NuScaleTRRaisPEm Resource

From: Cranston, Gregory
Sent: Wednesday, October 31, 2018 8:28 AM
To: NuScaleTRRaisPEm Resource
Cc: Lee, Samuel; Karas, Rebecca; Skarda, Raymond; Bavol, Bruce; Chowdhury, Prosanta
Subject: Request for Additional Information Letter No. 9580 (eRAI No. 9580) Topical Report, Thermal Hydraulics , 15.09, SRSB
Attachments: Request for Additional Information No. 9580 (eRAI No. 9580) - PUBLIC.pdf

Attached please find NRC staff's proprietary request for additional information (RAI) concerning review of the NuScale Topical Report.

Please submit your technically correct and complete response by December 24, 2018 to the NRC Document Control Desk.

If you have any questions, please contact me.

Thank you.

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Request for Additional Information No. 9580 (eRAI No. 9580) - Public

Issue Date: 10/30/2018
Application Title: NuScale Topical Report
Operating Company: NuScale
Docket No. PROJ0769
Review Section: 15.09 - A.DSRS NuScale Thermal Hydraulic Stability
Application Section: 15.09

QUESTIONS

15.09-15

Title 10 of the Code of Federal Regulations (10CFR), Part 50, Appendix A, General Design Criterion (GDC) for Nuclear Power Plants - Criterion 12—Suppression of reactor power oscillations requires that oscillations be either not possible or reliably detected and suppressed. The Design-Specific Review Standard (DSRS), 15.9.A, "Design-Specific Review Standard for NuScale SMR Design, Thermal Hydraulic Stability Review Responsibilities," indicates that the applicant's analyses should correctly and accurately identify all factors that could potentially cause instabilities and their consequences. The analyses should also demonstrate that design features that are implemented prevent unacceptable consequences to the fuel. The Standard Review Plan (SRP) 15.0.2 acceptance criteria with respect to accident scenario identification states that the process must include evaluation of physical phenomena to identify those that are important in determining the figure of merit for the scenario.

In section 4.4, "Phenomena Identification and Ranking Table (PIRT)," of the topical report (TR), TR-0516-49417-P, the TR states, under the Table 4.1 [ ] However, the applicant's response to RAI 9093 Question 01-39, indicates that secondary side instability is not precluded by design [ ]. The original response to RAI 9093, states "The maximum acceptable level of secondary flow oscillation magnitude (OM) is limited to 10% about the mean value as determined by the mass flow rate at the SG tube inlet". Similarly, the response to RAI 9158 states [ ] In contrast, the revised (final) response to RAI 9093 removed the [ ] and does not provide an alternative quantification for "maximum acceptable level of secondary flow oscillation magnitude," nor defines "acceptable limit."

RAI 9158 indicates that [ ]. RAI 9158 also states [ ] However, if the secondary side can become unstable without limits on the secondary side oscillation magnitude, the secondary side can be expected to become unstable during conditions of normal operation, and for oscillations that occur during the instability to grow beyond the linear range into the non-linear range. As these unstable secondary side oscillations grow beyond the linear range, the non-linear characteristics can result in changes in the time-average heat removal characteristics of the secondary side – leading to the potential for dramatic fluctuations in the primary side temperature, flow and power. The consequences of such flow oscillations must be evaluated to ensure that thermal margin is maintained and the staff's requirements with respect to GDC 12 are met.

In order to make an affirmative finding associated with the above regulatory requirement important to safety, NRC staff requests NuScale to:

1. Define the acceptable limit of secondary flow oscillation by providing a quantitative envelope. If the acceptable limit is not defined in terms of oscillation magnitude, the staff requests that NuScale provide this limit and explain how the limit relates to the flow oscillation magnitude.

2. The final response to RAI 9093 Question 01-39 describes a maximum acceptable level of secondary flow oscillation that appears to be a condition for approval of the long term stability solution. Update the topical report, TR-0516-49417-P, to clarify that whether or not the applicability is conditional to any COL applicant or licensee confirming that the maximum level of secondary flow fluctuation is within the acceptable limit(s) described in the response to this RAI.

3. Provide an evaluation of both in-phase and out-of-phase flow oscillations that considers oscillatory behavior in the non-linear regime and quantify the impact on reactor coolant system flow from large amplitude, non-linear secondary side oscillations of sufficient limit-cycle oscillation magnitude to cover the range of operation allowed by the acceptable limits described in the response to this RAI. It is acceptable to the staff for the applicant to provide the results of calculations using PIM that show the magnitude of the primary side flow oscillation where a bounding secondary oscillation is imposed as a boundary condition so long as the bounding boundary condition is consistent with, or conservative with respect to, the acceptable limits as defined by the response to this RAI.

