Response to SDAA Audit Question

Question Number: A-16.3.5.3-3

Receipt Date: 04/29/2024

Question:

Revision 1 of SDAA part 2, FSAR Table 15.0-23: Input Parameters for Emergency Core Cooling System Extended Passive Cooling Analysis - Limiting Level and Temperature Cases, for the Maximum Temperature case, lists a reactor pool water level of 48 ft and reactor pool temperature of 210 degrees F. The applicant is requested to explain why LCO 3.5.3, “Ultimate Heat Sink,” does not reflect these input values.

Response:

The values in the US460 Standard Design Approval Application (SDAA) Table 15.0-23 for the “Maximum Temperature” column are the assumed input parameters for the analysis to determine the maximum temperature reached in the reactor coolant system during the 72-hour period following a design-basis event without crediting operator actions. As described in US460 SDAA Section 15.0.5.3.3, with emphasis added, “[t]he maximum temperature analysis accounts for multi-module impacts by specification of **high pool temperature and low pool level conditions** in the transient analysis. Effects of reactor **pool temperature increase and level decrease over the 72-hour period**, considering spent fuel heat loads and all modules rejecting decay heat to the reactor pool, **are bounded**.” Rather than beginning the analysis within the Technical Specification Limiting Condition for Operation (LCO) 3.5.3 limits on pool level and temperature and then dynamically modeling the change in these parameters over the 72-hour period, the analysis assumes the parameters are constant at a value that is bounding of the predicted 72-hour value of these parameters.

High pool temperature is limiting for this particular analysis. An initial pool temperature of 210 degrees F (i.e., the pool boiling temperature) bounds the maximum temperature that could be reached during the 72-hour period when initially starting from the LCO 3.5.3 upper limit of 120 degrees F.

Low pool level is also limiting for this particular analysis. An initial pool level of 48 feet bounds the minimum level that could be reached during the 72-hour period when initially starting from the LCO 3.5.3 lower limit of 52 feet.

In an actual event, pool support system response and operator action consistent with the TS would be expected to maintain pool level and temperature within the LCO 3.5.3 limits. However, the US460 SDAA Chapter 15 analysis conservatively does not credit the pool support system response or operator actions.

In summary, the US460 SDAA Table 15.0-23 input values of 48 feet and 210 degrees F support the LCO 3.5.3 limits of 52 feet and 120 degrees F, respectively. Maintaining the current LCO 3.5.3 pool level and temperature limits ensures the US460 SDAA Table 15.0-23 inputs are conservative for performing the analysis in a bounding manner.

NuScale revises the US460 SDAA Section B 3.5.3, to clarify the relationship of the LCO 3.5.3 Ultimate Heat Sink level and temperature limits to the safety analyses.

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

BASES

BACKGROUND (continued)

provided in FSAR Chapter 15 (Ref. 2).

During transients and shutdowns which are not associated with design basis events in which DHRS or ECCS is actuated, water from the RP is added to the containment vessel by the Containment Flooding and Drain System (CFDS). After reaching an appropriate level in the containment, the reactor vent valves (RVVs) and reactor recirculation valves (RRVs) are opened to permit improved heat transfer from the reactor coolant system (RCS) to the containment vessel walls.

During normal operations, the RP limits temperatures of the module because the containment vessel is partially immersed in water. The water also provides shielding above and around the region of the core during reactor operations, limiting exposure to personnel and equipment in the area.

In MODE 4, the module is transported from the operating position to the RFP area of the UHS.

APPLICABLE SAFETY ANALYSES

During all MODES of operation and storage of irradiated fuel, the UHS supports multiple safety functions.

The UHS level is assumed and credited in a number of transient analyses. A UHS level of 52 ft provides margin above the minimum level required to support DHRS and ECCS operation in response to LOCA and non-LOCA design basis events and ensures initial conditions assumed in long term cooling analyses are bounding. The 52 ft level also ~~assures~~ensures the containment vessel wall temperature initial condition assumed in the peak containment pressure analysis. The upper limit of 54 ft for the maximum pool level is an initial condition ~~that ensures~~ assumed in long term cooling analyses ~~assumptions~~.

The UHS bulk average temperature is assumed and credited, directly or indirectly in design basis accidents including those that require DHRS and ECCS operation such as LOCA and non-LOCA design basis events. ~~The bulk average temperature is also assumed as an initial condition of the peak containment pressure analysis, and the~~ The minimum pool temperature is an ~~assumption used~~initial condition assumed in long- term cooling analyses where maximizing heat transfer from the containment vessel to the UHS is conservative.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The maximum pool temperature ensures initial conditions assumed in long term cooling analyses are bounding for analyses where minimizing heat transfer from the containment vessel to the UHS is conservative. The maximum pool temperature also ensures initial conditions assumed in the peak containment pressure analysis are bounding.

The UHS bulk average boron concentration lower limit is established to ensure adequate shutdown margin during unit shutdowns that are not associated with events resulting in DHRS or ECCS actuation, when the module is filled with RP inventory using the CFDS and the RRVs are opened. It also ensures adequate shutdown margin when the module is configured with the UHS inventory in contact with the reactor core, specifically in MODE 4 when the containment vessel is disassembled for removal, and in MODE 5.

~~The upper limit on boron concentration is established to limit the effect of moderator temperature coefficient (MTC) during localized or UHS bulk average temperature changes while the module and core are in contact with UHS water.~~

The ultimate heat sink level, temperature, and boron concentration parameters satisfy Criteria 2 and 3 of 10 CFR 50.36(c)(2)(ii).

LCO

The UHS must provide an adequate heat sink to perform its UHS function. This is accomplished by providing limits on submersion of the module and the mass of water that can be heated, and vaporized to steam if necessary, to remove decay heat via the decay heat removal system or conduction through the containment vessel walls and heat from irradiated fuel in the pool. The UHS level limits ensure that the assumed and required level of module submersion and mass of water is available.

The UHS bulk average temperature is an initial assumption of safety analyses. The limits on temperature preserve the analyses assumptions and permit crediting the pool to mitigate these events. The UHS level and temperature limits ensure CNV heat transfer is consistent with conditions assumed in the safety analyses for containment pressurization and long- term cooling. Determination of the UHS bulk average temperature is in accordance with approved procedures.

The boron concentration must be within limits when the UHS contents are in communication with the RCS to preserve core reactivity assumptions and analyses. Determination of the bulk average boron concentration is in accordance with approved plant procedures.