RAIO-0818-61199

August 02, 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. 202 (eRAI No. 8911) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 202 (eRAI No. 8911)," dated August 25, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 202 (eRAI No.8911)," dated October 27, 2017
3. NuScale Power, LLC Response to NRC "Request for Additional Information No. 202 (eRAI No.8911)," dated November 20, 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. 8911:

- 03.09.02-46

A majority of the responses to RAI No. 202, eRAI No. 8911, questions were previously provided in Reference 2 and Reference 3. The response for question 03.09.02-18 will be provided by September 24, 2018. The response to questions 03.09.02-43 and 03.09.02-45 will be provided by December 21, 2018. Markups for NPM Seismic Analysis technical report TR-0916-51502 are not included with this RAI response. Revision 1 of TR-0916-51502 is in preparation and will be provided at a later date.

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,

Jennie Wike
Manager, Licensing
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8911

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Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8911

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

eRAI No.: 8911
Date of RAI Issue: 08/25/2017

NRC Question No.: 03.09.02-46

10 CFR 50, Appendix A, GDC 4 requires structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. Regulatory guides (RG) describe methods that the NRC considers acceptable to use in implementing the agency's regulations. RG 1.61 Rev.1 states that for steel structures with a combination of different connection types, use the lowest specified damping value, or as an alternative, use a "weighted average" damping value based on the number of each type present in the structure. TR-0916-51502-P, Rev. 0, Table C-3, "Summary of NuScale Power Module Damping Values" states that a 7 percent damping is assigned for the NPM sub-system seismic analysis of reactor vessel internals (RVI), reactor pressure vessel (RPV), and containment as well as 7 percent NPM system damping is assigned for NPM system seismic analysis. For the RVI, the applicant states that because the RVI joints allow for sliding at the interfaces developing of sliding friction forces, and these connections are analogous to bolted steel with bearing connections in RG 1.61. However, NuScale FSAR Rev. 0, Section 3.9.5.1 states that the upper support blocks of the core support assembly are welded to the core barrel. In addition, the lower core plate is welded to the bottom of the core barrel to support and align the bottom end of the fuel assemblies. RG 1.61 specifies a 4 percent SSE damping for welded steel.

For the containment, the applicant uses energy dissipation in the plastic deformation based on containment yielding stresses in faulted condition for justification of 7 percent SSE damping. The applicant calculated the dissipated energy in terms of NPM equivalent drop height and equivalent static acceleration and stated that the amount of dissipated energy in these two cases justifies the use of 7 percent damping. The NRC staff recognizes that yielding of steel would increases damping. However, the staff has concerns with the use of 7 percent damping for the containment. First, the containment yielding stress in faulted condition consists of combination of seismic and loss of coolant accident (LOCA) stresses. The LOCA stress should be excluded from the yielding stress because LOCA stress is a short-term transient type stress and peaks of seismic stress and LOCA stress may not occur at the same time. Second, in the calculations of NPM equivalent drop height and static acceleration, the applicant didn't provide a direct quantitative correlation between energy dissipation and damping values. The NRC staff used 6 percent damping to calculate the NPM equivalent static acceleration, the result only

differs about 7.5 percent from that based on 7 percent damping. Therefore, the staff is not able determine whether the amount of energy dissipated in the containment plastic deformation could achieve 7 percent damping.

For the RPV, the applicant states that metal yielding in the nozzles increases damping and the RPV contains the steam generator (SG) with many sliding tube-to-support interfaces generating large frictional dissipative forces for justification of 7 percent damping. The NRC staff's concern is that steel/steel coefficient of friction is much smaller underwater than in dry condition because of the water film acting as a lubricant. For example, the coefficient of friction of cast iron brake material is 0.4 in dry condition and 0.2 in wet condition (Machinery's Handbook 19th edition and http://www.engineershandbook.com/Tables/frictioncoefficients.htm). The NRC staff questions the justifications for using 7 percent damping for RPV based on SG frictional dissipative forces and yielding of nozzles. In addition, provide the damping value for the SGs.

Based on the concerns mentioned above, follow the provision of RG. 1.61 Rev. 1 that uses the lowest specified damping value (i.e., 4% for welded steel) or provide a "weighted average" damping value based on the number of each type of connections in the RVI components, RPV, and containment. Recalculate the NPM system damping based on the weighted average of individual NPM components. Alternatively, provide testing data to justify the use of 7% damping for RVI, RPV, containment, and NPM system damping or add an ITAAC to measure the as-built RVI components, RPV, containment, and NuScale power module system damping.

Include the requested information in the NPM Seismic Report.

NuScale Response:

The composite damping value assigned to the NPM subsystem has been changed to 4% for welded steel or bolted steel with friction connections as discussed in the response to RAI 9021 Question 03.09.03-2, dated August 2, 2018.

Regulatory Guide 1.61, Revision 1 emphasizes a distinction between "slip-critical" and "bearing-bolted" connections. The difference between these types of joints is that in a slip-critical connection bolt forces are large enough to prevent joint sliding versus bearing-bolted type joints where the joint may slide and the bolts are loaded in shear. Conservatively, the 4% damping value is used instead of 7% for the bearing-bolted connections.

The NPM Seismic Analysis technical report TR-0916-51502 Section 8.1 (Transient Analysis) has been updated accordingly and Appendix C, discussing a higher NPM composite damping, has been removed.

Impact on DCA:

TR-0916-51502 Section 8.1 and Appendix C have been revised as described in the response above and will be incorporated into Revision 1 of the NPM Seismic Analysis technical report.