The response to RAI 9093 Question 01-39 does not address the staff's original question posed in that RAI. The original question requested NuScale to describe the process for demonstrating compliance with the applicant's previous requirement, which was that SG tubes are designed with sufficiently tight inlet orifices to preclude density wave instability. The final RAI response to RAI 9093 changes the current TR and DCD requirement that "instability is precluded" to a new unspecific requirement that, "flow fluctuations are maintained within acceptable limits."

According to the applicant's final response to RAI 9093 Question 01-39, flow oscillations on the secondary side of the steam generator (SG) will be allowed, rather than excluded. The applicant states that oscillations will be confined to acceptable limits that are yet to be determined. If the SG tubes are no longer inherently stable, it is conceivable that a secondary side system design could further destabilize the secondary side; which would allow in-phase flow oscillation and for these oscillations to achieve a greater oscillation magnitude when compared to that achieved by individual tubes.

4. Describe how compliance with the acceptable limits is demonstrated or maintained. The staff has identified four compliance options organized around different principles: 1.) passive design features, 2.) active design features, 3.) analytical demonstration, and 4.) experimental demonstration. The NRC staff requests NuScale to explain how any one of these principles is used demonstrate or maintain compliance within the acceptable limits and update the TR:
    4-1. If NuScale intends to maintain compliance using passive design features, then the staff requests NuScale to:

1. Provide a description of those specific design features of the secondary side that ensure that the in-phase flow fluctuation is limited within acceptable limits as defined in response to this RAI and update the TR and DCD to include descriptions of any design features relied on.

a. If the flow fluctuations are limited by the SG tube inlet orifices, then describe the process for demonstrating that the SG tubes are designed with sufficiently tight inlet orifices to limit flow fluctuations within the acceptable limits that are to be provided in response to this RAI. Provide an ITAAC item that addresses the demonstration.

b. If the flow fluctuations are not limited by the orifices, but rather through a different aspect of the thermal-hydraulic design, the NRC staff requests NuScale to describe those aspects of the design that limit flow fluctuations to remain within acceptable limits.

c. Address how secondary side design and control system design impact secondary side instability characteristics (e.g., how steam line pressure controlled throttling valves may effect total steam generator pressure drop).

2. Alternatively, if the applicant intends to disposition this issue under the COL item described by the response to RAI 9218, the staff requests that NuScale explicitly describe that aspect of the COL item in the response to this request; and revise the COL item in the RAI 9218 response and DCD to explicitly describe the associated aspect(s).

4-2. If NuScale intends to maintain compliance using active design features, then the staff requests NuScale to:

1. Clarify whether active means are part of the long term stability solution strategy with respect to managing the influence of secondary side instability on primary side response

2. If active means are part of the long term stability solution strategy, describe any additional, active means proposed to limit the secondary side in-phase flow oscillation magnitude (e.g., a trip function) and update the Stability Topical Report (TR-0516-49417-P) and the DCD to include a description of any of these additional active means as part of the description of the long term stability solution.

4-3. If NuScale intends to demonstrate compliance through analysis, then the staff requests NuScale to:

1. Provide an analysis that demonstrates compliance with the acceptable limits of flow fluctuation as defined in the response to this RAI and provide a submittal for NRC review that includes: (1) a description of the evaluation model, (2) a validation report, (3) an uncertainty analysis, and (4) the associated analytical results.

2. Alternatively, the applicant can respond to this request by including a COL item to provide essentially the same information requested under above under 4-3 Part 1.

4-4. If NuScale intends to demonstrate compliance through experimental demonstration, then the staff requests NuScale to:

1. If the applicant intends to reference the SIET-TF2 experimental results, provide rationale for the applicability of SIET-TF2 results to the NPM. Specifically:

a. Justify the SIET-TF2 experimental results applicability in light of the fact that the [ ].

b. Justify the applicability given that the oscillation magnitude of the NuScale SG tubes may be greater than the range covered by the conditions explored in the SIET-TF2 series of tests.

c. Justify the applicability of the results given that the SIET-TF2 tests do not address in-phase flow oscillation.

d. Justify the applicability given other aspects of the SEIT-TF2 test thermal-hydraulic conditions, [ ], which do not generally seem to correlate with the expected thermal-hydraulic conditions of normal operation.

2. If the applicant intends to demonstrate compliance through a different experiment:

a. Describe how the thermal-hydraulic conditions of this experiment would cover the anticipated range of operating conditions on the secondary side for all conditions of normal operation.

b. Describe how the SG inlet is or will be instrumented in the experiment.

c. Describe any COL item associated with the conduct of such an experiment (e.g., how the COL applicant will supply the experimental data and verification to the NRC to confirm compliance with the acceptable limit described in the response to this RAI).