Response to SDAA Audit Question

Question Number: A-12.2-1

Receipt Date: 04/10/2023

Question:

NuScale SDA Section 12.2.1.2, “Reactor Coolant System” discusses nitrogen-16 (N-16) concentrations in reactor coolant. It indicates that N-16 concentrations have been calculated at the core exit, the top of the upper riser/steam generator entrance, and at various points along the chemical and volume control system (CVCS) letdown line. SDA Table 12.2-4, "Nitrogen-16 Primary Coolant Concentrations at Full Power" provides the N-16 concentrations at "core exit," "Top of upper riser / entrance to SG," "CVCS letdown line," and "CVCS heat exchanger."

In TR-12342-NP, "Effluent Release (GALE Replacement) Methodology and Results," it indicates that the reactor coolant loop transit time is approximately 46 seconds, which is more than six N-16 half-lives (in the NuScale DCA design, the loop transit time was approximately 69 seconds, or approximately ten half-lives and N-16 concentrations were generally insignificant in coolant outside of the reactor containment). SDA Table 12.2-4 indicates that the reactor coolant N-16 concentration is 200 uCi/gram at the core exit and 2.4 uCi/gram at the CVCS letdown line in the reactor downcomer (which is less than a complete reactor coolant loop). This decrease in N-16 source strength is equivalent to over six N-16 half-lives from the time the coolant exits the core to it reaches the CVCS letdown line, assuming the concentration provided is at the entrance to the CVCS line (in the DCA the N-16 concentration exiting the core was smaller and decayed a little more than six half-lives by the time it entered the CVCS letdown line but as indicated above, the coolant loop transit time was much greater in the DCA).

In addition, Table 12.2-7, "Chemical and Volume Control System Component Source Terms - Source Strengths," provides source term energy strengths for components in the CVCS system, which are used in plant shielding calculations. It includes a source spectrum(?) for "CVCS pipe chase photon spectra N-16," and a separate source spectrum (?) for "CVCS Letdown - 71.3 seconds decay." Since 71.3 seconds is ten N-16 half-lives, staff assumes this source term was provided because at this time N-16 is decayed to a point where N-16 is insignificant. However, the location that this occurs in the CVCS piping is not specified and it is unclear if N-16 is

considered in CVCS equipment (or if the N-16 source term is significant enough that it needs be considered for this equipment). Finally, it is unclear if the Chapter 12 shielding and zoning calculations or the equipment qualification doses provided in SDA Table 3C-6, "Normal Operating Environmental Conditions," consider N-16 in the coolant, as appropriate.

Information needed: Additional clarification is needed regarding the N-16 reactor coolant concentrations, including the transit time of coolant from the core exit to the entrance of the CVCS letdown line and at which point in the CVCS letdown line Table 12.2-4 is referring. Also, additional information is needed regarding the N-16 concentrations in CVCS components and at different locations in the CVCS line. In order to facilitate this review please provide calculation packages relevant to the N-16 source term in the reactor coolant system and CVCS.

Response:

The reactor coolant system (RCS) N-16 concentration at the core exit is 200 µCi/g (SDA Table 12.2-4). Primary coolant enters the RCS discharge line in the downcomer region, travels upwards outside of containment, exits the module bay through the pool wall penetration and into the vertical CVCS pipe chase in the RXB gallery on EL 100’-0”. This location is described as the “CVCS letdown line” in Table 12.2-4, {{ }}$^{2(a)(c),ECI}$, resulting in an RCS N-16 concentration of 2.4 µCi/g. {{ }}$^{2(a)(c),ECI}$ The CVCS letdown line piping within the vertical pipe chase is evaluated using the 2.4 µCi/g N-16 concentration for the entire length.

Primary coolant continues downward through the vertical CVCS pipe chase to the CVCS heat exchanger (HX) cubicle on EL 55’-0”. The modeled transit time between the {{ }}$^{2(a)(c),ECI}$, resulting in an RCS N-16 concentration of 0.77 µCi/g. The CVCS HX is evaluated using the 0.77 µCi/g N-16 concentration at the CVCS HX inlet (SDA Table 12.2-4). The CVCS letdown line piping within the CVCS recirculation pump rooms on EL 40’-0” is evaluated using the same 0.77 µCi/g N-16 concentration

The LRWS degasifier vessels on EL 25’-0” receive primary letdown discharged from the CVCS after passing through the CVCS HXs. The degasifier vessels are evaluated using the

“CVCS Letdown - 71.3 seconds decay” (SDA Table 12.2-7), which is based on a decay of the shared systems CVCS HX inlet source term, with a decay (transit) time of 71.3 seconds (ten N-16 half-lives) to represent reduction of N-16 down to insignificant levels.

The N-16 concentrations described above are consistent with the shielding analysis and the radiation zone maps in Section 12.3. These dose rates support the normal operations dose criteria listed in Table 3C-6, therefore, N-16 was accounted for in equipment qualification.

NuScale has provided the following calculations for staff review in the eRR location "SDAA Chapter 12 Audit Response A-12.2-1."

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}}2(a)(c),ECI

NuScale letter number LO-140025 provides the spreadsheets and associated files for staff review.

No changes to the SDAA are necessary.