RAIO-103182

May 26, 2021

Docket No. 99902043

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 9830 (eRAI 9830) on the NuScale Topical Report, "Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones," TR-0915-17772, Revision 2

REFERENCES:
1. NRC Letter eRAI 9830 - EPZ, dated April 26, 2021, RAI# 9830
2. NuScale Topical Report Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones, dated 2021, TR-0915-17772

The purpose of this letter is to provide NuScale's response to NRC Request for Additional Information (RAI), RAI No. 9830, noted in the References above. The response to the individual RAI question is provided in the attached Enclosure.

This letter contains NuScale's response to the following RAI Question from NRC RAI# 9830:

- 01.05-49

This letter makes no new regulatory commitments and no revisions to any existing regulatory commitments.

Please contact Liz English at 541-452-7333 or at eenglish@nuscalepower.com if you have any questions.

Sincerely,

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Enclosure: NuScale Response to NRC Request for Additional Information RAI No. 9830

Enclosure:

NuScale Response to NRC Request for Additional Information eRAI No. 9830

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Response to Request for Additional Information
Docket: 99902078

RAI No.: 9830
Date of RAI Issue: 04/26/2021

NRC Question No.: 01.05-49

Requirement

The regulations in 10 CFR 50.47, "Emergency Plans," and 10 CFR Part 50 Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," contain the requirements for establishing the plume exposure pathway emergency planning zone (EPZ) for nuclear power plants. These regulations require the plume exposure pathway EPZ to consist of an area about 10 miles (16 km) in radius; however, there is a provision (10 CFR 50.47(c)(2)) for a different EPZ size for reactors that are gas-cooled and with a thermal power of 250 MWt or less on a case-by-case basis.

Issue

Revision 2 of NuScale Power (NuScale) topical report, TR-0915-17772-P, "Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones," (Agencywide Document Access and Management System (ADAMS) Accession No. ML20217L422) provides a methodology to determine the plume exposure EPZ for advanced reactors including non-light water reactors (non-LWRs). In Revision 2 of the topical report, the applicant expands the applicability of the topical report beyond its original scope of light-water reactors (LWRs) without revising the content to explicitly address such designs. Information pertinent to non-LWRs is necessary in the topical report because of: (1) the significant differences in designs between LWRs and non-LWRs; and (2) the ways the corresponding PRAs are developed and used. The following examples highlight the staff's need for additional information on non-LWRs in order to review and potentially approve the topical report:

- The topical report does not provide a pertinent method for demonstrating technical acceptability of non-LWR probabilistic risk assessments (PRAs). Assumption 4 in Section 3.1 of the topical report states a technically adequate PRA is necessary for use in the risk-informed EPZ sizing methodology. However, the ASME/ANS consensus standards and NRC guidance typically used to assess PRA acceptability are

substantially different between LWR PRAs and non-LWR PRAs. Section 3, "Accident Screening Methodology," of the topical report refers only to LWR guidance when it discusses the technically acceptable PRA for use. Specifically, it refers to ASME/ANS RA-Sa-2009, "Addenda to ASME/ANS RA-S-2008 Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," and Regulatory Guide (RG) 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Revision 3, (ADAMS Accession No. ML20238B871) through which the NRC staff endorsed the LWR standard with clarifications. In addition, the topical report also refers to Standard Review Plan, NUREG-0800, Section 19.0, "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors," which contains guidance for LWRs. The remaining sections of the topical report contain guidance based on LWR PRAs, some of which is not applicable to, or insufficient for, non-LWR applicants.

- The surrogate risk metrics of core damage frequency and large early release frequency as used in the topical report are typically used for LWRs. These surrogate risk metrics are not applicable to many advanced non-LWR designs. For example, because of the use of different materials for the fuel, moderator, and coolant, LWR risk metrics, such as core damage frequency, are not useful or relevant for many advanced non-LWR designs.
- The dose criteria for "less severe" or "more severe" scenarios used in the methodology are based on intact or failed containment. The scenarios are not applicable to those designs of non-LWRs that do not have a traditional containment but may be applicable to non-LWRs that do have a traditional containment.

