August 24, 2018

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 Supplemental Response to NRC Request for Additional Information No. 407 (eRAI No. 9468) on the NuScale Design Certification Application

**REFERENCES:**
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 407 (eRAI No. 9468)," dated April 03, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 407 (eRAI No.9468)," dated June 04, 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. 9468:

- 21.0-2

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
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Prosanta Chowdhury NRC, OWFN-8G9A

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9468

**Enclosure 1:**

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9468

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

**eRAI No.:** 9468
**Date of RAI Issue:** 04/03/2018

---

**NRC Question No.:** 21.0-2

General Design Criterion (GDC) 5, "Sharing of structures, systems and components," requires structures, systems, and components important to safety not be shared unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions.

GDC 10, "Reactor design," requires that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

DSRS 15.0 states, "The reviewer evaluates licensees' claims that individual AOOs [Anticipated Operational Occurences] and postulated accidents, including IEs [Infrequent Events], are limiting or nonlimiting, or bounded by other AOOs, IEs and postulated accidents, with particular attention to the bases used for comparison."

FSAR Tier 2, Section 21.2.3 states Table 21-2, "Shared System Interactions (Mechanical Systems)," identifies and evaluates shared systems that have the potential for an adverse system interaction or an undesirable multi-module interaction. In several locations, Table 21-2 states that an event is evaluated [considered, included, or captured] in the "safety analysis." Typically, the staff would interpret this as the safety analysis for design basis events located in Chapter 15 of the FSAR. However, the staff could not verify most of these statements. For example, Table 21-2 states, "A [Module Heatup System] MHS heat exchanger tube rupture or loss of the auxiliary boiler system (ABS) steam may result in an addition of cooler water to the reactor coolant system (RCS). This is a single-module event that is evaluated in the safety analysis." The staff reviewed FSAR Chapter 15 and Section 9.3.4, but could not find a discussion regarding the impact a MHS heat exchanger tube rupture would have on the RCS.

Therefore, the applicant is requested to substantiate statements made in Table 21-2 when referring to multi-module events that are evaluated as part of the safety analysis. The applicant is requested to revise the FSAR as necessary to include the absent evaluation or reference to a specific section in the FSAR where such an evaluation of the event already exists.

---

**NuScale Response:**

NuScale is supplementing its original response to RAI 9468 (Question 21.0-2) provided in letter RAIO-0618-60277, dated June 04, 2018. This supplemental response is provided to correct the last sentence of the first paragraph in the reactor component cooling water system (RCCWS) row of FSAR Table 21-2 to read, “The RCCWS supplies RCCW to ~~CVCS piping~~CNTS that then conducts RCCW to the ~~CRDM~~CRDS piping.”

The following conforming changes were also made in the second paragraph of the RCCWS row of FSAR Table 21-2:

~~Pipe~~CRDS pipe breaks inside the containment that could release RCCW are isolated on high-containment pressure, but could result in a design basis loss of containment vacuum or containment flooding event and are included as a single-module event in the safety analysis. The CRDS pipe break resulting in a release of RCCW does not result in an emergency core cooling system actuation from a high CNV water level. Section 15.1.6 of the FSAR discusses the safety analysis for ~~RCCWS~~ pipe breaks inside the containment vessel.

Information provided in the original response remains valid.

**Impact on DCA:**

FSAR Table 21-2 has been revised as described in the response above and as shown in the markup provided in this response.

