UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

February 13, 2020

MEMORANDUM TO: Matthew W. Sunseri, Chairman
Advisory Committee on Reactor Safeguards

FROM: Walter L. Kirchner, Chairman **/RA/**
NuScale Subcommittee
Advisory Committee on Reactor Safeguards

SUBJECT: PROPOSED RECOMMENDATION FOR ACRS REVIEW OF NUSCALE POWER, LLC, DESIGN CERTIFICATION APPLICATION – SAFETY EVALUATION WITH NO OPEN ITEMS FOR CHAPTER 6, "ENGINEERED SAFETY FEATURES"

In response to the Committee's request, I have reviewed the NRC staff's safety evaluation report (SER) with no open items for Chapter 6, "Engineered Safety Features," dated December 9, 2019 (ML19343A027). The following is my recommended course of action concerning further review of this chapter of the design certification application and the staff's associated safety evaluation.

SER Phase 4 Summary

Chapter 6 of the SER documents the staff's review of Revision 3 of Chapter 6, "Engineered Safety Features," of the NuScale Design Certification Application, Part 2, Tier 2 "Final Safety Analysis Report" (ML19241A414).

The engineered safety features (ESFs) that are part of an individual NuScale Power Module (NPM) include the containment systems, the emergency core cooling system (ECCS), and fission product removal and control systems. Also addressed in Chapter 6 are control room habitability systems and in-service inspection and testing of related ESF systems and components.

6.1 ESF Materials: There are no confirmatory or COL items for this section.

6.2 Containment Systems: The staff evaluated the containment structural capability to withstand a full spectrum of primary and secondary mass and energy releases. Peak pressure occurs as a result of an inadvertent actuation of an ECCS reactor recirculation valve (RRV) and peak containment temperature occurs as a result of a reactor coolant injection line break. For containment heat removal, given the unique NuScale passive design of a containment vessel (CNV) largely immersed in a pool of water serving as the ultimate heat sink, the staff granted an exemption to GDC 40 requiring testing of the containment heat removal systems. Regarding long-term cooling, there is a COL item requiring a containment cleanliness program limiting

debris in containment. Containment isolation systems were evaluated by the staff and deemed to provide an acceptable basis for meeting the many regulatory requirements applicable to this part of the ESF review.

There are no systems for combustible gas control in the NuScale containment design. Staff evaluated NuScale's analyses for a hypothetical deflagration-to-detonation pressure pulse loading on the CNV and determined that the design was sufficiently robust to justify an exemption to 10 CFR 50.44. "Combustible Gas Control for Nuclear Power Reactors." Regarding containment leakage testing, NuScale sought exemptions to GDC 52, periodic integrated leak rate testing, and 10 CFR 50, Appendix J, because the CNV is designed as a ASME Section III, Class 1 pressure vessel, and will be hydro-tested as per the ASME code; it is 100% inspectable (every 10 years); and all bolted flanges and connections will be leak tested or inspected at each refueling. The staff approved NuScale's proposed exemptions (there are two COL items related to this action). Finally, the staff reviewed and found that applicant met the fracture toughness requirements of GDC 51.

6.3 Emergency Core Cooling System: The ECCS is a passive system that includes five valve systems. When actuated, it vents steam through three reactor vent valves (RVVs) mounted at the top of the reactor pressure vessel (RPV) to the CNV and returns subsequent condensate back through the two RRVs to the downcomer region of the RPV. The ECCS does not provide additional coolant or poison to the system, but it's designed to retain sufficient inventory in the RPV to keep the core covered during the event. The capability of the "first-of-a-kind ECCS valve system to perform its safety function" is covered in Section 3.9.6 of the final safety evaluation report (FSER). The issues of boron precipitation and dilution are covered in Section 15.0.6. Pre-operational tests of the integral ECCS for the first NPM are specified in Table 14.2-63. The staff considers these tests as "essential."

