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.:	**473-8582**
SRP Section:	**09.01.03 – Spent Fuel Pool Cooling and Cleanup System**
Application Section:	**9.1.3**
Date of RAI Issue:	**05/02/2016**

Question No. 09.01.03-4

In RAI 77-7991 question 9.1.3-1 item a, the staff requested the applicant to indicate the minimum water level needed to provide the SFP cooling pumps with adequate NPSH. The safety related SFP cooling pumps need to have adequate NPSH at the minimum safety water level. The applicant's response stated that the SFP low level (153'-10") was considered for the calculation of the NPSH available for the SFP cooling pump. However, the staff identified several non-conservative or contradictory statements in this RAI response:

- The applicant mentioned that the SFP has non-Seismic Category I connections as low as the 149'-0" elevation. Based on the definition of seismic classifications in Chapter 3, only Seismic Category I components would remain functional following a safe shutdown earthquake (SSE). So, the staff would imply the SFP minimum safety water level should be revised to 149'-0".

- In response to item c of RAI 9.1.3-1, the applicant stated that there is an automatic interlock that shuts the SFPCS pumps if the SFP water level drops below elevation 144' -11". So, the staff would imply the SFP minimum safety water level should be higher than 144'-11".

- In response to item d of RAI 9.1.3-1, the applicant stated that "all non-Seismic Category I components (skimmer suction nozzle, cleanup discharge nozzle, demineralized water makeup nozzle, and cleanup suction nozzle) are located above EL. 144'-0", corresponding to the elevation of the suction nozzle of the SFP cooling pump. Therefore, the failure of non-Seismic Category I components will not drain the SFP water below the water level needed to operate the safety-related SFP cooling pumps." The staff finds this statement not only an indication that the SFP minimum safety water level should be revised to 144'-0" but also a contradiction to the EL. 144'-11" when the pumps would stop working, as mentioned in the bullet above.

The staff requests the applicant to:

a. clearly identify the minimum safety water level credited to be retained in the SFP in order to ensure the proper operation of the safety-related SFPCS, and update the DCD accordingly;

b. clearly demonstrate that the minimum safety water level still provides adequate NPSH to operate the SFPCS pumps, and to update the DCD accordingly;

c. revise the thermal-hydraulic calculations associated with the SFP cooling system using the revised minimum safety water level, and update the DCD accordingly.

Response

a. The minimum safety water level for the SFP is EL.146 ft. The minimum safety water level is selected based on the lowest SFP water level under the worst postulated accident condition, which is a single gate failure. During a single gate failure, the SFP water level drops to EL.146 ft. The operation of the SFP cooling pump in the SFPCS is always ensured at EL.146 ft, since the elevation of the pump suction is EL.144 ft and the pump stop set point is at EL.144’-11”. DCD Tier 2 Subsection 9.1.2.2.2 and 9.1.3.2.1.1 will be revised to clarify the minimum safety water level.

b. NPSH available for the SFP cooling pump is always guaranteed since the pump is located at EL.100’-0” and the center line of the pump suction is located at EL.144’-0”. Therefore, a sufficient static head is available for pump operation. DCD Tier 2 Subsection 9.1.3.2.1.1 will be revised to describe that the minimum safety water level provides adequate NPSH to operate the pump.

c. Thermal hydraulic analysis for new and spent fuel storage racks using minimum safety water level (EL.146 ft) will be issued as a new Technical Report by 04 October, 2016. DCD Tier 2 Subsection 9.1.2.3.2 will be revised to update the description for the thermal hydraulic analysis accordingly.

Impact on DCD

DCD Tier 2 Subsection 9.1.2.2.2, 9.1.2.3.2, and 9.1.3.2.1.1 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.

including related connections to the SFP is described in Subsection 9.1.3. Each area can be sealed from its adjacent area by a hinged gate equipped with elastomer seals. The gates are designed as seismic Category I and allow the spent fuel cask loading pit and the fuel transfer canal to be drained without affecting the water level in the SFP. The gates are designed to withstand the water pressure in the SFP when the adjacent areas are dewatered.

The fuel transfer canal contains the fuel transfer system that is used for transporting fuel assemblies to and from the containment building. The spent fuel cask loading pit contains the spent fuel cask that is used for the transport of spent fuel assemblies from the fuel storage area in the auxiliary building.

All the preceding areas are stainless-steel-lined and concrete-walled pools that are integral parts of the fuel handling area building structure.

