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.:	**77-7991**
SRP Section:	**09.01.03 – Spent Fuel Pool Cooling and Cleanup System**
Application Section:	**9.1.3**
Date of RAI Issue:	**07/15/2015**

Question No. 09.01.03-1

GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena. Acceptance for meeting this criterion is based on conformance to positions C.1, ″Seismic Design;” C.2, “Protection Against Extreme Winds;” C.6, “Drainage Protection;” and C.8, “Makeup Water,” of RG 1.13 and position C.1 of RG 1.29.

In DCD Tier 2 Section 9.1.3.2.1.1, the applicant describes the SFPCS cooling pumps and states that the net positive suction head (NPSH) available from the system exceeds each pump’s required NPSH. This is based on the minimum pool level and the maximum pool temperature of 60 °C (140 °F). DCD Tier 2, Section 9.1.3.1, states that, to preclude loss of minimum SFP water level that provides proper shielding, all piping that penetrates the pool are located approximately 3 m (10 ft) above the top of the spent fuel assemblies, and all piping extending down into the pool have siphon breaker holes at or above this level.

The SFPCS is a safety-related system credited to remain operational following a safe shutdown earthquake. In order to operate the SFP cooling pumps, the SFP needs to maintain a minimum water level in order to ensure sufficient NPSH to prevent pump cavitation. Additionally, DCD Tier 2 Section 9.1.3.5.4 states that the SFP cooling pumps are protected from cavitation by an automatic stop interlock on SFP low level. The SFP cleanup system is not designed to seismic category I standards; this system has several connections to the SFP. The staff evaluated the system description and determined that additional information is required.

The applicant is requested to:

a. indicate in the FSAR the minimum water level needed to provide the SFP cooling pumps with adequate NPSH,

b. indicate the elevation of all pipes that interact with the SFP (pipes that penetrate the SFP wall and pipes that extend down into the pool),

c. indicate in the FSAR the setpoint (water level) that activates the interlock that stops the SFP cooling pumps and protects them from cavitation, and

d. provide an evaluation that demonstrates that the failure of non-seismic category I components will not drain the SFP below the minimum water level needed to operate the safety related SFP cooling pumps.

Response

a. The SFP low level (153'-10") is considered for the calculation of the NPSH available of the SFP cooling pump. However, although the SFP water level reaches to the SFP cooling suction nozzle elevation, since the suction nozzle of the SFP cooling pump is located at the lowest elevation (EL. 144'-0") of the SFP in the auxiliary building, and the SFP cooling pump is installed at EL. 100'-0" of the auxiliary building, this height difference is sufficient that the NPSH available for the SFP cooling pump exceeds the required NPSH. Therefore, the NPSH available always satisfies the pump's required NPSH until the SFP cooling pump stops at a SFP water level (EL. 144'-11") that activates the interlock for the pump stop. The additional information for the SFP cooling pump NPSH available will be added in DCD Tier2 Subsection 9.1.3.2.1.1.

b. The elevations of all pipes that interact with the SFP are as followings;

   External makeup and spray nozzle of SFP: above EL. 154'-10"

   Skimmer suction nozzle of SFP: EL. 153'-0"

   Cleanup discharge nozzle of SFP: EL. 153'-0"

   Demineralized water makeup nozzle of SFP: EL. 153'-0"

   Cleanup suction nozzle of SFP: EL. 149'-0"

   Cooling discharge nozzle of SFP: EL. 149'-0" (The pipes extend down to EL. 141'-6" and include the siphon breaker hole at EL. 147'-9 1/2")

   Cooling suction nozzle of SFP: EL. 144'-0"

c. The setpoint (EL. 144'-11") that activates the interlock that stops the SFP cooling pumps and protects them from cavitation will be incorporated in DCD Tier2 Subsection 9.1.3.5.4.

d. As stated in the response to question b, 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", whose elevation is 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.

Impact on DCD

DCD 9.1.3.2.1.1 and 9.1.3.5.4 will be revised as indicated on the attached markup.

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.

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 net positive suction head (NPSH) available ~~from the system~~ exceeds each pump's required NPSH. This is based on ~~the minimum pool level~~ and the maximum pool temperature of 60 °C (140 °F). The pumps are controlled manually from the MCR.

pump

the SFP low level (El.153 ft 10 in)

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.

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.

9.1.3.5.2 Pressure

Instrumentation is provided to measure and give indication of the pressures in the SFPCCS pump discharge lines. A deviation from normal pressure in the SFP cooling pump discharge lines is alarmed in the MCR. Instrumentation is also provided upstream and downstream of each cleanup filter, demineralizer, and demineralizer filter to measure the pressure differential across the filters, demineralizers, and demineralizer filters.

