NuScale Power

RAIO-1117-57137

November 13, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 266 (eRAI No. 9174) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 266 (eRAI No. 9174)," dated October 18, 2017

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. 9174:

- 16-37

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 Steven Mirsky at 240-833-3001 or at smirsky@nuscalepower.com.

Sincerely,

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9174

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9174

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

eRAI No.: 9174
Date of RAI Issue: 10/18/2017

NRC Question No.: 16-37

10 CFR 50.36(c)(2)(ii)(B) requires that a technical specification limiting condition for operation (LCO) be established for a "process variable, design feature, or operating restriction that is an initial condition of a design basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier." The initial condition ranges assumed in the evaluation of design basis events is provided in Table 15.0-6 of the Final Safety Analysis Report (FSAR). This table includes the range of reactor coolant system (RCS) flowrates assumed to bound the minimum and maximum RCS flowrates. The currently proposed NuScale generic technical specifications (GTS) do not include an LCO that would limit operation within the bounds of the RCS flowrates assumed in the transient and accident analyses. The NRC staff relies upon such an LCO to establish a finding that each NuScale Power MODULE will be operated within the bounds of the safety analyses. Accordingly, on April 25, 2017, the NRC staff issued request for additional information (RAI) 8773, requesting that NuScale provide justification that the RCS flowrate during normal operation will be maintained within the bounds of the transient and safety analyses (ADAMS Accession No. ML17116A012). The response, provided in a letter dated August 2, 2017 (ADAMS Accession No. ML17214A896), updated FSAR Section 4.4.5.2 to state, "RCS flow measurement is performed during power ascension following refueling outages. This flow measurement provides confirmation that the RCS loop resistance used in the thermal-hydraulic design and Chapter 15 transient and accident analyses remains bounding." NRC staff accepted this response because it established a licensing basis commitment to perform a measurement to verify an operating restriction that is an initial condition to the transient and accident analyses conducted in Chapter 15 of the FSAR. The response, however, did not address the requirement to include RCS flowrate as an LCO in accordance with 10 CFR 50.36(c)(2)(ii)(B). Accordingly, NRC staff requests that NuScale update GTS to include an LCO on RCS flowrate (i.e., limits on RCS loop flow resistance), with appropriate Bases. The staff also requests that NuScale update GTS to include a surveillance requirement that verifies RCS loop flow resistance is within limits at the beginning of each fuel cycle consistent with the commitment being added to FSAR Section 4.4.5.2 as described in the response to RAI 8773. The surveillance frequency should include an appropriate period following unit startup from a refueling outage within which to complete performance of the surveillance. In addition, the Bases for the surveillance requirement should describe the process sensors used for measuring RCS pressure, temperature, and flow, and state the THERMAL POWER levels during power ascension at which these measurements are taken, and how these measurements are used to evaluate the

RCS loop flow resistance. The Bases should also justify the specified period following unit startup for performing the surveillance.

NuScale Response:

NuScale has modified LCO 3.4.1 and added a new surveillance requirement 3.4.1.3 to perform the requested testing. Additionally, the title of LCO 3.4.1 was modified to reflect the addition of the flow resistance limit. Alignment changes were made elsewhere in the technical specifications and bases to reflect the new title of 3.4.1.

Impact on DCA:

The Technical Specifications have been revised as described in the response above and as shown in the markup provided in this response.

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.1 RCS Pressure and Temperature, Temperature, and Flow Resistance Critical Heat Flux (CHF) Limits

LCO 3.4.1 RCS CHF parameters for pressurizer pressure and RCS temperature cold shall be within the limits specified in the COLR. Each RCS CHF parameter shall be within the limits specified in the COLR:

a. Pressurizer pressure,

b. RCS cold temperature, and

c. RCS flow resistance.

APPLICABILITY: MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One or more RCS pressurizer pressure or RCS cold temperature CHF parameters not within limits.	A.1	Restore RCS CHF parameter(s) to within limit.	2 hours
B. RCS flow resistance not within limits	B.1	Evaluate flow resistance effect on safety analysis and verify that the reactor coolant system flow rate is acceptable for continued operation.	7 days
BC. Required Action and associated Completion Time not met.	BC.1	Be in Mode 2.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.4.1.1	Verify pressurizer pressure is greater than or equal to the limit specified in the COLR.	In accordance with the Surveillance Frequency Control Program
SR 3.4.1.2	Verify RCS cold temperature cold is less than or equal to the limit specified in the COLR.	In accordance with the Surveillance Frequency Control Program
SR 3.4.1.3	-------------------------------NOTE---------------------------- Not required to be performed until 96 hours after exceeding 50% RTP. -- Verify RCS flow resistance is within the limits specified in the COLR.	Once prior to exceeding 75% RTP after each refueling

