NuScale Power

RAIO-1217-57706

December 16, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 28 (eRAI No. 8771) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 28 (eRAI No. 8771)," dated May 26, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 28 (eRAI No.8771)," dated July 24, 2017

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

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Question from NRC eRAI No. 8771:

- 15-1

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 Darrell Gardner at 980-349-4829 or at dgardner@nuscalepower.com.

Sincerely,

Jennie Wike
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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8771

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8771

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

eRAI No.: 8771
Date of RAI Issue: 05/26/2017

NRC Question No.: 15-1

15.0.06 Return to Power

According to General Design Criterion (GDC) 27, reactivity control systems shall be designed to reliably control reactivity changes to ensure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained. As described in the staff's response (ML16116A083) to the NuScale Gap Analysis Summary Report, Revision 1, Gap 11, GDC27, the staff has determined the applicant's design does not meet GDC 27 and, as such, the applicant has requested an exemption to GDC 27. The exemption to GDC 27 states, in part, that the return to power assuming a stuck rod is sufficiently unlikely and that specified acceptable fuel design limits (SAFDLs) for critical heat flux would not be exceeded even if it occurred. To demonstrate that SAFDLS are not exceeded, the applicant has analyzed a return to power in FSAR Section 15.0.06. An accurate determination of the minimum critical heat flux (MCHF) is dependent upon assessing reactor stability at these low power conditions and hence GDC 12 also applies.

Based on the detail provided in Section 15.0.06, the staff is unable to reach a reasonable assurance finding that the SAFDLs will not be exceeded. The staff is requesting that Final Safety Analysis Report (FSAR) Section 15.0.06, which assumes the use of the decay heat removal system (DHRS), be modified to include details provided for a licensing basis event, and the short term transient analyses in the various subsections of Chapter 15 should reference Section 15.0.06 for the potential long term acceptability of the events. Additional information should include, but not be limited to, a description of the evaluation model(s); the critical heat flux (CHF) correlation used and basis for the correlation (or a reference there to); the assumed radial and axial power distributions and the basis for those power distributions (or a reference there to); and a justification of how reactor stability is maintained under these conditions such that the MCHF can be accurately determined. In addition to Figure 15.0-8, "Power Response on a Return to Power," the staff is requesting the FSAR be updated to include plots of reactor coolant system average temperature, pressurizer pressure, core reactivity, hot channel nuclear enthalpy rise factor (F-delta-H), and MCHF ratio verses time.

NuScale Response:

This response supplements the original response provided for this RAI question. In a December 5, 2017 public phone call to discuss the response to this RAI, the NRC staff indicated they believed the response only addressed one scenario associated with return to power upon ECCS actuation and not the return to power during the DHRS scenario.

NuScale believes that the original response to eRAI 8771 addressed both DHRS cooldown and ECCS cooldown scenarions. Specifically, Table 15.0-16 provides the Sequence of Events for the Overcooling Return to Power with EDSS (DC Power) available. Since DC power is available, ECCS does not actuate and the reactor cools down on DHRS. Recriticality occurs at 6750 seconds and the peak power (14 MW) occurs at 7850 seconds. As the temperature of the RCS increases, power decreases until equilibrium power (3 MW) is reached at 12000 seconds. Power reaches an equilibrium level (Figure 15.0-8) and remains stable at about 3 MW, which is the DHRS heat removal capability, as concluded in the markup to the FSAR attached to the original RAI response.

Additionally, Table 15.0-17 provides the Sequence of Events for the Overcooling Return to Power with EDSS (DC Power) not available. Since DC power is not available, ECCS actuates. The power peak is lower than the DHRS case due to reactivity weighting differences in the modeling, as shown in Figure 15.0-15, but the lowest MCHFR occurs (Figure 15.0-14).

In order to provide additional clarification, additional wording has been added to FSAR Section 15.0.6 and two additional figures, Figure 15.0-18 peak power with EDSS available and Figure 15.0-19 for RCS flow with EDSS available have been incorporated.

Impact on DCA:

FSAR Section 15.0.6, Figure 15.0-18, and Figure 15.0-19 have been revised as described in the response above and as shown in the markup provided in this response.

presented: return to power with and without transition from DHRS cooling to ECCS cooling. The sequence of events for an overcooling return to power event with DHRS cooling is provided in Table 15.0-16 and with the transition to ECCS cooling is provided in Table 15.0-17.

