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.:	**211-8236**
SRP Section:	**09.02.01 – Station Service Water System**
Application Section:	**9.2.1**
Date of RAI Issue:	**09/14/2015**

Question No. 09.02.01-6

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

The acceptance criteria in SRP Section 9.2.1 states that the essential service water system (ESWS) must be capable of removing heat from SSCs important to safety during normal operating and accident conditions over the life of the plant in accordance with GDC 44 requirements.

DCD Tier 2, Section 9.2.1.2.1 states that Table 9.2.5-3 provides information on heat loads and water flow balance for various operating modes. However, Table 9.2.5-3 is denoted as a conceptual design of the ultimate heat sink (UHS), which the application does not seek certification.

The ESWS removes heat from the component cooling water system (CCWS) and transfer the heat to the UHS. The above DCD statement on a conceptual design does not provide the necessary ESWS heat load information that is subject to certification.

The applicant is requested to include additional information in DCD Tier 2, Section 9.2.1, to fully describe and explain the heat loads on the ESWS for normal operating, refueling, and accident conditions. The flow and temperature requirements and the cooling capability are also to be provided, including a supporting design basis discussion addressing available margins.

The applicant is requested to include a COL item identifying the heat load and interface requirements for the UHS in accordance with 10 CFR 47(a)(25), including the explanation on the bases for the determination of these values.

Response

Information on the heat loads and water flows for the ESWS is part of the standard plant design certification information, and is provided in Table 9.2.5-1. The original reference “Table 9.2.5-3” in DCD Tier 2 Subsection 9.2.1.2.1 will be revised to “Table 9.2.5-1”.

And the heat load for refueling mode will be added in DCD Tier 2, Table 9.2.5-1 and Table 9.2.5-3.

Based on the RAI 256-8321, Question No. 09.02.02-8 response, there is no additional margin included in the CCW heat excahnger (HX) sizing evaluation. However, the duties for the normal power operation contains various levels of conservatism built into the heat exchanger duties. Based on the inputs listed in Table 9.2.2-3 (A/B) and Table 9.2.5-1, the response also demonstrates the evaluation for each operating heat exchanger for different modes of operation that are summarized as follow:

Table 1 CCW Heat Exchanger Sizing Evaluation for Different Modes of Operation

Div. 1 Operational Mode	HX Operating	Heat Exchanger UA** Million BTU/hr/°F	Margin*
Normal Power	2	16.53	Base case
Shutdown Cooling + 3.5 hrs	3	4.98	70%
Refueling	3	8.39	49%
Design Basis Accident SIAS	2	2.31	86%
Design Basis Accident CSAS	2	5.67	66%
Safe Shutdown	2	11.52	30%

* Margin = (normal power case – other operational case)/normal power case

** Derived from q = U*A*LMTD; U*A = q/LMTD, where U represents the overall heat transfer coefficient, which include fouling factors; and A is the total heat transfer area in the individual CCW heat exchanger.

The above evaluation shows that normal power operation is the bounding condition for the CCW HX sizing in terms of the overall heat transfer rate per degree temperature (U*A).

The calculated UA of 16.53 BTU/hr/°F stated in Table 1 is a required value for the CCW HX sizing to ensure heat removal capability. The actual design UA includes the consideration of uncertainties, component wear and aging effects, fouling of heat transfer surfaces, etc. Therefore, the heat exchanger is designed to include a minimum of 10 percent margin for the considerations discussed above and to permit the addition of a minimum 20 percent increase in plates by the vendor in the final procurement.

Impact on DCD

Subsection 9.2.1.2.1, Table 9.2.5-1, and Table 9.2.5-3 of DCD Tier 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 Environment Report.

9.2.1.1.2 Power Generation Design Bases

Power generation design bases pertinent to the ESWS are as follows:

a. The ESWS, in conjunction with the CCWS and shutdown cooling system (SCS), is designed to cool the reactor coolant from 176.7 °C (350 °F) to 60 °C (140 °F) through the shutdown cooling (SC) heat exchangers and the CCW heat exchangers.

b. The ESWS, in conjunction with the CCWS, is designed to supply CCW at a temperature below 43.3 °C (110 °F) to all components required to operate during a normal shutdown.

c. The ESWS, in conjunction with the CCWS, is designed to supply CCW at a temperature below 35 °C (95 °F) to all components required to operate during normal plant operation.

