RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**497-8622**
SRP Section:	**09.01.03 – Spent Fuel Pool Cooling and Cleanup System**
Application Section:	**9.1.3**
Date of RAI Issue:	**06/17/2016**

Question No. 09.01.03-6

Compliance with GDC 61 requires that the fuel storage system be designed to assure adequate safety under normal and postulated accident conditions. As such, the system shall be designed with: the capability to permit appropriate periodic inspection and testing of components important to safety; suitable shielding for radiation protection; appropriate containment, confinement, and filtering capability; residual heat removal that reflects the importance to safety of decay heat and other residual heat removal; and the capability to prevent a significant reduction in fuel storage coolant inventory under accident conditions.

SRP 9.1.3.II I.1.F discusses the design features of the SFP water makeup system related SFP makeup. In DCD 9.1.3 the applicant stated that the SFPCS are designed to prevent boiling of the SFP water; however the applicant’s thermal analysis determined that the SFP contains sufficient water volume such that, in the unlikely event that the SFPCS is not operating, it would take 3.7 hrs for the SFP water to start boiling. The staff audited the applicant’s thermal analysis report and found that the report identifies that boiling could start after 2.5 hrs. The staff finds that this apparent inconsistency between the DCD and the thermal analysis needs to be justified or corrected.

Therefore, the staff requests the applicant to clarify this apparent inconsistency between the DCD and the SFP thermal analysis.

NOTE: In RAI 473-8582 the staff requested the applicant to revise the SFP thermal analysis; therefore, this RAI could be impacted by the resolution of RAI 473-8582.

Response

The value of 3.7 hours for the SFP water to start boiling when the SFPCS is not operating as stated in the DCD 9.1.3 was determined by a hand calculation before the specific design inputs were prepared for the thermal hydraulic (T/H) analysis. During the preparation of inputs for the T/H analysis, non-conservative design inputs were identified and corrected in the hand calculation. The latest value that was derived by the hand-calculation for the SFP water to start boiling is 2.0 hours. Therefore, the DCD Tier 2 Subsection 9.1.3.3.2 will be modified based on the current calculation result.

The purpose of T/H analysis is to verify the conservatism of the hand-calculated time for the SFP water to start boiling. A difference between the hand-calculated and T/H analysis results is expected since the T/H analysis had analyzed the boiling time with a time increment of 0.5 hours. Therefore, 2.5 hours means the SFP water is expected to boil between 2.5 and 3.0 hours. However, the hand-calculated boiling time will always provide a more conservative result than the T/H analysis (Revised analysis expected delivery date: 04 October 2016) based on the following justifications:

- A constant fuel heat load over time at the initial fuel heat load, which is the highest heat load, is applied in the hand calculation while the T/H analysis is considered with a time-dependent fuel heat load that is decreased over time. The total heat load for the constant fuel heat load over time is always greater than a time-dependent heat load that is decreased over time once each heat load is integrated over time. Therefore, the more heat is applied to the SFP water in the hand calculation and results in a shorter boiling time.

- A constant density and specific heat, which is the lowest density and the lowest specific heat, are applied in the hand calculation while in the T/H analysis uses temperature-dependent water density and specific heat. Water density is decreased with increasing water temperature. Specific heat is increased with increasing water temperature in the simulated temperature range. Since the SFP water temperature continuously increases until it boils, the SFP water density is the highest in the beginning of T/H analysis. Since a higher density absorbs more heat from the fuel and slows down SFP temperature increase, the boiling time takes longer. Analogously, the specific heat of SFP water is the highest near the boiling point of the T/H analysis and this also slows down the SFP temperature increase.

- The maximum allowed SFP water temperature (140°F) as an initial SFP water temperature is applied in the hand calculation. The initial temperature in the hand calculation is higher than the T/H analysis. A part of the T/H analysis verifies that the SFP water temperature is always below the maximum allowed SFP water temperature at a given operating condition prior to determining the boiling time. Then, the verified SFP water temperature, which is less than the maximum allowed SFP water temperature, is applied as an initial condition for the boiling time calculation. Therefore, the hand calculation results in a faster boiling time.

- The same SFP water volume, which is the Technical Specifications water level, is applied to the hand calculation and the T/H analysis.

Impact on DCD

DCD Tier 2 Subsection 9.1.3.3.2 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

2.0

is reactivated to resume SFP cooling, thereby precluding boiling. Furthermore, the SFP water volume allows an approximately ~~3.7~~-hour margin prior to SFP water boiling during a total loss of cooling condition or SBO at full core offloads. The SFP initial maximum boil-off rate for a worst case of full core off-load is approximately 579.17 L/min (153 gpm). The boil-off rate decreases over time as the spent fuel decay heat decreases. Based on the SFP boil-off and makeup analysis, a minimum flow rate of approximately 579.17 L/min (153 gpm) is required to match the SFP boil-off rate for the worst case. The SFP makeup flow rate is selected with a value that can exceed the boil-off rate of 579.17 L/min (153 gpm).

The SFP receives normal borated makeup water from the BAST, which is seismic Category I, safety Class 3, via the BAMP. The BAST is able to supply 643.52 L/min (170 gpm) of boric acid water through a seismic makeup line to the SFP.

The seismic Category I backup makeup water sources are also provided for SFP water makeup. The AFWSTs, as seismic Category I backup water sources, are able to supply 946.35 L/min (250 gpm) of non-borated water to the SFP via a CCW makeup pump. Non-borated water from a non-seismic category makeup water source is used to make up for the normal evaporation losses of the SFP from the DWST, and the makeup water is delivered via a manually operated valve in the connecting line.

Two makeup lines and two spray lines from outside the building are installed to establish a flexible means. Makeup water flow of 1,892 L/min (500 gpm) and spray water flow of 757 L/min (200 gpm) from an external water source can be injected into the SFP. The makeup lines and spray lines are provided as dry pipes located on opposite corners of the SFP and are designed to withstand a safe shutdown earthquake. A portable makeup pump such as a fire truck can be used to supply SFP makeup water and spray water through these connection lines.

9.1.3.3.3 Spent Fuel Pool Dewatering

The SFPCCS is designed to prevent the reduction in spent fuel pool coolant inventory under accident conditions. To prevent the SFP cooling water loss, the pool is designed to maintain a minimum of approximately 3 m (10 ft) of water above the top of the spent fuel for proper cooling and shielding in accordance with NRC RG 1.13 (Reference 11). All piping that penetrates the pool is located at approximately 3 m (10 ft) above the top of the