with welds fully inspected on both sides do not require leak detection channels because the additional inspection precludes the need for leakage detection.
- Liner sections welded in the field that cannot be fully inspected on both sides of the weld require leakage channels because they are more likely to exhibit flaws that could leak.
- With the exception of the base of the wall along the floor, the wall liner plate welds will be inspected on both surfaces before installation of the concrete therefore wall leakage channels are not required in those areas.
- If leakage should occur through the wall liner it would enter the space between the wall liner and concrete. Leakage would travel down this space due to gravity and be captured at the leak channel at the base of the wall.
- In the event the leak does not travel vertically down the outside of the liner to the leak channel, and remains somehow trapped at the general leakage site, it will propagate through the wall until it exits in the Reactor Building (RXB) corridor area between the leak site and the floor. A wet area will identify wall leakage.

Either method of leak detection and collection allows the general location of the leak to be identified. Since the pool wall is an internal wall, no direct leakage to the environment from a wall liner is possible.

Leakage captured before exiting the RXB meets the DSRS 9.1.3 guidance to monitor and prevent the release of leakage from the pool areas because:

- Periodic testing and inspection is provided by the ability of the leakage channels to be opened, inspected, and isolated so that a leakage rate determination can be made for

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each individual channel.

- Leakage is contained in the channels that are routed to the building drainage system.
- Any leakage through the wall would be constrained by the concrete and contained by the RXB.
- Leakage collection from channels is monitored through the radioactive waste drain system (RWDS) sump level instrumentation. The plant computer system detects level changes in the sump and alarms in the control room. Operations can then identify which leakage channels feed the alarming sump and determine by isolation and testing which channel or channels are leaking and leakage rate.
- A wall leak that becomes large enough will migrate to the floor in its proximity. This leakage will eventually be channeled to a drain and can be quantified through the drain system. Operator rounds for the RXB will include monitoring of the pool wall for moisture and leakage.
- Loss of pool level will be continuously monitored; excess losses due to leakage of the liner will be noted from the channel leakage determination, or from rapid loss and makeup from the pool inventory.

Monitoring for leakage by operator inspections and tracking leakage from the sumps will maintain pool leakage to within ALARA principals for radiation dose and potential off site releases.

In addition, FSAR Section 12.3.6.1, Facility Design Objectives for 10 CFR 20.1406, discusses the application of six objectives that demonstrate compliance with 10 CFR 20.1406 requirements consistent with RG 4.21.

Information clarifying detection of leakage through the wall liner has been added at the appropriate level of detail for a nonsafety-related system to FSAR Section 9.1.3.2.5.

Impact on DCA:

FSAR Section 9.1.3.2 has been revised as described in the response above and as shown in the markup provided in this response.

The elevation of the bottom of each PSCS piping penetration through a wall of the dry dock, RFP, or SFP; and the open ends of equalization line, are above the 55 ft pool water level. The piping deeper in the dry dock and RFP is equipped with anti-siphoning devices. These devices are also above the 55 ft pool water level.

The vent line on the pool surge control storage tank has a continuous air monitor with grab sample capabilities to monitor effluent releases from the tank. The radiation monitoring and sampling equipment for the tank vent are described in Section 11.5.2.

The supply and discharge lines to and from the pool surge control storage tank are embedded underground or in a yard area pipe chase. Each line is within a guard pipe from the catch basin to the RXB. The sump drain line is also embedded underground or in a yard area pipe chase and within a guard pipe from the catch basin to the RWB. Each guard pipe provides collection and permits periodic surveillance for PSCS piping leaks.

The PSCS storage tank is equipped with a water level instrument that provides overflow protection. In addition to initiating an alarm locally and in the main control room, the instrumentation provides an automatic isolation of the water transfer line to the tank when the water level reaches the high level setpoint.

