RAIO-1217-57685

December 14, 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. 103 (eRAI No. 8916) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 103 (eRAI No. 8916)," dated July 25, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 103 (eRAI No.8916)," dated September 18, 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. 8916:

- 09.03.06-2

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,

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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8916

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8916

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

eRAI No.: 8916
Date of RAI Issue: 07/25/2017

NRC Question No.: 09.03.06-2

GDC 34 states that "Suitable redundancy...shall be provided to assure that for onsite electrical power system operation (assuming offsite power is not available) and for offsite electrical power system operation (assuming onsite power is not available), the system safety function can be accomplished, assuming a single failure."

BTP 5-4 states that "The system(s) that can be used to take the reactor from normal operating conditions to cold shutdown shall satisfy the following functional requirements: A. The design shall be such that the reactor can be taken from normal operating conditions to cold shutdown using only safety-grade systems."

SECY-94-084 allows an alternative to BTP 5-4 position for passive systems based on the following:

> After the passive RHR system or main steam system effected the initial shutdown, a non-safety-grade reactor shutdown cooling system will be available to bring the plant to cold shutdown conditions for inspection and repair. EPRI stated that "these non-safety systems are required to be highly reliable . . . and there is no single failure of these systems or their support systems which would result in inability to terminate use of the passive safety grade system and achieve cold shutdown if desired.

NuScale DCD Tier 2 Section 5.4.3.1 states the following:

> Water Reactor Utility Requirements Document (Reference 5.4-3) was determined to be acceptable by the Nuclear Regulatory Commission as documented in SECY-94-084. Per SECY-94-084 and NUREG-1242, Volume 3, Part 2, transition of a passive plant from safe shutdown conditions to cold shutdown conditions may be reached using nonsafety-related systems. The nonsafety-related containment flood and drain system is used to flood the containment to allow passive long term decay heat removal via convection and conduction to the reactor pool via the RCS, RPV shell, flooded containment, and CNV shell.

NuScale DCD Tier 2 Figure 9.3.6-2 shows that a single CFDS line to the module has valves in series (CFDS containment isolation valves, CFDS module isolation valve, and the valve upstream of the six module isolation valves in parallel), and therefore, a failure of any of those valves may make the CFDS inoperable.

Explain how the CFDS is protected from a single failure and provide a markup to update the DCD.

NuScale Response:

This response supplements NuScale's response to eRAI 8916, Question 9.3.6-2.

The NuScale Power proposed technical specifications describe five operating modes: Operations, Hot Shutdown, Safe Shutdown, Transition and Refueling as shown in Part 4, Volume 1, Table 1.1-1. Of these modes, none are directly analogous to the legacy operating mode of "cold shutdown". If an accident scenario occurs, the reactor module will be brought from Mode 1 , "Operations," to Mode 3, "Safe Shutdown," utilizing either the decay heat removal system, emergency core cooling system, or normal non-safety means such as the feedwater system and condenser. Once in Safe Shutdown mode and passively cooled, transition to a colder reactor coolant temperature is not required as the passive cooling design can continue in safe shutdown indefinitely. Therefore, the terminology of SECY 94-084 with regard to cold shutdown does not apply to the NuScale Power design.

If additional coolant is needed to cool the nuclear power module (NPM) from normal operating conditions to conditions equivalent to cold shutdown in a conventional plant (i.e., RCS temperature less than 200 degrees F), inventory can be added to the NPM through either containment flooding and drain system (CFDS) or the chemical volume and control system (CVCS), as described in FSAR Sections 9.3.4 and 9.3.6. The CFDS and CVCS are separate systems that share no components, allowing the function of adding inventory to the NPM while meeting the intent of the single failure proof criteria.

FSAR Section 5.4.3 has been revised to clarify the NuScale design with regard to the safe shutdown condition.

Impact on DCA:

FSAR Section 5.4.3 has been revised as described in the response above and as shown in the markup provided in this response.

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or nickel-based alloy. Materials used for the RCS check valves and associated weld filler metals are provided in Table 6.1-3.The RCS check valve weld filler metals are in accordance, as applicable, with SFA-5.4 and SFA-5.9, of BPVC, Section II, Part C.

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

5.4.3 Decay Heat Removal System

5.4.3.1 Design Basis

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 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.

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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. Per SECY-94-084 and NUREG-1242, Volume 3, Part 2, transition of a passive plant from safe shutdown conditions to cold shutdown conditions may be reached using nonsafety-related systems. The nonsafety-related containment flood and drain system is used to flood the containment to allow passive long term decay heat removal via convection and conduction to the reactor pool via the RCS, RPV shell, flooded containment, and CNV shell.

