RAIO-0518-60040

May 17, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 417 (eRAI No. 9442) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 417 (eRAI No. 9442)," dated April 11, 2018

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's response to the following RAI Question from NRC eRAI No. 9442:

- 05.04.07-6

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Carrie Fosaaen at 541-452-7126 or at cfosaaen@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Samuel Lee, NRC, OWFN-8G9A
Prosanta Chowdhury NRC, OWFN-8G9A
Bruce Bavol, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9442

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9442

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9442
Date of RAI Issue: 04/11/2018

NRC Question No.: 05.04.07-6

10 CFR Part 50, Appendix A, GDC 34 requires in part that a system have the capability to transfer heat from the reactor such that fuel and pressure boundary design limits are not exceeded; this requirement is reflected in NuScale's PDC 34. For the NuScale design, the decay heat removal system (DHRS) serves this function.

FSAR Tier 2, Section 5.4.3.1 states that the design basis for the DHRS is to "remove post-reactor trip residual and core decay heat from operating conditions". During the course of interactions with NuScale regarding the return to power scenario as part of FSAR Section 15.0.6, NuScale has stated that the DHRS would be relied on for core cooling in the event of a select set of transient conditions involving a stuck rod. Such a scenario involves the DHRS removing core fission power, which is outside the design basis described in FSAR Section 5.4.3. Therefore, staff requests the applicant update the design basis description in Section 5.4.3.1 for the DHRS to include all scenarios for which DHRS is relied on to remove heat and/or core power. Additionally staff requests that the applicant provide a discussion somewhere in Section 5.4.3 describing the DHRS function during a return to power scenario, and either provide an appropriate system performance curve for the event (e.g. FSAR Figures 5.4.-13/14 and -15/16) or justify why the event is bounded by other design basis events. Further, staff requests that NuScale update PDC 34 to address fission power, or justify why PDC 34 adequately covers the existing design basis event spectrum.

NuScale Response:

In response to the NRCs request, NuScale has updated the design basis description of the Decay Heat Removal System (DHRS) in FSAR Section 5.4.3.1. The DHRS design basis includes all scenarios for which DHRS is relied on to remove heat and/or core power. Specifically, NuScale has added a statement to Section 5.4.3.1 that the DHRS is designed to cool the reactor coolant system (RCS) at a rate such that the specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded, during a return to power event as described in Section 15.0.6.

In addition, NuScale has updated Section 5.4.3.3.4 to describe the DHRS function during a return to power scenario. The new information provides a description of the return to power event and DHRS involvement in the scenario and references DHRS performance curves included in Chapter 15 for the event.

Finally, NuScale reviewed Principal Design Criteria (PDC) 34 and determined that no changes are required to address the DHRS design basis functions during a return to power event. The NuScale PDC 34 differs from the NRC General Design Criteria (GDC) 34 only by the removal of language from GDC 34 related to availability of onsite and offsite power sources. The NuScale DHRS design does not rely on safety-related power to perform its design function. A return to power event is not unique to the NuScale design and is evaluated under GDC 34 for other pressurized water reactor designs, NuScale has determined that the language of PDC 34 is consistent with the typical industry usage. Specifically, where PDC 34 states that the system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded. These statements are consistent with the return to power event as analyzed in FSAR section 15.0.6.

Impact on DCA:

FSAR Section 5.4.3.1 and 5.4.3.3.4 have been revised as described in the response above and as shown in the markup provided in this response.

including weld materials, conform to fabrication, construction, and testing requirements of ASME BPVC, Section III, Subsection NB. The materials selected for fabrication conform to the applicable material specifications provided in ASME BPVC, Section II and meet the requirements of ASME BPVC, Section III, Article NB-2000. The check valves are constructed of materials with a proven history in light water reactor environments. Surfaces of pressure retaining parts of the valves, including weld filler materials and bolting material, are corrosion resistant materials such as stainless steel or nickel-based alloy. Materials used for the RCS check valves and associated weld filler metals are provided in Table 6.1-3.