9.1.3.2.5 Pool Leakage Detection System

The PLDS performs the following nonsafety-related functions:

1) provides for collection of water leaking from the pool liner

2) directs the flow to sumps for detection of collected leakage for operator evaluation

RAI 12.03-43

The PLDS consists of floor leakage channels, perimeter leakage channels, channel drainage lines, leak collection headers, leakage rate measuring lines, and valves. The valves are used to isolate each channel drainage line and leakage rate measuring line. System components with the potential for contact with borated water are stainless steel. The floor leakage channels are embedded in the concrete beneath ~~the~~ field welded seams of the pool floor liner plates in the UHS pools and ~~the~~ dry dock that cannot be fully inspected on both sides. The wall liner plates are erected prior to concrete placement. Wall liner welds are inspected on both sides of the plate before pouring concrete that covers the welds. A perimeter channel is embedded in concrete at the wall and floor liner joint area. The channels collect leakage from the pool wall and floor liner plates and direct it to a sump or to collection header piping leading to a sump in the radioactive waste drain system (RWDS). The leakage collected in the RWDS sumps is routed to the LRWS for further processing. The PLDS will be accompanied by monitoring and surveillance by plant personnel (see COL Item 12.3-7). Section 3.2 provides the safety and seismic classifications for the system and identifies the applicable QA requirements.

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

eRAI No.: 9292
Date of RAI Issue: 02/08/2018

NRC Question No.: 12.03-44

The Regulatory Basis and Background are in RAI-9292 Question 31048

Key Issue 2

DCD Tier 2 Revision 0 Table 9.3.2-4: "Local Sample Points," does not list the pool leakage detection system (PLDS), as one of the process sampling points. Furthermore, the response to RAI-8963-03.08.05-23, states that channels collect leakage from the pool liner plates and direct it to a sump or to collection header piping that leads to a sump that is part of the radioactive waste drain system (RWDS). The RWDS sumps are located in the reactor building (RXB) gallery areas at top of concrete elevation 24'- 0". However, neither DCD Figure 1.2-10: "Reactor Building 24'-0" Elevation," nor DCD Figure 12.3-1a: "Reactor Building Radiation Zone Map - 24' Elevation" show sumps on this elevation of the Reactor Building.

Question 2

Revise DCD Figure 1.2-10 or DCD Figure 12.3-1a to show the location of the sump(s) used as collection points for the pool liner leakage detection system.

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

The description of the nonsafety-related pool leakage detection system (PLDS) in FSAR Section 9.1.3.2.5, 9.1.3.3, and 9.1.3.3.3 meets DSRS 9.1.3 guidance to include a statement in the DCA of a system to detect leakage with adequate capacity and appropriate alarms in the immediate area of the system.

DCD Tier 2 Revision 0 Table 9.3.2-4: "Local Sample Points," does not list the pool leakage detection system (PLDS), as one of the process sampling points but does list the Radioactive

Waste Drain System (RWDS) sump tanks; one sample point per each sump tank.

FSAR Figure 1.2-10: “Reactor Building 24’-0” Elevation,” and Figure 12.3-1a: “Reactor Building Radiation Zone Map - 24' Elevation” do not show the six equipment drain sumps because the figures were originally not envisioned to show that level of detail in the FSAR. However, Figure 9.3.3-1: Radioactive Waste Drain System Diagram does depict the equipment drain sumps, although not relative to elevation.

Impact on DCA:

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

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

eRAI No.: 9292
Date of RAI Issue: 02/08/2018

NRC Question No.: 12.03-45

The Regulatory Basis and Background are in RAI-9292 Question 31048

Key Issue 3

The “Liquid Radioactive Release Lessons Learned Task Force Final Report,” dated September 1, 2006 (ADAMS Accession No. ML062650312), describes an event where the liner leakage detection system became clogged with boric acid precipitate. DCD Section 9.1.3.2.5 “Pool Leakage Detection System,” and the response to RAI-8963-03.08.05-23 state that The PLDS shall be designed to support periodic testing and inspection of PLDS components to allow identification of leakage from the reactor building components pool liner (RBCM PL) welds. However, with the PLDS located in radioactive waste system sumps, it is not clear to the staff what design features are provided to facilitate the inspection and cleaning of the PLDS. For instance, are the sumps large enough to permit personnel or test equipment access? Can the sumps be accessed while one or more nuclear power modules are operating?

