NuScale Power™

RAIO-0218-58802

February 21, 2018

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. 337 (eRAI No. 9286) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 337 (eRAI No. 9286)," dated January 12, 2018

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 Questions from NRC eRAI No. 9286:

- 12.03-11
- 12.03-12

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,

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

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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9286

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9286

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

eRAI No.: 9286
Date of RAI Issue: 01/12/2018

NRC Question No.: 12.03-11

Regulatory Basis

10 CFR 52.47(a)(5) requires applicants to identify the kinds and quantities of radioactive materials expected to be produced in the operation and the means for controlling and limiting radiation exposures within the limits of 10 CFR Part 20.

Appendix A to Part 50—General Design Criteria for Nuclear Power Plants, Criterion 61—"Fuel storage and handling and radioactivity control," requires systems which may contain radioactivity to be designed with suitable shielding for radiation protection and with appropriate containment, confinement, and filtering systems.

10 CFR 20.1101(b) and 10 CFR 20.1003 require the use of engineering controls to maintain exposures to radiation as far below the dose limits in 10 CFR Part 20 as is practical. NuScale DSRS section 12.3, "Radiation Protection Design Feature," states in the specific acceptance criteria that radiation protection features should be incorporated into the design including design measures to reduce the production, distribution, and retention of activated corrosion products (e.g., material selection), including those resulting from direct neutron activation.

10 CFR 20.1406 requires applicants to describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste. The acceptance criteria of NuScale DSRS Section 12.3-12.4, "Radiation Protection Design Features," state that the applicant is to describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

Background

NuScale DCD Tier 2, Revision 0 Section 12.3.1.1.13, "Material Selection," states that proper material selection is an important factor to balance component performance while reducing the amount of corrosion and activation products generated. The use of materials containing cobalt and nickel is minimized to reduce the quantity of activation products. Ni-Cr-Fe alloys, such as Inconel, have a high nickel content that can become Co-58 when activated. Production of Co-58

and Co-60 are reduced by utilizing low nickel and low cobalt bearing materials, to the extent practicable. The cobalt content of austenitic stainless steel and Ni-Cr-Fe weld filler metals is limited to a maximum of 0.05 percent. The cobalt content of austenitic stainless steel base materials is limited to 0.15 percent. Steam generator (SG) heat transfer tubing is limited to a cobalt content of a maximum average of 0.014 percent, with no heat exceeding 0.020 percent. DCD Table 12.3-4, “Typical Cobalt Content of Materials,” states that the Maximum Weight Percent of Cobalt in the Austenitic stainless steel base materials is 0.15 weight percent.

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DCD Tier 2 Revision 0, Section 5.2.3.2.2, “Compatibility of Construction Materials with Reactor Coolant,” states that the use of cobalt based alloys is minimized and limits are established to minimize cobalt intrusion into the reactor coolant. DCD Table 5.3-2, “Chemical Composition of Reactor Pressure Vessel Beltline Materials,” list the maximum concentration by weight percent of cobalt for the RPV beltline material. DCD Section 5.1.1, “Design Basis,” states that reflector blocks reflect a portion of the neutrons that escape the fuel region, improving neutron economy in the core. DCD Table 5.2-7, “Reactor Vessel Internals Inspection Elements,” describes the location of the various blocks of material comprising the neutron reflector.

