October 25, 2016

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

SUBJECT: RESPONSE TO NUSCALE POWER, LLC KEY ISSUE RESOLUTION LETTER, SUPPLEMENTAL RESPONSE REGARDING MULTI-MODULE QUESTIONS

Dear Mr. Bergman:

The purpose of this letter is to provide the U.S. Nuclear Regulatory Commission (NRC) staff response with regard to multi-module and multi-unit review issues raised in your July 22, 2015, letter, "NuScale Power, LLC Key Issue Resolution Prior to Design Certification (DC) Application (NRC Project No. 0769)" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15203B306). In our letter of March 28, 2016, on the subject, we informed you that the NRC staff finalized Revision 3 to the "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (NUREG-0800 or SRP), Section 19.0, "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors," which might provide insight on multi-module risk assessment reviews by the NRC staff, and that further engagement was warranted (ADAMS Accession No. ML15257A514). We also mentioned in our March 28, 2016, letter that there had been several public meetings where the multi-module and multi-unit questions were raised but not fully resolved.

In the July 22, 2015, letter, you provided some examples of issues that may warrant different treatment for NuScale than typical multi-unit sites, and recommended that the NRC distinguish between issues that affect multiple modules and issues that affect multiple units, and that the policy distinguish between issues that can be evaluated deterministically, and those that are amenable to a risk-informed approach. You further expressed that for the latter category of issues, the draft Revision 3 to SRP 19.0 (November 2014) provides an appropriate framework, and stated that NuScale developed a preliminary approach for Probabilistic Risk Assessment (PRA) that was presented to the NRC staff demonstrating how the SRP 19.0 guidance could be implemented. The NRC staff notes that using a risk-informed approach to address design licensing issues involves consideration of more than just the risk insights identified through a PRA. General guidance on risk-informed integrated decision making can be found in Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis."

To address questions about the distinction between multi-module and multi-unit review issues, the NRC staff has considered the issue description and examples you provided in your July 22, 2015, letter, and believes that the perspectives described below address the multi-module review aspects. Our response reflects the NRC staff's perspectives on the key review aspects of a conventional multi-unit site, which the NRC staff believes equally pertain to a modular

reactor design, such as the NuScale proposed design. In developing its perspectives, the NRC staff used the definitions of a 'Nuclear Power Unit' found in Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," and 'Modular Design' found in 10 CFR 52.1, "Definitions." These definitions are shown below:

> *Nuclear power unit*. A nuclear power unit means a nuclear power reactor and associated equipment necessary for electric power generation and includes those structures, systems, and components required to provide reasonable assurance the facility can be operated without undue risk to the health and safety of the public.
>
> *Modular design* means a nuclear power station that consists of two or more essentially identical nuclear reactors (modules) and each module is a separate nuclear reactor capable of being operated independent of the state of completion or operating condition of any other module co-located on the same site, even though the nuclear power station may have some shared or common systems.

The above definitions are central to the NRC staff's perspectives on and approach to reviewing a multi-module design. NuScale uses the term 'module' typically to mean the reactor vessel and containment, including structures, systems, and components (SSCs) installed within the containment. For purposes of this discussion, the NRC staff will use the term 'nuclear power unit,' as defined in 10 CFR 50, Appendix A, to mean a single NuScale 'module' plus the associated equipment necessary for electric power generation. The NRC staff's current understanding of the NuScale facility design is that it will include twelve nuclear power units of a modular design such that each separate nuclear reactor can be operated independent of the stage of completion or operating condition of any other nuclear reactor on the same site.

In your July 22, 2015 letter, you stated that the NRC regulations generally address issues on a per-unit (per-reactor) basis, and that in almost all cases, this approach was appropriate for NuScale. You further stated that there are some issues unique to multi-module designs, and a new policy to identify and treat those issues on a multi-module basis would reduce regulatory uncertainty and provide for consistent regulatory treatment. As part of the DC application, NuScale must meet 10 CFR 52.47(c)(3) which requires submittal of information describing and analyzing the possible operating configurations of the reactor modules [units] including common systems, interface requirements, and system interactions.

The NRC staff believes that although differences exist between sites that have multiple, largely independent nuclear power units and sites with modular designs having multiple nuclear power units that share common systems, as would be the case for the NuScale facility, current regulations and guidance are adequate for conducting a thorough review by appropriately applying the definitions of a 'nuclear power unit' and 'modular design.'