The recently issued industry consensus standard, ASME/ANS RA-S-1.4-2021, "Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactor Nuclear Power Plants," provides guidance on the development and use of PRAs for non-LWRs. Note that the NRC staff expects to issue a trial use regulatory guide endorsing this standard later this year. The industry also submitted NEI 20-09, "Performance of PRA Peer Reviews Using the ASME/ANS Advanced Non-LWR PRA Standard," to the NRC for review and approval and it is currently under NRC staff review. In addition, the NRC staff engaged with industry on a risk-informed and performance-based approach to non-LWR licensing, called the Licensing Modernization Project (LMP). The approach, fundamentally different from the traditional approach for LWRs, is documented in Regulatory Guide (RG) 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals For Non-Light-Water Reactors," Revision 0 (ADAMS Accession No. ML20091L698). The RG endorses Nuclear Energy Institute

(NEI) 18-04, Revision 1, "Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development." While not required, the NRC staff anticipates that many non-LWR applicants would use the LMP approach in their licensing applications. Many of these documents appear to be relevant to this topical report and could be used by the applicant in demonstrating technically acceptable PRAs and their uses for non-LWRs; however, it appears they have not been considered in developing the methodology.

The staff's comparison of these documents against the topical report (Revision 2) confirms the need for additional information in the topical report as indicated above and including the following observations:

- In non-LWR PRAs, the risk is assessed based on a 'per plant' basis (versus 'per module' in the topical report) including all radiological sources.
- In non-LWR PRAs, event sequence family is defined and used (versus event sequence in the topical report). For instance, the non-LWR PRA standard has requirements on screening criteria based on event sequence family, which may be different from those in the topical report.
- In the LMP, the licensing basis events (i.e., anticipated operational occurrences, design basis events, beyond design basis events, and design basis accidents) are selected in a risk-informed and performance-based manner based on the frequency-consequence target described in NEI 18-04. They are defined differently from the traditional licensing basis events in Chapter 15, "Transient and Accident Analysis," of the NUREG-0800 on which the topical report is based. The definitions of licensing basis events such as design basis accidents used in the topical report may be different from those for non-LWRs.

The NRC staff notes that the approach discussed above using ASME/ANS RA-S-1.4-2021 and the LMP process is one acceptable method. If another approach is used, the applicant should explain it in sufficient detail in the topical report.

In summary, the method in Section 3, "Accident Screening Methodology," and Section 4, "Methodology for Source Term and Dose Evaluations," of the topical report (Revision 2) needs additional information to address differences between LWR and non-LWR guidance documents and licensing approaches, or the topical report should explain why the same approach is applicable to both LWRs and non-LWRs. This information is necessary to assess if the approach described in the topical report is an acceptable approach to determine the plume exposure EPZ by non-LWR applicants.

Request

The NRC staff requests that the applicant provide additional information in the topical report with sufficient justification such that the topical report contains clear guidance and criteria for non-LWRs to determine the plume exposure EPZ. Specifically, in accordance with the examples and observations provided above, the NRC staff requests that the following be provided:

- Provide a detailed discussion on demonstrating technical acceptability of PRAs for non-LWRs, or explain why the approach is the same as for LWRs. (Using the ASME/ANS Advanced Non-LWR PRA Standard is one acceptable approach for such demonstration).
- Provide the surrogate risk metrics for various non-LWR designs if used and corresponding guidance on how such risk metrics are developed and used in the topical report.
- Provide the dose criteria for the scenarios of the non-LWR designs without a traditional containment and corresponding guidance, including sufficient technical bases, (e.g., how the dose criteria were developed and how they will be used), in the topical report.
- Provide the criteria and corresponding guidance that reflect technically acceptable non-LWR PRAs performed based on a per plant basis including all radiological sources, or explain why the approach can also be used for both LWRs and non-LWRs.
- Provide the criteria and corresponding guidance on event sequence families (instead of event sequences) for non-LWR designs to be included in Revision 2 of the topical report.
- Provide the definitions of licensing basis events such as design basis accidents for non-LWR designs that the applicant intends to include in Revision 2 of the topical report.