The Electric Power Research Institute (EPRI) developed Technical Report (TR) TR-016780, “Advanced Light Water Reactor Utility Requirements Document (URD),” Volume 3, ALWR Passive Plants,” based on proven technology of 40 years of commercial United States and international light water reactor experience. NUREG-1242, “NRC Review of Electric Power Research Institute’s Advanced Light Water Reactor Utility Requirements Document,” Volume 3, Parts 1 and 2 (ADAMS Accession Nos. ML070600372 and ML070600373,) documented the NRC staff’s safety evaluation of the URD. TR-016780 Volume 3 Section 5.2.7, “Metallic Materials,” states that metallic materials in contact with reactor coolant shall be corrosion resistant, such as austenitic stainless steel, or carbon and low alloy steels with an adequate consideration for corrosion; resistant to detrimental forms of corrosion such as intergranular attack, stress corrosion cracking, and/or contact corrosion between different materials; and restricted in cobalt content to as low a level as practical with target of 0.02 weight percent (w/o) or less for all stainless steel or nickel base alloy components. Cobalt (Co) for components fabricated with stainless steel or nickel base alloy with a large wetted surface area (major piping, clad, etc.) and with operating temperature above 200 oF shall be restricted to a maximum content of 0.050 w/o. In addition, components made of stainless steel or NI-base alloy located in, or near, the core where neutron flux is high enough to cause activation of Co-59 to Co-60 in significant amounts, or for components that are expected to release significant quantities of corrosion products in the reactor coolant stream, and for components that are expected to be a significant source of radiation exposure to plant maintenance personnel cobalt content targets (mean values) lower than 0.05 w/o shall be specified by the Plant Designer. The URD states that cobalt is activated readily as the isotope, Co-60. It has a very long half-life and emits penetrating gamma rays. It is the major contributor to buildup of radioactivity in the plant. The URD states that reducing cobalt 60 generation is possible by specifying reduced cobalt content in materials (e.g., less than 0.020 percent weight for all metallic materials in contact with reactor coolant.)

NUREG-1242 Volume 3, Part 1, Section 5.2.7, “Metallic Materials,” states that that metallic materials in contact with reactor coolant, such as austenitic stainless steel or carbon and low-alloy steels, be restricted in cobalt content to as low a level as practical for all components that are made of stainless steel or nickel-based alloy and that have a large wetted surface area. For such components fabricated with stainless steel or nickel based alloys, the cobalt content will be restricted to 0.020 weight percent or less.

Key Issue 1

Given that the NuScale DCD says that the use of materials containing cobalt is minimized to reduce the quantity of activation products, and the EPRI URD represents an industry perspective of what constitutes low cobalt contents, the staff is seeking to understand the basis for the allowable cobalt content of bulk structural material exposed to a neutron flux (e.g., the neutron reflectors described in DCD Section 5.1.1,) that is a factor of 3 higher than industry and NRC recognized guidance. The large volume of material in conjunction with the higher allowable cobalt content will increase the cobalt available for irradiation in the nuclear power module. Since cobalt is a major source of radiation exposure in operating nuclear power plants and during decommissioning, the use of a higher cobalt containing material in the NuScale design will likely increase occupational radiation exposure (ORE) and fails to minimize the production of radioactive material that will impact the generation of radioactive waste and eventual decommissioning, .

Question 1

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to potential Co-60 production from irradiation of plant structural materials and the consequent impacts on dose, the staff requests that the applicant:

1. Explain/justify the difference between the NuScale stated goal of minimizing cobalt concentrations in materials with the proposed 0.15 w/o value specified in DCD Table 12.3-4, which is a factor of 3 higher than established in industry and NRC recognized guidance,
2. As necessary, revise and update section 12.3 of the NuScale DCD to specify cobalt content consistent with the referenced documents,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

The Electric Power Research Institute (EPRI) Utility Requirements Document (URD) and NUREG-1242 are included in the NuScale DSRS Section 12.3-12.4, and contain an industry perspective with specific design features, many of which have been incorporated into the NuScale design, however there is no requirement to incorporate any particular design feature,

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just because it is in the URD.

NuScale did utilize industry information and experience to guide the selection of cobalt limitations for various steel and alloy components, as provided in FSAR Table 12.3-4. For example, for steam generator tubing, the guidance of EPRI 3002003124, “Advanced Nuclear Technology: Alloy 690 Steam Generator Tubing Specification Sourcebook,” and EPRI NP-6737, “Cobalt Reduction Guidelines,” was included, by specifying an average maximum cobalt of 0.014%, with a 0.020% maximum for any one heat. The fuel spacer grids were also considered in the effort to reduce cobalt containing materials, by limiting its cobalt content to 0.03% maximum. It should also be noted that a wide range of fuel assembly and control rod assembly nuts, bolts, spacers, pins, screws, spider castings, locking lugs, and supports have a maximum allowable cobalt content of 0.03%. The aforementioned components are subject to a relatively high neutron flux during power operation.