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

GDC 1, 2, and 4 - The DHRS is classified Quality Group B and designed as Class 2 in accordance with Section III of the ASME BPVC and is designed, fabricated, and tested to the highest quality standards in accordance with Quality Assurance Program described in Chapter 17. The DHRS is designed to withstand the effects of natural phenomena without loss of capability to perform its safety function. The DHRS is designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. The design of the Reactor Building structure, NPM operating bays, and location of the NPM within the operating bays provides protection from possible sources of external or internal generated missiles. The DHRS is protected from pipe whip as described in Section 3.6.

GDC 5 - The DHRS does not share any active or passive components between individual NPMs necessary for performance of the DHRS safety functions. The NPMs share the reactor pool as the ultimate heat sink for removal of decay heat from the DHRS passive condensers. The shared Reactor Building and other structures are described in Chapters 1 and 3 and the reactor pool is described in Section 9.2.5. DHRS active components fail-safe on a loss of power. Therefore, shared power supplies between NPMs do not impact the capability of performing the DHRS safety functions.

GDC 14 - The DHRS is connected to the secondary system and does not directly interface with the RCPB. The SGs are described in Section 5.4.1 and the containment system piping coupling the DHRS to the SGs is described in Section 6.2.4. There are no other interfaces or shared components between the DHRS and the RCPB.

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GDC 19 - The DHRS is operated from the control room, and is capable of prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown conditions. The DHRS is also actuated and monitored from an alternate shutdown location outside the control room. Once the reactor reaches safe shutdown conditions, non-safety systems are used to lower RCS temperature and pressure to the point the containment can be flooded with reactor pool water allowing the NPM to reach transition ~~cold shutdown~~ conditions using convection and conduction heat transfer.

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PDC 34 (refer to Section 3.1 for the definition of PDC 34)- The DHRS is a passive design that utilizes natural circulation flow from the SGs to dissipate residual and decay core heat to the reactor pool. The DHRS consists of two independent trains each capable of performing the system safety function in the event of a single failure. The DHRS actuation valves fail open using nitrogen accumulation pressure when electrical power is interrupted to the valves. Therefore, electrical power is not required for system function. A nonsafety-related containment flood and drain system is used to flood the containment to allow cooldown to cold conditions by convection heat transfer from the RPV shell to the CNV shell to allow for disconnection and transfer of the NPM to the refueling area. During ~~cold shutdown and~~ NPM transfer to the refueling area, residual and decay heat removal is provided by heat convection and conduction from the reactor to the reactor pool via the RCS, flooded containment, and the RPV and CNV walls. Refer to Section 9.2.5 for discussion related to the reactor pool for GDC 45 and 46, and PDC 44. Refer to Section 3.1 for the definition of PDC 44.

GDC 54 and 57 - The DHRS is a passive closed system outside the NPM connected directly to the steam and feedwater piping between the steam and feedwater system isolation valves and the RPV. This closed-loop DHRS outside the containment is directly connected to the closed-loop SGS within the RPV providing dual passive barriers

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.

5.4.3.4 Tests and Inspections

Inservice inspection requirements of Section XI of the BPVC are applicable to the DHRS components including the steam piping, actuation valves, condensers, and condensate piping.

RAI 09.03.06-2S1

The DHRS actuation valves are classified as Category B valves in accordance with OM Code Subparagraph ISTC-1300(b) because seat leakage in the closed position is inconsequential for fulfillment of the required function(s). Exercising the actuation valves while at power is not practicable. Therefore, the valves are full-stroke exercised during ~~cold shutdown~~ the equivalent of cold shutdown conditions as allowed by OM Code, Subparagraph ISTC-3521(c). As described in Section 3.9.6, NuScale Mode 3 safe shutdown with all reactor coolant temperatures < 200 °F is considered to be the equivalent of cold shutdown as defined in the OM Code ISTA-2000. The DHRS actuation valves that are fully cycled as part of a plant shutdown satisfy the exercising requirements provided they meet the observation requirements for testing in accordance with ASME OM Code, Paragraph ISTC-3550. In addition, loss of valve actuator power and position verification testing is performed in accordance with OM Code, Paragraphs ISTC-3560 and ISTC-3700, respectively.

The DHRS automatic actuation testing and valve actuation testing, including position verification testing, is performed in accordance with plant technical specifications.

5.4.4 Reactor Coolant System High-Point Vents

5.4.4.1 Design Basis

10 CFR 52.47(a)(4) requires addressing the need for high-point vents following postulated LOCAs pursuant to 10 CFR 50.46a. 10 CFR 50.46a requires high-point vents for the RCS, reactor vessel head and other systems required to maintain adequate core cooling if the accumulation of noncondensible gases cause a loss of function of these systems. 10 CFR 52.47(a)(8) requires demonstrating compliance with technically relevant portions of the Three Mile Island (TMI) requirements set forth in certain paragraphs of 10 CFR 50.34(f), including 10 CFR 50.34(f)(2)(vi). The RCS venting capability required by 10 CFR 50.34(f)(2)(vi) is substantively similar to 10 CFR 50.46a requirements.