9.1.3.5.3 Flow

Instrumentation installed downstream of the SFP heat exchanger measures the SFP cooling portion flow and shows local indication of the SFP cooling portion flow. This instrument is used to check whether the flow rate of the cooling water returning to the SFP via the SFP heat exchanger is maintained at the specified value. Alarms that indicate a loss of cooling function are provided to the MCR to detect low flow rates.

A local flow indicator for measuring the purification flow is installed at the outlet of each purification line.

9.1.3.5.4 Water Level

Two safety-related SFP water level transmitters are installed in the SFP to measure the SFP water level from a 100 percent water level to the top level of the spent fuel assemblies. The SFP water level transmitters annunciate high water level, low water level, and low-low water level of the SFP to the MCR, RSR, and locally.

The SFP cooling pump and cleanup pump are interlocked with SFP water level to stop the pumps automatically as the SFP water level is decreased to ~~a predetermined setpoint.~~ El.144 ft 11 in and El.153 ft 7 in, respectively. The interlock prevent the pumps from cavitation and failure.

9.1.3.5.5 Radiation

Gamma radiation is continuously monitored in the fuel handling area. A high-level signal is alarmed locally and annunciated in the MCR.

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Application Section:	**9.1.3**
Date of RAI Issue:	**07/15/2015**

Question No. 09.01.03-2

GDC 61 requires that the fuel storage system be designed to assure adequate safety under normal and postulated accident conditions. The system shall be designed with residual heat removal that reflects the importance to safety of decay heat and other residual heat removal.

NUREG-0800, SRP 9.1.3.III.1 states that the application section describing the system functional performance requirements is reviewed to determine that it describes minimum system heat transfer and system flow requirements for normal plant operation, component operational degradation requirements (i.e., pump leakage, etc.) and also describes the procedures that will be followed to detect and correct these conditions should degradation become excessive.

The staff evaluated the system description provided in DCD Tier 2, Section 9.1.3, and determined that additional information was needed. The system description does not provide the values of the maximum normal and abnormal (full core offload) SFP heat loads, nor does it states what the minimum heat exchanger heat transfer and minimum system flow area. The staff needs this information to confirm that there is adequate cooling of the spent fuel in the SFP.

The applicant is requested to update DCD Tier 2, Section 9.1.3, to include the values of the maximum normal and abnormal (full core offload) SFP heat loads and the minimum heat exchanger system flow

Response

The SFP cooling heat exchanger sizing for the APR1400 design is based on of the highest heat transfer capacity (UA = overall heat transfer coefficient (U) and the effective heat transfer area (A)) required for the operation mode with the highest calculated heat transfer capacity. The heat transfer capacity during refueling operations (full core offload) is calculated as the limiting case, which has the highest heat transfer capacity among plant operation modes (i.e., normal power operation, etc.) and abnormal operation mode. Therefore, the SFP cooling heat exchanger is sized with the maximum heat transfer capacity that could occur during refueling operations. The

design heat load for refueling operations (full core offload) and design heat transfer capacity will be added to DCD Table 9.1.3-2.

Impact on DCD

DCD Table 9.1.3-2 will be revised as indicated on the attached markup.

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.

Design Heat load (for refueling operation with full core offload) 17.7 X 10^6 W(60.6 X 10^6 Btu/hr)
Design Heat Transfer Capacity (UA)(1) 2.28 X 10^6 kcal/hr-ºC (5.015 X 10^6 Btu/hr-ºF)

Table 9.1.3-2

Spent Fuel Pool Cooling System Principal Component Design Parameters

Cooling Pumps	
Quantity	2
Type	Centrifugal
Design Pressure	10.55 kg/cm^{2}G (150 psig)
Design Temperature	93.3 °C (200 °F)
Design TDH	21.95 m (72 ft)
Normal Flow	15,142 L/min (4,000 gpm)
Normal Operating Temperature	60.0 °C (140 °F)
Cooling Heat Exchangers	
Quantity	2
Type	Plate
Code (Plate)	ASME Section III Class 3
Hot Side	
Fluid	Spent Fuel Pool Water
Design Pressure	10.55 kg/cm^{2}G (150 psig)
Design Temperature	93.3 °C (200 °F)
Operating Temperatures (inlet/outlet)	60 °C (140 °F) / ~~43.26 °C (109.87 °F)~~
~~Normal~~ Flow	15,142 L/min (4,000 gpm)
Material	Austenitic Stainless Steel
Cold Side	
Fluid	Component Cooling Water
Design Pressure	14.1 kg/cm2G (200 psig)
Design Temperature	93.3 °C (200 °F)
Operating Temperatures (inlet/outlet)	35 °C (95 °F) / ~~53.98 °C (129.16 °F)~~
~~Normal~~ Flow	13,249 L/min (3,500 gpm)
Material	Austenitic Stainless Steel