5.6 Reporting Requirements

5.6.3 Core Operating Limits Report (COLR)

a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:

3.1.1, "SHUTDOWN MARGIN (SDM)";

3.1.3, "Moderator Temperature Coefficient (MTC)";

3.1.4, "Rod Group Alignment Limits";

3.1.5, "Shutdown Group Insertion Limits";

3.1.6, "Regulating Group Insertion Limits";

3.1.8, "PHYSICS TESTS Exceptions";

3.1.9, "Boron Dilution Control";

3.2.1, "Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$) ";

3.2.2, "AXIAL OFFSET (AO)";

3.4.1, "RCS Pressure and Temperature, Temperature, and Flow Resistance Critical Heat Flux (CHF) Limits"; and

3.5.3, "Ultimate Heat Sink".

b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

1. Reload Safety Evaluation Methodology (later).[List of NRC-approved Topical Reports that are used to determine the core operating limits listed in 5.6.3.a above.]

2. TR0616-48793-NP, Rev 0, Nuclear Analysis Codes and Methods Qualification

c. The core operating limits shall be determined such that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Passive Core Cooling Systems limits, nuclear limits such as SDM, transient analysis limits, and accident analysis limits) of the safety analysis are met.

BASES

APPLICABLE SAFETY ANALYSES

The fuel cladding must not sustain damage as a result of normal operation and AOOs. The reactor core SLs are established to preclude violation of the following fuel design criteria:

a. There must be at least 95% probability at a 95% confidence level (the 95/95 CHF criterion) that the hot fuel rod in the core does not experience CHF; and

b. The hot fuel pellet in the core must not experience centerline fuel melting.

The Module Protection System (MPS) setpoints (Ref. 2), in combination with all the LCOs, are designed to prevent any anticipated combination of transient conditions for Reactor Coolant System (RCS) temperature, pressure, RCS Flow, ΔI, and THERMAL POWER level that would result in a critical heat flux ratio (CHFR) of less than the CHFR limit and preclude the existence of flow instabilities.

Automatic enforcement of these reactor core SLs is provided by the appropriate operation of the MPS and the decay heat removal system.

The SLs represent a design requirement for establishing the MPS Trip System setpoints (Ref. 2). LCO 3.4.1, "RCS Pressure Temperature Pressure, Temperature, and Flow Resistance Critical Heat Flux (CHF) Limits," or the assumed initial conditions of the safety analyses (as indicated in FSAR Section 7.2Chapter 15, Ref. 32) provide more restrictive limits to ensure that the SLs are not exceeded.

SAFETY LIMITS

The reactor core SLs are established to preclude violation of the following fuel design criteria:

a. There must be at least a 95% probability at a 95% confidence level (the 95/95 CHF criterion) that the hot fuel rod in the core does not experience CHF; and

b. There must be at least a 95% probability at a 95% confidence level that the hot fuel pellet in the core does not experience centerline fuel melting.

The reactor core SLs are used to define the various MPS functions such that the above criteria are satisfied during steady state operation, normal operational transients, and anticipated operational occurrences (AOOs). The NSP2 correlation limit is used to evaluate non-LOCA transients as described in the FSAR (Ref. 3). The Extended Hench-Levy and Griffith-Zuber correlation limit iss are usedtilized to evaluate other transients that occur with high and low RCS flow rates respectively as also described in

B 3.4 REACTOR COOLANT SYSTEM (RCS)

B 3.4.1 RCS Pressure and Temperature, Temperature, and Flow Resistance Critical Heat Flux (CHF) Limits

BASES

BACKGROUND

These Bases address requirements for maintaining RCS pressure and temperature within the limits assumed in the safety analyses. The safety analyses (Ref. 1) of normal operating conditions and anticipated operational occurrences assume initial conditions within the normal steady state envelope of operating conditions. For a given RCS flow resistance, RCS pressure and temperature in combination with THERMAL POWER establish the flow through the RCS including the reactor core. The limits placed on RCS pressure and temperature, in combination with the reactor power, ensure that the minimum critical heat flux ratio (CHFR) will be met for each of the transients analyzed.

