August 28, 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 Response to NRC Request for Additional Information No. 42 (eRAI No. 8836) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 42 (eRAI No. 8836)," dated June 02, 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 Questions from NRC eRAI No. 8836:

- 03.06.02-1
- 03.06.02-6

Revisions for the FSAR Section 3.6 and the NuScale Pipe Rupture Hazards Analysis technical report TR-0818-61384 are not included with this response. Revisions of the FSAR Section 3.6 and Revision 0 of TR-0818-61384 are in preparation and will be provided by separate letter.

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 Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

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

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8836

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NuScale Response to NRC Request for Additional Information eRAI No. 8836

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

eRAI No.: 8836
Date of RAI Issue: 06/02/2017

NRC Question No.: 03.06.02-1

General Design Criteria (GDC) 4, "Environmental and Dynamic Effects Design Bases," requires, in part, that structures, systems, and components (SSCs) important to safety be designed to accommodate the effects of postulated accidents, including protection against the dynamic effects of postulated pipe ruptures. SRP 3.6.2 and its associated BTP 3-4 provides, in part, guidelines acceptable to the staff for meeting these GDC 4 requirements.

To address its compliance with GDC 4 requirements, in NuScale FSAR Tier 2, Section 3.6, the applicant describes the criteria and method used in the NuScale design to mitigate the dynamic effects of postulated pipe ruptures. NuScale FSAR Section 3.6.5, "Integral Jet Impingement Shield and Pipe Whip Restraint," states that one method used in the NuScale design to mitigate the dynamic effects of postulated pipe rupture is installation of an integral shield restraint (ISR). Based on its review of the information described in the FSAR Sections 3.6.5, 3.6.5.1, and 3.6.5.2, the staff determined that additional information for ISR design, CFD analysis, and confirmation testing as described below are needed to ensure that ISR performs its intended function to mitigate the dynamic effects of postulated high-energy pipe ruptures in the NuScale design.

a. A typical ISR is shown in FSAR Figure 3-6-33 and Figure 3-6-34. However, FSAR Section 3.6.5 states that the ISR designs will continue to be developed to be compatible with the various configurations of piping where breaks are postulated and with the types of break which must be postulated , including longitudinal breaks, as the detailed piping analyses indicate they are required. The applicant is requested to provide more ISR design details to ensure they are compatible with the various piping configurations and with the types of breaks postulated and to provide the locations where the ISRs will be used.

b. NuScale FSAR Section 3.6.5.1, "Integral Jet Impingement Shield and Pipe Whip Restraint Computational Fluid Dynamics Analysis," states that computational fluid dynamics (CFD) models were developed for the flow exiting the ISR following the pipe break and were used to determine the effect on nearby components resulting from jet impingement. It also included some information related to the CFD analysis performed as well as the analysis results. However, the NRC staff found that more detailed CFD analysis information (including, but not limited to, definition of problem, geometric configuration and physical modeling assumed, range of conditions in the specified scenario including initial condition and boundary condition, iteration convergence criteria, and discretization of special mesh and time step used) are needed for the NRC staff's review to ensure that representative and appropriate CFD analysis has been performed for the plant specific ISR application in the NuScale design. The applicant is requested to provide the information described above.

c. NuScale FSAR Section 3.6.5.2, "Integral Jet impingement Shield and Pipe Whip Restraint Confirmatory Test Program," states that proof of concept testing is being performed to validate the analytical model and to demonstrate that the ISR performs its intended function as the NuScale ISR is a first-of-a-kind application to mitigate the dynamic effects of postulated high-energy pipe rupture in the nuclear power plant design. It further describes the test objectives, parameters to be measured, and some information related to the facility design. However, the NRC staff found that more detailed information (including, but not limited to, test facility design/configuration, and the test repeatability which includes instrumentation accuracy and potential uncertainty of test results) are needed to ensure that the prototypic testing performed is representative for the NuScale ISR design and application. In addition, the recorded test parameters/results are needed by the NRC staff to validate the ISR analytical model and demonstrate that the ISR performs its intended function to mitigate the dynamic effects of postulated high-energy pipe ruptures in the NuScale design. The applicant is to provide the information described above and the schedule of performing the ISR confirmatory testing, development of reports, and when the NRC staff will have access for review.

NuScale Response:

NuScale has discontinued development of the Integral Jet Impingement Shield and Pipe Whip Restraint (ISR) concept, and discussion of the ISR has been removed from the FSAR. Instead, NuScale has performed a high and moderate energy line break analysis considering NRC guidance, as discussed in a revision to FSAR Section 3.6. Mitigation strategies, including separation and the design and use of traditional pipe whip restraints and jet impingement shields, are discussed in the NuScale Pipe Rupture Hazards Analysis technical report, TR-0818-61384.

Impact on DCA:

The FSAR Tier 2, Section 3.6 has been revised as described in the response. The FSAR markup is being provided by separate letter.

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

eRAI No.: 8836
Date of RAI Issue: 06/02/2017

NRC Question No.: 03.06.02-6

NuScale FSAR Tier 2, Section 3.6.2.1.3, “Pipe Breaks in the Reactor Building outside the reactor Pool Bay,” states that evaluation of the unrestrained pipe whip may also be performed to show that the effects of the rupture are acceptable without mitigation. However, the staff found that no information (or pointer) related to the design criteria/methodologies for assessing the dynamic effects of unrestrained pipe whip included in the FSAR Tier 2, Section 3.6. The applicant is requested to provide the information for the NRC staff’s review.

NuScale Response:

NuScale has performed an assessment of the pipe whip for different regions of the plant. The energy of a whipping pipe in the NuScale plant is limited because of its smaller pipe sizes and more compact arrangements that limit whip distance. The assessment approach and results are described in the NuScale Pipe Rupture Hazards Analysis technical report TR-0818-61384 and in the FSAR Section 3.6, and are summarized briefly below.

In the reactor building (RXB) outside the reactor pool bay, high and moderate energy piping is separated from essential and safety-related equipment by compartmentation. Key structural elements, including the RXB floors and walls, are 3 feet and 5 feet thick, respectively. Although the routing of high and moderate energy piping within this region is not final and is COL applicant scope (see COL Items 3.6-1, 3.6-2, and 3.6-3), to ensure that the design will be satisfactory, NuScale performed a bounding analysis (i.e., main steam system (MSS) rupture with maximum energy at impact by assuming a long, unrestrained pipe segment).

A steam line pipe whip event within the reactor building pipe gallery is capable of applying an impact force to the concrete wall. Concrete penetration equations developed via empirical relationships provide a means of estimating damage based on an impact velocity. The Sandia formula (Young, C. W., “Penetration Equations,” Sandia National Laboratories, SAND97-2426, October 1997) is an empirical representation taking into account the shape of the penetrator (in this case a piping elbow), the weight and velocity of the penetrator (i.e., the whipping pipe section) at impact, the impact area, and a target penetrability index.

The analysis demonstrates that the consequences (depth of penetration of the concrete structure) of main steam HELB pipe whip impacts are localized and of limited depth and therefore acceptable.

Impact on DCA:

The FSAR Tier 2, Section 3.6 has been revised as described in the response. The FSAR markup is being provided by separate letter.