Question 3

Describe the design features provide to minimize radiation exposure in accordance with 10 CFR 20.1101(b) and 10 CFR 20.1701(a) during maintenance and testing activities.

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

Leakage channels are designed as Seismic Category III with stainless steel materials compatible with the expected environment of borated water. An end cap on the leak channel is removable to facilitate cleaning of individual leakage channels. When the end caps are removed from the leak channels, appropriate radiation protection measures will be taken in accordance with a licensee's Radiation Protection Program. With the end cap removed several cleaning methods are available to clear the channel. Clean hot water can be pumped through the leakage channel or down the drain line to dissolve the accumulated boron and flush the material out. If needed, mechanical devices can be used to break up hard deposits to clear the channel. Sump pumps are stainless steel to facilitate maintaining cleanliness. Cleaning methods depend on the licensee's needs, desired methods, and procedures to minimize radiation exposure.

Impact on DCA:

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

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

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Date of RAI Issue: 02/08/2018

NRC Question No.: 12.03-46

The Regulatory Basis and Background are in RAI-9292 Question 31048

Key Issue 4

DCD section 9.1.3.2.5 "Pool Leakage Detection System," states that the sumps in the RWDS are monitored for level and that the RWDS supports the leakage detection function of the PLDS by providing local and control room indication and associated alarms when the leakage rate from the PLDS reaches a predetermined level. However, DCD Section 9.3.3.2.3 "System Operation," states that the pool leak detection (PLD) system works in cooperation with the RWDS equipment drain subsystem. The PLD drains are not individually monitored; however, because all other drains into the equipment drain system are manually initiated, unplanned changes in sump volume can be attributed to the PLD system. The guidance contained in RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," regarding the regulatory requirements of 10 CFR 20.1406, states that structures and components, such as a spent fuel pool and associated piping, should be provided with the capability to detect and quantify small leakage rates (e.g., several gallons per week) from each zone. Based on the staff operating experience, other sources of radioactive liquid are volumetrically large enough that actuation of the radioactive sump pumps from normally expected in leakage will mask all but major liner weld failures.

Question 4

a. Consistent with DCD section 9.1.3.2.5 "Pool Leakage Detection System," describe in the DCD how the sumps in the RWDS, associated with the PLDS, are monitored for level.
b. Consistent with DCD section 9.1.3.2.5 "Pool Leakage Detection System," describe in the DCD, the types and functions of the alarms and indications available for detecting leakage from the PLDS.
c. Describe the leakage rate detection criteria for the PLDS (i.e.. how many gallons per minute of leakage from the PLDS will initiate an alarm) Describe how the components of the PLDS satisfy this leakage detection criteria.
d. If the leakage detection criteria is more than several gallons per week, please provide the justification for the value selected.

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

a. The radioactive waste drain system (RWDS) consists of five subsystems: floor drain subsystem, chemical waste drain subsystem, reactor component cooling water system drain subsystem, detergent waste collection subsystem, and the equipment drain subsystem. Only the equipment drain system collects pool leakage detection system (PLDS) drainage. (FSAR Figure 9.3.3-1).

In addition, the equipment drain sump tanks are not interconnected. Each equipment drain sump tank serves a dedicated set of equipment. The sumps are provided with level instrumentation to continuously monitor sump level during normal operations.

As noted in the RAI, the PLDS works in cooperation with the RWDS equipment drain subsystem. The PLDS drains are not individually monitored; however, because all other drainage into the equipment drain system are manually initiated, unplanned changes in sump volume can be attributed to PLDS drainage.

