RAIO-0118-58141

January 12, 2018

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. 282 (eRAI No. 9196) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 282 (eRAI No. 9196)," dated November 14, 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. 9196:

- 19-36

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,

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9196

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9196

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

eRAI No.: 9196
Date of RAI Issue: 11/14/2017

NRC Question No.: 19-36

Regulatory basis

10 CFR 52.47(a)(23) requires a description and analysis of design features for the prevention and mitigation of severe accidents, e.g., challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass. Standard Review Plan Chapter 19.0 refers to SECY-93-087 for guidance regarding intersystem loss-of-coolant accident (ISLOCA). SECY-93-087 provides the following guidance:

> Designers should reduce the possibility of a loss-of-coolant accident outside containment by designing (to the extent practicable) all systems and subsystems connected to the reactor coolant system (RCS) to withstand the full RCS pressure. Systems that have not been designed to full RCS pressure should include the following:
>
> - the capability for leak testing of the pressure isolation valves;
> - valve position indication that is available in the control room when isolation valve operators are de-energized; and
> - high-pressure alarms to warn control room operators when rising reactor coolant pressure approaches the design pressure of attached low pressure systems and both isolation valves are not closed.
>
> The degree of isolation or number of barriers (for example, three isolation valves) is not sufficient justification for using low-pressure components that can practically be designed to the full RCS ultimate rupture strength criterion.

Request for additional information

Final Safety Analysis Report (FSAR) Section 19.2.2.5 states that the chemical and volume control system (CVCS) is the only system connected to the RCS that has piping outside containment, the CVCS is designed to RCS pressure, and the CVCS has pressure isolation

valves with the capability for leak testing.

The information in FSAR Section 9.3.4 indicates that CVCS subsystems may not meet the guidance in SECY-93-087. FSAR Table 9.3.4-1 lists 150 psig as the design pressure for the CVCS Chemical Mixing Tank and the CVCS Expansion Tank.

The information in FSAR Section 9.3.4 indicates that CVCS connecting systems (i.e., systems that are connected to the RCS via the CVCS) may not meet the guidance in SECY-93-087. CVCS connecting systems (e.g., liquid radioactive waste system, demineralized water system, process sampling system, boron addition system) are shown in Figure 9.3.4-1. FSAR Table 9.3.4-2 lists 125 psig and atmospheric pressure as the design pressure for two of the components in the boron addition system which is a CVCS connecting system.

NuScale Response:

For the NuScale design, intersystem LOCAs are mitigated by actuation of the CVCS containment isolation valves on reactor coolant system (RCS) pressure and RCS level signals (refer to FSAR Table 7.1-4). Ultimately, the closure of the CVCS containment isolation valves stops leakage from the RCS ensuring sufficient coolant inventory for core cooling and provides containment. Therefore, the design provisions recommended by SECY-93-087 are not required for CVCS connected equipment outside of the CVCS containment isolation valves in the NuScale design, because failure of equipment outside of the CVCS containment isolation valves does not result in a loss-of-coolant accident. The CVCS containment isolation valves meet the SECY-93-087 recommendations for pressure isolation valves; position indication is provided to the control room and they have the capability for leak testing and are periodically leak tested as part of the Inservice Testing Program (refer to FSAR Section 3.9.6).

Although intersystem loss-of-coolant accidents are mitigated by the CVCS containment isolation valves, the CVCS is designed to withstand full RCS pressure to the extent practicable. The CVCS recirculation loop as shown in FSAR Figure 9.3.4-1, including the coolant purification equipment, has a design pressure greater than RCS design pressure (see FSAR Table 9.3.4-1), therefore this equipment is designed to withstand RCS pressure in all events. Due to the basis for determining allowable stresses in applicable piping codes, there is margin in the ultimate rupture strength of this CVCS equipment at RCS design pressure due to the selected CVCS design pressures. As stated in FSAR Section 9.3.4.5 under the heading 'Chemical and Volume Control System Alarms', the CVCS design incorporates pressure and level alarms that provide the control room with indication of adverse conditions. The CVCS makeup line takes low pressure makeup sources (boric acid and demineralized water) and uses high head pumps to add makeup into the high pressure CVCS recirculation loop. The CVCS makeup pumps are positive displacement type with integral check valves, and a check valve is provided between the makeup pumps' discharge and the injection tee into the recirculation loop. The CVCS chemical mixing tank is located in the low pressure portion of the makeup line, upstream of the makeup pumps. All boron addition system (BAS) equipment and demineralized water system

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(DWS) equipment is also located upstream of the CVCS makeup pumps. Therefore the CVCS chemical mixing tank, BAS equipment, and DWS equipment is not exposed to full RCS pressure.