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For the overcooling return to power event, it is assumed that a reactor trip occurs at end of cycle (EOC) with the most reactive control rod stuck out of the core. The subsequent DHRS cooldown is left unmitigated and boron addition does not occur. While there are simple operational means for mitigating the DHRS extended cooldown and thereby eliminating the need for boron addition, operator action is not credited for either mitigating the cooldown or adding boron, consistent with Section 15.0.0.6.4.

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The overcooling return to power event assumes a reactor trip coincident with the loss of normal AC power as the initiating event. This analysis concerns the post-reactor trip return to power; therefore, the MPS is not specifically credited.

RAI 15-1, RAI 15-1S1

In the event that the highly reliable DC power (EDSS) is available, the reactor cools down on DHRS and ECCS is not actuated. If EDSS is unavailable concurrent with the initiating event, ECCS would be actuated while RCS pressure is above the IAB release pressure, and the ECCS valves would not initially open. During an extended DHRS cooling event, RCS pressure decreases due to reactor pressure vessel (RPV) heat loss and reactor coolant system (RCS) shrinkage causing an expansion of the pressurizer vapor space. Although unlikely, if the initial pressurizer pressure and level were sufficient, it is possible to postulate an IAB release concurrent with the overcooling return to power peak. This scenario generates the most challenging CHF conditions and is presented as the transition to ECCS cooling scenario.

RAI 15-1

15.0.6.3 Thermal Hydraulic and Critical Heat Flux Analyses

15.0.6.3.1 Evaluation Models

The transient evaluations are performed in separate parts. First, the peak power portion of the analysis, where EDSS is available, is analyzed using the non-LOCA NRELAP5 model discussed in Section 15.0.2. The purpose of the peak power analysis is to demonstrate the limited magnitude of the return to power, to characterize the event should DHRS cooling be sustained and to examine the various sensitivities that influence the moderator temperature-driven power response to inform the CHF modeling of the appropriate case to simulate.

RAI 15-1

The MCHFR portion of the analysis, where EDSS is unavailable, uses the LOCA NRELAP5 model. The CHF correlation applied in the LOCA evaluation model discussed in Reference 15.0-3 is evaluated against the 95/95 CHFR acceptance criterion of an AOO, as described in Section 15.6.6.

little impact on the calculated peak power. Therefore, it is concluded that protection of shutdown margin is insignificant for this event.

RAI 15-1

The return to power (Figure 15.0-8 and Figure 15.0-10) occurs more than two hours from the start of the transient, meaning the initiating event has little impact on the event progression and results. These cases are initiated from HZP conditions, which subsumes initiation events from hot full power (HFP) conditions due to the nature of the reactivity balance. The time of return to power would be greatly delayed with realistic decay heat levels and an event initiating from HFP conditions.

RAI 15-1

With the initial negative reactivity insertion, the average RCS temperature (Figure 15.0-11), average fuel temperature (Figure 15.0-12), and RPV pressure (Figure 15.0-13) decrease until the return to power occurs. At the time of the return to power, the temperature and pressure increase slightly and then either stabilize at a low value or continue to decline.

RAI 15-1

For the limiting MCHFR event, which is a loss of highly reliable DC power (EDSS) resulting in a transition to ECCS cooling, the CHFR is presented in Figure 15.0-14. This analysis considers the short term transition period to demonstrate that even at elevated local power distributions, a transition to ECCS cooling is not a safety concern. Further analysis demonstrates that once ECCS equilibrium conditions are established, the density reactivity feedback is sufficient that even very low heat levels will suppress the critical power response. Therefore, it is concluded that the limiting condition for MCHFR is at the time of the ECCS transition when the core power levels are much higher than the equilibrium ECCS cooling power levels. Reactor power, RCS flow rate, and hot channel heat flux are provided in Figure 15.0-15, Figure 15.0-16, and Figure 15.0-17, respectively.

RAI 15-1S1

For the peak power case, recriticality occurs at 6750 seconds and the peak power (14 MW) occurs at 7850 seconds. As the temperature of the RCS increases, power decreases until equilibrium power (3 MW) is reached at 12000 seconds. This scenario results in the highest power level but is not limiting for MCHFR or other parameters. RCS Power is shown in Figure 15.0-18 and RCS flow in Figure 15.0-19.