The requested items above are some of the significant ones based on the NRC staff's high-level evaluation of the topical report against the consensus industry standard (i.e. ASME/ANS RA-S-1.4-2021) and the LMP. The applicant should evaluate RG 1.233, NEI 18-04, Revision 1, ASME/ANS RA-S-1.4-2021, and NEI 20-09 to gain relevant information as part of the effort to provide additional information.

NuScale Response:

The scope of the emergency planning zone licensing topical report will be reduced to light water reactor (LWR) small modular reactors. References and discussion of the use of the method for non-LWRs are removed.

Impact on Topical Report:

Topical Report TR-0915-17772, Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones, has been revised as described in the response above and as shown in the markup provided in this response.

Abstract

The purpose of this licensing topical report (LTR) is to provide the technical basis for NuScale's plume exposure pathway emergency planning zone (EPZ) sizing methodology. The ingestion EPZ is not addressed in this methodology, as the determination of this distance is dependent on land usage that is site-specific. The methodology is informed by the Nuclear Energy Institute (NEI) risk-informed EPZ methodology (Proposed Methodology and Criteria for Establishing the Technical Basis for Small Modular Reactor Emergency Planning Zone, Reference 6.1.5) and extends this risk-informed methodology to address the issue of determining the appropriate accident sequences to be included in the EPZ technical basis, and to consider a consequence orientation in the approach. The screening of accident sequences includes the use of quantitative insights from probabilistic risk assessment (PRA) as well as application of engineering insights emphasizing safety margin and layers of defense-in-depth. The screening methodology includes consideration of all hazards and operating modes and also contains integrated assessment of both multi-module effects, when applicable, and uncertainty analysis. Based on the accident sequence screening, the risk results, including source terms and off-site dose versus distance, will serve as the basis for a plume exposure EPZ size. The methodology is intended for use by light water~~all advanced nuclear reactor designs, particularly~~ small modular reactors (SMRs) such as NuScale~~, although it is acknowledged that not every element of the method will be applicable to all designs~~.

The main body of the LTR contains the plume exposure EPZ size methodology for which NRC approval is being sought. In some instances, NuScale design information is used as examples to explain the methodology; however NuScale design information does not form the basis of the methodology. Additionally, to aid in the NRC's review and to illustrate how the EPZ size methodology would be used by future applicants, example source term and dose evaluations and example assessments of appropriate accident sequences to be evaluated are included in Appendices A, B, and C. Appendices D and E also contain examples of multi-module assessment and operational mitigation features, respectively. NuScale is not seeking NRC approval of the information in the appendices.

The topical report requests an NRC review of NuScale's plume exposure EPZ sizing methodology. NuScale also requests, as part of this review and associated comment resolution, that the NRC provide a safety evaluation report (SER) on the design-specific sizing methodology, including the following:

1. A conclusion that the NuScale-proposed plume exposure EPZ methodology in the LTR, when supported by design-specific information and appropriately implemented by the applicant, is an acceptable approach for justifying the plume exposure EPZ size.
2. Identification of issues related to the EPZ technical basis that are to be resolved prior to or as part of the application review process.

To aid in the NRC's review, each section of the topical report individually identifies the approval request and associated acceptance criteria.

Executive Summary

The purpose of this LTR is to provide a methodology to establish the technical basis for plume exposure EPZ sizing. The methodology is intended for use by light water~~all advanced nuclear reactor designs, particularly~~ small modular reactors (SMRs) such as NuScale~~, although it is acknowledged that not every element of the method will be applicable to all designs~~. Nuclear power plant emergency planning regulatory requirements are codified under Emergency Plans, 10 CFR 50, Part 50.47 (Reference 6.1.1), and Emergency Planning and Preparedness for Production and Utilization Facilities, 10 CFR Part 50 Appendix E (Reference 6.1.2). The responsibility for reviewing emergency planning lies with the U.S. Nuclear Regulatory Commission (NRC) in coordination with the Federal Emergency Management Agency (FEMA). The current regulatory plume exposure EPZ for power reactors is 10 miles, but there is a provision for a different EPZ size for reactors with a thermal power of 250 MWt or less on a case-by-case basis. This report describes a methodology to establish the technical basis for plume exposure EPZ sizing. The ingestion EPZ is not addressed in this methodology, as the determination of this distance is dependent on land usage that is site-specific.

