NuScale Power

July 26, 2017

Docket: PROJ0769

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 17 (eRAI No. 8808) 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. 17 (eRAI No. 8808)," dated June 08, 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. 8808:

- 29740
- 29741
- 29742

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

RAIO-0717-55082

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8808

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Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8808

NuScale Power

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8808
Date of RAI Issue: 06/08/2017

NRC Question No.: 29740

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General Design Criterion (GDC) 10 – Reactor Design, states that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). Title 10 of the CFR, Appendix A, GDC 12 states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillations which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The SRP 15.0.2 acceptance criteria with respect to evaluation models states 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 of the topical report, TR-0516-49417-P, describes the pellet heat transfer model and provides a correlation for the fuel thermal time constant, but no basis is provided. To demonstrate compliance with GDCs 10 and 12:

1. Provide the technical basis for the fuel thermal time constant correlation.
2. Clarify whether the correlation is fuel-design-specific; if not, justify the application of this correlation generally.
3. Describe the method for determining the correlation in licensing calculations.

NuScale Response:

The thermal time constant concept is a carry-over from Boiling Water Reactor (BWR) experience. This calculation was performed when it was not known *a priori* that the oscillation period in the NuScale power module is considerably larger than the typical BWR period (more than an order of magnitude). Given the long time scale for the flow and power responses relative to the thermal time constant in a fuel pin, a quasi-steady state model for heat conduction is sufficient. As a result, consideration for conduction dynamics in the licensing methodology is used but not required for stability calculation accuracy.

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.

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Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 8808
Date of RAI Issue: 06/08/2017

NRC Question No.: 29741

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General Design Criterion (GDC) 10 – Reactor Design, states that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). GDC 12 – Suppression of reactor power oscillations, states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillation which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The Standard Review Plan 15.0.2 acceptance criteria with respect to evaluation models states 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 5.6.4.4 of the topical report, TR-0516-49417-P, describes the pellet centerline and average temperature calculations. This section is not clear as to the basis for the burnup dependent factor: "a." Further it does not provide the value used for the temperature weighting. To demonstrate compliance with GDCs 10 and 12:

1. Provide the temperature weighting.
2. Describe the method for determining the burnup dependent factor for licensing calculations. Be clear in this description if the method is fuel-design-specific.
3. Justify the method.

NuScale Response:

The equation for the burnup-dependent thermal conductivity is given in symbolic form in Equation 5.98 in the topical report for the purpose of deriving the pellet center versus surface temperature relationship. The numerical value of the burnup-dependent coefficient "a" is given in Section 5.7 of the topical report (Material Properties) in Equation 5-109. It is shown there that the burnup-dependent coefficient is a linear function in burnup given by:

$$a = 456.89+7.60B$$

where B is burnup in units of MWd/kg.

Thermal conductivity is a property of irradiated UO_2, and therefore this relationship is for generic application and is not limited to any particular fuel design.

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.: 8808
Date of RAI Issue: 06/08/2017

NRC Question No.: 29742

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General Design Criterion (GDC) 10 – Reactor Design, states that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). GDC 12-Suppression of reactor power oscillations, states that the reactor core and associated coolant, control, and protection system shall be designed to assure that power oscillation which can result in conditions exceeding SAFDLs are not possible or can be reliably and readily detected and suppressed. The Standard Review Plan 15.0.2 acceptance criteria with respect to evaluation models states 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 5.7 of the topical report, TR-0516-49417-P, describes the source of material properties used in the PIM method. However, this section is not clear how the fuel conductivity is determined. In particular, since only an average fuel assembly is considered, the derivation of the core-average quantities is unclear. To demonstrate compliance with GDCs 10 and 12:

1. Describe the method for determining a core average fuel conductivity.
2. Describe how exposure dependence is captured.
3. Justify the method for averaging quantities across multiple exposures.

NuScale Response:

The thermal conductivity degradation with burnup is captured by the formula given in Section 5.7, Equation 5-109 of the topical report. The burnup value used in the analysis is dependent on the cycle exposure. Since the core is not represented in 3-D, the average core burnup is used. Tracing the effect of this approximation downstream to the rest of the analysis, it is clear that this approximation is limited to the fuel temperature used to calculate Doppler reactivity feedback. In effect, the Doppler feedback at an average temperature is used to approximate the averaged Doppler feedback of individual nodes at different temperatures. This approximation is compatible with the point kinetics method. It should be noted that large exposure changes from beginning of cycle to end of cycle were made throughout the stability analysis and were shown to result in minor stability effects.

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.