For large austenitic stainless steel forgings used for reactor vessel internals (core barrel, lower core plate, and reflector blocks), the cobalt limitations are more practical because the base metal can be procured directly from a steel mill. Therefore, for these large forgings, NuScale imposes a cobalt limitation of 0.05% maximum, as indicated in FSAR Table 5.3-2. For small components or lot sizes, the base metal is typically procured from warehouses, which cannot always guarantee the availability of extra low cobalt materials. Therefore, the overall maximum cobalt for the base metal is limited to 0.15%. The reactor pressure vessel base metal cobalt content is limited to 0.10% maximum. These cobalt limitations are consistent with typical nuclear industry practice, and minimize, to the extent practicable, the cobalt content of various metal components that are near the reactor core.

Impact on DCA:

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

Response to Request for Additional Information
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10 CFR 20.1406 requires applicants to describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste. The acceptance criteria of NuScale DSRS Section 12.3-12.4, "Radiation Protection Design Features," state that the applicant is to describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

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and Co-60 are reduced by utilizing low nickel and low cobalt bearing materials, to the extent practicable. The cobalt content of austenitic stainless steel and Ni-Cr-Fe weld filler metals is limited to a maximum of 0.05 percent. The cobalt content of austenitic stainless steel base materials is limited to 0.15 percent. Steam generator (SG) heat transfer tubing is limited to a cobalt content of a maximum average of 0.014 percent, with no heat exceeding 0.020 percent. DCD Table 12.3-4, “Typical Cobalt Content of Materials,” states that the Maximum Weight Percent of Cobalt in the Austenitic stainless steel base materials is 0.15 weight percent.

Table 12.3-4, “Typical Cobalt Content of Materials,” states that the Maximum Weight Percent of Cobalt in the Austenitic stainless steel base materials is 0.15 weight percent.

DCD Tier 2 Revision 0, Section 5.2.3.2.2, “Compatibility of Construction Materials with Reactor Coolant,” states that the use of cobalt based alloys is minimized and limits are established to minimize cobalt intrusion into the reactor coolant. DCD Table 5.3-2, “Chemical Composition of Reactor Pressure Vessel Beltline Materials,” list the maximum concentration by weight percent of cobalt for the RPV beltline material. DCD Section 5.1.1, “Design Basis,” states that reflector blocks reflect a portion of the neutrons that escape the fuel region, improving neutron economy in the core. DCD Table 5.2-7, “Reactor Vessel Internals Inspection Elements,” describes the location of the various blocks of material comprising the neutron reflector.

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NUREG-1242 Volume 3, Part 1, Section 5.2.7, “Metallic Materials,” states that that metallic materials in contact with reactor coolant, such as austenitic stainless steel or carbon and low-alloy steels, be restricted in cobalt content to as low a level as practical for all components that are made of stainless steel or nickel-based alloy and that have a large wetted surface area. For such components fabricated with stainless steel or nickel based alloys, the cobalt content will be restricted to 0.020 weight percent or less.

Key Issue 2

Given that the NuScale DCD says that the use of materials containing cobalt is minimized to reduce the quantity of activation products, and the EPRI URD represents an industry perspective of what constitutes low cobalt contents, the staff is seeking to understand the basis for the allowable cobalt content of large wetted surfaces areas in contact with RCS that is a factor of about 7 higher than industry and NRC recognized guidance for materials exposed to a neutron flux. Based on information made available to the staff as part of the RPAC Chapter 12 Audit, the staff identified that these components are subjected to irradiation prior to the release from the wetted surfaces. The large wetted surface area in conjunction with the higher allowable cobalt content, and the long term irradiation of these components will likely increase the amount of irradiated cobalt in the RCS. Since cobalt is a major source of radiation exposure in operating nuclear power plants, the use of a higher cobalt containing material should result in increased operational radiation exposure, and contamination.

Question 2

To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to potential Co-60 production and introduction into the reactor coolant fluid and the consequent impacts on dose, the staff requests that the applicant:

1. Explain/justify the difference between the NuScale stated goal of minimizing cobalt concentrations in materials with the proposed 0.15 w/o value specified in DCD Table 12.3-4, which is a factor of 7.5 higher than established in industry and NRC recognized guidance,
2. As necessary, revise and update section 12.3 of the NuScale DCD to specify cobalt content of RCS wetter materials exposed to a neutron flux, consistent with the referenced documents,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:

See the response to RAI 12.03-11.

Impact on DCA:

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