The NRC staff provides the following overall perspectives regarding reviewing a multi-module design:

1. **Protection of SSCs important to safety of multiple nuclear power units**

   NRC regulations in Appendix A to 10 CFR Part 50 state requirements that address hazards within the design basis - internal and external to a plant. These requirements

are stated most notably in Appendix A, General Design Criterion 2 – *Design bases for protection against natural phenomena*, Criterion 3 – *Fire Protection*, and Criterion 4 – *Environmental and dynamic effects design bases.* These requirements address assurance that a single hazard would not render SSCs important to safety incapable of performing their intended safety function. *Criterion 5 – Sharing of structures, systems and components* states that SSCs important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair the SSC's ability to perform the safety function. For example, the NRC staff expects that provisions will be included in the station design to prevent fires or floods initiated in one nuclear power unit from spreading to another nuclear power unit and causing the failure of safety-related equipment associated with that nuclear power unit. Typical hazards include internal fires, internal flooding, and natural phenomena (e.g., seismic events and high winds).

Other hazards include those that can be caused by events in other nuclear power units on a site or by industrial facilities near the site, such as, chemical plants or oil refineries.

2. Failures in SSCs in one nuclear power unit or SSCs shared among nuclear power units leading to transients or accidents in other nuclear power units

Based on its current understanding of the NuScale facility design regarding the extent to which safety-related (e.g., reactor building pool ultimate heat sink) and non-safety related (e.g., instrument air) SSCs are shared among multiple nuclear power units, the NRC staff believes the following types of events that could affect multiple nuclear power units simultaneously will need to be addressed in the DC application:

- events caused by activities during construction, operation, modification, or decommissioning of other nuclear power units;
- events which occur simultaneously on multiple nuclear power units caused by failures of systems shared among the nuclear power units;
- beyond design basis external events that could impact multiple nuclear power units.

Examples of such events may include:

- damage in the reactor building caused by a ruptured pipe in one nuclear power unit causing an accident in one or more of the other nuclear power units;
- simultaneous reactor transients in multiple nuclear power units caused by a single failure in a shared system or the spread of flood or fire in the turbine building;
- breach of the reactor pool that affects the ultimate heat sink for all nuclear power units.

The NRC staff will consider the identification of these events and categorization according to frequency of occurrence as well as the acceptability of the response of a

single nuclear power unit to these events, in accordance with the SRP, Chapter 15, "Transient and Accident Analyses." Separately, the NRC staff will consider the acceptability of these types of events from a risk perspective in accordance with guidance specific to integral pressurized water reactors in NUREG-0800, Section 19.0, "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors." This guidance directs the NRC staff to

> *"…verify that the applicant has selected alternative features, operational strategies, and design options to prevent these [multi-module accident] sequences from occurring and demonstrated that these accident sequences are not significant contributors to risk."*

In your aforementioned letter, you provided the following four examples of issues that may warrant different treatment for NuScale than typical multi-unit sites. The NRC staff addresses each of these issues as follows:

1. *Control room operator workload for simultaneous off-normal events including design-basis and beyond-design-basis accidents because NuScale's design includes less than one operator per unit. This contrasts with current operating plants that normally have dedicated crews for each unit, even with a shared control room.*

   With respect to this issue, the control room staffing should be established to handle the highest level work load given consideration for the NuScale modular facility design. In this light, the NRC staff conducted an initial audit from March 29, 2016 through April 15, 2016, to review NuScale's pre-engagement process for submitting its proposed control room staffing and Human Factors Engineering information (HFE). The NRC staff acknowledged that aspects of the concept of operations and the Human-Systems Interface design were still evolving at the time of this audit. During the audit period, the NRC staff provided written comments to the NuScale staff on topics that should be clarified in the design certification application to ensure that the acceptance criteria as listed in NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," and NUREG-0711, "Human Factors Engineering Program Review Model," are addressed. The audit summary report is available via ADAMS Accession No. ML16137A552. In addition, the NRC staff conducted a follow-up audit from August 16, 2016 through August 19, 2016, to observe multiple workload analysis simulator scenarios associated with the staffing plan validation to observe control room operator actions and responses. The audit plan is available via ADAMS Accession No. ML16195A178. A summary report of this audit will be issued by November 18, 2016.

2. *The number of modules to be considered in development of the source term for the emergency planning zone (EPZ). NRC EPZ regulations are not different for single and multi-unit sites. In most cases, the single-unit approach is appropriate for small modular reactors including NuScale. For some situations, consideration of more than a single module may be appropriate when evaluating the size of the EPZ. Examples 3 and 4 illustrate different circumstances for single or multiple modules issues.*

The NRC staff agrees that consideration of more than a single module in development of the source terms and technical basis to evaluate EPZ size is appropriate, and is generally consistent with the NRC staff's expectations on consideration of multi-module designs within the PRA and severe accident assessment, as given in SRP Section 19.0. In SECY-11-0152, "Development of an Emergency Planning and Preparedness Framework for Small Modular Reactors" (ADAMS Accession No. ML112570439), the NRC staff discussed possible consideration of potential changes to the emergency planning and preparedness framework for Small Modular Reactors (SMRs). Among the considerations for establishing the size of EPZs for SMRs, the NRC staff stated its expectation that the dose assessments that provide the basis for the EPZ distances would evaluate a spectrum of accidents, using the plant design PRA, as well as including current insights on severe accident progression.

