**UNITED STATES**
**NUCLEAR REGULATORY COMMISSION**
**ADVISORY COMMITTEE ON REACTOR SAFEGUARDS**
**WASHINGTON, DC 20555 - 0001**

March 25, 2020

Ms. Margaret M. Doane
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: SAFETY EVALUATION REPORT FOR TOPICAL REPORT TR-0516-49416, REVISION 2, "NON-LOSS-OF-COOLANT ACCIDENT ANALYSIS METHODOLOGY"

Dear Ms. Doane:

During the 671st meeting of the Advisory Committee on Reactor Safeguards, March 5-6, 2020, we reviewed the NRC staff's safety evaluation (SE) report of NuScale Power, LLC (NuScale), topical report TR-0516-49416, Revision 2, "Non-Loss-Of-Coolant Accident Analysis Methodology." Our NuScale Subcommittee also reviewed this matter on February 19-20, 2020. During these meetings, we had the benefit of discussions with the staff and representatives of NuScale. We also had the benefit of the referenced documents.

## CONCLUSION AND RECOMMENDATIONS

1. The Non-Loss-Of-Coolant Accident (non-LOCA) Analysis Methodology topical report, with the limitations and conditions imposed by the staff SE report, provides an acceptable methodology to analyze anticipated occurrences, infrequent events, and postulated accidents for the NuScale Power Module (NPM).

2. The staff should include an additional condition that allows application of this topical report with any critical heat flux (CHF) correlation approved for use in NPM applications.

3. The staff's SE report should be issued with this additional condition.

## BACKGROUND

The Non-LOCA Analysis Methodology topical report documents an evaluation model for the analysis of system transient response to non-LOCA initiating events for the NPM. The evaluation model uses a modified version of the RELAP5 computer code, referred to as NRELAP5. It is intended for analysis of anticipated occurrences, infrequent events, and postulated accidents in the NPM. The evaluation model is limited to a short time frame following a design-basis non-LOCA event in which the primary coolant mixture level remains above the top of the core riser, so that primary-side natural circulation is maintained.

Events where the water level drops below the top of the core riser, interrupting natural circulation flow, are addressed in the applicant's long-term cooling methodology, which includes events that transition to: decay heat removal system cooling; emergency core cooling system (ECCS) heat removal; and longer-term progression of non-LOCA events that include the potential of boron redistribution and return to power with one control rod stuck out of the core.

The intended application of this methodology is calculation of Chapter 15 events in the Final Safety Analysis Report (SAR) or Reload SAR calculations for future cycles.

**DISCUSSION**

The staff review of the non-LOCA methodology includes the following areas:

1. The phenomena identification and ranking table.

2. The NRELAP5 NPM model, including nodalization issues.

3. Validation of the NRELAP5 results against integral and separate effect tests, including experimental data from the following:
    a. Korea Advanced Institute of Science and Technology high-pressure condensation tests.
    b. NuScale Integral System Test facility tests.
    c. Società Informazioni Esperienze Termoidrauliche TF1 and TF2 tests for steam generator performance.

4. Results of sensitivity analyses that address relevant uncertainties.

The staff concludes that the NRELAP5 validation basis and NPM sensitivity calculation results support the overall conclusion that the NRELAP5 code and the NPM system model are applicable for calculation of non-LOCA system response.

We concur with the staff assessment, but we are concerned about the screening CHF correlation proposed for this evaluation model. The non-LOCA evaluation model uses a screening CHF correlation that is built into the NRELAP5 code to screen the events that are analyzed with the more accurate VIPRE-01 sub-channel code. The staff evaluation indicates that the screening CHF correlation has a very large non-conservative bias. The staff concludes that the use of the screening correlation is acceptable because the CHF trends match those of the more accurate VIPRE-01 calculation. However, we are concerned that no attempt was made to identify the cause of this bias. Because generic CHF correlations typically do not account for advanced spacer designs, the results should be conservative; thus, the observed non-conservative bias is unexpected and may indicate that a hidden problem exists (e.g., a coding error). The NRELAP5 screening CHF correlation was submitted in the original application. During the review, the applicant developed a more accurate CHF correlation, which is now implemented in NRELAP5 and approved for NPM use in LOCA calculations. The applicant originally requested to use the screening CHF correlation for non-LOCA analyses and did not modify this request after the LOCA CHF correlation was developed. The staff SE report approves the non-LOCA request because: (a) it is only used for screening; and (b) the CHF trends (but not the actual value) align with the more accurate correlations. While the staff approach is acceptable from a regulatory point of view, we are concerned that it forces the use of a CHF correlation that may be less accurate than other correlations now available.

Therefore, adding a condition to the SE report would allow the use of any CHF correlation approved for NPM, as long as its range of applicability covers the transient being analyzed.

The staff has imposed six limitations and conditions, including: the application is limited to events that do not uncover the riser; changes in design that affect heat transfer biases or single failure criteria (including credit for non-safety isolation valves and operator actions assumed for this report) must be approved; and the methodology is limited to NRELAP5 v1.4 and NPM Model Revision 2.

**SUMMARY**

The non-LOCA Analysis Methodology topical report, with the limitations and conditions imposed by the staff SE report, provides an acceptable methodology to analyze anticipated occurrences, infrequent events, and postulated accidents for the NPM. The staff should include an additional condition that allows application of this topical report with any CHF correlation approved for use in NPM applications.

The staff's SE report should be issued with this additional condition.

Sincerely,

**/RA/**

Mathew W. Sunseri
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, Safety Evaluation of NuScale Power, LLC, Topical Report, TR-0516-49416, Revision 2, "Non-Loss-of-Coolant-Accident Analysis Methodology," February 18, 2020 (ML20044E082).

2. NuScale Power, LLC, Topical Report TR-0516-49416, Revision 2, "Non-Loss-of-Coolant-Accident Analysis Methodology," November 30, 2019 (ML19331A895).

3. NuScale Power, LLC, Topical Report TR-0916-51299, Revision 1, "Long-Term Cooling Methodology," August 5, 2019 (ML19218A146).

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