RAI 15-1

15.0.6.3.4 Conclusions

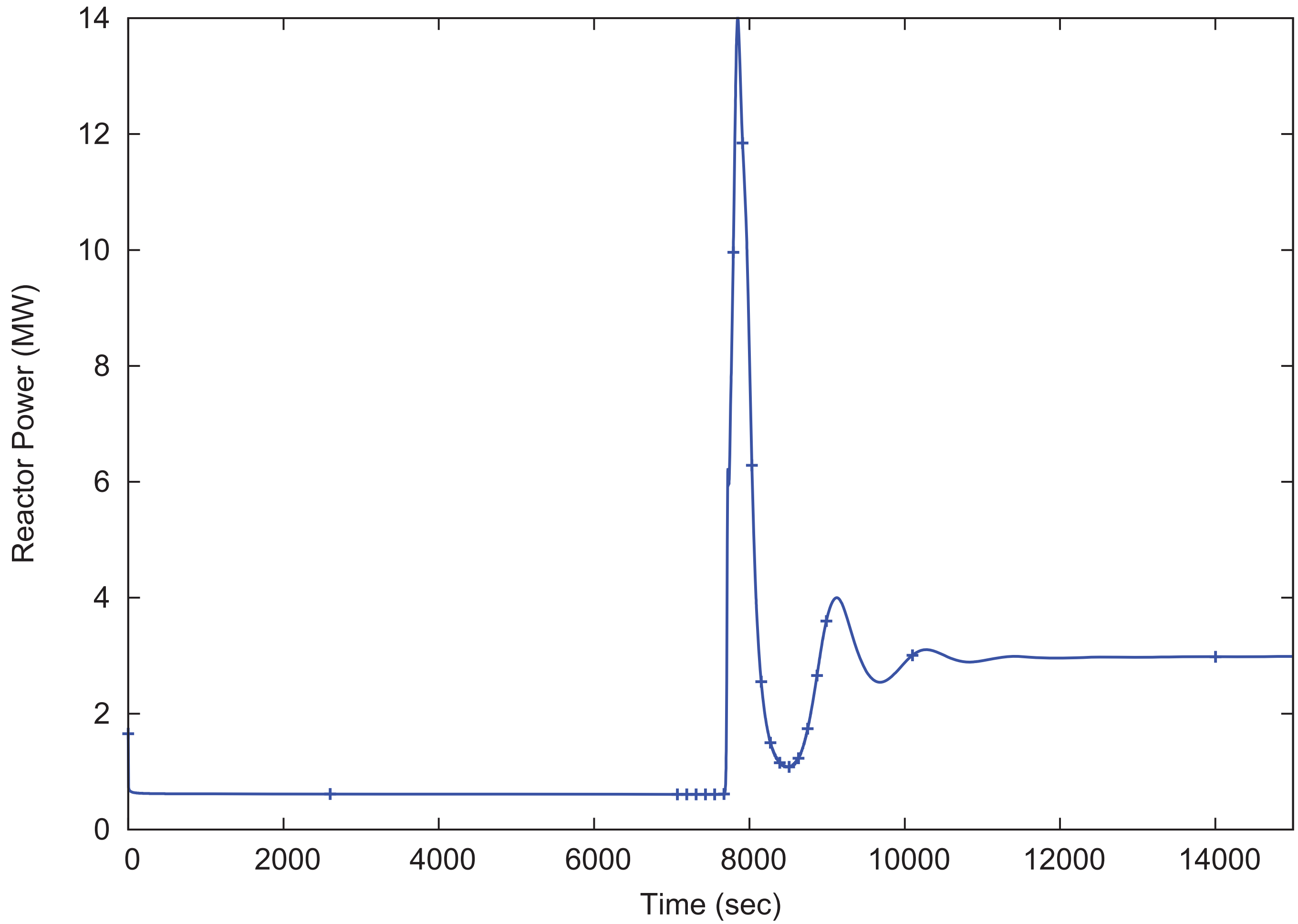
The AOO acceptance criteria outlined in Table 15.0-2 are used as the basis for the overcooling return to power event. The acceptance criteria, followed by how the NuScale design meets them, are listed below:

RAI 15-1

1) Potential core damage is evaluated on the basis that it is acceptable if the minimum departure from nucleate boiling ratio (DNBR) remains above the 95/95 DNBR limit.

RAI 15-1S1

Figure 15.0-18: Reactor Power EDSS Available - Peak Power Case



RAI 15-1S1

Figure 15.0-19: RCS Flowrate (Peak Power Case EDSS Available)