NuScaleDCRaisPEm Resource

From: Cranston, Gregory
Sent: Monday, April 16, 2018 4:21 PM
To: Request for Additional Information
Cc: Lee, Samuel; Tabatabai, Omid; Karas, Rebecca; Lu, Shanlai; NuScaleDCRaisPEm Resource; Chowdhury, Prosanta
Subject: Request for Additional Information No. 426 eRAI No. 9469 (6.3)
Attachments: Request for Additional Information No. 426 (eRAI No. 9469).pdf

Attached please find NRC staff's request for additional information (RAI) concerning review of the NuScale Design Certification Application.

Please submit your technically correct and complete response within 60 days of the date of this RAI to the NRC Document Control Desk.

If you have any questions, please contact me.

Thank you.

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Division of New Reactor Licensing
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301-415-0546

Hearing Identifier: NuScale_SMR_DC_RAI_Public
Email Number: 461

Mail Envelope Properties (CY4PR09MB12879ADC65223E30E047A0FD90B00)

Subject: Request for Additional Information No. 426 eRAI No. 9469 (6.3)
Sent Date: 4/16/2018 4:21:26 PM
Received Date: 4/16/2018 4:21:32 PM
From: Cranston, Gregory

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Post Office: CY4PR09MB1287.namprd09.prod.outlook.com

Files	**Size**	**Date & Time**
MESSAGE	566	4/16/2018 4:21:32 PM
Request for Additional Information No. 426 (eRAI No. 9469).pdf	101056	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Request for Additional Information No. 426 (eRAI No. 9469)

Issue Date: 04/16/2018
Application Title: NuScale Standard Design Certification - 52-048
Operating Company: NuScale Power, LLC
Docket No. 52-048
Review Section: 06.03 - Emergency Core Cooling System
Application Section: Chapter 6. Section 6.3

QUESTIONS

06.03-1

Title 10 of CFR Part 50, Section 46 provides the acceptance criteria for Emergency Core Cooling Systems (ECCS) for Light-Water nuclear power reactors. Specifically, it requires that an ECCS be designed to remove the decay heat during a post LOCA long term cooling period. Item 5 of 10CFR 50.46 states that after any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptablly low value. Regulatory Guide 1.82 (RG 1.82) describes methods that the staff of the U.S. Nuclear Regulatory Commission (NRC) consider acceptable to determine debris amounts that could affect long-term cooling following a loss-of-coolant accident (LOCA) by affecting the emergency core cooling system (ECCS) components and the reactor core cooling. RG 1.82 also provides guidelines for staff to review PWR sump strainer performance and the in-vessel downstream effects.

Based on the staff's current understanding of the procedures used to calculate the amount of debris that could be present in the NuScale containment vessel (CNV) following a LOCA, the staff is requesting the applicant to address the following concerns. The staff has also considered NuScale's response to RAI 9169 in formulating this question. The following concerns should be addressed in the revised text for FSAR Section 6.3.3.1.

1. Discuss the calculation of the post-LOCA containment fiber, particulate and chemical precipitate debris estimated values for the NuScale design.

Section 6.3.3.1 states: "Chemical species are not expected to form in the NuScale design. Boron is used to control reactivity and buffering agents are not included in containment." This statement implies that typical PWR chemical precipitates would not be expected due to the lack of buffer agent; however, discussions in this section refer to a chemical precipitate mass of 27.1 lbm from operating plant data and also indicate that adequate design margin for core cooling can be ensured with 271 lbm chemical precipitate in addition to 7.5 gm/FA of fiber and 30 lbm of particulates. Section 6.3.1.1 further states, "Due to the size and nature of debris that reaches the RPV, it may not accumulate at the core inlet. Instead, some or all of the debris may pass through the core inlet and reach the heated core region. " Provide justification for the determination that debris would not accumulate and generate a potential blockage to the core inlet.

2. FSAR Section 6.3.3.1 Debris Generation and Impact Evaluation describes an evaluation of the impact of debris blockage of a single fuel pin based on the assumption that the debris could, at most, form some localized blockages, given the size and quantity of the debris generated and assumptions on its migration through the fuel assembly. The description in the FSAR does not provide a sufficient description of the methodology or evaluation, which is stated in the FSAR to have resulted in a PCT of 592 F at the localized blockage. Please provide a description of how this evaluation was performed.

06.03-2

The NRC regulations, relevant requirements and acceptance criteria pertaining to the emergency core cooling system (ECCS) design present in NuScale FSAR Section 6.3 are General Design Criteria (GDC) 17, GDC 35 and 10CFR 50.46 regarding the ECCS capacity and the relevant cooling capacity. Guidance relevant to the staff's review of ECCS design is provided in NUREG–0800, Section 6.3, "Emergency Core Cooling System". Review interfaces with other Standard Review Plan sections can also be found in NUREG–0800 Section 6.3.

Standard Review Plan 6.3 (SRP 6.3) describes the areas of review that the U.S. Nuclear Regulatory Commission (NRC) considers in performing a system and technical evaluation of a PWR Emergency Core Cooling System (ECCS). SRP 6.3 addresses both short and long-term cooling by the ECCS following LOCA and non-LOCA transients.

Based on the staff's current understanding of the NuScale ECCS provided in FSAR Section 6.3, the staff is requesting the applicant to provide descriptions of ECCS actuation and performance for non-LOCA events. As part of the performance evaluation, it is expected that an evaluation of the ECCS performance for non-LOCA events be provided. Please provide descriptions, including references to any reports, that document the ECCS performance for all non-LOCA events which require ECCS actuation such as, but not limited to, an inadvertent ECCS valve operation, a secondary system pipe break inside containment and a steam generator tube rupture.

