NuScaleTRRaisPEm Resource

From:	Cranston, Gregory
Sent:	Wednesday, June 20, 2018 1:00 PM
To:	NuScaleTRRaisPEm Resource
Cc:	Chowdhury, Prosanta; Lee, Samuel
Subject:	Request for Additional Information Letter No. 9351 (eRAI No. 9351) Transient Analysis, 15, SRSB
Attachments:	Request for Additional Information No.9351 (eRAI No. 9351)-public.pdf

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

The NRC Staff recognizes that NuScale has preliminarily identified that the response to one or more questions in this RAI is likely to require greater than 60 days. NuScale is expected to provide a schedule for the RAI response by email within 14 days.

If you have any questions, please contact me.

Thank you.

Hearing Identifier: NuScale_SMR_DC_TR_Public
Email Number: 98

Mail Envelope Properties (BN3PR09MB035569783A157B5F14FBC21290770)

Subject: Request for Additional Information Letter No. 9351 (eRAI No. 9351) Transient Analysis, 15, SRSB
Sent Date: 6/20/2018 1:00:20 PM
Received Date: 6/20/2018 1:00:24 PM
From: Cranston, Gregory

Created By: Gregory.Cranston@nrc.gov

Recipients:
"Chowdhury, Prosanta" <Prosanta.Chowdhury@nrc.gov>
Tracking Status: None
"Lee, Samuel" <Samuel.Lee@nrc.gov>
Tracking Status: None
"NuScaleTRRaisPEm Resource" <NuScaleTRRaisPEm.Resource@nrc.gov>
Tracking Status: None

Post Office: BN3PR09MB0355.namprd09.prod.outlook.com

Files	**Size**	**Date & Time**
MESSAGE	469	6/20/2018 1:00:24 PM
Request for Additional Information No.9351 (eRAI No. 9351)-public.pdf	148934	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Request for Additional Information No.9351 (eRAI No. 9351)

Issue Date: 05/12/2018
Application Title: NuScale Topical Report
Operating Company: NuScale
Docket No. PROJ0769
Review Section: 15.00.02 - Review of Transient and Accident Analysis Methods 01/2006
Application Section: TR-0516-49416-P, Non-LOCA Analysis Methodology

QUESTIONS

15.00.02-31

Topical report (TR) TR-0516-49416-P, "Non-Loss-of-Coolant Accident [Non-LOCA] Analysis Methodology," supports the conclusions in the NuScale Final Safety Analysis Report (FSAR), which under 10 CFR 52.47 must describe the facility, present the design bases and the limits on its operation, and present a safety analysis of the structures, systems, and components and of the facility as a whole. Chapter 15 of the NRC's "Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants" (NUREG-0800) describes a subset of the transient and accident events that should be considered in the safety analyses. Design-Specific Review Standard for NuScale Small Modular Reactor Design (DSRS) Section 15.0, "Introduction – Transient and Accident Analyses," directs the staff to verify that the implementation of models or codes is within the applicable ranges and conditions. Additionally, 10 CFR 50.43(e) states that applications that use simplified, inherent, passive, or other innovative means to accomplish their safety functions will be approved only if sufficient data exist on the safety features of the design to assess the analytical tools used for safety analyses over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences.

Regulatory Guide (RG) 1.203, "Transient and Accident Analysis Methods," describes a process that the NRC staff considers acceptable for use in developing and accessing evaluation models (EMs) used to analyze transient and accident behavior. Step 3 of RG 1.203 (Section 1.1.3) discusses the identification of systems, components, phases, geometries, fields, and processes that must be modeled. Step 4 (Section 1.1.4) discusses the identification and ranking of key phenomena and processes and states that EM development and assessment should be based on a credible and scrutable phenomena identification and ranking table (PIRT). The PIRT should be used to determine the requirements for physical model development, scalability, validation, and sensitivities studies. Ultimately, the PIRT is used to guide any uncertainty analysis or in the assessment of overall EM adequacy. Furthermore, SRP Section 15.0.2, "Review of Transient and Accident Analysis Methods," states that models must be present for all phenomena and components that have been determined to be important or necessary to simulate the accident under consideration.

