NuScaleDCRaisPEm Resource

From:	Cranston, Gregory
Sent:	Tuesday, May 29, 2018 3:25 PM
To:	Request for Additional Information
Cc:	Lee, Samuel; Franovich, Rani; Karas, Rebecca; Schmidt, Jeffrey; NuScaleDCRaisPEm Resource; Thurston, Carl
Subject:	Request for Additional Information No. 484 eRAI No. 8930 (15)
Attachments:	Request for Additional Information No. 484 (eRAI No. 8930).pdf

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

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.

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Created By: Gregory.Cranston@nrc.gov

Recipients:
"Lee, Samuel" <Samuel.Lee@nrc.gov>
Tracking Status: None
"Franovich, Rani" <Rani.Franovich@nrc.gov>
Tracking Status: None
"Karas, Rebecca" <Rebecca.Karas@nrc.gov>
Tracking Status: None
"Schmidt, Jeffrey" <Jeffrey.Schmidt2@nrc.gov>
Tracking Status: None
"NuScaleDCRaisPEm Resource" <NuScaleDCRaisPEm.Resource@nrc.gov>
Tracking Status: None
"Thurston, Carl" <Carl.Thurston@nrc.gov>
Tracking Status: None
"Request for Additional Information" <RAI@nuscalepower.com>
Tracking Status: None

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Request for Additional Information No. 484 (eRAI No. 8930)

Issue Date: 05/28/2018
Application Title: NuScale Standard Design Certification - 52-048
Operating Company: NuScale Power, LLC
Docket No. 52-048
Review Section: 15 - Introduction - Transient and Accident Analyses
Application Section: 15

QUESTIONS

15-27

Requirements:

Title 10 of the Code of Federal Regulations, Section 50.46, “Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,” requires, in part, that after any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

10 CFR, Part 50, Appendix A, General Design Criterion (GDC) 28—*Reactivity limits* requires that the reactivity control systems be designed with appropriate limits on the potential amount and rate of reactivity increase to ensure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition. In addition, Generic Safety Issue (GSI) 185 (Control of Re-criticality Following small break (SB) loss of coolant accidents (LOCAs) addresses scenarios of potential return to criticality following a SB LOCA resulting from insertion of unborated water into a pressurized water reactor (PWR) core.

To meet the requirements mentioned above regarding long-term cooling, the results of the accident analysis should show that for the worst case boron dilution event the capability to cool the core is maintained.

Background:

Page 2 of the applicant’s report, “Long-Term Cooling Methodology,” TR-0916-51299-P, Revision 0, states that the criterion for the core remaining subcritical (Criterion #5) is “not applicable to the Long-Term Cooling (LTC) condition since no mechanism to push a large volume of diluted water into the core inlet exists, and therefore no credible mechanism for recriticality due to boron dilution exists.” However, there are postulated events that could allow the addition of cooler water with diluted boron concentrations from containment to the reactor vessel via the RRVs during the long term cooling phase following any Chapter 15 scenario. For instance, diluted or unborated water can accumulate inside containment due to steaming from the reactor vent valves (RVVs) (which may concentrate boron in the area above the core) when the reactor is being cooled by emergency core cooling system (ECCS) recirculation. The diluted or unborated water accumulating inside containment can also further mix with secondary side unborated water that was introduced into containment after a pipe carrying unborated water ruptered inside containment (see RAI 8744, Question 15.02.08-3). The diluted or unborated water can then make its way back into the reactor pressure vessel, and ultimately, into the core via the RRV ECCS recirculation path. The diluted or unborated water can affect core criticality, potentially leading to recriticality, and thus present a challenge to acceptance criteria.

This RAI is being issued, in part, as a follow-up RAI to RAI 8744, Question 15.02.08-3 after determining that RAI 8744, Question 15.02.08-3 did not provide adequate information to resolve the issue. All together, this RAI will require the applicant to detail and define the methodology used for boron transport inside the reactor pressure vessel and containment vessel after ECCS actuates as well as to present the results in the FSAR of a long-term cooling analysis that show how a bounding boron dilution event affects the criticality and coolability of the core.

The staff asked RAI 8744, Question 15.02.08-3, to require the applicant to determine if core criticality is affected by the introduction of pure, secondary side water into the core after ECCS recirculation begins following a FWLB inside containment. The applicant's response to RAI 8744, Question 15.02.08-3 argues that void fraction due to "high" decay heat limits (or precludes) the return to power evaluated in the LTC analysis. This may be true, but sufficient detail regarding void reactivity vs. dilution reactivity (core generated dilution due to boiling and unborated water pipe break generated dilution) and how these values were determined should be provided. Analysis assumptions (e.g. dilution water volume) and plots of reactivity and, if necessary, core power vs. time are necessary to address this RAI.

Request:

The staff requests the applicant to specify and describe in sufficient detail in the FSAR a methodology used to calculate boron transport during long-term cooling following ECCS actuation after any Chapter 15 event. As part of the description of the methodology, the applicant should appropriately justify the methods, assumptions, and techniques using acceptable validation bases. Furthermore, the staff requests the applicant to provide the results of a long-term cooling analysis that show how a bounding boron dilution event affects the core criticality and coolability. These results should include the quantitative distribution of boron throughout the RCS and containment vessels as a function of time following ECCS actuation. The analysis should consider the most limiting boron dilution volume (e.g. condensate in containment from steaming through the RVVs and from any additional un-borated water already inside containment from breaks in piping carrying un-borated water inside containment). Similarly, the response should include the analysis assumptions and plots of various reactivity effects that determine reactor power to confirm that the core is sub-critical.