December 5, 2016

Mr. Thomas Bergman
Vice President, Regulatory Affairs
NuScale Power, LLC
1100 Circle Boulevard, Suite 200
Corvallis, OR 97330

SUBJECT: RESPONSE TO NUSCALE GAP ANALYSIS SUMMARY REPORT FOR REACTOR SYSTEMS REACTIVITY CONTROL SYSTEMS, ADDRESSING GAP 11, GENERAL DESIGN CRITERION 26 (PROJ 0769)

Dear Mr. Bergman:

In a July 31, 2014, letter, NuScale Power, LLC (NuScale) submitted to the U.S. Nuclear Regulatory Commission (NRC) staff the "Gap Analysis Summary Report," Revision 1 (Report) (ML14212A831). The stated purpose of the Report was to facilitate discussion on specific regulations listed in Table 3-1 of the Report that warrant further consideration with regard to their applicability or relevancy to the NuScale power plant design and to solicit feedback on the utility of the document. The Report provided the results of a regulatory gap analysis performed by NuScale as part of pre-application activities. This analysis identified potential regulatory issues (gaps) by comparing current NRC requirements and guidance to the characteristics of the NuScale power plant design. Current NRC requirements are set forth in Title 10 of the *Code of Federal* Regulations, Parts 1 through 199, and current NRC guidance is set forth in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP) and documents referenced in the SRP. The Report highlights the unique features of the NuScale reactor design that may present novel applications of existing NRC staff requirements and guidance. NuScale stated in the Report that the intent of highlighting these issues was to determine the appropriate regulatory process to be used to address the "regulatory gaps" identified in the Report.

As it relates to the reactivity control requirements provided in 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," (GDC), Gap 11 in the Report focused on GDC 27, "Combined reactivity control systems capability," and provided limited information on NuScale's approach for complying with GDC 26, "Reactivity control system redundancy and capability." Subsequently, in a letter dated November 2, 2016, "NuScale Power, LLC - Submittal of White Paper Entitled 'NuScale Reactivity Control Regulatory Compliance and Safety,' Revision 0," (ML16307A449), NuScale submitted additional information to address reactivity control regulatory compliance for the NuScale design. This information was considered by the staff in developing their response addressing GDC 26.

NRC staff and NuScale representatives have had a number of engagements to further the NRC staff's understanding of the NuScale design. NRC staff acknowledges that it is important that the key regulatory process issues be addressed before NuScale submits a design certification application to facilitate the development of a complete application.

There is one enclosure to this letter which responds to Report Table 3-1, Gap 11, as it relates to GDC 26. This is the last gap issue for reactor systems and supplements the letter dated April 21, 2016, "Response to Gap Analysis Summary Report for Reactor Systems Issues," (ML15265A252) and the letter dated September 8, 2016, "Response to NuScale Gap Analysis Summary Report for Reactor Systems Reactivity Control Systems, Addressing Gap 11, General Design Criterion 27," (ML16116A083). This response is based on information in the Report, NuScale's letter of November 2, 2016, and information obtained during various NuScale meetings, presentations, and from submitted information. However, as you are aware, there is no licensing action before the NRC staff in these areas and, therefore, the NRC staff cannot perform its detailed technical review on all technical and regulatory issues at this time to determine if the design will be acceptable in its present form.

Should you have any questions, please contact Mr. Gregory Cranston, Senior Project Manager for the NuScale design certification at (301) 415-0546 or via email at gregory.cranston@nrc.gov.

Sincerely,
/RA/

Frank Akstulewicz, Director
Division of New Reactor Licensing
Office of New Reactors

Project No.: PROJ0769

Enclosure: NRC Response to NuScale's position on Gap 11, "Combined Reactivity Control Systems Capability," (GDC 26 only).

cc: DC NuScale Power LLC Listserv

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NRC Staff Response to NuScale's Position on Gap 11:
"Combined Reactivity Control Systems Capability," (GDC 26 only)

Summary of NuScale Position:

In its "Gap Analysis Summary Report," Revision 1, July 2014, (Report) (ML14212A831), Table 3-1, Gap 11, and in its letter dated November 2, 2016, "NuScale Power, LLC - Submittal of White Paper Entitled 'NuScale Reactivity Control Regulatory Compliance and Safety,' Revision 0," (ML16307A449), NuScale discussed the reactivity control aspects of their design with respect to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, "General Design Criteria," (GDC) 26, "Reactivity control system redundancy and capacity."