TR-0516-49416-P, Section 6.1.1, discusses the fluid volume for the core and riser sections. The NRELAP5 model represents the core and riser regions as [[ ]]. The staff observes there is potential for the hotter fluid leaving the core from the higher-power core regions to result in a central plume/jet in the riser section that could cause recirculating or convective regions to develop and thereby reduce the buoyancy and overall natural circulation potential inside the primary circuit. This is important since it could reduce primary coolant flow and core cooling.

TR-0516-49416-P, Section 6.1.1, also describes the NRELAP5 representation of the primary fluid volumes and heat structures. It is not clear how several non-LOCA HIGH-ranked phenomena, such as [[ ]], are captured in the NRELAP5 non-LOCA EM representation of the NuScale Power Module (NPM). The transient multi-dimensional effects in the riser are not discussed, and as noted above, these effects could reduce buoyancy and therefore reduce primary flow.
Furthermore, the multi-dimensional effects in the reactor pool (RP) are not discussed [[ ]], which is a concern because thermal stratification in the RP may reduce heat transfer performance of the decay heat removal system (DHRS). The DHRS is relied upon to mitigate most non-LOCA events.

In addition, the PIRT in the audited document ER-0000-2934, “Non-Loss-of-Coolant Accident Phenomena Identification and Ranking Table for NuScale Power Plant,” discusses some HIGH-ranked phenomena that appear to be applicable to the non-LOCA EM discussed in TR-0516-49416-P, but the TR does not appear to discuss all the phenomena that are important to the non-LOCA evaluation model.

Information Requested:

a. Table 5-1 in ER-0000-2934 lists the highly important phenomena with large uncertainties, and Table 5-3 provides the recommended resolution methods for those phenomena. For [[ ]]. To demonstrate that these specific phenomena are adequately addressed, the staff requests the applicant to provide additional information for the staff to determine how this specific subset of highly important phenomena with large uncertainties was assessed and resolved. Such information may include CFD calculations, or bounding and/or multi-dimensional sensitivity calculations utilizing suitable computational tools (e.g., NRELAP5 with judicious nodalization), or specific experiments appropriate for the phenomenon at hand. Based upon this information, the staff requests the applicant to justify how the current nodalization captures the potential for multi-dimensional flow effects resulting from a hot plume/jet caused by regions of high power inside the reactor core and riser regions. Furthermore, based upon the calculations or experiments, the staff requests the applicant to demonstrate that the combined effect of cooler fluid entering the riser from the peripheral core regions, and heat transfer from the riser boundary to the region of the steam generators and the downcomer, would not produce a radially non-uniform temperature distribution inside the riser region that causes non-negligible deleterious effects on natural circulation and primary flow (e.g., formation of local convective cells). Subsequently, the staff requests the applicant to reference the calculations or experimental information and update the TR as appropriate.

b. The staff requests the applicant to provide detailed information on what NRELAP5 modeling considerations (e.g., nodalization, two-phase turbulent mixing models, etc.)

are used to address the HIGH-ranked phenomena in Table 5-3 of TR-0516-49416-P [[ ]] and update TR-0516-49416-P as appropriate.

c. Significant thermal stratification is exhibited in the RP in some test results. ER-0000- 2934 also recommended resolution of [[ ]]. The staff requests additional information to assess how the applicant assessed and resolved RP thermal stratification. This information could include additional CFD calculations or multi-dimensional sensitivity/bounding studies utilizing suitable computational tools (e.g., NRELAP5 with judicious nodalization) to assess the 3-D flow and mixing behavior in the RP. The applicant is also requested to justify how the NRELAP5 model of the NPM addresses or bounds the multi-dimensional effects in the RP, including impacts on heat removal by the DHRS, and to update TR-0516-49416-P as appropriate.

d. The staff requests the applicant to provide a comprehensive list of HIGH-ranked phenomena applicable to the TR-0516-49416-P, and update TR-0516-49416-P as appropriate.

15.00.02-32

TR-0516-49416-P supports the conclusions in the NuScale FSAR, which under 10 CFR 52.47 must describe the facility, present the design bases and the limits on its operation, and present a safety analysis of the structures, systems, and components and of the facility as a whole.

RG 1.203 describes the evaluation model development and assessment process (EMDAP), which the NRC staff considers acceptable for use in developing and accessing EMs used to analyze transient and accident behavior. Step 18 of the EMDAP discusses preparing input and performing calculations to assess system interactions: “The ability of the EM to model system interactions should also be evaluated in this step, and plant input decks should be prepared for the target applications. Sufficient analyses should be performed to determine parameter ranges expected in the nuclear power plant.”