The PLDS has no instruments and uses the level indicators in the RWDS collection sumps for detecting leakage from a pool liner. FSAR Section 9.1.3.3.3 Containment, Confinement, and Filtering describes how the sumps in the RWDS are provided with level instrumentation to continuously monitor sump level during normal operations.

b. FSAR Section 9.1.3.3.3 Containment, Confinement, and Filtering describes that the RWDS provides local and control room indication and associated alarms when the leakage rate from the PLDS reaches a predetermined rate. This alerts operators to identify the area of the pool with leakage using the leak chase system in the PLDS. FSAR Table 14.2-6: Pool Leak Detection System Test #6, describes testing the main control room alarm when the RWDS sump fill rate exceeds the PLDS leakage rate setpoint. FSAR Section 9.3.3.5 describes the instrumentation and controls for the RWDS in more detail.

c . The RWDS has 4ft x4 ft x4 ft concrete, steel lined collection sumps with level indicators to detect leakage rate from each zone of the PLDS. When the leakage rate into a sump reaches a predetermined value, operators perform inspections to determine the cause and implement repairs as necessary to stop the leakage from the liner. Operations can identify which leakage channels feed the alarming sump and determine by isolation and testing which channel or channels are leaking and leakage rate. The level indication instrumentation will have the capability to detect and quantify small leakage rates (e.g., several gallons per week) from each zone.

d. In addition to FSAR Table 12.3-28: Regulatory Guide 4.21 Design Features for Pool Leak

Detection System and Table 12.3-42: Regulatory Guide 4.21 Design Features for Ultimate Heat Sink System, the intent of the RG is met because:

- A leak identification program will be developed for components containing radioactive materials to prevent unnecessary contamination of equipment and surrounding areas and to minimize radioactive waste.
- Provision has been made to allow for timely identification of leak locations.
- Structures and components, such as a spent fuel pool and associated piping, have been designed to permit the isolation of clearly defined zones within that system and have been provided with the capability to detect and quantify small leakage rates.
- The RXB equipment drain tank level control system is integrated with pool level controls. Inflow to the sump is continuously monitored determining change in tank level over time. Since equipment drainage is a preplanned, manually initiated event, the only unplanned inflow to the sump comes from PLDS drainage.
- The RWDS sump level indication instrumentation will have the capability to detect and quantify small leakage rates from each zone.
- The PLDS leakage detection value, a level of detail typically not stated in the FSAR, will meet the intent of the example used by RG 4.21 of "several gallons per week" as indicated in Table 12.3-42 Objective 2.
- As an alternative provision, the set of leakage channels, or the individual channel, that flows to one RWDS sump form a leak chase and allow liner leakage to be isolated to a zone with a leak in the pool liner. From the sump collecting the leakage, a leakage channel with flow can be determined.
- After identifying a channel with flow, the flow rate for the leakage channel can be isolated and monitored by collecting and measuring the amount of water flowing from the channel. The valve on the leakage rate measuring line can be opened and flow rate determined by catching flow in a calibrated container. Knowing the leakage rate and location of the leakage channel provides the basis for further inspections from inside the pool.

Impact on DCA:

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

NuScale Power

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

eRAI No.: 9292
Date of RAI Issue: 02/08/2018

NRC Question No.: 12.03-47

The Regulatory Basis and Background are in RAI-9292 Question 31048

Key Issue 5

The PLDS system appears to be connected to sumps in the Reactor Building that are part of the RWDS. Any ingress of water from the sump into the PLDS will contaminate the PLDS with borated water, which may dry and clog the PLDS, or be mistaken for pool leakage.

Question 5

Please describe in the DCD the design features of the PLDS and RWDS that are provided to prevent back flow from the RWDS into the PLDS.

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

The PLDS drain is a closed system, not subject to intrusion from other water sources, except in extreme cases such as a significant flooding event. This design prevents the undetected intrusion of water into the PLDS / RWDS drain pathway In the event that there is a flood on the 24’ floor level the sumps would have to fill up and water would have to rise to above the 24’ 7” level before water from the flood would start to backfill any of the leakage channels due to the location of the bottom of the channel being at ~24’8” elevation.

A check valve is provided in the sump lines as the water enters the sump area. Should there be an event that floods up to the height of the channels, the channels can be inspected and cleaned as needed. The design of the leakage channels provides a cap at the end of each channel as it comes out of the wall. This cap is designed to be removable for inspection and cleaning of the channel.

Impact on DCA:

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