9.2.1.2 System Description

9.2.1.2.1 General Description

The flow diagram of the ESWS is shown in Figure 9.2.1-1. The ESWS consists of two independent, redundant, once-through, safety-related divisions. Each division cools one of two divisions of the CCWS, which cools 100 percent of the safety-related loads. This arrangement provides reasonable assurance that failures and postulated events in one division do not affect the safety-related functions of the other division during accident conditions, such as a LOCA or safe shutdown with LOOP, or in a postulated single active component failure. The ESWS operates at a lower pressure than the CCWS to avoid contamination of the CCWS with the UHS.

The maximum operation supply temperature of the ESW is 33.2 °C (91.8 °F). It is believed to eliminate CCW heat exchanger heat load sufficiently under all operating conditions. Table ~~9.2.5-3~~ 9.2.5-1 provides information on heat loads and water flow balance for various operating modes. The ESWS design heat loads are based on the maximum safe shutdown heat loads with only one operable ESWS division. The other division is assumed to be failed due to a single active component failure. Even in these conditions,

Table 9.2.5-1

Heat

Ultimate Heat Sink Maximum ~~Head~~ Loads for All Modes of Operation

Operation Mode	Max Heat Load (MW/MBtu/hr) per Division	Required ESW Flow (L/min / gpm) per Division	Supply Temperature to ESW (°C / °F)
Normal	37.7 / 128.7	71,923 / 19,000	≤ 32.1 / 89.8
3.5 hours after shutdown	80.2 / 273.8	100,692 / 26,600	≤ 32.1 / 89.8
Refueling	38.0/129.6	100,692/26,600	≤ 32.1/89.8
Accident			
SIAS	23.9 / 81.6	75,708 / 20,000	≤ 33.2 / 91.8
CSAS	56.1 / 191.6	75,708 / 20,000	≤ 33.2 / 91.8
Safe shutdown	106.0 / 361.8	75,708 / 20,000	≤ 33.2 / 91.8

Table 9.2.5-3

Ultimate Heat Sink Design Parameters

UHS Cooling Towers	
Parameter	Description
Type	Wet Type, Mechanical Draft Counter Flow Linear Type Concrete Structure
Total Number of Body/Cells, each	1/3
Design Heat Load, MW/MBtu/hr	37.7 / 128.7 (for normal operation) 38.0 / 129.6 (for refueling) 80.2 / 273.8 (for 3.5 hours after shutdown) 106 / 361.8 (for safe shutdown) The UHS cooling tower is selected based on the head load of 3.5 hours after shutdown.
Total Water Flow (cell), L/min / gpm	71,923 / 19,000 (for normal operation) 100,692 / 26,600 (for 3.5 hours after shutdown) 75,708 / 20,000 (for safe shutdown)
Design Cold Water Temperature, °C/°F	32.1 / 89.8 (for normal operation and shutdown) 33.2 / 91.8 (for accident and safe shutdown)
Design Wet Bulb Temperature, °C/°F	≤ 27.2 / 81 (non-coincident) at 0% exceedance value for accident conditions ≤ 26.1 / 79 at 5% exceedance value for normal plant operation
Basin Size, m/ft	Footprint : Approx. 106.1 x 79.9 / 348 x 262 (inside dimensions) Depth : Approx. 8.3 / 27.2 (at normal water level)
Required Basin Water Volume, m^3/gal	≥ 38,460/10.16 × 10^6 for 30 days
Basin Minimum Water Level, m/ft	≥ 7.90 m / 25.93 ft above basin bottom
Fan and Motor, each	One per each cell
Fan Driver per cell	250 HP
Design Air Flow per Fan, cfm	920,500
Cooling Tower Design Life	60 years