NuScale Power

RAIO-0518-59975

May 14, 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. 26 (eRAI No. 8840) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 26 (eRAI No. 8840)," dated May 22, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 26 (eRAI No.8840)," dated July 19, 2017

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. 8840:

- 19-2

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 Paul Infanger at 541-452-7351 or at pinfanger@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Samuel Lee, NRC, OWFN-8G9A
Rani Franovich, NRC, OWFN-8G9A
Prosanta Chowdhury NRC, OWFN-8G9A

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8840

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8840

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

eRAI No.: 8840
Date of RAI Issue: 05/22/2017

NRC Question No.: 19-2

10 CFR 52.47(a)(27) states that a DC application must contain a Final Safety Analysis Report (FSAR) that includes a description of the design-specific probabilistic risk assessment (PRA) and its results. In accordance with the Statement of Consideration (72 FR 49387) for the revised 10 CFR Part 52, the staff reviews the information contained in the applicant's FSAR Chapter 19, and issues requests for additional information (RAI) and conducts audits of the complete PRA (e.g., models, analyses, data, and codes) to obtain clarifying information as needed. The staff uses guidance contained in Standard Review Plan (SRP) Chapter 19.0 Revision 3, "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors." In accordance with SRP Chapter 19.0 Revision 3, the staff determines if "the PRA reasonably reflects the as-designed, as-built, and as-operated plant, and the PRA maintenance program will ensure that the PRA will continue to reflect the as-designed, as-built, and as- operated plant, consistent with its identified uses and applications."

The staff has reviewed the information in the FSAR and examined additional clarifying information from the audit of the complete PRA and determined that it needs additional information to confirm that the PRA reasonably reflects the as-designed plant. The containment isolation function supports the passive core cooling and heat removal key safety functions by ensuring sufficient coolant inventory in the reactor pressure vessel and the containment vessel. The staff notes that FSAR Table 19.1-6, "System Success Criteria per Event Tree Sequence," assumes that containment isolation is guaranteed to succeed except for the chemical and volume control system (CVCS) pipe breaks outside containment and the steam generator tube failure (SGTF). The containment isolation function is accordingly not questioned in any of the Level 1 event trees except for the CVCS pipe breaks outside containment and the SGTF.

To allow the staff to evaluate the Level 1 model and assumptions related to the containment isolation function, the staff requests the applicant to explain how the containment isolation function can be guaranteed to succeed in the Level 1 accident sequences. In your response, please provide the following:

a. Identify the potential scenarios (combinations of pathways, equipment failures and human failure events) that could lead to coolant inventory loss from the reactor pressure vessel to outside of the containment vessel.
b. For the scenarios identified in a), explain how the containment isolation function is

accounted for in the Level 1 model, if this function is necessary to support any key safety functions (e.g., passive safety functions).

c. For the scenarios identified in a), if the containment isolation function is not necessary to support any key safety functions, please describe any relevant analyses used to support this conclusion. Describe any uncertainty analyses performed for these supporting analyses.
d. Augment FSAR Table 19.1-21, “Key Assumptions for the Level 1 Full Power Internal Events Probabilistic Risk Assessment,” and/or Table 19.1-23, “Key Insights from Level 1 Full Power, Internal Events Evaluation,” accordingly with a discussion of the dependency of the passive safety functions on the containment isolation function. Include a discussion of the safety-significance of the active backup systems for scenarios resulting in failure of containment isolation.

NuScale Response:

NuScale is supplementing its response to RAI 8840 (Question 19-2) originally provided in letter RAIO-0717-55003, dated July 19, 2017. This supplemental response is provided as a result of discussions with the NRC during the PRA audit that began on March 06, 2018 (ML18053A216). This supplemental response replaces the second paragraph of NuScale’s response to Item c with the following paragraph:

> For LOCAs inside containment, simulations have been performed to consider event tree model uncertainty. Simulations were performed including a failure of containment isolation on the CES line penetration. The CES line is open during module operation to maintain sub-atmospheric conditions in the CNV; as such, it is the most likely containment bypass path despite the low probability of failure of both safety-related CES containment isolation valves. Containment penetrations and their methods of isolation are listed in FSAR Table 19.1-24. Simulation results demonstrate that one train of the ECCS with success of the reactor trip system (RTS) following a failure of CES isolation is sufficient to maintain the coolant levels in the RPV and CNV to provide core cooling by circulation through the ECCS valves. The ECCS effectively depressurizes the RPV and the driving force for coolant loss from the CNV stops when the CNV reaches atmospheric pressure. As a result, passive fuel cooling is provided for more than 72 hours. Note that in the very unlikely case in which both the RTS and automatic containment isolation fail following a LOCA inside containment, there is adequate time for operator action to either isolate containment or initiate makeup coolant using either the CVCS or CFDS to prevent core damage.