06.03-3

The NRC regulations, relevant requirements and acceptance criteria pertaining to the emergency core cooling system (ECCS) design present in NuScale FSAR Section 6.3 are Principle Design Criteria (PDC) 4, PDC 35 and 10CFR 50.46 regarding the ECCS capacity and the relevant cooling capacity. PDC 4 specifically requires that ECCS is designed to withstand the dynamic effects associated with the environmental conditions during normal operation and accident conditions. Guidance relevant to the staff's review of ECCS design is provided in NuScale Design Specific Review Standard, Section 6.3, "Emergency Core Cooling System".

FSAR Section 6.3.2.4 states that the RRVs and actuators are designed for a minimum neutron exposure of 2.5E17 neutrons/cm^2. However, it is not clear to the staff that the fluence results during 60 years of full power operation compiled in TR-0116-20781-P, "Fluence Calculation Methodology and Results," which supports Section 6.3 of the FSAR, fall below the design exposure for the RRVs and actuators. Therefore, NuScale is requested to provide the corresponding expected exposure for the RRVs and compare it to the design exposure, as well as a description of the potential degradation mechanism.

06.03-4

The NRC regulations, relevant requirements and acceptance criteria pertaining to the emergency core cooling system (ECCS) design present in NuScale FSAR Section 6.3 are Principle Design Criteria (PDC) 4, PDC 35 and 10CFR 50.46 regarding the ECCS capacity and the relevant cooling capacity. PDC 4 specifically requires that ECCS is designed to withstand the dynamic effects associated with the environmental conditions associated with normal operation and accident conditions. Guidance relevant to the staff's review of ECCS design is provided in NuScale Design Specific Review Standard, Section 6.3, "Emergency Core Cooling System".

FSAR Section 6.3.2.2. references Table 6.3-2 "Emergency Core Cooling System Valve and Actuator Design and Operating Parameters." The table includes a row at the bottom for the RVV and RRV design temperatures for accident conditions, however the values are blank. Further, the fluid temperature and

valve external temperature are not reported in the table for accident conditions. Please update and correct the table, as necessary.

06.03-5

The NRC regulations, relevant requirements and acceptance criteria pertaining to the emergency core cooling system (ECCS) design present in NuScale FSAR Section 6.3 are Principle Design Criteria 35 and 10CFR 50.46 regarding the ECCS capacity and the relevant cooling capacity. Guidance relevant to the staff's review of ECCS design is provided in NuScale Design Specific Review Standard, Section 6.3, "Emergency Core Cooling System".

FSAR Section 6.3.3 states "Analyses show that under bounding conditions of core mixing volume for long-term core cooling conditions (quasi-static state), boron precipitation does not occur at temperatures greater than 80 degrees F." However, the higher values for the boron precipitation temperature in section 6 of TR-0916-5122, "Long-Term Cooling Methodology," Table 6-1, which is incorporated by reference into the FSAR, are in conflict with the statement in FSAR Section 6.3.3. Please correct or provide appropriate justification for the FSAR statement.

06.03-6

The NRC regulations, relevant requirements and acceptance criteria pertaining to the emergency core cooling system (ECCS) design present in NuScale FSAR Section 6.3 are Principle Design Criteria 35 and 10CFR 50.46 regarding the ECCS capacity and the relevant cooling capacity. Guidance relevant to the staff's review of ECCS design is provided in NuScale Design Specific Review Standard, Section 6.3, "Emergency Core Cooling System".

NuScale stated in FSAR Section 6.3.2.5 that the ECCS actuator lines and trip reset valves are susceptible to water hammer. The FSAR also indicates that the system is designed to withstand water hammer, however no information is provided in the FSAR to explain what analysis and/or testing will be completed to demonstrate that the design can accommodate water hammer effects. Therefore, NuScale is requested to discuss testing that has been or will be performed to show that potential water hammer will not adversely affect the structural integrity of piping, components and supports. In addition, NuScale is requested to provide the process and method used to determine water hammer loads/forcing functions and how these water hammer loads are used in the load combinations in the piping structural analysis.

06.03-7

10 CFR 52.47(b)(1) requires that a design certification application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the [Atomic Energy] Act, and the Commission's rules and regulations. NUREG-0800, "Standard Review Plan," Section 14.3.4, "Reactor Systems - Inspections, Tests, Analyses, and Acceptance Criteria," provides guidance for the Tier 1 design commitment and ITAAC related to Reactor systems, which encompasses emergency core cooling systems (active and passive). SRP 14.3.4 specifies that the Tier 1 design certification should include the top-level design features and performance standards that pertain to the safety of the plant and include descriptive text and supporting figures. The top-level design features and performance standards are those that are most important to safety, including safety-related and defense-in-depth features and functions, and non-safety-related systems that potentially impact safety.

FSAR, Tier 2, Section 6.3.1 states that the principal function of the emergency core cooling system (ECCS) is to cool the reactor core in situations when it cannot be cooled by other means and therefore performs a safety function. NRC staff did not identify information within FSAR, Tier 1 that provides design commitments to address the principal function of the ECCS. NRC staff relies upon such design commitments and associated ITAAC to support findings that the modeling of the ECCS in the safety analyses is suitable. In particular, NRC staff needs to establish design bounds for (1) the minimum and maximum flow capacity of the ECCS valves, and (2) the opening times of the ECCS valves. Accordingly, NRC staff requests that the applicant update FSAR, Tier 1 to include design commitments and associated ITAAC to address design values (bounds) for flow capacity and opening times for the ECCS valves.