August 23, 2017

Docket: PROJ0769

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. 8872 (eRAI No. 8872) on the NuScale Topical Report, "Evaluation Methodology for Stability Analysis of the NuScale Power Module," TR-0516-49417, Revision 0

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 8872 (eRAI No. 8872)," dated June 30, 2017
2. NuScale Topical Report, "Evaluation Methodology for Stability Analysis of the NuScale Power Module," TR-0516-49417, Revision 0, dated July 2016

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. 8872:

- 01-16

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 Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com.

Sincerely,

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

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Bruce Bavol, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8872

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvalis, Oregon 97330, Office: 541.360.0500, Fax: 541.207.3928
www.nuscalepower.com

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8872

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8872
Date of RAI Issue: 06/30/2017

NRC Question No.: 01-16

In accordance with 10 CFR 50 Appendix A GDC 10, “Reactor design,” the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. The SRP 15.0.2 acceptance criteria with respect to evaluation models includes the requirement that the chosen mathematical models and the numerical solution of those models must be able to predict the important physical phenomena reasonably well from both qualitative and quantitative points of view.

Section 5.6.4.1, ”Pellet Heat Transfer,” of the topical report, TR-0516-49417-P, describes the pellet heat transfer model and refers to the direct energy deposition factor. It is not clear what value of the direct energy deposition factor is used, how it is determined, or if it is a fuel-design-specific value.

In order to make an affirmative finding associated with the above regulatory requirement important to safety, NRC staff requests NuScale to describe the method for determining the direct energy deposition factor for licensing calculations.

NuScale Response:

The fraction of direct fission energy deposition in the coolant is a user input to the code PIM. The value used for the calculations reported in TR-0516-49417-P is 0.026 which is a typical value for LWR fuel. The code internally multiplies this value by the liquid volume fraction.

It should be noted that direct energy deposition fraction is important for Boiling Water Reactor (BWR) stability and has been included in PIM because it was not known *a priori* if this parameter is also important for the NuScale power module (NPM) stability. For a BWR, the oscillation frequency is of the order 0.5±0.2 Hz which results in significant damping of heat flux oscillation magnitude relative to the magnitude of the fission power oscillation. This damping is approximately 10~15 percent depending on oscillation frequency and fuel pin conduction time constant. On the other hand, the direct energy fraction is not damped. The direct energy deposition is stabilizing as an instant negative feedback, unlike the conduction component which is phase-lagged and is destabilizing. The relative magnitude of the two energy transfer components influences the BWR stability. For example, for 13 percent conduction damping and 0.026 direct deposition fraction, the ratio is 20 percent which is significant and stresses the importance of the role of direct energy deposition. References 1 and 2 provide additional detail on the effect of direct energy deposition on BWR stability.

For the NPM, the oscillation frequency is at least an order of magnitude smaller than for a BWR, while the fuel pin conduction time constant is comparable to BWR fuel. The damping and phase lag of the indirect component (through conduction in the fuel pin) are small in the case of a NPM. Also, the ratio of direct-to-indirect components of energy deposition is small, which makes the direct and indirect components of the fission energy deposition essentially indistinguishable with regard to phase lag and damping. The conclusion is that the effect of the magnitude of the direct energy deposition fraction on NPM stability is insignificant, and using a typical value justified.

References:

1. Yousef M. Farawila, “Fuel Design Concept to Stabilize Boiling Water Reactors,” Top Fuel 2016, Boise, ID, September 11-15, 2016
2. T.H.J.J. van der Hagen, “The Influence of Direct Energy Deposition on BWR Stability,” Annals of Nuclear Energy, 28, 1447-1456, (2001)

Impact on Topical Report:
There are no impacts to the Topical Report TR-0516-49417, Evaluation Methodology for Stability Analysis of the NuScale Power Module, as a result of this response.