RAIO-0817-55539

August 22, 2017

Docket: PROJ0769

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 8848 (eRAI No. 8848) 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. 8848 (eRAI No. 8848)," dated June 23, 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 Questions from NRC eRAI No. 8848:

- 01-8
- 01-9

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

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8848

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8848

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Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8848
Date of RAI Issue: 06/23/2017

NRC Question No.: 01-8

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 Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to evaluation models specifies 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 5.5.6.2.1, “Single-Phase Friction Factor,” of the topical report, TR-0516-49417-P, describes the model for single phase friction factor. This section of the topical report provides numerical values for certain parameters. It is not clear what the basis for the Reynold’s number transition point is, nor it is clear the fuel-design-specific geometry is considered in the core friction factor calculation.

In order to make an affirmative finding associated with the above regulatory requirement important to safety, NRC staff requests NuScale to clarify the single phase friction numbers in the licensing calculations and justify any assumptions in deriving the friction factors.

NuScale Response:

The numerical values governing the single-phase friction are user input to the code PIM. Since the methodology is generic and not fuel- or cycle-specific, typical values for NuScale power module (NPM) fuel bundle are used to illustrate the appropriateness of the methodology.

The treatment for laminar flow and transition to turbulent flow are also consistent with RELAP3-3D as stated in the Topical Report, where the transition Reynolds number range is 2200-3000. The laminar and transition regions are used in PIM for completeness, while the core flow is turbulent in all calculations.

The total friction accuracy is indicated by the ability to predict the natural circulation flow rate.

Unlike the case for BWR, the spatial distribution of friction is not important for NPM stability because the coolant remains in single-phase. The demonstration and application of stability methodology to the NPM shows the insensitivity of the results to changes in the magnitude of the friction factor.

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.

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8848
Date of RAI Issue: 06/23/2017

NRC Question No.: 01-9

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 Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to evaluation models specifies 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 5.5.6.2.2. “Two-Phase Friction Factor,” of the topical report, TR-0516-49417-P, describes the two phase friction factor model. It is not clear from this section how the two phase friction factor model is assessed.

In order to make an affirmative finding associated with the above regulatory requirement important to safety, NRC staff requests NuScale to describe the qualification and assessment of the two phase friction factor model.

NuScale Response:

The two-phase friction is taken from the Topical Report Reference 12.1.27 (H. Müller-Steinhagen and K. Heck, “A simple friction pressure drop correlation for two-phase flow in pipes,” Chemical Engineering and Processing, 20(6): 297-308, November 1986). The formula interpolating the friction factor between the single-phase liquid and single-phase vapor to represent the friction factor for two-phase mixture has been assessed by the authors with comparison to data. NuScale did not perform independent assessment beyond verifying the correct physical trend. It should be noted that the coolant circulating in the NuScale power module under normal operation is single-phase and that the two-phase friction is not rated as high importance in the Stability PIRT.

The two-phase regime is explored in the Topical Report as it defines the border of permitted operation and to assure a transition to two-phase is understood. As shown in the Topical

Report, the transition to two-phase through a depressurization transient was found to be stable at end of cycle, and unstable at beginning of cycle but the oscillations do not grow sufficiently to challenge CHF. The impact of two-phase flow is mainly due to density head change in the riser while friction (single- or two-phase) in the riser is small by comparison.

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.