UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 25, 2020

Matthew W. Sunseri, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: RESPONSE TO THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS LETTER ON NUSCALE POWER, LLC, AREA OF FOCUS—BORON REDISTRIBUTION

Dear Mr. Sunseri:

On behalf of the U.S. Nuclear Regulatory Commission (NRC) staff, I would like to thank you for the letter from the Advisory Committee on Reactor Safeguards (ACRS or the Committee) dated July 29, 2020 (Agencywide Documents Access and Management System Accession No. ML20210M890). In that letter, the ACRS reported on the Committee's review of the NRC staff's safety evaluation for the NuScale Power, LLC (NuScale), Area of Focus—Boron Redistribution. I appreciate the time and effort the ACRS has devoted to this review, as reflected in meetings held with the ACRS Full Committee on June 3–5, 2020; July 8–10, 2020; and July 21–25, 2020.

The ACRS letter included the following conclusions and recommendations:

1. NuScale has incorporated design and setpoint changes to the NuScale Power Module (NPM) to mitigate the effects of boron dilution in the downcomer for design basis uncontrolled passive cooling events and loss-of-coolant accidents (LOCAs) up to the time of emergency core cooling system (ECCS) actuation.

   Staff Response: The staff agrees with the ACRS conclusion.

2. The applicant has demonstrated for these scenarios, through a conservative analytical approach, that the design modifications maintain the boron concentration in the downcomer above the critical boron concentration level necessary to prevent recriticality and a return to power. The staff's evaluation confirms the applicant's analyses out to 72 hours.

   Staff Response: The staff agrees that while on passive decay heat removal system cooling, prior to emergency core cooling system actuation, the boron concentration in the downcomer remains above the critical boron concentration necessary to prevent recriticality.

3. However, ECCS actuation events result in water levels below the new riser holes and render them ineffective; thus, coolant in the downcomer will deborate for a range of design basis accidents, including small-break LOCAs. The estimated time for the boron concentration to drop below the critical boron concentration in the downcomer for these events is within a few hours.

   Staff Response: The staff agrees that following an emergency core cooling system actuation, the water level will drop below the riser holes and coolant in the downcomer and containment will begin to deborate. However, the applicant has demonstrated and the staff has independently confirmed that under this configuration the reactor core remains highly borated with margin to criticality. The staff concludes in its safety evaluation report (SER) for Chapter 15, dated July 23, 2020, (ADAMS Accession No. ML20205L408) that for scenarios of uneven boron distribution following passive cooling modes with no operator action, the core remains subcritical and the top of active fuel remains covered with acceptably low cladding temperatures.

4. Operator recovery actions raise the possibility of an influx of deborated water into the core, which may result in recriticality, return to power, and the potential for core damage.

   Staff Response: In the staff's SER for Chapter 19, dated July 17, 2020, (ADAMS Accession No. ML20196L734), the staff identified two post-event recovery scenarios that could pose a challenge to reactivity control. The first scenario is recovery from a non-LOCA extended decay heat removal system (DHRS) cooling condition which can occur following initiating events such as general transients and losses of off-site power. The second scenario is recovery from a LOCA ECCS cooling condition which can occur following initiating events such as breaks in the primary coolant lines. The staff notes that either action to inject would likely be governed by plant-specific procedures; however, such procedures are not required at the design certification stage and have not been developed. The staff evaluated the potential core damage risk for the two scenarios. For reasons discussed in the SER which are supported by two papers developed by the Office of Nuclear Regulatory Research (RES) (ADAMS Accession Nos. ML20191A069 and ML20205L317), the staff concludes that enough margin exists such that these recovery scenarios are unlikely to lead to core damage based on the physical effects of fluid mixing, reactivity feedback mechanisms, and associated time constants. Based on the SER and the two RES papers, the staff found that there is reasonable assurance that there are no known significant risk contributors that are unaccounted for and that the identified risk insights are acceptable to support the uses of probabilistic risk assessment (PRA) at the design stage.

5. Detailed operator response and recovery procedures will be developed by the combined license (COL) applicant. The staff must ensure that these recovery strategies will prevent core damage with a high degree of confidence.

Staff Response: The staff has concluded enough margin exists such that these recovery scenarios are unlikely to lead to core damage. As such, the staff has reasonable assurance that operator actions associated with the recovery scenarios are not risk significant and, therefore, an assessment of operator actions was not needed or performed during the review of the design certification application. See the response to No. 6 below for additional information regarding any recovery procedures and the COL applicant.

6. A focused effort by the COL applicant is needed to develop recovery strategies that will lead to effective operating procedures. Given the inability to measure the distribution of boron in the NPM during these events, these strategies should have a stronger technical basis than is currently documented that demonstrates a path to successful recovery to prevent core damage. The probabilistic risk assessment should be updated accordingly at the COL stage to appropriately reflect the risk of boron dilution events, including associated operator actions.

Staff Response: Recovery strategies are not required at the COL application stage, rather the COL license holder is responsible for developing effective operating procedures for its facility during the construction phase. Staff expects that operating procedures developed by a combined license holder would provide additional defense in depth during recovery actions.

As discussed in the response to conclusion and recommendations No. 4 and No. 5 above, the staff evaluated the potential core damage risk for the two recovery scenarios. For reasons discussed in the SER which are supported by two papers developed by RES (ADAMS Accession Nos. ML20191A069 and ML20205L317), the staff concludes that enough margin exists that these recovery scenarios would not lead to core damage based on the physical effects of fluid mixing, reactivity feedback mechanisms, and associated time constants. As described in the Chapter 19 SER, the staff identified one possible condition that could lead to a prompt criticality excursion; however, while the thermal hydraulic conditions for this scenario are theoretically possible (i.e., it requires rods remaining withdrawn, and low pressure and power, without ECCS operation), the staff was not able to postulate any suitable scenarios in which the requisite conditions would occur simultaneously. After the extensive discussions with the ACRS on the staff technical analysis, the staff clarified the SER to reflect this insight on the thermal-hydraulic conditions. Additionally, in accordance with COL Item 19.1-1, a COL applicant that references the NuScale Power Plant design certification will identify and describe the use of the probabilistic risk assessment in support of licensee programs being implemented during the COL application phase.

The NRC staff appreciates the ACRS's review of this highly complex issue.

Sincerely,

Ho K. Nieh Digitally signed by Ho K. Nieh
Date: 2020.08.25 12:22:52 -04'00'

Ho K. Nieh, Director
Office of Nuclear Reactor Regulation

Docket No.: 52-048

cc: Chairman Svinicki
Commissioner Baran
Commissioner Caputo
Commissioner Wright
Commissioner Hanson
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