To further clarify, in the enclosure to SECY-16-0012, "Accident Source Terms and Siting for Small Modular Reactors and Non-Light Water Reactors" (ADAMS Accession No. ML15309A319), the NRC staff's discussion of EPZ size evaluation identified that the technical basis for both emergency plans and EPZs needs to include consideration of beyond design basis accidents. Additional interaction with the NRC staff on this issue will also take place in the ongoing review of the NuScale Topical Report TR-0915-17772-NP, "Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones at NuScale Small Modular Reactor Plant Sites," dated December 22, 2015 (ADAMS Accession No. ML15356A842), and during activities related to the planned proposed rulemaking for emergency preparedness for SMRs and other new technologies as presented in SECY-16-0069, "Rulemaking Plan on Emergency Preparedness for Small Modular Reactors and Other New Technologies" (ADAMS Accession No. ML16020A388).

3. *Certain internal events, such as fire and flooding; as it is plausible that fires and floods could affect multiple modules. Conversely, it is not credible that an internal fire or flood would propagate to a second unit at a typical multi-unit site if they do not have shared structures.*

   The NRC staff has covered this issue under its review perspectives described earlier in this letter. The issue of internal events such as fire and flooding that could affect multiple modules is addressed in the NRC staff perspective #1. As stated in this perspective, provisions should be included in the design to prevent fires or floods to spread from one nuclear power unit to another and causing the failure of safety related equipment. In addition, the NRC staff perspective #2 describes the expectation for NuScale to identify events that could affect multiple nuclear power units, including events such as fire and flooding, and, as a part of Section 19.0, describe the acceptability of these types of events from a risk perspective.

4. *Most external events should be treated on a per-unit basis just as they are for typical multi-unit sites, but there may be some exceptions. In most cases involving external hazards such as beyond-design-basis seismic events, external floods, external fires, or high winds, the impacts of these events do not require consideration of multiple units at a site. This approach should be applied to NuScale because the differences in spacing between the NuScale modules and between reactors at a typical multi-unit site are irrelevant given the geographic scale of these events, especially severe events. Possible exceptions would be localized beyond-design-basis external events, such as an aircraft impact or certain small-scale but severe weather events, such as a tornado, where more*

than one module could be affected because of their closer spacing compared to the reactors at a typical multi-unit site.

As stated by the NRC staff in its review perspective #2 described earlier in this letter, beyond design basis external events that could impact multiple nuclear power units will need to be addressed in the DC application.

With respect to content of the DC application in the multi-module area, the NRC staff expects NuScale to submit design details containing identification and description of issues that affect the NuScale modular reactor design and characterize their distinction from those that affect licensed multi-unit plants. Specifically, the NRC staff's expectation is that applicants with modular plant designs will use information related to the interaction between plant SSCs in conjunction with risk insights from consideration of the modular design and operation (refer to SRP Chapter 19.0) to appropriately categorize events and determine the design basis accidents (DBAs) for the plant design, including any credible nuclear power unit events or accidents resulting from the modular design. This would include a description of the scenarios considered and determination of the event category for any potential DBAs that are unique to the design or may not have been previously described in the SRP as applicable to a single-reactor unit, including the DBAs used to evaluate potential radiological consequences for the safety and siting assessment. The NRC staff notes that review perspectives specific to NuScale design will be appropriately addressed during the review of the DC application.

Finally, consideration should be given to the eventual license structure to the extent that it impacts the DC application for a standard plant. It is not clear to the NRC staff how NuScale envisions the structure of future licenses in terms of each module being licensed individually or the entire facility being licensed as one. Initial considerations by the NRC staff in this area are in SECY-11-0079, "License Structure for Multi-Module Facilities Related to Small Modular Nuclear Power Reactors" (ADAMS Accession No. ML110620459). For example, these considerations could impact the DC application for NuScale's modular design, if a future licensee elects to not utilize the full complement of nuclear power units. As such, 10 CFR 52.47(c)(3) requires the application to address possible operating configurations given common systems, interface requirements and systems interactions. In the same light, the application must also address differences in configurations including restrictions necessary during construction and startup of a nuclear power unit while other nuclear power units are in operation at the facility. This should include, to the extent applicable, the proposed changes to 10 CFR 50.54(m) and operator licensing for a modular facility.

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

Sincerely,

/RA/ ABradford for

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

Project No.: PROJ0769

cc: NuScale Power LLC Listserv

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