6.4 Control Room Habitability: NuScale states that the control room habitability system (CRHS) is not a safety function because the design does not credit any control room operator actions to mitigate design-basis events (DBEs). The staff's review of NuScale's exemption request to GDC 19 is documented in Section 1.14 of the FSER. The staff concurred in finding that the CRHS can be categorized as not safety-related. There is a control room ventilation system that can be used as a backup for the CRHS, and after 72 hours into an event, it is used for the duration of the accident.

Finally, the staff stated that they cannot make a satisfactory finding regarding post-accident monitoring of containment atmosphere oxygen and hydrogen concentrations (pursuant to 10 CFR 50.34(f)(2)(xxviii)), and associated potential leakage from those systems, hence consequent dose to control room (and to the environment). See Section 12.3.4 for proposed rule language on this item.

Applicable Concerns from ACRS Phase 3 Letter Report

From our August 2, 2019 letter report, we concluded that the ECCS valve test program currently underway is required to provide confidence for valve functionality and performance. In our discussion we pointed out that the ECCS valves are sophisticated in their design because they incorporate a DC powered solenoid trip valve for actuation in combination with an integrated hydraulic and spring mechanical valve. Inadvertent valve actuation, considered an anticipated operational occurrence by the applicant, was analyzed in Chapter 15, and as described above, leads to the peak DBE containment pressure loading.

Staff Response to ACRS Letter Report

The staff agreed with the ACRS position regarding the need for the ECCS valve testing program. In their response of September 13, 2019, they further stated that they will continue their review of the ECCS valve system design (which includes a main valve, inadvertent actuation block valve, and solenoid trip and reset valves). They have recently observed sample demonstration test runs of the valve design conducted by NuScale at the Target Rock facility in NY. "This enhances agency confidence in functionality and performance of the ECCS valve system pursuant to 10 CFR 52.47(c)(2) and 50.43(e)."

Open Items from Phase 3 Requiring Further ACRS Review

The Subcommittee was briefed on the ECCS valve test program on February 4, 2020.

The Committee will be briefed on Chapter 15 analyses on March 2-4, 2020, which includes boron precipitation and dilution matters during ECCS performance and long-term cooling (Section 15.0.6 of the SER).

The Committee commented on the topic of post-accident monitoring of containment oxygen and hydrogen concentrations (via unisolating the containment evacuation system (CES) – potential dose implications of leakage on control room habitability and to environment) in its source term focus area review. This reviewer notes that the applicant classifies the CES as a "non-essential" system, which raises further concerns about pressure rating and quality level of piping/valves, especially were a detonation to occur. This concern was raised as part of our source term focus area review. In response to our letter report, the staff indicated they will address this concern in an upcoming ACRS meeting.

Recommendation

As lead reviewer for NuScale Chapter 6, I recommend that the Committee not perform any additional Phase 5 review of this chapter, contingent on the Committee's future focus area review of ECCS & Valve Performance, and briefings on Chapter 15 Transient and Accident Analyses, leading to the Boron Dilution & Return to Criticality focus area review, and the staff response to our concern from the source term focus area review.

February 13, 2020

SUBJECT: PROPOSED RECOMMENDATION FOR ACRS REVIEW OF NUSCALE POWER, LLC, DESIGN CERTIFICATION APPLICATION – SAFETY EVALUATION WITH NO OPEN ITEMS FOR CHAPTER 6, "ENGINEERED SAFETY FEATURES"

Package No.: ML20044D595
Accession No: **ML20044D549** **Publicly Available Y** **Sensitive N**
Viewing Rights: ☒ NRC Users or ☐ ACRS Only or ☐ See Restricted distribution *via email

OFFICE	**ACRS/TSB**	**SUNSI Review**	**ACRS/TSB**	**ACRS**
NAME	WWang	WWang	LBurkhart *(KHoward for)*	WKirchner *(KHoward for)*
DATE	2/13/2020	2/13/2020	2/13/2020	2/13/2020

OFFICIAL RECORD COPY