The RCS pressure limit is consistent with operation within the nominal operational envelope. Pressurizer pressure indications are used to determine a value for comparison to the limit. A pressure below the limit will cause the reactor core to approach CHFR limits.

The RCS coolant cold temperature limit is consistent with full power operation within the nominal operational envelope. Indications of cold coolant temperature are averaged to determine a value for comparison to the limit. An RCS cold temperature above the limit willcould cause the core to approach CHF limits.

RCS flow resistance above the limit could cause a reduction in RCS flow and cause the core to approach CHF limits. The RCS flow resistance limit is consistent with and assures that the flow rates assumed in the safety analyses will occur.

Operation for significant periods of time outside these CHF limits increases the likelihood of a fuel cladding failure in a CHF limited event.

APPLICABLE SAFETY ANALYSES

The requirements of this LCO represent the initial conditions for CHF limited transients analyzed in the plant safety analyses (Ref. 1). The safety analyses have shown transients initiated within the requirements of this LCO will result in meeting the CHFR criterion. This is the acceptance limit for the RCS CHF parameters. Changes to the unitMODULE which could impact these parameters must be assessed for their impact on the CHFR criterion. The NSP2 correlation limit is used to evaluate non-LOCA

BASES

APPLICABLE SAFETY ANALYSES (continued)

as described in the FSAR (Ref. 1). The Extended Hench-Levy and Griffith-Zuber correlation limits are utilized to evaluate other transients that occur with high and low RCS flow rates respectively as also described in the FSAR Chapter 15 (Ref. 1). An assumption for the analysis of these events is that the core power distribution is within the limits of LCO 3.1.6, “Regulating Group Insertion Limits”; LCO 3.2.1, "Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$)," and LCO 3.2.2, “AXIAL OFFSET (AO).”

The flow resistance in the RCS directly affects the reactor coolant natural circulation flow rate established by THERMAL POWER, RCS pressure, and RCS temperature. The safety analyses assume flow rates that are based on a conservative value of flow resistance through the RCS. Therefore the resistance must be verified to ensure that the assumptions in the safety analyses remain valid.

The pressurizer pressure limit and the RCS cold temperature limit specified in the COLR, as shown on the Thermal Margins Limit Map, correspond to analytical limits, with an allowance for steady state fluctuations and measurement errors.

The RCS CHF parameters satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

This LCO specifies limits on the monitored process variables, pressurizer pressure and RCS cold temperature to ensure the core operates within the limits assumed in the safety analyses. It also specifies the limit on RCS flow resistance to ensure that the RCS flow is consistent with the flow assumed in the safety analyses. These variables are contained in the COLR to provide operating and analysis flexibility from cycle to cycle. Operating within these limits will result in meeting CHFR criterion in the event of a CHF-limited transient.

APPLICABILITY

In MODE 1, the limits on pressurizer pressure and RCS cold temperature must be maintained during steady state unitplant operation in order to ensure CHFR criterion will be met in the event of a CHF-limiting transient. In all other MODES, the power level is low enough that CHF is not a concern.

The CHFR limit is provided in SL 2.1.1, “Reactor Core SLs.” The conditions which define the CHFR limit are less restrictive than the limits of this LCO, but violation of a Safety Limit (SL) merits a stricter, more severe Required Action. Should a violation of this LCO occur, the operator must check whether a SL may have been exceeded.

BASES

ACTIONS

A.1

RCS pressure and RCS cold temperature are controllable and measurable parameters. With one or both of these parameters not within LCO limits, action must be taken to restore parameter(s).

The 2 hour Completion Time for restoration of the parameters provides sufficient time to adjust unit~~plant~~ parameters, to determine the cause for the off normal condition, and to restore the readings within limits.

B.1

RCS flow occurs due to the density differences in the RCS during operations with the flow rate limited by the flow resistance in the RCS. Small changes in flow resistance may occur over the life of the unit, and the effect on RCS flow as a function of THERMAL POWER, RCS pressure, and RCS temperature must be verified to ensure that flow remains consistent with the flow rates assumed in the safety analyses. B.1 addresses the condition of flow resistance that is not consistent with that assumed. The Required Action provides an opportunity to compare the measured flow rate to the safety analyses values to verify that the safety analysis assumptions are being met or to initiate action to otherwise restore the flow rate to that assumed. Seven days provides adequate time to perform the required analyses of the RCS flow resistance and establish an appropriate revised RCS flow rate.

