Response to SDAA Audit Question

Question Number: A-12.2.1.8-1

Receipt Date: 05/01/2023

Question:

NuScale DSRS Section 9.1.2 specifies that acceptance for meeting the relevant aspect of GDC 61 for the spent fuel storage facility includes compliance with the appropriate paragraphs of ANS 57.2. DSRS Section 9.1.2 also states review of the spent fuel storage facilities also covers the ultimate heat sink pool, which includes the shared water of the reactor pool, refueling pool, and spent fuel pool in the NuScale design. In SDAA Section 9.1, NuScale references ANSI/ANS 57.2 (1983) and indicates that it was considered in the design of the spent fuel storage facility and handling equipment. ANSI/ANS 57.2-1983, Section 5.3.7 states that the spent fuel storage pool shall provide the capability to maintain pool water activity such that worker exposures are less than 2.5 mrem/hour and as low as is reasonably achievable during activities such as spent fuel handling, including full core removal. However, SDAA Section 12.2.1.8, “Reactor Pool Water” states that the post-CRUD burst cleanup of the primary coolant in the NPM by CVCS continues until the projected dose rate (after NPM disassembly) at 1 meter above the pool water is less than 5 mrem/hour (this is different than the DCA, which specified that the post-crud burst cleanup by CVCS will operate until the projected dose rate (after NPM disassembly) to an operator on the refueling bridge is less than 2.5 mrem/hour).

Please explain why the criteria of 2.5 mrem/hour to an operator on the refueling bridge is not included in the SDAA. In addition, explain why a dose rate of 5 mrem/hour at 1 meter above the pool water after NPM disassembly is ALARA for workers performing NPM disassembly, refueling activities, and other activities near the ultimate heat sink water. Also, discuss the expected dose rates to workers performing activities near the ultimate heat sink water. Finally, SDAA Chapter 12 should discuss dose rates and projected dose to workers performing NPM disassembly, refueling activities, and other activities near the ultimate heat sink and to explain how dose rates above the ultimate heat sink will be ALARA for occupational workers (if the basis for why 5 mrem/hour at 1 meter above the pool is ALARA, includes that NPM disassembly, refueling activities, and/or other activities are normally expected to be performed primarily by workers from a remote location, as NuScale indicated in the response to the readiness assessment observation, SDAA Section 12.2.1.8 should be updated to discuss this).

Response:

NuScale is compliant with ANSI/ANS 57.2 such that workers on the fuel handling machine are exposed to radiation levels of less than 2.5 mrem/hr. Section 12.2.1.8 is modified to include consistent language with ANSI/ANS 57.2 for the protection of workers on the fuel handling machine to 2.5 mrem/hr.

Markups of the affected changes, as described in the response, are provided below:

Tables 12.2-12a and 12.2-12b provide component source terms and Tables 12.2-13a and 12.2-13b provide source strengths.

12.2.1.6 Gaseous Radioactive Waste System

The radionuclide input to the gaseous radioactive waste system (GRWS) comes primarily from the LRWS degasifier, which strips the dissolved gases from the primary coolant that enters the degasifier from the CVCS. The gases from the degasifier are sent to the GRWS for conditioning and processing. Table 12.2-14 lists the assumed values pertaining to the GRWS source geometries and Table 11.3-1 describes the GRWS processing parameters. Tables 12.2-15 and 12.2-16 respectively, provide the GRWS component source terms and strengths.

The radioisotopic inventory shown in Table 12.2-15 for the GRWS guard bed and decay beds results in a lesser RG 1.143 safety classification than what is shown in Table 11.3-2. Because an end of operating cycle degasification evolution could result in a transient radioisotopic inventory that exceeds RW-IIb, the classification of the guard bed and decay beds are increased to RW-IIa to cover such transients, as reflected in Table 11.3-2.

12.2.1.7 Solid Radioactive Waste System

Table 12.2-17 lists the assumed values used to develop the solid radioactive waste system (SRWS) component sources modeling in shielding analysis. Table 12.2-18 lists the radionuclide inventory of the major SRWS components and Table 12.2-19 lists the SRWS component source strengths. For shielding design purposes, it is assumed that the Class A/B/C high integrity container (HIC) storage area contains five HICs loaded with Class B/C dewatered spent resins from the spent resin storage tank, which is decayed for approximately two years. Table 12.2-12b provides the radionuclide inventory of the drum dryer and Table 12.2-13b provides the drum dryer source strength. Storage areas are shielded to limit the radiation level to be compliant with the designated radiation zone.

12.2.1.8 Reactor Pool Water

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There are two sources of radioactive material considered for the reactor pool water: primary coolant released during refueling outages and direct neutron activation. Because of the low power and low temperatures in the spent fuel pool, the radionuclide contribution to the pool water from defective fuel assemblies in the storage racks is considered negligible. The primary source of radionuclides in the reactor pool comes from the primary coolant system when an NPM is disassembled in the reactor pool during outages. During refueling outages, after the primary coolant is cleaned by the CVCS, the remaining quantities of radionuclides are released into the pool water during NPM disassembly. The post-CRUD burst cleanup of the primary coolant in the NPM by CVCS ~~continues~~operates until the projected dose rate (after NPM disassembly) ~~at 1 meter above the pool water is less than 5~~to an operator on the refueling bridge is less than 2.5 mrem/hr. Table 12.2-8 lists the major input assumptions for the pool water source term and PCWS component shielding modeling.

The radionuclide contribution resulting from neutron activation of the reactor pool water contents is not significant due to the reduced neutron flux in the reactor pool water. The neutron flux at the outside edge of the containment vessel is many orders of magnitude less than the average neutron flux in the core and continues to decrease in the reactor pool borated water. The amount of neutron activation products in the reactor pool water is determined to be insignificant compared to the amount of primary coolant radionuclides released to the reactor pool water during refueling outages.

Table 12.2-8 lists the characteristics of the pool surge control storage tank, which is modeled as a vertical cylinder.

Tables 12.2-9 and 12.2-10 provide the source terms and source strengths respectively, for the pool water and pool surge control storage tank.

12.2.1.9 Spent Fuel

Spent fuel stored in the spent fuel racks presents a radiation source that is shielded by the water in the spent fuel pool as well as by the pool walls. The same methodology used to determine the maximum core isotopic source term in Section 11.1 is used to develop the spent fuel source term, resulting in the bounding assumption that the spent fuel racks are filled with irradiated fuel assemblies. Spent fuel gamma ray and neutron source strengths are considered in the evaluation of radiation levels for fuel handling and spent fuel storage.

Spent fuel gamma ray source strengths are presented in Table 12.2-20 for a spent fuel rack full of irradiated fuel assemblies. Spent fuel neutron source strengths are given in Table 12.2-21 for the same spent fuel rack.

12.2.1.10 In-Core Instruments

There are 12 fuel assemblies distributed in the reactor core that are instrumented with in-core instruments. Each of the 12 instruments contains self-powered neutron detectors and thermocouples. During reactor operations, the in-core instruments are irradiated, resulting in activation. Table 12.2-22 lists the major input assumptions and Table 12.2-23 provides the gamma spectra.

12.2.1.11 Control Rods and Secondary Source Rods

Control Rod Assemblies

Because the reactor core operates in an all-rods-out configuration, it is assumed that only the tip of the control rod is irradiated. This portion of the control rod assembly (CRA) consists of Ag-In-Cd neutron absorber. Table 12.2-24 lists the major input assumptions and Table 12.2-25 lists the CRA gamma spectra. The activated source from the CRA tips peaks early, therefore the source term reported is for end of Cycle 1.