The SFP is approximately 7.31 m (42 ft) deep and made of reinforced concrete lined with stainless steel plate. The SFP is sufficiently deep that when a spent fuel assembly is being carried over the spent fuel storage racks by the spent fuel handling machine (SFHM) at its maximum lift height, there is sufficient water coverage to provide reasonable assurance that personnel on the SFHM or on the operating floor around the pool are not exposed to radiation levels exceeding 0.025 mSv per hour.

Piping penetrations to the SFP are at least 3.05 m (10 ft) above the top of the fuel assemblies seated in the spent fuel storage racks. The bottom of the gates that lead from the SFP to the fuel transfer canal and the spent fuel cask loading pit are above the top of the stored fuel assemblies. The SFP water level in the event of a single gate failure, which is considered as the worst postulated accident condition is El.146 ft. In addition, the SFP is designed that the SFP water leakage to the adjacent fuel handling areas level would not reduce the SFP water level to less than 3.05 m (10 ft) above the top of the stored fuel assemblies in the event of a single gate failure. The spent fuel storage racks and the pool floor are designed to withstand the maximum impact energy of a fuel handling tool or a fuel assembly with its handling tool dropped from the maximum lift height. Redundant low- and high-level water alarms and temperature measurement instruments, as described in Subsection 9.1.3.5, minimize the potential for reducing the pool water or overfilling the pool. The ventilation system for the SFP area is described in Subsection 9.1.3.1.

Pipes that discharge into the spent fuel pool include siphon breaker holes as an anti-siphon device between the normal water level and the level of the SFP pumps' suction connection.

The makeup water to the SFP is provided by a safety Class 3, seismic Category I water supply, as described in Subsection 9.1.3.2.

The new fuel assemblies are stored dry. The rack structure is designed to maintain a safe geometric array for normal and postulated accident conditions. The rack structure maintains the required degree of subcriticality for normal and postulated accident conditions such as flooding with pure water and worst-case moderator density.

9.1.2.3.2 Spent Fuel Storage Racks

The spent fuel storage racks are designed to seismic Category I requirements (described in Section 3.2) and are capable of withstanding normal and postulated dead loads, live loads, loads resulting from thermal effects, and loads caused by an SSE.

The spent fuel racks are designed with adequate energy absorption capabilities to withstand the impact of a dropped fuel assembly from the maximum lift height of the fuel handling machine, as described in Subsection 9.1.2.3.3. Handling equipment capable of carrying loads heavier than fuel components (e.g., spent fuel cask handling crane) is prevented by design from carrying heavy loads over the spent fuel storage area. The spent fuel storage racks can withstand an uplift force greater than or equal to the uplift capability of the fuel handling machine (2,268 kg [5,000 lb]).

Materials used in rack fabrication are compatible with the storage pool environment, and surfaces that come into contact with the fuel assemblies are made of annealed austenitic stainless steel. Structural materials are corrosion resistant and do not contaminate the fuel assemblies or pool environment. The neutron absorbing material used in the rack design is suitable for the storage environment.

and the minimum safety water level (El. 146 ft) at single gate failure condition

Design of the spent fuel storage facility is in accordance with NRC RG 1.13 (Reference 11).

The thermal-hydraulic analysis demonstrating that the flow through the spent fuel rack is adequate for decay heat removal from the spent fuel assemblies during anticipated operating conditions is provided in the thermal-hydraulic analysis report.

The spent fuel storage racks and storage facility are designed to seismic Category I requirements. The spent fuel storage rack is designed to meet the following criteria under plant conditions such as seismic or fuel handling accidents:

a. Prevent physical damage to the stored fuel category. The SFP water is separated from the water in the fuel transfer canal by a gate. The gate is installed so the fuel transfer canal is drained after the refueling operation is finished or to allow maintenance of the fuel transfer equipment.

The cooling portion of the SFPCCS is designed to maintain its functionality during and following an SSE. Each cooling portion is designed to service the SFP under the condition of the temperatures and heat loads described in Subsection 9.1.3.1. The performance of the system satisfies the requirements of GDC 2, 4, 61, and 63. In Table 9.1.3-3, a failure modes and effects analysis (FMEA) for the SFP cooling system is presented. The cooling and cleanup flow paths are shown in Figure 9.1.3-1.

The cleanup portion of the SFPCCS, piping, demineralizers, and filters is non-safety-related.

9.1.3.2.1 Component Description

The SFP cooling pumps and heat exchangers are classified as safety Class 3 and are designed to ASME Section III, Subsection ND. The SFP cleanup pumps, filters, strainers, and demineralizers are classified as non-safety-related. All containment isolation valves and associated piping of the SFPCCS are classified as safety Class 2 and are designed according to ASME Section III, Subsection NC.

