RAIO-0518-60029

May 17, 2018

Docket: PROJ0769

U.S. Nuclear Regulatory Commission
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Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 9443 (eRAI No. 9443) 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. 9443 (eRAI No. 9443)," dated March 20, 2018
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. 9443:

- 15.09-3

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 Paul Infanger at 541-452-7351 or at pinfanger@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9443

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9443

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Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9443
Date of RAI Issue: 03/20/2018

NRC Question No.: 15.09-3

Title 10 of the *Code of Federal Regulations* (10 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 are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. Title 10 of CFR, Part 50, Appendix A, GDC 12, “Suppression of reactor power oscillations,” requires that instabilities that could challenge thermal limits either be detected and suppressed or excluded. Title 10 CFR 50.43 requires licensees to submit safety analyses that demonstrate how a given reactor complies with associated safety criteria. According to the standard review plan (SRP) 15.0.2, the reviewer must ensure that the field equations of the evaluation model are adequate to describe the set of physical phenomena that occur in the accident and ensure that the closure relationships are valid over the full range of conditions encountered.

Question 29851 of the original RAI, RAI 8846, was intended to seek clarification with respect to the PIM inputs related to steam generator heat transfer, specifically. The original response appears to address PIM input more globally and does not address the specific question regarding modeling of steam generator heat transfer. The staff reviewed the response to the original RAI and found that the response was insufficient for the staff to reach a conclusion regarding the adequacy of the stability analysis methodology.

In order to make an affirmative finding with regard to the above regulatory requirements important to safety, the NRC staff requests the following supplemental information:

- Provide the steam generator modeling option used in PIM licensing calculations. This response should clearly state if PIM calculations are performed using the correlations described by the topical report and/or original RAI response or if the heat transfer is calculated according to some other method (e.g., if the user defines the heat transfer through specific user inputs, specify this as well as the method for determining those input specific to the steam generator heat transfer).
- It is not clear from either the topical report or the original RAI response, but it appears as though PIM applies a tuning factor to the total steam generator heat transfer. Describe what tuning factors are applied to the PIM calculations of the

heat transfer. The description should provide an explicit step-by-step process that shows how a tuning factor is determined (either by the user or internally to the code) and then applied in the calculations. Justify the tuning factor method, as applicable.

- If the method is different from a tuning factor – provide a clear description of the method and address any inconsistencies between the topical report, the applied methodology, and the RAI response. Justify the method.
- It is not clear from either the topical report or the original RAI response, but it appears that the steam generator heat removal performance is somehow adjusted by the user during the input generation process such that a desired initial condition of primary side temperature can be established in the calculation methodology. Therefore, the methodology must rely on some source of information that relates parameters such as power level and feedwater temperature to primary side temperature. Provide a clear description of the information that is needed by the user during the input generation process in order to achieve the desired steady-state thermal-hydraulic conditions.
- Describe the source of the information discussed above, for example, clarify if NRELAP5 calculations are performed before the PIM calculations and then somehow interpolated to determine the initial conditions. Justify the application of the associated information for stability analysis, for example, if thermal-hydraulic calculations are performed using another code, defend the suitability of its use in safety analysis.

NuScale Response:

Bullet Item 1

The steam generator (SG) model used for the reported licensing calculations is the one described in the TR-0516-49417-P, Section 5.5.3. The other SG options were introduced as means of examining the code and model performance for the benefit of code developers and are not intended for licensing calculations.

The SG options are set using the input parameter isgtyp, and briefly described as follows.

isgtyp = 0 is the licensing option as described in the TR

isgtyp = 1 is a simplified method where the HTC is uniform along the entire height of the SG

isgtyp = 2 override by freezing cold leg density and enthalpy during transient

isgtyp = 3 like option isgtyp=0 initially, but freezes HTC during the transient

isgtyp = 4 allows for user input SG heat flux profile

Options isgtyp = 1, 3, and 4 offer modeling simplifications that help to understand different aspects of the full modeling of the licensing option of isgtyp=0. However, option isgtyp=2 is not meant to provide a realistic approximation but rather aims at dynamically isolating the SG so that the riser density wave dynamics can be examined and compared with known analytical solutions as means of verification of the code numerics.

Bullet Item 2

The input parameters specifying the initial operating state include power, flow, and the temperature or enthalpy at one point such as core inlet. Energy balance of the primary loop flow determines the temperature at the core inlet and exit, or equivalently the SG primary side temperatures at its two terminal points. The SG model may not match these temperatures exactly, for example if the SG heat transfer coefficient is overestimated then the temperature difference driving the heat transfer of the specified core power must decrease. The initialization of the steady state operating point is therefore over-determined. One option to restore the initial energy balance is to allow PIM to compute the initial coolant temperature, which may not exactly match the specified state. The other option, which is the adopted option in PIM, is to adjust the computed SG heat transfer coefficient. The adjustment factor is iteratively computed internally, and the adjustment factor is printed to the output. A small adjustment is expected which characterizes and corrects for the SG modeling differences between PIM and NRELAP5 code which is used to compute the initial operating points for every power level. A warning is written to the output file of PIM if the SG HTC adjustment factor falls outside the range of 0.8-1.2 which alerts the code user to the possible existence of an input error.

Bullet Item 3

The method is applying a tuning factor. There are no inconsistencies between the topical report, the applied methodology, and the RAI response.

Bullet Item 4

The SG heat removal performance is adjusted internally. The user may provide an initial guess of the adjustment factor to accelerate the convergence of the steady state initialization. The PIM input information of a consistent set of initial steady state parameters including power level and feedwater temperature and primary side temperature are the same set used for other calculations not only stability and have been prepared by detailed NRELAP5 analysis.

Bullet Item 5

NRELAP5 calculations are performed before the PIM calculations, which provide the upstream steady state operating point data to stability and other methodologies. No NRELAP5 calculations were performed specifically to support stability calculations. With NRELAP5 and PIM being two different codes with different models and sets of correlations, a small mismatch is to be expected. It is judged that NRELAP5 detailed models accurately characterize the NPM operation, while PIM is designed for optimal fidelity for stability analysis. Adjusting the PIM initial steady state to match the initial steady state calculated by NRELAP5 improves the PIM model without negatively impacting its fidelity in the dynamic aspects.

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.