NuScaleDCRaisPEm Resource

From:	Chowdhury, Prosanta
Sent:	Tuesday, March 27, 2018 11:03 PM
To:	Request for Additional Information
Cc:	Lee, Samuel; Cranston, Gregory; Tabatabai, Omid; Haider, Syed; NuScaleDCRaisPEm Resource
Subject:	CORRECTION: THIS RAI IS NON-PROP: Request for Additional Information No. 398 eRAI No. 9317 (6.2.1.1)
Attachments:	Request for Additional Information No. 398 (eRAI No. 9317).pdf

Resending with the subject line and following correction – the date of issuance (3/22/2018) remains unchanged.

Attached please find the ~~proprietary version of~~ 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.

Prosanta Chowdhury, Project Manager
Licensing Branch 1 (NuScale)
Division of New Reactor Licensing
Office of New Reactors
U.S. Nuclear Regulatory Commission
301-415-1647

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Created By: Prosanta.Chowdhury@nrc.gov

Recipients:
"Lee, Samuel" <Samuel.Lee@nrc.gov>
Tracking Status: None
"Cranston, Gregory" <Gregory.Cranston@nrc.gov>
Tracking Status: None
"Tabatabai, Omid" <Omid.Tabatabai-Yazdi@nrc.gov>
Tracking Status: None
"Haider, Syed" <Syed.Haider@nrc.gov>
Tracking Status: None
"NuScaleDCRaisPEm Resource" <NuScaleDCRaisPEm.Resource@nrc.gov>
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"Request for Additional Information" <RAI@nuscalepower.com>
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Request for Additional Information No. 398 (eRAI No. 9317)

Issue Date: 03/22/2018
Application Title: NuScale Standard Design Certification - 52-048
Operating Company: NuScale Power, LLC
Docket No. 52-048
Review Section: 06.02.01.01.A - PWR Dry Containments, Including Subatmospheric Containments
Application Section: 6.2.1.1 Containment Structure

QUESTIONS

06.02.01.01.A-8

NRELAP5 NIST-1 CNV Model Benchmarking with HP-02 Test Data

To make its safety findings, the staff must understand and assess the ability of the applicant's analytical tools used in the safety analyses to meet the aspects of GDCs 16, 38, and 50; Part 52.47 and Part 50.43(e) relevant to the containment design basis. Specifically, the staff must assess the ability of the applicant's NRELAP5 model to predict the safety-significant phenomena in order for the staff to conclude that the code results are valid over the applicable range of accident conditions. The thermal-hydraulic phenomena pertinent to NuScale FSAR Section 6.2 containment design basis accident (DBA) analyses are the heat transfer from the containment vessel (CNV) to reactor pool (including condensation on the inner surface of the CNV), conduction through CNV wall (represented by the heat transfer plate (HTP) in NIST-1), and the convection to the reactor pool (CPV in NIST-1). The staff needs to understand and assess the conservatism of the licensing-basis models, constitutive correlations, and input parameters used for the applicant's NPM DBA containment response analyses, as well as the experimental data used to validate the accident phenomenology. In this regard, the staff has reviewed the NIST-1 HP-02 test data analysis as submitted by the RAI 8783 response along with the HP-02 test information included in the Loss-of-Coolant Accident Evaluation Model (LBLOCAEM) topical report (TR-0516-49422-P, Rev. 0).

HP-02 is a separate effects high pressure steam condensation test. Figures 7-76, 7-80, and 7-84 in Section 7.5.4 of the LBLOCAEM topical report compare the containment pressures computed by NRELAP5 with the test data, for HP-02 test data Runs 1, 2, and 3. There is a consistent trend of an increasing over-prediction of pressure by NRELAP5 as the CNV test pressure increases. The peak CNV pressure predicted by NRELAP5 is about 20% higher than the measured value for the highest pressure test, Run 3. The cause of the pressure discrepancy is not clear to the staff (e.g., caused by heat loss, by a pressure effect in modeling the steam condensation, by temperature dependence of thermal conductivity, or by some other phenomena not modeled by NRELAP5). This discrepancy is safety significant as HP-02 is the only steam condensation test available to the staff whose results can be used to validate NRELAP5 heat transfer modeling across the CNV wall – a basic component of the NPM heat removal system. Therefore, NuScale is requested to address the following five questions regarding NIST-1, HP-02 tests to further the staff's understanding of NRELAP5's capability to model the NIST-1 CNV conservatively or realistically. The regulatory bases and the SRP acceptance criteria identified above are applicable to all questions in this RAI.

Provide additional NRELAP5 analyses that include heat losses and other phenomena that may have been neglected in the original analyses (Runs 1, 2, and 3). Include plots that clearly show the impact of modeling changes.

06.02.01.01.A-9

Provide plots of the NRELAP5 computed: condensation heat transfer coefficients and associated Reynolds numbers, fluid temperatures, inner and outer wall surface temperatures, pool temperature, pool side convective heat transfer, and heat fluxes at the inner and outer surfaces of the HTP at three elevations (high, middle, low) for Runs 1, 2 and 3. Provide overlay plots of the computed temperatures at the HTP (T_{fluid}, T_{inner}, T_{outer}, T_{pool}) compared with NIST-1 data at consistent elevations. Provide overlay plots of steam flow rate and enthalpy, and condensation rate that compare NRELAP5 predictions with the NIST-1 data.

06.02.01.01.A-10

For the equilibrium conditions after 2000 seconds for HP-02 Runs 1 to 3, use the calculated heat addition to the CNV based on the average rate at which steam is added to the CNV and condensing on the HTP plate, and convert the heat addition rate to an average heat flux on the portion of the HTP plate above the liquid level in the CNV. Based on the estimated average heat flux into the HTP wall, the measured bulk steam temperature, HTP inside wall temperatures, HTP grid temperatures, HTP outside wall temperature and pool temperature, please provide the estimates of average condensation heat transfer coefficient, HTP wall thermal conductivity, pool convective heat transfer coefficient, condensate rate, and CNV water level rise. Compare these average NIST-1 estimated values to the average NRELAP5 calculated values and explain any differences. Also identify the location of inner, outer, and embedded HTP grid thermocouples.

06.02.01.01.A-11

For the early portion of the HP-02 tests [times up to 500 seconds], provide comparison plots of NRELAP5 calculated steam temperature and pressure and compare to the NIST data. Address whether there are significant differences between NRELAP5 predictions and NIST-1 test data during this transient portion of the HP-02 Runs 1 to 3.

06.02.01.01.A-12

Provide a sensitivity study with NRELAP5 showing the impact of the number of nodes used for the HTP plate. For the early transient portion of the tests [times less than 500 seconds], show the temperature profile calculated by NRELAP5 and the steam condensation rate as a function of the number of nodes selected. Also, address based on this analysis whether the CNV wall noding selected for the NRELAP5 NPM model results in a conservative heat removal rate during the first 200 seconds after an RRV inadvertent opening transient.