NuScaleDCRaisPEm Resource

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Sent: Sunday, July 30, 2017 8:18 AM
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Cc: NuScaleDCRaisPEm Resource; Lee, Samuel; Chowdhury, Prosanta; Chakravorty, Manas; Park, Sunwoo; Vera Amadiz, Marieliz; Samaddar, Sujit
Subject: RE: Request for Additional Information No. 109, RAI 8932 (3.7.2)
Attachments: Request for Additional Information No. 110 (eRAI No. 8932).pdf

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

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

Gregory Cranston, Senior Project Manager
Licensing Branch 1 (NuScale)
Division of New Reactor Licensing
Office of New Reactors
U.S. Nuclear Regulatory Commission
301-415-0546

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Request for Additional Information No. 110 (eRAI No. 8932)

Issue Date: 07/30/2017
Application Title: NuScale Standard Design Certification - 52-048
Operating Company: NuScale Power, LLC
Docket No. 52-048
Review Section: 03.07.02 - Seismic System Analysis
Application Section: 3.7.2

QUESTIONS

03.07.02-1

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake (SSE) through design, testing, or qualification methods.

In modeling structures using finite elements for dynamic analysis, the discretization should be adequately refined to sufficiently capture the frequency contents of the ground motion in the structural response. DSRS Section 3.7.2 provides a guideline that the element mesh size should be selected on the basis that further refinement has only a negligible effect on the solution results. For the RXB and CRB standalone models as well as the triple building model, the applicant is requested to provide a detailed explanation for why the finite elements employed in the models are adequate. Include discussion of applicant's consideration of the effects of element size, shape, and aspect ratio of each structural system and their impact on solution accuracy.

03.07.02-2

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake (SSE) through design, testing, or qualification methods.

On Page 3.7-20 of the FSAR, in the third paragraph, the applicant states, "The building models have element sizes that are similar to the 6.25 feet layers that were used to determine the wave passage frequency of the soil. There are instances where development of the model required individual elements to have a dimension as large as 12 feet in the RXB and as large as 20 feet in the CRB. However, the typical element size is approximately 6 feet. Therefore the wave passage frequencies of both buildings is above the cut-off frequencies used for the analysis." For elements that have a dimension of 12 ft or 20 ft, the applicant is requested to provide the elements locations in the building, and explain how the presence of these coarse elements do not affect the results of seismic demand analyses for the RXB and CRB.

03.07.02-3

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake (SSE) through design, testing, or qualification methods.

a. On Page 3.7-20 of the FSAR, in the first paragraph, the applicant states, “For the analysis of Soil Types 7, 8 and 11 with the CSDRS the cut-off frequency was established at 52 Hz. This is higher than the wave passing frequency of the soft soil profile (Soil Type 11) but less than the passing frequency of the other two soils (see Table 3.7.1-20).” Table 3.7.1-20 shows 12 Hz as the passing frequency of Soil Type 11. Tables 3.7.2-18 and 19 indicate the transfer functions (TFs) are calculated for frequencies up to 52 Hz (cut-off frequency) for Soil Type 11. The applicant is requested to justify the validity of the TF calculations for frequencies beyond the passing frequency for Soil Type 11.

b. On Page 3.7-20 of the FSAR, in the first paragraph, the applicant states, “For the analysis of Soil Types 7, 8 and 11 with the CSDRS, the cut-off frequency was established at 52 Hz.” However, in Table 3.7.2-19, for Soil Type 7 with the CSDRS, a cut-off frequency of 72 Hz is used. The applicant is requested to clarify the inconsistency.

c. On Page 3.7-20 of the FSAR, in the second paragraph, the applicant states, “For the analysis with the rock profiles (Soil Type 7 and 9) and the CSDRS-HF, the cut-off frequency was established at 72 Hz.” However, in Table 3.7.2-21, for Soil Type 9 with the CSDRS-HF, a cut-off frequency of 52 Hz is used. The applicant is requested to clarify the inconsistency. Also, Table 3.7.2-21 does not provide analysis frequencies for Soil Types 8 and 11 with CSDRS and for Soil Type 7 with CSDRS-HF. Please explain why these frequencies are not provided.

d. In Figure 3.7.2-20 in the FSAR, The applicant is requested to clarify if the bottom two layers represent the basemat which is to be considered as part of the RXB and color-coded accordingly (in blue). The figure also appears to show mixed coloring for certain elements in the bottom two layers. Please explain what the mixed colors represent for these elements.