42.98 ºC (109.36 ºF)

Design

54.41 ºC (129.94 ºF)

Design

(1) UA = overall heat transfer coefficient (U) and the effective heat transfer area (A)

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Question No. 09.01.03-3

GDC 63 requires appropriate systems in fuel storage and radioactive waste systems and handling areas to detect conditions that may cause loss of residual heat removal capability and excessive radiation levels and to initiate appropriate safety actions. For spent fuel storage facilities, GDC 63 also requires spent fuel pool water level, pool temperature, and pool building radiation monitoring to protect personnel and to prevent significant offsite radiation doses.

The SFP water provides cooling for the stored fuel and radiation shielding; therefore, monitoring pool leakage is relevant to GDC 63. In DCD Tier 2, Section 9.1.3, the applicant presented COL 9.1(1), which requires the COL applicant to provide operational procedures and a maintenance program related to leak detection and contamination control.

The staff evaluated the proposed COL information item and determined that additional information is needed. The proposed COL information item does not specify which detection equipment or contamination control programs need to be provided for an operational procedure and maintenance program. The COL information item also lacks the inspection interval for the maintenance program (for example, DCD Tier 2, Section 9.1.2.2.2 states that the SFP liner leakage monitoring system is monitored weekly and inspected every refueling).

The applicant is requested to update COL 9.1(1) to identify the detection equipment and contamination control programs that the COL applicant needs to create.

Response

DCD section 9.1.3.2.3, 9.1.6, Table 1.8-2, and Table 12.4-10 will be revised to provide additional information for the COL item.

Impact on DCD

DCD 9.1.3.2.3, 9.1.6, Table 1.8-2, and Table 12.4-10 will be revised as indicated on the attached markup.

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.

Table 1.8-2 (11 of 29)

Item No.	Description
COL 8.3(1)	The COL applicant is to provide and to design a mobile generator and its support equipment.
COL 8.3(2)	The COL applicant is to describe and provide detailed ground grid and lightning protection.
COL 8.3(3)	The COL applicant is to provide testing, inspection, and monitoring programs for detecting insulation degradation of underground and inaccessible power cables within the scope of 10 CFR 50.65.
COL 8.3(4)	The COL applicant is to provide protective device coordination.
COL 8.3(5)	The COL applicant is to provide insulation coordination of surge and lightning protection.
COL 8.3(6)	The COL applicant is to develop the maintenance program to optimize the life and performance of the batteries.
COL 8.3(7)	The COL applicant is to provide short circuit analysis of onsite dc power system with actual data.
COL 8.3(8)	The COL applicant is to describe any special features of the design that would permit online replacement of an individual cell, group of cells, or entire battery.
COL 8.4(1)	The COL applicant is to identify local power sources and transmission paths that could be made available to resupply power to the plant following the loss of a grid or the SBO.
COL 8.4(2)	The COL applicant is to develop detailed procedures for manually aligning the alternate AC power supply when two (Trains A and B) of the four diesel generators are unavailable during a loss of offsite power event.
COL 9.1(1)	~~The COL applicant is to provide operational procedures and maintenance program as related to leak detection and contamination control~~.
COL 9.1(2)	The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.
COL 9.1(3)	The COL applicant is to address the load-handling procedures. Load-handling procedures are established for component handling procedures and plant operating procedures in accordance with ASME B30.2. ASME B30.2 requires establishing component handling procedures that include (1) a safe load path for lifting heavy loads to perform special handling component inspections, (2) acceptance criteria prior to lift, and (3) use of steps and proper sequence in handling the load. ASME B30.2 requires plant operating procedure guidelines that include appropriate crane operator training and crane inspections. ASME B30.2 also requires that the load-handling procedures include preparing operating procedures for preoperational load testing and checkouts of interlocks, brakes, hoisting cables, control circuitry, and lubrication of OHLHS equipment.

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The COL applicant is to provide operational procedures and maintenance programs for the inspection, calibration, testing, and maintenance of the SFP leak detection provision (sight glasses), pool water temperature, pool water level, SFP area radiation monitor, and the SFP steel liner. The COL applicant is also to provide the inspection interval for the maintenance program. In addition, the COL applicant is to provide operational procedures and maintenance programs for the design features implemented for SFP contamination control, including heat exchanger seals, epoxy coating, and SFP filters and demineralizers. The contamination control procedures and programs can be integrated into an overall plant-wide RG 4.21 program following the guidance from NEI 08-08A.