9.1.3.2.1.1 Spent Fuel Pool Cooling Pumps

Two identical pumps are installed in parallel in the SFP cooling system. Each pump is sized to deliver sufficient coolant flow through an SFP cooling heat exchanger to meet the system cooling requirements. The pumps are horizontal, centrifugal type, with all wetted surfaces being stainless steel or an equivalent corrosion-resistant material. The [pump] net positive suction head (NPSH) available ~~from the system~~ exceeds each pump's required NPSH [~~as a result of the sufficient static pressure due to the height difference between the elevation of the SFP water level and the elevation of the pump.~~]. This is based on ~~the minimum pool level~~ [~~the SFP low level (El.153 ft 10 in)~~] [the minimum safety water level (El.146 ft) established from the SFP water level at the worst postulated accident condition, which is single gate failure,] and the maximum pool temperature of 60 °C (140 °F). The pumps are controlled manually from the MCR.

9.1.3.2.1.2 Skimmer

The skimmers are designed to circulate surface water through the SFP cleanup system and return it to the pool via the SFP cleanup pumps.

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Question No. 09.01.03-5

While evaluating the applicant's responses to RAI 77-7991, the staff identified that, in some places the normal water level has been identified as elevation 154', while in other places it shows as elevation 153'. The technical specifications identify the normal water level as 23' above the stored fuel, which results in EL. 153'.

The staff requests the applicant to:

a. correct the inconsistency in the values of normal water level, and update the DCD accordingly.

b. revise the thermal-hydraulic calculations associated with the SFP cooling system using the appropriate normal water level, and update the DCD accordingly.

Response

a. The normal water level for the spent fuel pool is EL.154 ft and the level of the SFP is maintained at the normal water level during all operation modes. The water level of 23 ft above the stored fuel that is in Technical Specification Subsection 3.7.14 is the water level, which shields and minimizes the general area dose when the storage racks are at their maximum capacity and provides shielding during the movement of spent fuel. Therefore, the normal water level is different from the technical specification water level. In addition, the normal water level will be described in DCD Tier 2 Subsection 9.1.3.2 to clarify the elevation of the SFP normal water level.

b. Thermal hydraulic analysis for new and spent fuel storage racks will be issued as a new Technical Report by 04 October, 2016. The Technical Report will have consistent SFP water levels, such as the normal water level and minimum safety water level.

Impact on DCD

DCD Tier 2 Subsection 9.1.3.2 will be revised.

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.

The SFP cooling system is located in a seismic Category I building that provides protection from the effects of natural phenomena and external missiles. SFP cooling system components such as piping, pumps, valves, and heat exchangers are safety-related and designed as safety Class 3.

The SFP is initially filled with water that has a boron concentration range of 4,000 to 4,400 ppm. The SFP receives normal borated makeup water from the boric acid storage tank (BAST) from the boric acid makeup pump (BAMP). The BAST, BAMP, and all associated piping are classified as seismic Category I and safety Class 3.

The seismic Category I makeup water sources are the auxiliary feedwater storage tanks (AFWSTs). The makeup water is delivered to the SFP by the component cooling water (CCW) makeup pumps. The non-seismic category makeup water source is the demineralized water storage tank (DWST), and the makeup water is delivered via a manually operated valve in the connecting line. Makeup water compensates for normal evaporative losses. to maintain the SFP normal water level (El.154 ft)

The failure of the spent fuel pool cooling portion raises the SFP water temperature and then increases evaporative loss. Minor leakage from the SFPCCS piping, components, or SFP liner also lowers the SFP water level. A liner leakage collection system drains any possible leakage from SFP liner plate welds and floor to the auxiliary building sumps. Component or system leakage from the SFPCCS is detected by several means, including area sump and floor drain level monitoring, radiation monitoring, SFP level monitoring, and refueling pool level monitoring during refueling operations. Once a low-level alarm signal from the SFP to the main control room (MCR) is detected, the SFP makeup is provided to the SFP manually and compensates the losses from makeup water sources.

The safety-related boric acid water makeup line is connected from the BAST to the SFP. The BAST, as a primary water source of water to the SFP, is classified as seismic Category I, and the makeup line from the BAST to the SFP is classified as seismic Category I and designed in accordance with ASME Section III.

Another seismic Category I makeup line is provided from the auxiliary feedwater storage tanks (AFWST), as a backup water sources to the SFP. The makeup water is delivered to the SFP via CCW makeup pumps.

The demineralized water storage tank (DWST) is a non-seismic category source of makeup water to the SFP. In addition, the makeup line from the DWST to the SFP is a non-seismic