Table 7-14 of TR-0516-49416-P provides the initial condition biases for the increase in feedwater flow event. The [[ ]], ostensibly based upon this statement in TR-0516- 49416-P, Section 7.2: [[ ]] No basis is provided to justify that these bias directions are bounding for MCHFR.

In addition, it appears the statement that the [[ ]]. TR Table 7-15 determines the bounding increase in feedwater flow when [[ ]]. TR Table 7-16 determines the bounding increase in feedwater flow when [[ ]]. Based upon the information presented in Tables 7-15 and 7-16, it is not clear how the SG inventory is minimized or maximized by this combination of parameter biases. Further, it appears that some other combination, such as

[[ ]], could provide a more limiting combination since this combination could lead to a larger secondary heat removal capacity, thereby providing lower temperature fluid to the core inlet.

In Table 7-14, [[ ]] It therefore appears that the bias in the SG tube plugging level was determined by [[ ]].

Information Requested:

a. Provide additional justification, such as a single-effects sensitivity study, that demonstrates that the bias directions selected for [[ ]] are bounding for MCHFR, and that the limiting bias methodology is used for the FSAR analysis.

b. Provide the basis for the conclusion that the [[ ]] and that the combination of parameters in TR Table 7-16 maximizes the SG liquid inventory.

c. Provide the final steady-state SG secondary side pressure, temperature distribution, and liquid and vapor masses for the cases in Tables 7-15 and 7-16. Confirm that the combinations of bias directions in Tables 7-15 and 7-16 encompass the limiting bias parameters for the increase in feedwater flow event and that these define the methodology used for the FSAR analysis.

d. Describe the methodology used to represent steam generator tube plugging for the FSAR analysis and provide a justification, such as a sensitivity study, that demonstrates that the biased low condition is limiting for the increase in feedwater flow event.

In addition to these requests, please update TR-0516-49416-P as appropriate, based on your responses.

15.00.02-33

TR-0516-49416-P supports the conclusions in the NuScale FSAR, which under 10 CFR 52.47 must describe the facility, present the design bases and the limits on its operation, and present a safety analysis of the structures, systems, and components and of the facility as a whole. Chapter 15 of SRP describes a subset of the transient and accident events that should be considered in the safety analyses. DSRS Section 15.0 directs the staff to verify that the implementation of models or codes is within the applicable ranges and conditions. Additionally, 10 CFR 50.43(e) states that applications that use simplified, inherent, passive, or other innovative means to accomplish their safety functions will be approved only if sufficient data exist on the safety features of the design to assess the analytical tools used for safety analyses over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences.

RG 1.203 describes the EMDAP, which the NRC staff considers acceptable for use in developing and accessing EMs used to analyze transient and accident behavior. Step 7 of this process (described in RG 1.203, Section C.1.2.3) discusses an applicant's identification and performance of separate effects tests and integral effects tests to complete the database against which the EM will be assessed. Furthermore, Step 17 (Section C.1.4.5 of RG 1.203) discusses the determination of the applicability of the model to simulate system components and states that before performing integrated analyses, an applicant should determine the various EM options, special models, and inputs to have the inherent capability to model the major systems and subsystems required for the particular application.

Based on the staff's audit of document [[ ]] and audit discussions with the applicant, the primary flow in the SIET TF-2 NRELAP5 model [[ ]].

Reliance upon incorrect primary flow rate information in the assessment could lead to incorrect conclusions regarding the code capability and code models. Therefore, the NRC staff requests the applicant to please confirm whether or not [[ ]] was active during any of the tests. If it was active, either (a) revise the assessment to account for the correct flow rates if it does not already, or (b) justify the acceptability of the current assessment. In addition:

a. The staff requests the applicant to provide the primary flow rates used for all SIET validation cases documented in LOCA TR Section 7.4.2 as input to the SIET NRELAP5 model and explain whether they included [[ ]].

b. The staff requests the applicant to explain [[ ]].

c. Update TR-0516-49416-P, Section 7.4 of TR-0516-49422-P, "Loss-of-Coolant Accident Evaluation Model," and any other documents as appropriate, based on your responses.