GDC 26, "Reactivity control system redundancy and capability, states that:

> [t]wo independent reactivity control systems of different design principles shall be provided. One of the systems shall use control rods, preferably including a positive means for inserting the rods, and shall be capable of reliably controlling reactivity changes to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits are not exceeded. The second reactivity control system shall be capable of reliably controlling the rate of reactivity changes resulting from planned, normal power changes (including xenon burnout) to assure acceptable fuel design limits are not exceeded. One of the systems shall be capable of holding the reactor core subcritical under cold conditions.

NuScale does not interpret GDC 26 as requiring two safety-related means of reactivity control. NuScale states that one of the independent reactivity control systems that can be used to meet the requirements of GDC 26 in the NuScale design is the chemical and volume control system (CVCS), which is not safety-related. The other is the control rod system, which is safety-related. During operation, sufficient instantaneous shutdown margin is preserved to ensure that the control rods are capable of rapidly shutting down the reactor (i.e., within a few seconds) to assure that under conditions of normal operation, including anticipated operations occurrences (AOOs), and with appropriate margin for stuck rods, specified acceptable fuel design limits (SAFDLs) are not exceeded. CVCS is used during normal operation to adjust the target boron concentration during power changes to maintain shutdown margin and rod insertion limits prior to an AOO, to protect fuel design limits. Control rods, with all control rods inserted, can maintain the reactor shutdown under cold conditions.

NRC Staff Response:

The NRC staff began addressing the Gap 11 technical area, as described in the Report, some time ago based on the NRC staff's understanding that the NuScale safety-related control rod system alone was adequate to maintain the reactor subcritical under design basis event conditions, including AOOs, with appropriate margin for stuck rods. The NRC staff was in the process of responding to NuScale based on that understanding. However, in March of 2016, the NRC staff learned from NuScale that reactor subcriticality cannot be maintained in certain design basis event scenarios with the control rod system alone, assuming the most reactive rod is fully withdrawn. The fact that the reactor would return to critical and reach a post trip power level was not described in the Report. This new information is important and called into question the NRC

staff's prior understanding of how NuScale will meet GDC 26 and GDC 27, in particular, reliably controlling reactivity. The NRC staff's investigation of this phenomenon resulted in a public meeting on April 26, 2016, "Public Meeting with NuScale Power, LLC to Discuss Combined Reactivity Control System Capability (PROJ0769)," (ML16126A472), where NuScale provided information to the NRC staff to the effect that, under certain circumstances, the reactor would be unable to maintain subcriticality beyond the first few hours of event initiation with appropriate margin for stuck rods, following a design basis event. On May 19, 2016 the NRC staff held a closed meeting with NuScale, "Closed Meeting with NuScale Power, Reactivity Control Design and Licensing Basis Meeting (TAC NO. RN6110)," (ML16162A154), to further discuss the reactivity control issue. Subsequently, in a letter dated November 2, 2016 (ML16307A449), NuScale submitted additional information to address reactivity control regulatory compliance for the NuScale design.

Based on the NRC staff's current understanding, the NuScale design could meet the reactivity control requirements of GDC 26. Accordingly, meeting GDC 26 includes showing that, among other things, "under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits [SAFDLs] are not exceeded."

The NuScale design appears to have two independent reactivity control systems of different design principles which consist of the safety-related control rods and the CVCS, which is not safety-related. Based on the current available information, the staff understanding of the NuScale design is that during operation, sufficient shutdown margin is preserved to ensure that the control rods are capable of rapidly shutting down the reactor (i.e., within a few seconds) to assure that under conditions of normal operation, including AOOs, and with appropriate margin for stuck rods, SAFDLs are not exceeded. The NRC staff also assumes that the CVCS is capable of reliably controlling the rate of reactivity changes resulting from planned, normal power changes (including xenon burnout) to assure that SAFDLs are not exceeded.

In addressing the last sentence of GDC 26, "One of these systems shall be capable of holding the reactor subcritical under cold conditions," NuScale credits the control rods, with all rods inserted. However, based on the NRC staff's current understanding, similar to currently operating PWRs, the reactor can be held subcritical under cold conditions through adequate boration by the CVCS with margin for stuck rods.

Having said the above, the NRC staff does not now have before it a formal application that describes in detail the current NuScale design. Therefore, the NRC staff has not been able to engage with NuScale in a manner that would permit the detailed review necessary to finally resolve this issue.