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

April 17, 2019

Ms. Margaret M. Doane
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: INTERIM LETTER: CHAPTERS 9, 10, 11, 12 AND 16 OF THE NRC STAFF'S SAFETY EVALUATION REPORT WITH OPEN ITEMS RELATED TO THE DESIGN CERTIFICATION APPLICATION REVIEW OF THE NUSCALE SMALL MODULAR REACTOR

Dear Ms. Doane:

During the 662nd meeting of the Advisory Committee on Reactor Safeguards, April 4-5, 2019, we met with representatives of NuScale Power, LLC (NuScale) and the NRC staff to review Chapter 9, "Auxiliary Systems," Chapter 10, "Steam and Power Conversion Systems," Chapter 11, "Radioactive Waste Management," Chapter 12, "Radiation Protection," and Chapter 16, "Technical Specifications," of the safety evaluation report (SER) with open items associated with the NuScale design certification application (DCA). Our NuScale Subcommittee also reviewed these chapters on March 20-21, 2019. During these meetings, we had the benefit of discussions with NuScale and the staff. We also had the benefit of the referenced documents.

CONCLUSION AND RECOMMENDATION

1. There are potentially risk-significant items in the NuScale design that are not yet fully developed. For these items, requirements should be included in the DCA to ensure that the licensed NuScale plant will perform as credited.

2. We have not identified any additional major issues at this time for Chapters 9, 10, 11, 12 and 16.

BACKGROUND

NuScale submitted a DCA for its small modular reactor on December 31, 2016. The staff's Phase 2 SER chapters related to the DCA include open items. In addition to a description of the staff review and their bases for acceptance of the DCA, the SER chapters also identify the information a combined license (COL) applicant must provide. Our review is being conducted on a chapter-by-chapter basis to identify issues that may merit further consideration by the staff. This process aids in the resolution of concerns and facilitates timely completion of the design

certification application review. Our review addresses the staff's SER and DCA Chapter 9, Revision 1; Chapter 10, Revision 1; Chapter 11, Revision 2; Chapter 12, Revision 1; and Chapter 16, Revision 2; along with supplemental material, including NuScale responses to staff requests for additional information.

DISCUSSION

For this interim letter, we note the following observations on selected elements of the design addressed in these chapters.

DCA Chapter 9 – Auxiliary Systems

NuScale auxiliary systems include: fuel storage and handling systems; water systems; process auxiliaries; heating, ventilation and air conditioning systems; and systems required for fire protection, communications and lighting.

The Overhead Heavy Load Handling System (OHLHS) consists of all equipment required for moving heavy loads, e.g., NuScale Power Module (NPM) movement as part of a module refueling. The staff reviewed this system to identify any malfunctions or operations that could result in an inability to achieve a safe shutdown of the reactor modules. NPM movement is of particular interest because this operation occurs while other modules are operating, and involves the reactor building crane moving the NPM in a prescribed safe load path scheduled by the operator. The staff reviewed the OHLHS design and found it to be consistent with staff guidance (NUREG-0612 and RG 1.13) after NuScale revised COL Item 9.1-7 to require that COL applicants provide a program governing heavy load lifts. This program should prescribe the operating and maintenance procedures, inspection and test plan, personnel qualification and operator training as well as a detailed description of the safe load paths for movement of heavy load lifts.

The NuScale design has several unique features and processes where additional design information and requirements should be provided in the DCA for the COL applicant. Examples identified in our review include: human actions associated with reactor building crane operations, motion limiters and interlocks associated with manipulations of all cranes, and ultimate heat sink water sampling (the ultimate heat sink includes the spent fuel pool) to ensure adequate boron concentration throughout the pool. Uncertainties in the design have the potential to introduce important contributors to risk. It should be made clear how or when these design features will be finalized by NuScale or by the COL applicant, as well as reviewed by the staff. Requirements for potentially risk-significant items such as these should be included in the DCA to ensure that the licensed NuScale plant will perform as credited.