RAI 05.02.01.01-7

Refer to Section 5.2.3 and Section 5.2.4 for additional description of material compatibility, fabrication and process controls, ~~and~~ welding controls and inspections related to the ASME Class 1 components.

5.4.3 Decay Heat Removal System

5.4.3.1 Design Basis

RAI 05.04.07-6

The DHRS provides cooling for non-LOCA design basis events when normal secondary-side cooling is unavailable or otherwise not utilized. The DHRS is designed to remove post-reactor trip residual and core decay heat from operating conditions and transition the NPM to safe shutdown conditions without reliance on external power. The DHRS is designed to cool the RCS at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded during a return to power event as described in Section 15.0.6.

The safety-related DHRS function is an engineered safety feature of the NPM design. Reliability of DHRS is evaluated using the reliability assurance program described in Section 17.4 and risk significance is determined using the guidance described in Chapter 19. The DHRS classification and risk categories are included in Table 3.2-1.

RAI 09.03.06-2S1

The DHRS design ensures the RCS average temperature is below 420 degrees F within 36 hours after an initiating event without challenging the RCPB or uncovering the core. An RCS average temperature of 420 degrees F was chosen based on the safe shutdown temperature proposed by EPRI for passive plant designs in the EPRI Advanced Light Water Reactor Utility Requirements Document (Reference 5.4-3) and determined to be acceptable by the Nuclear Regulatory Commission as documented in SECY-94-084.

The DHRS heat removal function does not rely on actuating ECCS. Any ECCS actuation after a DHRS actuation allows continued residual heat removal by both systems from the reactor core as described in Section 6.3.

Applicable 10 CFR 50 Appendix A, General Design Criteria and Other Design Requirements

RAI 05.02.01.01-7

compared to the 100 degrees Fahrenheit initial condition. Based on these results, the DHRS design is capable of cooling the RCS to below a safe shutdown temperature of 420 degrees Fahrenheit in less than 36 hours with one DHRS train in operation assuming limiting off-normal conditions and a single active failure of the associated MSIV to close.

Figure 5.4-11 and Figure 5.4-13 show the hot and cold leg temperatures difference increase as the water level in the RPV drops to near the top of the riser. When the liquid level is near the top of the riser, the reduced flow area causes more losses and impedes RCS natural circulation that increases the temperature difference. Oscillations in natural circulation of the RCS could occur once the level drops to near the top of the riser due to vapor build up in the top of the core and lower riser. The vapor eventually is discharged into the upper riser and condenses as it rises. During these potential surges, liquid water is pushed over the top of the riser and into the downcomer. Results show that the potential oscillations do not affect the ability of the DHRS to remove heat. The DHRS has been shown to be capable of removing heat in excess of decay heat after 36 hours with the RCS at 420 degrees Fahrenheit and the pool at boiling conditions.

Refer to Chapter 15 for plant initial conditions, assumptions, and response to design basis events that result in DHRS actuation.

RAI 05.04.07-6

Return to Power Event

In the event of an extended DHRS cooldown (post-reactor trip), when the RCS is at low boron concentrations and the CVCS is unavailable to add boron, it may be possible for DHRS to cool the core to the point of reestablishing some level of critical neutron power, if it is assumed that the most reactive control rod is stuck out. This event is caused by increased net reactivity post-reactor trip, due to a stuck or partially withdrawn control rod, followed by the DHRS overcooling the RCS.

RAI 05.04.07-6

Figure 15.0-8 shows the increase in reactor power due to the reduced negative reactivity. The DHRS mitigates this event by continuing to remove both residual decay heat and fission heat for the duration of the event until a new equilibrium reactor power is reached. As shown in Figure 15.0-11, during this event, the average RCS temperature does not increase above 420 degrees F, safe shutdown temperature, and fuel and thermal hydraulic acceptance criteria are met. See Section 15.0.6 for further discussion of DHRS performance during a return to power event.

5.4.3.4 Tests and Inspections

RAI 05.02.01.01-7

Preservice and ~~I~~inservice inspection requirements of Section XI are met for Class 2 components of the BPVC are applicable to the DHRS components including the steam piping, actuation valves, condensers, and condensate piping.