~~B~~C.1

If Required Action A.1 or B.1 is not met within the associated Completion Time, the unit~~plant~~ must be brought to a MODE in which the LCO does not apply. To achieve this status, the unit~~plant~~ must be brought to at least MODE 2 within 6 hours. In MODE 2, the subcritical condition eliminates the potential for violation of the accident analysis bounds. The Completion Time of 6 hours is reasonable to reach the required plant conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.4.1.1

This surveillance demonstrates that the pressurizer pressure remains greater than or equal to the limit specified in the COLR. Required Action A.1 allows a Completion Time of 2 hours to restore parameters that are not within limits and the Surveillance Frequency is sufficient to ensure the pressure can be restored to a normal operation, steady state condition following load changes and other expected transient operations. The surveillance frequency is sufficient to regularly assess for potential degradation and to verify operation is within safety analysis assumptions.

BASES

SURVEILLANCE REQUIREMENTS (continued)

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

SR 3.4.1.2

This surveillance demonstrates that the average RCS temperature remains less than or equal to the limit specified in the COLR. Required Action A.1 allows a Completion Time of 2 hours to restore parameters that are not within limits, and the Surveillance Frequency is sufficient to ensure the temperature can be restored to a normal operation, steady state condition following load changes and other expected transient operations. The surveillance frequency is sufficient to regularly assess for potential degradation and to verify operation is within safety analysis assumptions.

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

SR 3.4.1.3

Verification that the RCS flow resistance is less than that assumed in the safety analysis is accomplished by performing measurements of RCS flow rate under controlled conditions. Assuring the RCS flow resistance remains less than or equal to the limit specified in the COLR after each refueling provides assurance that the safety analysis assumptions regarding the relationship between expected RCS flow, reactor power, RCS pressure, and RCS temperature remains accurate. The flow rate used to determine RCS flow resistance may be determined by installed instrumentation, thermodynamic analyses, or by other methods.

The SR is modified by a Note that permits operation for up to 96 hours at greater than 50% RTP to permit the unit to establish conditions that permit measurements of RCS flow that allow evaluation of the RCS flow resistance. This is acceptable because the testing must be completed before exceeding 75% RTP which provides margin to safety analysis limits that are established at 100% RTP, and due to the low likelihood of a design basis event during the time allowed to perform testing.

The frequency requires this surveillance to be performed once after each refueling. The potential for inadvertent changes that impact on flow resistance is most likely to occur during refueling operations. Other credible changes to flow resistance are slow developing phenomena and unlikely to change significantly between performances of the surveillance.

BASES

APPLICABILITY

The RCS P/T limits LCO provides a definition of acceptable operation for prevention of nonductile (brittle) failure in accordance with 10 CFR 50, Appendix G (Ref. 1). Although the P/T limits were developed to provide guidance for operation primarily during heatup or cooldown or required testing, they are applicable at all times in keeping with the concern for nonductile failure.

During MODE 1 other Technical Specifications provide limits for operation that can be more restrictive than, or can supplement these P/T limits. LCO 3.4.1, RCS Pressure and Temperature, Temperature, and Flow Resistance Critical Heat Flux (CHF) Limits. LCO 3.4.2, “RCS Minimum Temperature for Criticality”; and Safety Limit 2.1.2, Reactor Coolant System (RCS) Pressure SL,” also provide operational restrictions for pressure and temperature and maximum pressure. Furthermore, MODE 1 is above the temperature range of concern for nonductile failure, and stress analyses have been performed for normal maneuvering profiles, such as power ascension or descent.

ACTIONS

The actions of this LCO consider the premise that a violation of the limits occurred during normal unitplant maneuvering. Severe violations caused by abnormal transients, at times accompanied by equipment failures, may also require additional actions from abnormal operating procedures.

A.1 and A.2

Operation outside the P/T limits must be restored to within the limits. The RCPB must be returned to a condition that has been verified by stress analyses. Restoration is in the proper direction to reduce RCPB stress.

The 30 minute Completion Time reflects the urgency of restoring the parameters to within the analyzed range. Most violations will not be severe, and the activity can be accomplished in this time in a controlled manner.

Besides restoring operation within limits, an evaluation is required to determine if RCS operation can continue. The evaluation must verify the RCPB integrity remains acceptable and must be completed before continuing operation. Several methods may be used, including comparison with pre-analyzed transients in the stress analyses, new analyses, or inspection of the components.

ASME Code, Section XI, Appendix E (Ref. 6) may be used to support the evaluation. However, its use is restricted to evaluation of the vessel beltline.