NuScale requests, as part of the review and associated comment resolution of this LTR, that the NRC provide an SER on the plume exposure EPZ sizing methodology. The methodology herein, when supported by design-specific information and appropriately implemented by the applicant, is an acceptable approach to plume exposure EPZ sizing. To aid in the NRC's review, each section of the topical report individually identifies the approval request and associated acceptance criteria.

The methodology described in this report is informed by the 2013 NEI White Paper framework and incorporates concepts from the original, generic 1978 EPZ size basis (Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans, NUREG-0396, Reference 6.1.3) in that the objective goal is dose-based linked to considerations of consequences. However, the methodology is applied utilizing PRA information supported by a comprehensive evaluation of severe accident sequences. It includes consideration of internal events, external hazards, all operating power levels, and all modes of operation.

The main body of the LTR, in Section 3.0, presents the EPZ size methodology for which NRC approval is sought. In some instances, NuScale design information is used as examples to explain the methodology; however NuScale design information does not form the basis of the methodology. The methodology requires compilation of accident sequences from the PRA for all initiators and screens the sequences for inclusion in the EPZ technical basis based upon multiple criteria. To aid in the NRC's review and to illustrate how the EPZ size methodology would be used by future applicants, example source term and dose evaluations and example assessments of appropriate accident sequences to be evaluated are included in Appendices A, B, and C. Appendices D and E also contain examples of multi-module assessment and operational mitigation features, respectively. NuScale is not seeking NRC approval of the information in the appendices.

The methodology first determines the appropriate sequences to be evaluated for EPZ. The screening of accident sequences includes the use of quantitative insights from the PRA as well as application of engineering insights emphasizing safety margin and layers of defense-in-depth. Both "less severe" and "more severe" sequences are evaluated, differentiated by containment

1.0 Introduction

1.1 Purpose

The purpose of this licensing topical report (LTR) is to provide a methodology and criteria that can be implemented to establish the design-specific and site-specific plume exposure emergency planning zone (EPZ) size. The methodology is intended for use by light water~~all advanced nuclear reactor designs, particularly~~ small modular reactors (SMRs) such as NuScale~~, although it is acknowledged that not every element of the method will be applicable to all designs~~. The purpose of submitting this LTR is to provide information to the U.S. Nuclear Regulatory Commission (NRC) to facilitate efficient and timely review of the NuScale plume exposure EPZ sizing methodology. NuScale also requests, as part of this review and associated comment resolution, that the NRC provide a safety evaluation report (SER) on the plume exposure EPZ sizing methodology.

1.2 Scope

This report provides a methodology for determining an appropriate plume exposure EPZ. The ingestion EPZ is not addressed in this methodology, as the determination of that distance is dependent on land usage, which is site-specific. The NuScale methodology expands on the Nuclear Energy Institute (NEI) risk-informed EPZ methodology (Reference 6.1.5).

This report is based on the following regulatory guidance and technical considerations:

- methodology designed to be structured and repeatable
- NRC EPZ documents (NUREG-0396 [Reference 6.1.3], Generalized Dose Assessment Methodology for Informing Emergency Planning Zone Size Determinations [Reference 6.1.11], Required Analyses for Informing Emergency Planning Zone Size Determinations [Reference 6.1.12], Results of Evaluation of Emergency Planning for Evolutionary and Advanced Reactors, SECY-97-020 [Reference 6.1.8], Development of an Emergency Planning and Preparedness Framework for Small Modular Reactors, SECY-11-0152 [Reference 6.1.6], and Options for Emergency Preparedness for Small Modular Reactors and Other New Technologies, SECY-15-0077 [Reference 6.1.7])
- risk-informed methods to determine appropriate accident sequences to be evaluated, including multi-module events and external events
- analysis of uncertainties

