December 13, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 268 (eRAI No. 9178) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 268 (eRAI No. 9178)," dated October 19, 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 Question from NRC eRAI No. 9178:

- 19-35

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 Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com.

Sincerely,

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9178

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NuScale Response to NRC Request for Additional Information eRAI No. 9178

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

eRAI No.: 9178
Date of RAI Issue: 10/19/2017

NRC Question No.: 19-35

10 CFR 52.47(a)(27) states that a DC application must contain an 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 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 whether:

"The PRA reasonably reflects the as-designed, as-built, and as-operated plant."

The staff understands that during design development, PRA assumptions may be needed to account for the incomplete aspects of the design. To allow the staff to determine that the PRA reasonably reflects the as-designed, as-built, and as-operated plant, NRC staff requests the applicant to please clarify the bases for the design assumptions used for the internal fire PRA by responding to the following questions:

a) The staff understands that there are assumed fire scenarios (e.g., IE-FIRE-3-ECCS) during which the emergency core cooling system (ECCS) solenoid operated valves are subject to hot short, but not the containment isolation solenoid valves – even though the cabling for both functions appears to be routed through a shared fire area (e.g., Fire Area 010-208). Please describe the assumed circuit design differences between the ECCS and the containment isolation functions that lead to the ECCS function impacted by hot short but not the containment isolation function. In your response, please discuss any differences in terms of the assumed cable materials (e.g., fiber optic vs. copper) for the various segments of the control circuits, the assumed locations of the instrumentation and control (I&C) equipment that is expected to respond (e.g., main control room, remote shutdown panel, I&C cabinet rooms) and the expected I&C system responses.

b) The staff understands that the fire-induced spurious opening of an ECCS valve is assumed to be caused by a hot short, which decreases the likelihood of a spurious valve opening by more than an order of magnitude compared to a short to ground. Please describe the design assumptions that make a hot short (vice only a short to ground) a necessary condition for ECCS to spuriously actuate.

c) The staff is unclear how the decay heat removal system, ECCS, and containment isolation system functions are assumed to respond to a hot short. A hot short may keep the solenoid valves energized and keep them from moving to the safe position. Please describe the assumed response for each of these systems to a hot short.

NuScale Response:

a) Control circuit design (e.g., materials used) is similar for all equipment controlled by the module protection system (MPS). The MPS is described in detail in FSAR Chapter 7. Circuitry design differences between the emergency core cooling system (ECCS) and containment isolation function are not the bases for differences in the fire PRA (FPRA) modeling of hot shorts, as described below.

Fire scenario IE-FIRE-3-ECCS postulates circuit failures involving the manual control switches for the ECCS. A fire is modeled as being able to spuriously operate the ECCS valves through a fire-induced hot short on the manual actuation switch circuit. In the case of the ECCS, a spurious actuation that results in the valves transitioning to the “fail-safe” position is a potential concern because it presents a possibility for an incomplete ECCS actuation, which would complicate the module response to the event. Thus, a hot short is modeled as a contributor to an inadvertent ECCS actuation demand.

Similar circuits exist for the containment isolation valves (CIVs). However, fire-induced hot shorts on the manual actuation switches for the CIVs may result in the valves operating (i.e., closing), which is the safety position. Thus, such failures are not modeled in the PRA to avoid crediting a failure that would be beneficial to mitigating potential accident progression.

b) Hot shorts are not necessary in all cases for ECCS to spuriously actuate. Hot shorts, ground faults, and open circuits can all potentially result in the spurious operation of the ECCS valves depending on the specific portion of the control circuits affected by a given fire.

As discussed in the response to Item a) of this question, a hot short is modeled as required for spurious actuation of the ECCS valves because it relates to valve operation through the manual actuation switch. Fire-induced failures of other portions of the valve controls (e.g., 125 VDC power to the ECCS valve solenoids) may operate the valves via a ground fault.

c) The FPRA considers that hot shorts are capable of preventing the decay heat removal system (DHRS), ECCS, and CIVs from performing their safety functions. As discussed in the responses to Item a) and Item b) of this question, hot shorts are also modeled as spuriously demanding the ECCS valves to operate.

The FPRA model is built using standard industry guidance. Circuit failure modes and probabilities are developed following the guidance of NUREG/CR-6850 (FSAR Reference 19.1-42), NUREG-7150 (FSAR Reference 19.1-46), and NEI 00-01, Rev 2 (FSAR Reference 19.1-43). Collectively, applying the methodology presented in these documents results in a conservative estimate of fire risk as it relates to fire-induced spurious operations.

One conservative aspect of the FPRA is the timing of when fires are considered to induce a failure. Given fire damage occurs, hot shorts are assumed to occur at the most limiting time.

- In the case of the DHRS valves and CIVs, two solenoids per valve require hot shorts in order to prevent the valves from performing their safety functions. In addition, if the valves are in their fail-safe state, the control chamber for the valves is required to pressurize which can also require spurious operation of the hydraulic pump which makes the required failures time sensitive. Failures of the hydraulic pump were not considered necessary for fire-induced failure of the valves to occur. Details regarding the operation of these valves are provided in FSAR Sections 5.4.3 and 6.2.4.
- In the case of the ECCS valves, after successful actuation (i.e., valves are in their fail-safe state), hot shorts are required to both the trip and reset valves and spurious alignment and operation of the chemical and volume control system makeup pumps to reset the valve which makes the required failures time sensitive. Failures of the reset valve and operation of the chemical and volume control system makeup pumps are not considered necessary for fire-induced failure of the valves to occur. Details regarding the operation of these valves are provided in FSAR Section 6.3.2.

Impact on DCA:

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