RAIO-0219-64717

February 28, 2019

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 Supplemental Response to NRC Request for Additional Information No. 345 (eRAI No. 9294) on the NuScale Design Certification Application

REFERENCES:

1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 345 (eRAI No. 9294)," dated January 26, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 345 (eRAI No.9294)," dated March 23, 2018

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. 9294:

- 12.03-26

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,

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

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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9294

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9294

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

eRAI No.: 9294
Date of RAI Issue: 01/26/2018

NRC Question No.: 12.03-26

The Regulatory Basis and Background are in RAI-9294 Question 31054

Key Issue 4

The acceptance criteria of NuScale DSRS section 12.3-12.4, states that the acceptability of the facility design features will include an assessment of design features provided to protect shielding material subject to degradation, such as through the effects of radiation (e.g., depletion of boron neutron absorbers,) temperature extremes (e.g., degradation of polymer based materials because of high temperature,) density changes (e.g., sagging or settling of shielding material with age). The guidance contained in Regulatory Guide (RG) 1.69, “Concrete Radiation Shields and Generic Shield Testing for Nuclear Power Plants,” discusses the use of American Concrete Institute (AC)I 349-06, “Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary,” and ACI 349.1R-07, “Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures,” and the associated environmental constraints on shielding material.

DCD Tier 2 Section 12.3.1.2.3, “Penetrations,” states that if penetrations through shield walls are necessary, the penetrations are designed to minimize streaming (e.g., with an offset) from a radiation source to accessible areas. If penetration offsets are not practical, then penetrations are either shielded or elevated above floor level. DCD Section 12.3.2.2, “Design Considerations,” states that in addition to concrete, other types of materials such as steel, water, tungsten, and polymer composites are considered for both permanent and temporary shielding. However, DCD Tier 2 Revision 0 Section 12.3.2, “Shielding,” does not identify any areas of the plant shielding (e.g., penetration shielding around hot pipes,) that have limitations associated with the shielding material or for which specific design criteria (e.g., maximum temperature, radiation resistance etc.,) are required for the integrity of the shielding to be maintained.

Question 4

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions regarding the adequacy of the radiation shielding, the staff requests that the applicant:

- Describe the locations in the RXB and RWB where the integrity of radiation shielding may be adversely affected by the local environmental conditions,
- Describe the design features provided to protect the integrity of the radiation shielding at those locations,
- Describe the locations in the RXB and RWB, where materials other than steel or concrete are credited for the shielding design, (e.g., the use of polymeric shielding material, or the use of tungsten,)
- Describe the locations in the RXB and RWB where potentially degradable shielding material is credited for the radiation shielding design, and the associated critical criteria for maintaining integrity of the shielding material,
- If the COL applicant is expected to provide programmatic controls to protect the integrity of the radiation shielding, describe the COL Item that provides that requirement to the COL Applicant,
- As necessary, revised section DCD Section 12.3.2, to include the aforementioned information related to maintaining the integrity of the radiation shielding,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

NuScale's original response stated that the design of the bioshield had removed the high density polyethylene (HDPE). The design of the bioshield has now reincorporated HDPE into the front face, so NuScale is providing this revised response to address the locations and potential degradation of this material.

The NuScale design primarily uses steel and concrete for radiation shielding materials throughout the facility. An exception to this is the bioshields that shield the NuScale power modules (NPMs) while they are in the operating bays. The vertical front face of each bioshield contains radiation panels that are made from high density polyethylene (HDPE) borated to 5%. The HDPE panels on the front face consist of four, one-inch thick panels and are enclosed (non-air-tight) in 0.25-inch thick stainless steel plates. There are no other permanently installed HDPE shields in the NuScale design.

This borated HDPE material was evaluated against the operating environment in which it would reside. The environmental parameters included in this evaluation are air temperature; neutron and gamma irradiation; and water submersion.

Because the degradation effects of radiation can be accelerated at elevated temperatures, these two parameters are evaluated together. The normal operating temperature of the atmosphere underneath the bioshields does not exceed 120°F (49°C). The total integrated dose (from all radiation types) on the inside surface of the bioshield is conservatively estimated to be less than 6E+05 rad for the life of the plant (60 years).

A literature review performed by NuScale has found that HDPE irradiated to 9E+06 rads at 140°F (60°C) in the presence of air resulted in noticeable loss of tensile yield strength and elongation at break from the initial condition. However, the irradiated tensile properties remain adequate for NuScale bioshield application. For the NuScale application of HDPE in the bioshields, there are no torsional, compressive, or tensile forces applied to the HDPE panels. In the NuScale bioshield design, the borated HDPE panels do not have a structural function or any mechanical loads besides their own weight during normal operation or handling. Studies also show that HDPE will break without yielding after 2E+08 rads, and can shatter like glass after 1E+10 rads, which are well above the integrated dose for the NuScale application.

The maximum lifetime absorbed dose for the borated HDPE panels (<6E+05 rad) is more than an order of magnitude below the elevated temperature irradiation data at 9E+06 rad, and the operating temperature does not exceed 120°F. Because the maximum dose and operating temperature of the borated panels are well below, or bounded, by the literature data, irradiation degradation is not a concern for the borated HDPE panels during the bioshield design life.

The HDPE off-gassing, vicat softening point, and melting temperatures are all well above the 120°F operating temperature as well, so there are not thermal degregation mechanisms.

Because the bottom edge of the vertical front face of the bioshield will be partially submerged in water, potential HDPE degradation was evaluated, as the stainless steel enclosure is not water-tight. Based on a literature review, neither unirradiated HDPE nor highly irradiated HDPE is soluble in water. Because HDPE is not a silicon based polymer, it is not subject to dissolution in water like Boraflex. Dissolution of Boraflex is caused by radiation assisted transformation of siloxane [SiO] in the polydimethyl siloxane (PDMS) polymer matrix to an amorphous silica [SiO_2]. Amorphous silica has a relatively high solubility in water. The borated HDPE does not contain PDMS or siloxane. Even Boraflex does not have a dissolution concern in water below 5E+08 rads. Therefore, dissolution of polymer matrix of the submerged portion of the borated HDPE panels in the NuScale bioshields is not a concern.

Additonally, an evaluation of the potential impact on boron depletion as a result of the integrated neutron dose to borated HDPE over the life of the plant was provided in NuScale's supplemental response to RAI 9298 (Q12.03-17) on December 12, 2018. This impact was determined to be negligible and would not affect the reported radiation zones in the Reactor Building.

Based on the above, a COL item for programmatic monitoring of HDPE is not deemed necessary.

Impact on DCA:

There are no impacts to the DCA as a result of this response.