RAIO-0518-60208

May 29, 2018

Docket: PROJ0769

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 9417 (eRAI No. 9417) on the NuScale Topical Report, "Evaluation Methodology for Stability Analysis of the NuScale Power Module," TR-0516-49417, Revision 0

REFERENCES:

1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 9417 (eRAI No. 9417)," dated March 28, 2018
2. NuScale Topical Report, "Evaluation Methodology for Stability Analysis of the NuScale Power Module," TR-0516-49417, Revision 0, dated July 2016

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's response to the following RAI Question from NRC eRAI No. 9417:

- 15.09-4

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Paul Infanger at 541-452-7351 or at pinfanger@nuscalepower.com.

Sincerely,

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9417

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9417

NuScale Power™

Response to Request for Additional Information
Docket: PROJ0769

eRAI No.: 9417
Date of RAI Issue: 03/28/2018

NRC Question No.: 15.09-4

Title 10 *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, General Design Criterion (GDC), “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 (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). Title 10 CFR, Part 50, Appendix A, GDC 12, “Suppression of Reactor Power Oscillations,” requires 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. Title 10 CFR Part 52.47, ”Contents of applications; technical information,”

Standard Review Plan (SRP) Section 15.0.2, ”Review of Transient and Accident Analysis Method,” and Regulatory Guide (RG) 1.203, “Transient and Accident Methods,” provide guidance for complying with GDCs 10 and 12. Standard Review Plan 15.0.2 and RG 1.203 state that documentation must include a complete description of the code assessment, including showing a model nodalization diagram and all code options used for the calculations. Assessments must also compare code predictions to analytical solutions, where possible, to show the accuracy of the numerical methods in the mathematical models. RG 1.203 states that numerical solution convergence studies, including the basis for the time steps used and the chosen convergence criteria should be provided.

The staff reviewed the response to the original RAI, RAI 8801, and found that the response was insufficient for the staff to reach a conclusion regarding the adequacy of the stability analysis methodology. The following supplemental information is therefore requested:

- Provide a summary of numerical results of the sensitivity studies described in the original response.

- Quantify the impact on the decay ratio for the different nodalization and time step cases analyzed. It is acceptable to respond to this request by providing the results as a table that in one column describes the nodalization, in a second column provides the time step, in a third column provides the Courant number, and in a fourth column provides the decay ratio.

- Compare the sensitivity of the results to nodalization/time-step to the uncertainty in the decay ratio.

NuScale Response:

Bullet Item 1

The PIM cases for which a summary has been presented in the response to RAI 8801 were run to parametrically vary time-step size with and without a fine nodalization of the core. In the base case, the core was set up with 20 nodes in order to provide for adequate thermal-hydraulic modeling such as subcooled boiling inception and phase change phenomena. This resulted in nodal volumes approximately five times smaller than in the rest of the primary loop. An alternative nodalization with fewer nodes in the core (6 nodes) was examined for the purpose of having nearly uniform Courant number around the entire natural circulation loop.

The PIM geometry data input required to reduce the core nodalization from 20 to 6 nodes, and increase the core nodal volume to approximately equal to that of the rest of the primary loop, is given in Table 1 compared with the standard nodalization.

Table 1 Geometry Comparison between the Standard and Sensitivity (Core-6) Nodalization

Data	Standard	Sensitivity
Number of core nodes	20	6
Core node volume (ft^3)	11	38
Pressurizer first node	64	50
CVCS first node	38	24
CVCS last node	105	91
SG first node	65	51
SG last node	104	90
Total number of nodes	139	125

The Courant number was varied by running cases with different time steps, using both the standard and sensitivity (Core-6) nodalization options. The BOC conditions are used at 100% and 20% of rated power. A total of 14 runs are summarized in Table 2.

Decay ratios were calculated from the core inlet flow signals. Some of the flow signals calculated at 100% of rated power failed to discern a clear decay ratio as the state is very stable and interference between fast decaying modes made the identification of decay ratio from successive peaks difficult. The decay ratio results from the 20% power are more reliable.

It should be noted that there are two Courant numbers for the initial state because the flow velocity changes with the change of density along the loop.

Table 2 Nodalization, Time Step, Courant Number, and Decay Ratio Summary

Case #	Power rated	Nodalization	Δt	Courant Number Range sec		Decay Ratio
				Core	Else	
160-00	100	standard	0.05	0.39 - 0.44	0.08 - 0.10	0.33
160-01	100	standard	0.10	0.77 - 0.88	0.16 - 0.20	0.27
160-02	100	standard	0.20	1.55 - 1.75	0.32 - 0.40	-
160-03	100	standard	0.25	1.94 - 2.19	0.39 - 0.50	-
160-04	100	Core-6	0.10	0.24 - 0.26	0.16 - 0.20	-
160-05	100	Core-6	0.20	0.47 - 0.53	0.32 - 0.40	-
160-06	100	Core-6	0.25	0.59 - 0.66	0.39 - 0.50	-
32-00	20	standard	0.1	0.45 - 0.47	0.09 - 0.11	0.52
32-01	20	standard	0.2	0.90 - 0.93	0.18 - 0.21	0.51
32-02	20	standard	0.4	1.79 - 1.87	0.36 - 0.42	0.47
32-03	20	standard	0.5	2.24 - 2.33	0.46 - 0.53	0.45
32-04	20	Core-6	0.2	0.27 - 0.28	0.18 - 0.21	0.51
32-05	20	Core-6	0.4	0.54 - 0.56	0.36 - 0.42	0.47
32-06	20	Core-6	0.5	0.67 - 0.70	0.46 - 0.53	0.45

Bullet Item 2

The decay ratio for the nodalization and time step sensitivity runs are provided in Table 2. The shaded rows for cases 106-01 and 32-01 represent the standard nodalization and time step for the particular power level.

Bullet Item 3

Based on the presented decay ratio results in Table 2, there is no bias or uncertainty comparable with the decay ratio margin of 0.2. The standard nodalization and time step case 32-01 produced a decay ratio of 0.51 which is less than the maximum calculated decay ratio of the other cases at the same state by an insignificant 0.01.

Impact on Topical Report:

There are no impacts to the Topical Report TR-0516-49417, Evaluation Methodology for Stability Analysis of the NuScale Power Module, as a result of this response.