RAI 21.0-2, RAI 21.0-2S1

## Table 21-2: Shared System Interactions (Mechanical Systems)

| Shared System | NPMs Supported | System Interactions |
|---|---|---|
| Module heatup system (MHS) | Two independent subsystems each supporting 6 NPMs | The MHS supports one NPM at a time via an interface with the module-specific CVCS during startup and shutdown operations (if necessary) to heat the reactor coolant. The MHS design eliminates the possibility of boron dilution via inter-system leakage by providing double isolation valves with drains and pressure monitoring between the isolation valves. The instrument air supply to these valves can be removed via administrative controls to prevent a spurious or inadvertent opening. ~~A MHS heat exchanger tube rupture or loss of the auxiliary boiler system (ABS) steam may result in an addition of cooler water to the reactor coolant system (RCS). This is a single-module event that is evaluated in the safety analysis. An MHS component failure does not adversely affect safety-related NPM functions.~~<br><br>As an interfacing system with the chemical and volume control system (CVCS), a malfunction in the module heatup system (MHS) resulting in loss of heat addition could result in injection of colder fluid through the CVCS injection lines to the reactor coolant system. Injection of colder fluid through the CVCS injection lines, particularly during startup, could lead to decreased reactor coolant system flow due to the natural circulation forces of the NuScale reactor design. An MHS malfunction could cause a reactivity transient if the colder fluid reaches the core. The CVCS is isolated from the RCS by the module protection system on low low reactor coolant system flow, limiting the amount of cold water injection that could possibly occur. Therefore, considering the capacity of the NPM CVCS, a reactivity change due to MHS malfunction is judged a non-limiting reactivity event compared to the spectrum of reactivity events analyzed as presented in the FSAR Section 15.4. Note that for consistency with Section 15.4.4 of the Standard Review Plan, Section 15.4.4 of the FSAR discusses startup of an inactive loop or recirculation loop at an incorrect temperature; however, this event is not applicable to NuScale because the NuScale design does not have multiple coolant loops or means in the design to introduce a substantial amount of cold water similar to an inactive loop startup. A decrease in RCS inventory that could be caused by a tube failure in the MHS is bounded by the safety analysis for CVCS line breaks outside the containment vessel as presented in the FSAR Section 15.6.<br><br>The MHS does not involve a unique NPM operating configuration. The design of the MHS and the CVCS reactor startup mode ensures that the reactor operates within the RCS stability map during reactor startup. A loss of both MHS heat exchangers would delay NPM startups until repairs could be made, but would not affect NPM operating configurations. |
| Boron addition system (BAS) | 12 | The BAS supplies borated water to each NPM via an interface with the module-specific CVCS. The BAS is designed to prevent a boron dilution event via plant control system (PCS) mode logic during tank transfers and batch tank manual isolation valves. BAS operation does not result in a new DBE. Administrative controls are used to control boron concentrations. A BAS component failure does not adversely affect safety-related NPM functions.<br><br>As described in Section 9.3.4, the BAS sizing is conservatively based on a 12-NPM shutdown event. The BAS is designed such that the loss or outage of a single major component does not result in a significant loss of plant capacity, and a failure of a single BAS component does not prevent continued operation of up to 12 NPMs.<br><br>In the unlikely event of a total failure of the BAS, failure to deliver borated water to the CVCS may result in a controlled reactor shutdown if the condition persists in the long term. If the BAS design features and administrative controls that prevent dilution fail, a failure of the CVCS that results in the BAS and demineralized water system (DWS) combining valve spuriously repositioning to the DWS bounds the BAS dilution. |

**Table 21-2: Shared System Interactions (Mechanical Systems) (Continued)**

| Shared System | NPMs Supported | System Interactions |
|---|---|---|
| Containment flooding and drain system (CFDS) | Two independent subsystems each supporting 6 NPMs | The CFDS subsystems are only operated after shutdown and prior to startup of a single NPM at a time. The NPM interface is via a nozzle in the CNV through containment isolation valves. There are three normally closed valves in series between the CFDS pumps and an NPM's containment. These include two containment isolation valves and a CFDS module isolation valve. The sequence necessary to inadvertently flood a containment of an operating NPM requires multiple spurious failures, starting of a CFDS pump, and operator errors, and is not considered an initiating event for containment flooding. A CFDS component failure does not adversely affect safety-related NPM functions.<br><br>The CFDS can provide water to the CNV for cooling during a beyond design basis event as described in Section 9.3.6. |
| Reactor component cooling water system (RCCWS) | Two independent subsystems each supporting 6 NPMs | Each RCCWS supports up to 6 NPMs at a time. The system interface with the NPM is via control rod drive mechanism (CRDM) cooling within the NPM and via system piping routed in the CNV. The RCCWS is designed such that no single failure can cause the loss of RCCWS heat removal from more than one NPM. A leak in an RCCWS cooler, heat exchanger, condenser, or tank can be isolated locally. This could cause the shutdown of an individual NPM depending on the component failure, but it would not require the shutdown of multiple NPMs. In the event a NPM is shut down for maintenance or refueling, the RCCWS will continue to operate under normal conditions for the other five NPMs with the isolation valves closed to the CRDMs for the shutdown NPM. An RCCWS component failure does not adversely affect safety-related NPM functions. The RCCWS has no piping in the CNV. The RCCWS supplies RCCW to CNTS that then conducts RCCW to the CRDS piping.<br><br>~~RCCWS p~~CRDS pipe breaks inside the containment that could release RCCW are isolated on high-containment pressure, but could result in a design basis loss of containment vacuum or containment flooding event and are included as a single-module event in the safety analysis. The ~~RCCWS~~ CRDS pipe break resulting in a release of RCCW does not result in an emergency core cooling system actuation from a high CNV water level. Section 15.1.6 of the FSAR discusses the safety analysis for pipe breaks inside the containment vessel.<br><br>A failed-open RCCWS flow control valve on the CVCS non-regenerative heat exchanger secondary side may result in introduction of cooler CVCS water to the NPM primary system~~, which is a single module event that is considered in the safety analysis,~~ but does not result in a new DBE. In addition, Section 15.5.1 of the FSAR addresses cold water injection through the CVCS, focusing on pressurization related to the increased inventory. A loss of RCCWS to the CVCS nonregenerative heat exchanger adds negative reactivity and is not a DBE.<br><br>A total failure of a RCCW subsystem would eventually result in a manual shutdown of up to six NPMs due to rising CRDM temperatures, which are indicated in the control room, but does not prevent safety-related NPM functions and does not result in a design basis event. |