November 07, 2017

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. 263 (eRAI No. 9141) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 263 (eRAI No. 9141)," dated October 16, 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. 9141:

- 15.01.01-1

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,

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

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Rani Franovich, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9141

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NuScale Response to NRC Request for Additional Information eRAI No. 9141

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

eRAI No.: 9141
Date of RAI Issue: 10/16/2017

NRC Question No.: 15.01.01-1

10 CFR Appendix A, General Design Criterion (GDC) 10, requires in part that the RCS be designed with appropriate margin to ensure that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operations, including anticipated operational occurrences. Demonstration of this criterion for various transients is documented in FSAR Chapter 15, including for an event unique to the NuScale design, a loss of containment vacuum and/or containment flooding.

One important assumption in the analysis for the loss of containment vacuum / containment flooding event is the volume of the reactor component cooling water (RCCW) piping line. The analysis assumes that the total volume of the RCCW piping floods the containment with no further makeup; this assumption is predicated on design assumptions regarding the volume of the RCCW system, as well as assumptions that automatic makeup and/or operator action to refill the RCCW do not occur. The NRC staff requests that NuScale provide a justification for why a flooding event larger than the assumed 500 ft^3 cannot occur in the event of automatic makeup or an operator initiated manual makeup to the RCCW following the break. In the event a flooding event of greater volume is possible, NRC staff requests that NuScale provide the results of a sensitivity study involving a more severe flooding event, or provide an adequate justification of why the event described in the FSAR is limiting.

NuScale Response:

Each reactor component cooling water system (RCCWS) subsystem provides service to six NuScale Power Modules (NPMs). The two RCCWS subsystems cannot be cross connected. The containment flooding analysis in FSAR Section 15.1.6 assumed 500 cubic feet (approximately 3740 gallons) as a conservatively large volume of water to enter containment from a break in the RCCWS piping. The entire volume of each RCCWS subsystem is approximately 3740 gallons. Additional inventory can be added to the RCCWS expansion tank (200 gallon volume). An alarm and indication in the control room will alert the operator if the expansion tank level is low (bottom of the normal operating band). Makeup from the demineralized water system (DWS) to the expansion tank is provided through a permissive feature. The main control room operator must acknowledge the makeup alarm for filling of the expansion tank to begin. The makeup system fills the expansion tank until the high level setpoint is reached (top of normal operating band). This allows the operator to monitor the filling process to ensure that any leak in the RCCWS is quickly identified and isolated. The assumed analysis leakage volume of 500 cubic feet could not be exceeded without refilling the expansion tank multiple times. If the leakage rate exceeds the makeup rate, a LO-LO level alarm will notify the operator when the expansion tank is nearly empty indicating that RCCWS has excessive leakage. The RCCWS also has other alarms that would alert operators to system leakage including: RCCWS pump low suction pressure, RCCWS pump flow high or low, and RCCWS heat exchanger inlet temperature high. Individual NuScale Power Module control rod drive mechanisms also have alarms for low flow or high temperature.

In addition to the RCCWS instrumentation, the reactor coolant system (RCS) leakage detection instrumentation provides indication and alarms that would identify an RCCWS leak into containment. Technical Specification 3.4.7 provides the operability requirements for this instrumentation. The RCS leak detection system is described in FSAR Section 5.2.5. Although designed to detect RCS leakage, while operating at power, RCCWS fluid would contact the reactor pressure vessel and some of the fluid would flash to steam and would be detected as an increase in water vapor and containment pressure by the RCS leakage detection instrumentation. The RCS leakage detection system provides indication and alarms in the control room and is capable of detecting very small leaks (less than one gallon per minute). If sufficient water flashes to steam and increases the containment pressure to 9.5 psia, the containment isolation system would actuate, terminating the RCCWS leakage into containment.

Multiple and diverse monitors and alarms are available to detect RCCWS leakage into containment. The only credible failure for all of these instruments to be unavailable is a loss of DC power. If DC power were to fail, the containment isolation valves would close, terminating any RCCWS flow into containment.

The RCCWS expansion tank makeup permissive was not described in the FSAR. Also, the availability of diverse monitoring features was not discussed. FSAR Section 9.2.2 is modified to add a description of these features.

Impact on DCA:

FSAR Section 9.2.2 has been revised as described in the response above and as shown in the markup provided in this response.

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The RCCWS is monitored from the main control room via remote instrument indication and alarms to determine important parameters such as the heat exchanger inlet and outlet temperatures and cooling water flow rates. ~~Some actions such as the~~The start of a standby pump upon the loss of a pump ~~and opening and closure of the makeup valve to the expansion tank are~~is automatic. The makeup to the expansion tank is automatic after a permissive is acknowledged by the control room operator. The RCCWS can be controlled from the main control room.

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Off-Normal Operations

In the event of a pump failure in the RCCWS, the standby pump will automatically start. In the event of leakage out of the RCCWS, the operator is notified of low expansion tank level by an alarm. After the permissive is acknowledged by the operator, the automatic makeup valve will open ~~on low expansion tank level~~ and makeup water from the demineralized water system will fill the expansion tank. In the event the expansion tank level is high, the automatic makeup valve to the tank will close.