The chemical and volume control system provides several critical functions for the NuScale reactor design. These include inventory control, chemical control, and boric acid addition. The significance of these functions will be evaluated in the SER of Chapters 15, "Transient and Accident Analyses," and 19, "Probabilistic Risk Assessment and Severe Accident Evaluation." ACRS will await completion of these DCA chapter reviews before evaluating the risk significance of these systems. For example, the chemical and volume control system uses a circuitous process to inject boron into the reactor coolant system and into the core. The delivery of the boric acid solution to the core requires successful operation of multiple valves in series. If any single one of these valves fails to function as intended, boric acid will not be injected.

DCA Chapter 10 – Steam and Power Conversion Systems

The steam and power conversion system removes thermal energy from the reactor coolant system and transfers it to the main turbine generator. The main elements of the steam and power conversion system include the main steam, turbine generator, turbine bypass, main condensers, circulating water, condensate polishing, feedwater treatment, condensate and feedwater, and auxiliary boiler systems. The power conversion system is not safety related and is not required for safe shutdown. However, the main steam and main feedwater systems have piping that penetrate the containment and components that directly interface with safety-related structures, systems, and components (SSCs). The failure of these components can have an adverse impact on plant safety and the plant's ability to achieve a safe shutdown.

In particular, the main turbine-generator is oriented such that some safety-related equipment is in the turbine low-trajectory hazard zone of potential missiles generated by a turbine-generator catastrophic failure. NuScale has chosen to protect these vulnerable components using strong physical barriers. The analysis supporting the acceptability of these barriers is described in Chapter 3, "Design of Structures, Systems, Components and Equipment," of the DCA. We defer judgment on the acceptability of this approach until our review of Chapter 3.

DCA Chapter 11 – Radioactive Waste Management

The NuScale radioactive waste management system consists of the liquid radioactive waste system, gaseous radioactive waste system, solid radioactive waste system, and process and effluent radiation monitoring instrumentation and sampling system. These systems are designed for normal operations, including refueling outages, routine maintenance, and anticipated operational occurrences. As operational events, anticipated operational occurrences include unplanned releases of radioactive materials associated with fuel failures, equipment failures, operator errors, and administrative errors, with radiological consequences that are not considered accident conditions.

NuScale has proposed to use EPRI historical data as a conservative bound for the realistic failed fuel fraction (RFFF). Staff reviewed the information for calculating the revised RFFF and found it acceptable for source terms during normal operations. Staff also confirmed that Revision 1 of NuScale TR-1116-52065-P and Revision 2 of FSAR Tier 2, Sec. 11.1, included this revised RFFF and corresponding source terms during normal operations. The design basis failed fuel fraction is assumed to be an order of magnitude greater than the RFFF. The staff is still reviewing the use of the design basis failed fuel fraction as a source term for radiation shielding, ventilation systems, and radiation zoning. This is being tracked as an open item.

With the exception of the open items, we agree with the staff's conclusions that the NuScale design-basis source term, the realistic source term, and the radioactive waste management systems comply with the regulatory requirements.

DCA Chapter 12 – Radiation Protection

This chapter provides information on facility and equipment design and programs used to meet the radiation protection requirements in 10 CFR Part 20, "Standards for Protection against Radiation"; 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"; and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

Chapter 12 discusses four aspects of radiation protection: 1) assuring that occupational radiation exposures are as low as reasonably achievable; 2) determining projected radiation sources during normal operations, anticipated operational occurrences, and accident conditions; 3) establishing radiation protection design features (shielding, ventilation, radioactivity monitoring systems, and contamination controls); and 4) providing the basis for the dose assessment for normal operation and post-accident sampling and analysis. Operational considerations on the implementation of a radiation protection program are outside the scope of the DCA review and will be addressed by a COL applicant.

NuScale Topical Report, TR-0915-17565, Revision 3, "Accident Source Term Methodology," is to be submitted to include a revised accident source term methodology. This revised accident source term methodology directly affects some of the source terms used in Chapter 12 and impacts many of the existing open items that include dose calculations. Another example is in Chapter 9 where an open item exists for the NuScale exemption request for post-accident sampling. The staff will conduct a full review of the revised TR-0915-17565, Revision 3, when it is available.