The CVCS letdown line and CVCS reactor vessel high point degasification line connections to the liquid radwaste system are designed to withstand full RCS pressure up the degasifier tank where design pressure is reduced and overpressure protection is provided. The process sampling system lines connected to the CVCS are designed to withstand full RCS pressure.

SECY 93-087 allows for portions of the connecting systems that cannot practically be designed to full RCS pressure. Certain portions of the CVCS and connecting systems must operate at lower pressures. For example, boric acid is initially added to a batch tank. This process is typically performed by manually pouring bags of boric acid into the batch tank, a process that can only practically be performed at atmospheric pressure. As described above, the CVCS makeup equipment moves the boric acid solution through adequate isolation, increasing the pressure to full RCS pressure in order to inject the solution into the RCS. The portions of the CVCS and connecting systems involved with boric acid injection are designed to RCS pressure to the extent practical.

In summary, the CVCS design is consistent with the intent of SECY-93-087, Item I.F. Appropriate FSAR sections have been revised accordingly.

Impact on DCA:

FSAR Table 1.9.8 and FSAR Sections 9.3.4 and 19.2 have been revised as described in the response above and as shown in the markup provided in this response.

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Table 1.9-8: Conformance with SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs"

Issue	Description	Conformance Status	COL Applicability	Comments	Section
I.A	Use of a Physically-Based Source Term: Incorporation of engineering judgment and a more realistic source term in design that deviates from the siting requirements in 10 CFR 100.	Conforms	Applicable	None.	15.0.3
I.B	Anticipated Transient without SCRAM (ATWS): Position on the current practices and design features to achieve a high degree of protection against an ATWS.	Partially Conforms	Applicable	NuScale submitted a white paper that describes the underlying purpose of the rule which is to reduce the risk from ATWS events (NuScale Power Plant Design for ATWS and 10 CFR 50.62 Regulatory Compliance, NP-ER-0000-2196, September 18, 2013). The proposed treatment of the rule was described in a presentation to the NRC, Design for ATWS and 10 CFR 50.62 Regulatory Compliance, PM-0114-5922-P, February 26, 2014. The NuScale design relies on diversity within the module protection system (MPS) to reduce the risk associated with ATWS events.	15.8
I.C	Mid-Loop Operation: Position on design features necessary to ensure a high degree of reliability of RHR systems in PWR.	Not Applicable	Not Applicable	Design does not use external loops and no drain down condition for refueling.	19.2
I.D	Station Blackout (SBO): Position on methods to mitigate the effects of a loss of all AC power.	Not Applicable	Not Applicable	The relevance of the SECY-90-016 SBO issue to passive ALWR designs was deferred to and addressed in Section F of SECY-94-084 and SECY-95-132. The NuScale design conforms to the passive plant guidance these documents.	8.4

Table 1.9-8: Conformance with SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs" (Continued)