FSAR Table 19.1-7 has been revised to be consistent with this supplement.

Impact on DCA:

FSAR Table 19.1-7 has been revised as described in the response above and as shown in the markup provided in this response.

RAI 19-2, RAI 19-1S1, RAI 19-2S1

Table 19.1-7: Success Criteria per Top Event

Mitigating System[1]	Top Event	Redundancy	Description
Containment flooding and drain system (CFDS)	CFDS-T01	One of two pumps needed for success. System is shared by six modules.	In sequences with a loss of RCS inventory (e.g., un-isolated LOCA) and success of the RTS, CFDS, in conjunction with ECCS, can provide control of RCS inventory. In transients where DHRS and both RSVs fail and RTS is successful, CFDS can provide fuel assembly heat removal by establishing a convection/conduction heat transfer pathway from the RPV through the CNV to the reactor pool. Operator action to use CFDS to add water to the CNV can prevent core damage in sequences involving: • Pipe breaks outside containment not isolated • SGTF not isolated • General reactor trip Actuation requires an operator action which includes un-isolating containment, aligning a flow path and activating a CFDS pump. It may also require valve realignment because CFDS is a shared system. The CFDS is not credited to mitigate an unisolated break or SGTF if the reactor fails to trip; i.e., given the additional power due to the ATWS, CFDS does not guarantee success.
Chemical and volume control system (CVCS) for RCS injection	CVCS-T01	One of two pumps needed for success. Each module supported by a dedicated system.	The CVCS can provide control of RCS inventory. As a modeling simplification, DWS provides CVCS makeup inventory. Operator action to inject CVCS can prevent core damage in sequences involving: • Failure of ECCS • Pipe breaks outside containment not isolated • SGTF not isolated • Failure of the control rods to insert and both RSVs to open following a general reactor trip (to alleviate RPV pressure through the normal operation of pressurizer spray and CVCS discharge) Operator action requires un-isolating containment, aligning a flow path from the DWS, and activating a makeup pump.

Table 19.1-7: Success Criteria per Top Event (Continued)

Mitigating System[1]	Top Event	Redundancy	Description
Emergency core cooling system (ECCS)	ECCS-T01	One of three RVVs and one of two ~~RVVs~~RRVs needed for success. Each module is supported by a dedicated system.	The ECCS provides fuel assembly heat removal and control of RCS inventory. The system passively circulates coolant inventory by removing heat from the reactor core to the CNV which transfers heat to the reactor pool. Success requires one RVV and one RRV to open; failure of both RRVs or all three RVVs to open is an incomplete ECCS actuation. The ECCS is actuated on low RPV water level or high CNV water level. The system is also demanded upon a loss of two or more EDSS busses, and 24 hours after a loss of AC power. ~~The~~As discussed in Section 6.3.2.2, the system includes an inadvertent actuation block (IAB) that prohibits the valves from opening until the differential pressure between the RPV and CNV is low; this precludes a valve from opening at power. In some postulated scenarios, it is possible to actuate the IAB when the differential pressure between the RPV and CNV is high. However, as differential pressure lowers, the main spring, assisted by reactor coolant pressure, will open the valve. Therefore, failure of the IAB does not affect successful opening of the ECCS valves. An operator action to actuate ECCS is considered in cases where automatic initiation fails; the action can be completed from the MCR. For initiators that involve a continued loss of coolant from the RPV to outside of containment, this top event is credited only if makeup coolant is successful. For initiators that involve a loss of coolant inside of containment, with success of RTS and a failure of containment isolation (as defined in Table 19.1-24), ECCS provides passive fuel cooling ~~for (i) at least 72 hours with one train of DHRS available or (ii) for at least 36 hours with both trains of DHRS unavailable~~ without the need for inventory makeup.
Reactor coolant system RSV opens	RCS-T01	One of two RSVs needed for success. Each module is supported by a dedicated system.	The RSVs provide RPV pressure relief and RCS integrity. The RSVs are self-actuating pressure relief valves and not operator controlled. Cycling of an RSV transfers RCS to containment and removes fuel assembly heat by convection and conduction to the reactor pool; pressure eventually stabilizes below the RSV setpoint. If both trains of DHRS fail and both RSVs fail to open, the ECCS IAB prohibits the ECCS valves from opening and RPV pressure continues to increase.