03.07.02-4

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake (SSE) through design, testing, or qualification methods.

On Page 3.7-22 of the FSAR, in the second paragraph, to discuss the adequacy of 7P Extended Subtraction Method (ESM) model, the applicant provided 7P versus 9P ISRS comparisons for the Capitola time histories in Figures 3.7.2-8 to10. However, the FSAR does not provide a comparison of transfer functions for the 7P and 9P models. The review of transfer functions is essential to ensure that the numerical implementation of the SSI analysis methods is acceptable and consistent with the guidance in DSRS Section 3.7.2. In the same paragraph, the applicant also states, “This level of agreement justifies using a 7P versus a 9P model and, because the results are similar, demonstrates the acceptability of using the extended subtraction method as an alternative to the direct method.” The staff believes that 7P vs 9P ESM comparison captures only an “incremental” enhancement between the two models. The adequacy of an ESM model should be established against the direct method (DM). Therefore, in addition to a comparison of the 7P and 9P ESM models, the applicant is requested to provide a comparison of the transfer functions for the 7P ESM and the DM models at selected nodes of the critical sections and other important locations in the RXB and CRB, or, provide technical justification for why a 7P vs 9P comparison is sufficient and acceptable. Guidance in DSRS Section 3.7.2 allows the use of reduced-size models in comparing the solutions of the subtraction or modified subtraction method (SM/MSM) with those of the DM to gain insight into the adequacy of SM/MSM.

03.07.02-5

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake (SSE) through design, testing, or qualification methods.

On Page 3.7-22 of the FSAR, in the fourth paragraph, the applicant states, “However due to the size and complexity of these models it is not practical to review transfer functions at all the nodes in the models.” The staff views that the applicant may not need to review transfer functions (TFs) at all nodes; however, the staff views that TFs at key locations should be reviewed to ensure the adequacy of the SSI models and methodologies implemented in the seismic analyses. Therefore, the applicant is requested to provide information on TFs (in plots) at selected nodes of the critical sections and other important locations in the RXB and CRB. The plots should be inspected whether spurious spikes in the TFs are present within the frequency range of interest to the SSI analysis; and, if spikes are present, the applicant should discuss their potential effects on computed seismic demands.

03.07.02-6

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake (SSE) through design, testing, or qualification methods.

a. DSRS 3.7.2 provides guidance that effects of potential separation or loss of contact between the structure and the soil during the earthquake should be considered in SSI analysis. On Page 3.7-23 of the FSAR, in the second paragraph from the bottom, the applicant states, “To model the soil separation, the Young's modulus of the backfill elements down to a depth of 25’ (the top four layers of backfill elements) was decreased by a factor of 100.” The applicant is requested to provide a basis for 25 ft of separation depth. Also, please clarify if the modulus reduction by a factor of 100 applies only to the backfill elements interfacing with the exterior walls or to all the backfill elements outside the exterior walls.

b. On Page 3.7-23 of the FSAR, in the bottom paragraph, the applicant states, “Soil separation has negligible effect on the response of the structure. The primary point of comparison is at the NPM. The study showed that the maximum reaction force at the base of the NPMs decreased by approximately 5 percent, and the maximum reaction force at the NPM lug restraints decreased by more than 15 percent.” The applicant is requested to provide information on soil separation effect on computed transfer functions and seismic demands (forces, ISRS) at critical section locations and external walls. Please provide comparison plots for results between the intact and soil-separated cases. When soil-separation results in increased seismic demands, such increased demands should be taken into account in establishing the design basis seismic demands.

c. The staff notes that a soil-separation study was conducted for the RXB but not for the CRB. The applicant is requested to provide a technical justification for not conducting a similar study for the CRB.