NuScaleTRRaisPEm Resource

From:	Chowdhury, Prosanta
Sent:	Friday, February 23, 2018 9:57 AM
To:	'RAI@nuscalepower.com'
Cc:	NuScaleTRRaisPEm Resource; Lee, Samuel; Cranston, Gregory; Bavol, Bruce; Skarda, Raymond; Karas, Rebecca
Subject:	Request for Additional Information Letter No. 9388 (eRAI No. 9388) Topical Report TR-0516-49417-P (Stability Analysis)
Attachments:	Request for Additional Information No. 9388 (eRAI No. 9388).pdf

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

Please submit your technically correct and complete response within 60 days of the date of this RAI to the NRC Document Control Desk.

If you have any questions, please contact me.

Thank you.

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301-415-1647

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Request for Additional Information No. 9388 (eRAI No. 9388)

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Operating Company: NuScale
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QUESTIONS

01-68

Title 10 of the Code of Federal Regulations (CFR), Part 50, Appendix A, General. Design Criterion (GDC) 10, “Reactor design,” requires 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. 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 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 5.5.4 “Ambient Heat Loss Model,” of the topical report (TR), TR-0516-49417-P, provides a brief summary of PIM’s ambient heat loss model. A cubic curve fit, where an ambient heat transfer coefficient, hamb, is computed as a function of coolant temperature is given by Eq. 5-47 of the TR. The TR does not indicate how the data (hamb, Tcoolant) that was used to obtain the cubic fit was originally computed. The TR does note that the cubic expression includes effects of conduction through the RPV and CNV, thermal radiation between the outer RPV and inner CNV surfaces, and convection at inner RPV and outer CNV surfaces.

On December 13, 2017, NuScale and NRC staff participated in an audit call, and NuScale provided clarification to several questions concerning the ambient heat loss model. The remaining issues needing clarification are described herein. During the audit call, NuScale provided a qualitative description of the simplified heat loss model, indicating it was a steady state, 1-D, (multi-layer) conduction approximation to the energy conservation equation. Also, during the audit call, NuScale could not recall the geometry (cylindrical, slab, or other) of the simplified ambient heat loss model, but indicated additional details of the model could be found in two reports, EC-0000-2339 and EC-A010-00001507_03, which were added to NuScale’s Electronic Reading Room (ERR). These references provided parameter values, such as heat transfer coefficients and emissivities on the RPV and containment wall surfaces. However, the NRC staff still needs clarification of the simplified ambient heat loss geometry, explicit mathematical expression of hamb developed for the ambient heat loss model, and radii/length values used for RPV/containment surfaces. The estimated ambient heat loss affects the primary side energy balance through heat addition term described in section 5.5.1.2, “Energy Balance,” of the TR. Since NuScale’s PIM code is currently an (NRC) unapproved code, and NuScale is

seeking approval to use the PIM code to perform safety analyses as part of its stability methodology, further information regarding its ambient heat loss model is necessary. In order to make an affirmative finding associated with the above regulatory requirement important to safety, NRC staff requests NuScale to provide the following information.

1. Provide the mathematical expression for hamb that was used in the simplified ambient heat loss model used to generate the data for the curve fit given by Eq. 5.47 of the TR and that appears to also be used for the ambient heat loss estimates described in section 4.4 of Appendix B of EC-0000-2339. For example, if a cylindrical geometry, hamb might have the form:

   $$hamb = [1/h_r + r_{ri} \ln(r_{ro}/r_{ri})/k_r + r_{ri}/(r_{ro}*h_{rad}) + r_{ri} \ln(r_{co}/r_{ci})/k_c + r_{ri}/(r_{co}*h_c)]\text{-}1$$

   where: $hrad = emissivity_{eff}*sigma*(T2_{ro} + T2_{ci})*(T_{ro}+T_{ri})$

   i. r = radius
   ii. h= convective coefficients
   iii. sigma= Stephan Boltzmann constant

   subscripts

   iv. ri=inner RPV radius
   v. ro=outer RPV radius
   vi. ci=inner containment radius
   vii. co=outer containment radius

   Update TR-0516-49417-P as appropriate based on the above request.

2. Provide the geometry (for example, cylindrical or slab) that was used to determine the ambient heat loss estimate given in section 4.4 of Appendix B of EC-0000-2339.

3. Confirm that the height(s) (elevation(s)) used to compute the RPV and containment surface areas is (are) the riser outlet elevation per section 4.4 of Appendix B of EC-0000-2399. Also confirm that elevation value used for the ambient heat loss calculations was [ ] m ([ ]") as per Table 3-1 of EC-A010-0001507_03, "System Transient Model Input Parameter Calculations." If other lengths or elevations are used, provide their values, corresponding surface (RPV or containment), and rationale for the value.

4. Provide radii used to represent the RPV and containment surface areas and thermal resistances for the ambient heat loss estimate of [ ] kW given in section 4.4 of Appendix B of EC-0000-2339. If radii are not used to compute thermal resistance terms in hamb, provide the lateral dimensions used to compute surface areas for the ambient heat loss estimate; and rationale for how the dimensions apply to the actual RPV and containment geometry and associated heat losses.

5. If Tcoolant does not equal Tavg, [ ] K, provide the coolant temperature used to compute the ambient heat loss estimate of [ ] kW provided in section 4.4 of Appendix B of EC-0000-2339.