The main body of the LTR contains the plume exposure EPZ size methodology for which NRC approval is sought. In some instances, NuScale design information is used as examples to explain the methodology; however NuScale design information does not form the basis of the methodology. In addition, to illustrate how the EPZ size methodology would be used by future applicants, example source term and dose evaluations, as well as example assessments of appropriate accident sequences to be evaluated, are included in Appendices A, B, and C. Appendices D and E also contain examples of multi-module assessment and operational mitigation features, respectively. The information in

the appendices is provided to facilitate: (1) NRC's review of the EPZ size methodology in the main body for which approval is sought; and (2) an understanding of how this LTR would be implemented by future applicants. NuScale is not seeking NRC approval of the information in the appendices. Rather, the appendices are examples illustrative of applying the methodology. This LTR is not part of the NuScale design certification application (DCA).

The use of this methodology to determine final EPZ size will occur when an application is submitted to the NRC to construct and operate a light water small modular~~an advanced~~ reactor design. The most likely mechanism is a combined license (COL) application; however it is acknowledged that other regulatory processes exist. For simplicity, "COL applicant" and "COL application" are used throughout this LTR to refer to implementation of the methodology.

1.3 Abbreviations and Definitions

Table 1-1 Abbreviations

Term	Definition
AOP	abnormal operating procedure
ARP	alarm response procedure
ATD	atmospheric transport and dispersion
ATWS	anticipated transient without scram
BDBE	beyond-design-basis event
BDG	backup diesel generator
CCDP	conditional core damage probability
CCF	common-cause failure
CCFP	conditional containment failure probability
CDF	core damage frequency
CFDS	containment flooding and drain system
CNV	containment vessel
COL	combined license
CVCS	chemical and volume control system
DBA	design-basis accident
DBST	design-basis source term
DCA	design certification application
DCF	dose conversion factor
DHRS	decay heat removal system
EAL	emergency action level
ECCS	emergency core cooling system
EDMG	extensive damage mitigating guideline
ELAP	extended loss of AC power
EOP	emergency operating procedure
EPA	Environmental Protection Agency

5.0 Summary and Conclusions on Methodology

The NuScale proposed approach for developing the technical basis for plume exposure EPZ size utilizes the 2013 NEI white paper framework and incorporates applicable concepts from the original, generic 1978 EPZ size basis in that it is dose-based and has a consequence orientation. At the same time, important differences exist in the NuScale approach including:

- it applies the severe accident knowledge base and analytical methods developed over the four decades since the original EPZ basis was formulated
- it is designed to be comprehensive, transparent, and repeatable

In addition, given the extent of PRA development and the evolution of risk-informed regulatory applications over the last several decades, NuScale is using risk-informed methods for determining appropriate accident sequences to be evaluated for the EPZ size basis. This risk-informed approach includes PRA information, deterministic source terms, and a qualitative evaluation of defense-in-depth.

This LTR submits a proposed plume exposure EPZ sizing methodology for NRC review. NuScale requests, as part of this review and associated comment resolution, that the NRC provide an SER on the sizing methodology, including:

- a conclusion that the NuScale proposed plume exposure EPZ methodology in the LTR, when supported by design-specific and site-specific information and appropriately implemented by the COL applicant, is an acceptable approach for determining the plume exposure EPZ size; and
- identification of any issues related to the EPZ technical basis that are to be resolved prior to or as part of the COL proceeding.

To aid in the NRC's review, each section of the topical report individually identifies the approval request and associated acceptance criteria.

The EPZ methodology, as proposed in this LTR and to be implemented with detailed design information as part of a COL application, is a complete and sufficient approach for developing the basis for and specifying the size of the plume exposure EPZ for a light water small modular~~an advanced~~ reactor design. The methodology is applicable to any plume exposure EPZ size, including the site boundary. The final EPZ size is the smallest distance at which the dose consequences of all screened-in accident sequences are less than their respective dose criteria. Based on the results of applying the methodology, the final plume exposure EPZ size may be different from the current 10 mile requirement.

The following summarizes the NuScale methodology for the technical basis for plume exposure EPZ size:

1. Dose criteria for the NuScale EPZ methodology have been defined based on the original EPZ basis and on EPA guidelines. These dose criteria are summarized in Table 5-1.