Issue	Description	Conformance Status	COL Applicability	Comments	Section
I.E	Fire Protection: Positions on design configuration and features the fire protection system and other management schemes to ensure safe shutdown of the reactor.	Conforms	Applicable	None.	Appendix 9A
I.F	Intersystem LOCA: Position on acceptable design practices and preventative measures to minimize the probability of an ISLOCA.	Conforms	Applicable	None.	9.3.4, 19.2
I.G	Hydrogen Control: Position on acceptable requirements to measure and mitigate the effects of hydrogen produced due to a water reaction with zirconium fuel cladding.	Partially Conforms	Applicable	Licensing Awareness.	6.2.5
I.H	Core Debris Coolability: Acceptability criteria for cooling area and quenching ability regarding corium interaction with concrete.	Conforms	Not Applicable	None.	19.2
I.I	High-Pressure Core Melt Ejection: Position on acceptable design features to prevent the event of a high-pressure core melt ejection.	Conforms	Not Applicable	None.	19.2
I.J	Containment Performance: Position on acceptable conditional containment failure probabilities or other analyses to ensure a high degree of protection from the containment.	Conforms	Not Applicable	None.	19.1 19.2
I.K	Dedicated Containment Vent Penetration: Position for a dedicated vent penetration to preclude containment failure resulting from a containment over-pressurization event.	Conforms	Not Applicable	None.	19.2
I.L	Equipment Survivability: Position on the applicability of environmental qualification and quality assurance requirements related to plant features provided only for severe-accident protection.	Conforms	Not Applicable	None.	19.2
I.M	Elimination of Operating-Basis Earthquake: Position on the applicability of the OBE in design and the possibility of decoupling the OBE and SSE in the design of safety systems.	Conforms	Applicable	By setting the OBE to 1/3 of the SSE it is decoupled from the design evaluation process.	3.7
I.N	In-Service Testing of Pumps and Valves: Position on periodic testing to confirm operability of safety-related pumps and valves.	Conforms	Applicable	None.	3.9.6
II.A	Industry Codes and Standards: Position on use of recently developed or modified design codes and industry standards in ALWR designs that have not been reviewed for acceptability by the NRC.	Conforms	Applicable	NuScale use the latest endorsed codes and standards or others on case by case basis.	all
II.B	Electrical Distribution: Positions originally addressed by SECY-91-078 that specified that an evolutionary ALWR provide: (1) an alternate power source to nonsafety-related loads, and (2) at least one offsite circuit connected directly to each redundant safety division with no intervening nonsafety-related buses.	Not Applicable	Not Applicable	The NuScale electrical system design conforms to the passive plant guidance of SECY-94-084, Section G.	8.1.4

are designed to provide confinement of radioactive material and to minimize the potential exposure to radioactive materials to the lowest practical levels.

GDC 64 was considered in the design of the CVCS and MHS. The CVCS and MHS do not have direct release paths to the environment. For normal operations, process fluid is passed in closed lines to the PSS, liquid radioactive waste system (LRWS), solid radioactive waste system (SRWS), or radioactive waste drain system (RWDS). The CVCS and MHS support the capability to monitor spaces (Section 12.3.4) containing components that contain radioactivity.

Consistent with 10 CFR 20.1406, "Minimization of contamination," the CVCS and MHS include practicable design features to minimize contamination of the facility and environment, facilitate decommissioning and minimize the generation of radioactive waste including minimizing the potential for contamination of the normally clean BAS at the interface with the CVCS. These features are described in Section 12.3.5.

Consistent with 10 CFR 50.34(f)(2)(xxvi), CVCS is designed to have provisions for leakage detection and monitoring to minimize the leakage from those portions of CVCS outside of the containment that contain or may contain radioactive material following an accident.

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Consistent with SECY-93-087, Item I.F, the design of the CVCS reduces the possibility of a LOCA outside containment.

9.3.4.2 System Description

9.3.4.2.1 General Description

Chemical and Volume Control System

A simplified diagram of the CVCS is shown in Figure 9.3.4-1. Major CVCS components and design parameter values are available in Table 9.3.4-1 and consist of:

- CVCS makeup pumps
- CVCS recirculation pumps
- CVCS regenerative heat exchanger
- CVCS non-regenerative heat exchanger
- CVCS Ion exchangers
- CVCS reactor coolant filters
- CVCS chemical mixing tank
- CVCS expansion tank
- CVCS makeup combining valve
- CVCS makeup and module isolation valves

The BAS is supplied by the DWS via a direct connection to the BAS batch tank and an indirect connection to the BAS storage tank that can be used to supply demineralized water for recirculation and flushing through any of the tanks and piping, and then discharged to the LWRS.

With respect to 10 CFR 50.34(f)(2)(xxvi) (Item III.D.1.1 in NUREG-0737), the CVCS is designed to be as leak free as practical. The system is in continuous use during normal operation and is provided with leakage detection instrumentation. During accident conditions, the CVCS is isolated from the RCS by the CIVs and is not needed to circulate primary coolant outside of containment. In addition, there are no safety systems that circulate reactor coolant outside of containment. However, in order to support post-accident sampling by the PSS as described in Section 9.3.2, the CVCS is capable of being unisolated from the RCS, when conditions permit, to establish the sample flow path from the CVCS discharge piping upstream of the RHX.