Decommissioning Planning

a. The SSCs are designed for the full service life and are fabricated as individual assemblies for easy removal, with the exception of the liner plates.

b. The SSCs are designed to facilitate decontamination. Design features, such as the welding techniques that are used and surface finishes, are included to minimize the need for decontamination and the resultant waste generation.

c. The SFPCCS is designed with minimum embedded or buried piping. Piping between buildings is equipped with piping sleeves or tunnel, as applicable, with leak detection features, thus preventing unintended contamination to the environment.

Operations and Documentation

a. The removal and packaging of spent filter elements and spent resin is designed for remote manual operation. Adequate space is provided around the equipment to enable prompt assessment and responses when required.

b. ~~The combined license (COL) applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control~~ (COL 9.1(1)). Procedures and maintenance programs are to be completed before fuel is loaded.

c. The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations (COL 9.1(2)). Documentation requirements are included as a COL information item.

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Site Radiological Environmental Monitoring

The SFPCCS is designed to manage radioactive contamination through the storage of spent fuel. The integrity of the SFPCCS is maintained through monitoring, in-service inspection, and the implementation of lessons learned from industry experience. Maintaining the SFPCCS results in a low level of contamination in the facility. Because the SFPCCS is located at higher plant elevations, the potential for environmental contamination of soil and

The two mechanical holding brakes and their controls that are automatically activated when electric power is off or mechanically tripped by over speed or overload devices in the hoisting system are operable for emergency lowering after a single brake failure to stop and hold the hoisting drums.

Both bridge and trolley drives are provided with control and holding braking systems that are automatically applied when the power is shut off or if an overspeed or overload condition occurred because of malfunction or failure in the drive system. Inching control is provided for bridge and trolley motion of 6.35 mm (0.25 in). Limiting devices, mechanical and/or electrical, are provided to control or prevent overtravel and overspeed of the trolley and bridge. Safety devices such as limit-type switches provided for malfunction, inadvertent operator action, or failure are in addition to and separate from the limiting means or control devices provided for operation.

9.1.6 Combined License Information

COL 9.1(1) ~~The COL applicant is to provide operational procedures and maintenance program as related to leak detection and contamination control.~~

COL 9.1(2) The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.

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COL 9.1(3) The COL applicant is to address the load-handling procedures. Load-handling procedures are established for component handling procedures and plant operating procedures in accordance with ASME B30.2. ASME B30.2 requires establishing component handling procedures that include (1) a safe load path for lifting heavy loads to perform special handling component inspections, (2) acceptance criteria prior to lift, and (3) use of steps and proper sequence in handling the load. ASME B30.2 requires plant operating procedure guidelines that include appropriate crane operator training and crane inspections. ASME B30.2 also requires that the load-handling procedures include preparing operating procedures for preoperational load testing and checkouts of interlocks, brakes, hoisting cables, control circuitry, and lubrication of OHLHS equipment.

Table 12.4-10 (31 of 74)

Objective		SSC Control Measures / Design Features in DCD to Meet Objective	DCD Tier 2 Reference
4	Decommissioning Planning	• The SSCs are designed for the full service life and are fabricated as individual assemblies for easy removal, with the exception of the liner plates. • The SSCs are designed to facilitate decontamination. Design features, such as the welding techniques that are used and surface finishes, are included to minimize the need for decontamination and the resultant waste generation. • The SFPCCS is designed with minimum embedded or buried piping. Piping between buildings is equipped with piping sleeves or tunnel, as applicable, with leak detection features, thus preventing unintended contamination to the environment.	9.1.3
5	Operations and Documentation	• The removal and packaging of spent filter elements and spent resin is designed for remote manual operation. Adequate space is provided around the equipment to enable prompt assessment and responses when required. • ~~The combined license (COL) applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control~~ (COL 9.1(1)). Procedures and maintenance programs are to be completed before fuel is loaded. • The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations (COL 9.1(2)). Documentation requirements are included as a COL information item.	9.1.3
6	Site Radiological Environmental Monitoring	• The SFPCCS is designed to manage radioactive contamination through the storage of spent fuel. The integrity of the SFPCCS is maintained through monitoring, in- service inspection, and the implementation of lessons learned from industry experience. Maintaining the SFPCCS results in a low level of contamination in the facility. Because the SFPCCS is located at higher plant elevations, the potential for environmental contamination of soil and groundwater from pool liquid leakages is minimized. However, because the pool is open, contamination from the evaporation of water from the SFPCCS and other systems is included in the site radiological environmental monitoring program. The program is included as a COL information item.	9.1.3

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