Various radiation source determination issues raised by the staff have led to changes in NuScale assumptions and approaches. Other issues include: post-shutdown crud burst; resin transfer piping sizes; RCS flow rate changes; radiation fields around the top of the containment vessel; source term and related information during degasifying reactors for shutdown; and ultimate heat sink pool temperature assumptions for airborne activity source terms. The staff expects these issues to be resolved in their Phase 4 review.

We agree with the staff's conclusion that, with the exception of the SER open items, the design meets the applicable radiation protection requirements. However, there are numerous COL Items identified in Chapter 12. It is important that NuScale provide sufficient information regarding how such requirements should be met. This is particularly important when the DCA credits such design features.

DCA Chapter 16 – Technical Specifications

The NuScale Generic Technical Specifications (GTS) set forth the safety limits, limiting safety system settings, limiting conditions for operation , and other limitations on facility operation that are necessary for adequate protection of public health and safety. The GTS are based on current light water reactor technical specifications, where differences are a result of unique design differences from standard light water reactor designs. Staff's review of these GTS was conducted resulting in open items such as instrumentation surveillance requirements, response time testing, application of limiting conditions for operation selection criteria and COL action items. No significant issues remain to resolve open items.

SUMMARY

There are potentially risk-significant items in the NuScale design that are not yet fully developed. For these items, requirements should be included in the DCA to ensure that the licensed NuScale plant will perform as credited. We have not identified any additional major issues at this time for Chapters 9, 10, 11, 12 and 16.

Sincerely,

/RA/

Peter C. Riccardella
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, "NuScale Power, LLC, Design Certification Application – Safety Evaluation With Open Items for Chapter 9, 'Auxiliary Systems'," March 25, 2019 (ML19084A286).
2. NuScale Power, Design Certification Application, Chapter 9, "Auxiliary Systems," Revision 1, March 15, 2018 (ML18086A180).
3. U.S. Nuclear Regulatory Commission, SECY 94-084, "Policy and Technical Issues Associated With the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs," March 28, 1994 (ML003708068).
4. U.S. Nuclear Regulatory Commission, "NuScale Power, LLC, Design Certification Application – Safety Evaluation With Open Items for Chapter 10, 'Steam and Power Conversion System'," January 23, 2019 (ML18257A276).
5. NuScale Power, Design Certification Application, Chapter 10, "Conduct of Operations," Revision 1, March 15, 2018, (ML18086A181).
6. U.S. Nuclear Regulatory Commission, "NuScale Power, LLC, Design Certification Application – Safety Evaluation With Open Items for Chapter 11, 'Radioactive Waste Management'," January 17, 2019 (ML19015A051).
7. NuScale Power, Design Certification Application, Chapter 11, "Radioactive Waste Management," Revision 2, October 30, 2018, (ML18310A333).
8. NuScale Power, Technical Report TR-1116-52065-NP, "Effluent Release (GALE Replacement) Methodology and Results," Revision 0, January 13, 2017 (ML17005A135).
9. U. S. Nuclear Regulatory Commission, "NuScale Power, LLC, Design Certification Application – Safety Evaluation With Open Items for Chapter 12, 'Radiation Protection'," January 18, 2019 (ML19015A137).
10. NuScale Power, Design Certification Application, Chapter 12, "Radiation Protection," Revision 1, March 15, 2018, (ML18086A183).
11. U.S. Nuclear Regulatory Commission, "NuScale Power, LLC, Design Certification Application – Safety Evaluation With Open Items for Chapter 16, 'Technical Specifications'," March 21, 2019 (ML19050A439).

12. NuScale Power, Design Certification Application, Chapter 16, “Technical Specifications,” Revision 2, October 30, 2018 (ML18310A338).

13. NuScale Power, Design Certification Application Part 4, “Generic Technical Specifications, Volume 1 ‘Specifications’,” December 31, 2016 (ML17013A298).

14. NuScale Power, Design Certification Application Part 4, “Generic Technical Specifications, Volume 2, ‘Bases’,” December 31, 2016 (ML17013A299).

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