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Consistent with SECY-93-087, Item I.F, the design of the CVCS reduces the possibility of a LOCA outside containment. The CVCS containment isolation valves meet the SECY-93-087 recommendations for pressure isolation valves; position indication is provided to the control room and they have the capability for leak testing and are periodically leak tested as part of the Inservice Testing Program (FSAR Section 3.9.6). The CVCS is designed to withstand full RCS pressure to the extent practicable. The CVCS letdown line and CVCS reactor vessel high point degasification line connections to the liquid radwaste system are designed to withstand full RCS pressure up to the degasifier tank where design pressure is reduced and overpressure protection is provided. The process sampling system lines connected to the CVCS are designed to withstand full RCS pressure. The CVCS design incorporates pressure and level alarms that provide the control room with indication of adverse conditions.

9.3.4.4 Inspection and Testing

The in-service inspection (ISI) requirements of the American Society of Mechanical Engineers Boiler Pressure Vessel Code, 2013 Edition, Section XI, Reference 9.3.4-2, are applicable to the CVCS Quality Group C (per RG 1.26) equipment. This includes the Quality Group C equipment just outside of containment and the demineralized water supply isolation valves. Section 5.2 and Section 6.6 provide the requirements applicable to the CVCS regarding in-service nondestructive examination requirements for system components. The MHS and BAS are nonsafety-related, and have no safety functional requirements, and therefore have no in-service inspection requirements.

10 CFR 50.55a requires in-service testing (IST) for American Society of Mechanical Engineers Boiler and Pressure Vessel Code Section III, Class 1, 2 and 3 pumps and valves; therefore the CVCS American Society of Mechanical Engineers Section III, Class 1 and Class 3 components are subject to these requirements. 10 CFR 50.55a specifies the American Society of Mechanical Engineers Operation and Maintenance Code as the testing standard. See Section 3.9.6 for the inservice testing program plan.

The methodology associated with the development of Inspections, Tests, Analyses, and Acceptance Criteria is presented in Section 14.3.

Section 19.1.4, illustrate the unique capability of the NuScale Power Plant design with respect to loss of all DC power and to loss of all AC power (i.e., all onsite and offsite sources), respectively.

19.2.2.4 Fire Protection

The NuScale design includes the following features to cope with potential fires that could affect module or plant safety:

- redundant safety systems to perform safety-related functions, such as reactor shutdown and core cooling
- physical separation between redundant trains of safety-related equipment used to mitigate the consequences of a design basis accident
- passive design which minimizes the need for support systems and the potential effects of "hot shorts"
- annunciation of fire indication in the main control room and in the security central alarm station to facilitate personnel response
- electrical power is not required for mitigating design basis events as safety systems are fail-safe on loss of power

As described in Section 9.5.1, the fire protection design conforms with National Fire Protection Association codes and standards in effect six months prior to the submittal of the Design Certification Application.

The risk associated with internal fires is addressed in Section 19.1.5.

19.2.2.5 Interfacing Systems Loss-of-Coolant Accident

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Traditional use of the term “intersystem” LOCA or “interfacing systems” LOCA applies to low-pressure systems connected to the high-pressure RCS. Consistent with ~~SECY-90-016 and~~ SECY-93-087, the NuScale design does not have low-pressure systems connected to the RCS. Hence, the term “interfacing systems LOCA” is not used in the PRA. The term "piping breaks outside containment" is applicable to the design. The NuScale design reduces the potential for a pipe break outside containment by minimizing system connections to the RCS with piping external to containment. As described in Section 6.2.4, the only system with connections to the RCS and piping that runs outside containment is the chemical and volume control system ~~(CVCS)~~(CVCS, described in Section 9.3.4). These penetrations are isolated by dual-valve, single-body isolation valves, which have the capability to test for leakage past the inboard valve. Section 9.3.4 addresses conformance with the requirements of SECY-93-087.

Section 19.1.4 evaluates the possibility of a pipe break outside containment due to a break in CVCS piping from the probabilistic perspective. Specifically, initiating event CVCS--ALOCA-COC represents either an RCS injection line break or a pressurizer spray supply line break outside containment. Initiating event CVCS--ALOCA-LOC evaluates a discharge line break outside the CNV.