In the event radiation is introduced into the RCCWS piping, in-line radiation monitors in the RCCWS piping will detect the radiation and alarm in the control room. If radiation is detected, the leak is isolated by the operators and the source of leakage determined. Grab sample points are provided in the RCCWS to assist in the confirmation of radionuclides in the system.

The radioactive fluid can be drained to the radioactive waste drain system and the leaking heat exchanger or cooler can be identified and isolated. Vents and drains are also routed to the radioactive waste drain system. The RCCWS normally contains a nonradioactive fluid which is routed to the radioactive waste drain system nonradioactive waste drain tank for sampling, release and treatment in the liquid radwaste system, if necessary.

The RCCWS is a closed system that is expected to have very low levels of radioactivity because there would have to be a pressure boundary failure of a heat exchanger or cooler for radioactive material to enter the RCCWS. This design minimizes the contamination of the facility and the environment in accordance with Regulatory Guide 4.21 and 10 CFR 20.1406. The radiation monitors are described in Section 11.5.

In the event a NPM is shut down for maintenance or refueling, the RCCW subsystem will continue to operate under normal conditions for the other five NPMs with the isolation valves closed to the CRDMs for the unit that is shutdown.

In the event of a plant wide shutdown, the RCCWS is not required for safe shutdown of the plant.

the requirements of 10 CFR 20.1406 related to minimization of contamination. All systems cooled by the RCCWS with the exception of the CRDMs contain fluid that has the potential to contaminate the RCCWS with radioactivity. The RCCWS is designed as a closed loop system to act as an intermediate system between radioactive systems and the nonradioactive SCWS that transfers the heat to the environment. This design ensures that any potential contamination is contained within the Reactor Building. Radiation monitors are located downstream of the cooled components to alert the control room if there is a radioactive fluid leak into the RCCWS. Manual isolation valves are provided on all coolers and condensers to isolate leaks.

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During normal and off-normal conditions, sufficient redundancy and cross connectivity within each subsystem exists to remove heat from the serviced systems. During and after an accident, the RCCWS is not relied upon to remove heat from the affected NPM. In the event of an RCCWS pipe break inside containment, the volume of RCCWS fluid is limited by the available inventory in the RCCWS. Makeup to the RCCWS expansion tank requires an operator action to acknowledge the low expansion tank level. A variety of instrumentation is available to identify RCCWS leaks in containment including RCCWS pump low suction pressure, RCCWS pump flow high or low, and RCCWS heat exchanger inlet temperature high. Individual NPM control rod drive mechanisms also have alarms for low flow or high temperature. In addition, the RCS leakage detection system (Section 5.2.5) is capable of detecting RCCWS leakage into containment.

9.2.2.4 Inspection and Testing Requirements

Preoperational testing is performed in accordance applicable codes, manufacturer recommendations, and normal startup testing practices. The RCCWS components are inspected and tested prior to installation and as an integrated system following installation. Preoperational testing of the RCCWS is described in Section 14.2.

Inspections are specified and performed based on the applicable codes, manufacturer standards, and good engineering practice.

Periodic visual inspection of the RCCWS can be performed during normal operation. In addition flow, temperature, pressure, and level measurements can be used to verify RCCWS condition.

The methodology associated with the development of inspections, tests, analyses, and acceptance criteria is presented in Section 14.3.

9.2.2.5 Instrumentation Requirements

RCCWS instrumentation includes the following:

- temperature, flow, and radiation detectors for heat exchangers
- pressure and flow for pumps
- level and valve position for tanks
- position indication for power-operated valves

RCCWS instrumentation signals that are NPM specific are sent to the module control system, and RCCWS main header signals are sent to the plant control system. A summary of the instrumentation, associated indications, and alarms used to monitor the RCCWS is provided in Table 9.2.2-2.

The RCCWS is designed to be controlled remotely from the main control room. The control room operator selects and controls pump operation. The pumps will alarm upon a low suction pressure and trip on low-low suction pressure signal. Pump discharge pressure is used to trigger an automatic start of a standby pump. Status indication of remote manual controls is available in the main control room.

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Expansion tanks are equipped with high-level and low-level indication. In the event of a low level in the expansion tank, an alarm will notify control room operators. Once the permissive is acknowledged, the makeup water supply control valve will ~~automatically~~ open to fill the expansion tank. Upon high level in the expansion tank, the control valve will automatically close. Alarms are triggered by both high-level and low-level switches.

Radiation monitors are located downstream of RCCWS heat exchangers and will alert plant operators of abnormal radiation levels within the system. An alarm alerts the operators in the main control room of a potential radioactive leak into RCCWS.

9.2.2.6 References

9.2.2-1 American Society of Mechanical Engineers, Power Piping - ASME Code for Pressure Piping B31, ASME B31.1, New York, NY.

9.2.2-2 American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, 201 Edition, Section VIII, Division 1, “Rules for Construction of Pressure Vessels,” New York, NY.