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**
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Question No. 09.02.01-7

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 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 the following:

“The ESWS blowdown line is installed at the ESW pump discharge common pipe to remove impurities concentrated in the UHS. The ESWS is designed with the capability to isolate nonessential portions of the system. The ESW blowdown operation is terminated by the engineered safety features actuation signal (ESFAS), ESW pump stop signal, or UHS basin low-level signal. An ESW blowdown bypass line is provided to bypass the ESW blowdown flow during the ESW blowdown isolation valve maintenance.”

“The ESW flow of 71,923 L/min (19,000 gpm) excluding ESW blowdown is maintained during normal operating conditions. During shutdown and refueling, the ESW flow of 100,692 L/min (26,600 gpm) excluding ESW blowdown is maintained. The ESW flow of 75,708 L/min (20,000 gpm) is maintained during accident and safe shutdown conditions.”

The above information is denoted as conceptual design information, which the application does not seek certification. However, the staff finds that the above information is an essential part of the standard design and should be subject to the certification review.

The applicant is requested to confirm that the above information is included in the standard design and revise DCD Tier 2 accordingly. If any portions of the ESWS are determined as conceptual design only, the applicant should provide justification for its determination and establish an appropriate COL information item to require COL applicants provide such information.

Response

The ESW blowdown flow rate and operation are dependent on the site specific environmental conditions and the cooling tower vendor's design characteristics. Therefore the designs related to the ESW blowdown are determined as conceptual design information.

DCD Tier 2, Subsection 9.2.1.2.1 will be revised to establish a COL information item to require COL applicants to provide the ESW blowdown design.

In addition, DCD Tier 2, Subsection 9.2.1.2.1, 9.2.1.2.2.3, 9.2.1.3, 9.2.5.2.1, 9.2.5.2.2, and 9.2.5.3 will be revised to identify the CDI for the ESW blowdown and UHS cooling tower design, and the standard design for the others.

Impact on DCD

DCD Tier 2, Subsection 9.2.1.2.1, 9.2.1.2.2.3, 9.2.1.3, 9.2.5.2.1, 9.2.5.2.2, and 9.2.5.3 will be revised as shown 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.

the ESW flow rate and maximum supply temperature are maintained at 75,708 L/min (20,000 gpm) and 33.2 °C (91.8 °F), respectively.

Each division of the ESWS consists of two pumps, three CCW heat exchangers, three debris filters, and associated piping, valves, controls and instrumentation. The ESW pumps are located at 81 ft in the ESW building. The ESW pumps take suction from the UHS ~~basin~~, circulate cooling water through the CCW heat exchangers, and return cooling water back to the UHS. [[The ESWS blowdown line is installed at the ESW pump discharge common pipe to remove impurities concentrated in the UHS. The ESWS is designed with the capability to isolate nonessential portions of the system. The ESW blowdown operation is terminated by the engineered safety features actuation signal (ESFAS), ESW pump stop signal, or UHS basin low-level signal. An ESW blowdown bypass line is provided to bypass the ESW blowdown flow during the ESW blowdown isolation valve maintenance.]]

Deleted

[[The ESW flow of 71,923 L/min (19,000 gpm) [[excluding ESW blowdown]] is maintained during normal operating conditions. During shutdown and refueling, the ESW flow of 100,692 L/min (26,600 gpm) [[excluding ESW blowdown]] is maintained. The ESW flow of 75,708 L/min (20,000 gpm) is maintained during accident and safe shutdown conditions.]] Deleted Provisions are made to provide reasonable assurance of a continuous flow of cooling water under normal and accident conditions. Manual valves V1005 through V1016 are installed for the isolation/initiation of ESW flow to the CCW heat exchangers. These valves are manually locked open or closed. Each ESWS discharge header is connected to the UHS at the same division.

The CCWS serves as an intermediate barrier between the reactor coolant system (RCS) and the ESWS. Thus, no radioactive contamination leaks directly from the RCS to the ESWS. Each division has a sump for collection of leakage from sources within the room. The sump is equipped with level instrumentation for leak detection purposes. Radiation monitors are provided in each discharge line of the CCW heat exchanger cold side (ESW) to detect any radioactive leakage from the CCWS to the ESWS. These monitors are indicated and alarmed to alert the operator in the MCR. Prior to any radiation leakage being detected in the ESWS, radiation alarms in the CCWS side alerts the operators of contamination in the CCWS. The affected CCWS division is immediately isolated followed by the isolation of the aligned ESWS to prevent possible contamination of the UHS and the environment. In conjunction with Subsection 9.2.5, the COL applicant is to provide the UHS-related systems, such as blowdown, chemical injection, and makeup water system (COL 9.2(18)).

9.2.1.2.2.3 Essential Service Water Debris Filters

ESW debris filters are installed at the upstream of each CCW heat exchanger to minimize clogging of CCW heat exchangers. The debris filters are of the automatic backwash type. The differential pressure provides a high-pressure differential signal across the filtering element for the annunciator in the MCR to notify operators that the backwashing operation is required. Backwashing operation is initiated automatically or manually by a pressure differential signal across the filtering element. Water for backwashing debris filters is supplied by corresponding ESW pumps.

Failure of the ESW debris filters or backwash isolation valves does not lead to failure of the ESWS because redundant debris filter or a backwash isolation valve is available. The failure modes effects and analysis is shown in Table 9.2.1-2.

During normal operation, the operator may also periodically switch over the debris filter to operate the standby debris filter in the same operating division. Common cause failures from operator errors are not expected when manually switching over the debris filters because the isolation valves are administratively locked on each side of the CCW heat exchangers.

Deleted

The debris filters are designed not to degrade the CCW heat exchanger capability by minimizing the inflow of debris or foreign substances. [[The filtering element perforations size is 2.5 mm (0.1 in), which is considered to prevent the potential clogging of the cooling tower nozzles.]]

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The COL applicant is to determine the design details of backwashing line, vent line, and their discharge locations in the ESWS (COL 9.2(4)).

9.2.1.2.2.4 CCW Heat Exchangers

Six plate-type CCW heat exchangers are provided, three per division, to handle the essential and nonessential cooling requirements. CCW heat exchangers are described in Subsection 9.2.2.2.2.1.

A chemical cleaning connection line is provided for each CCW heat exchangers to enable ESW side chemical cleaning of CCW heat exchangers with the cleaning in place (CIP) unit.

b. The ESWS is designed with minimal embedded or buried piping. Piping between buildings is designed to be routed in seismic Category I, reinforced concrete pipe tunnels (one per division) under the yard.

Operations and Documentation

a. The ESWS is designed for automated operations with manual initiation for the different modes of operation in conjunction with the CCWS.

b. Adequate ingress and egress spaces are provided for prompt assessments and appropriate responses when and where they are needed.

Site Radiological Environmental Monitoring

The ESWS is designed to minimize the potential for contamination through leakage in the heat exchangers. Through monitoring, inservice inspection, and lessons learned from industry experiences, the integrity of the CCW heat exchangers is expected to be well maintained, resulting in no contamination or a very low level of contamination of the system. Leakage from the system to the facility and the environment is captured by the design. Any residual contamination of the hydrogeology is not likely to be distinguishable from other contamination sources. Hence, ESWS has low risk and low radiological consequence, and this design is in compliance with RG 4.21.

9.2.1.3 Safety Evaluation

The ESWS in designed to satisfy the safety design bases of Subsection 9.2.1.1.1, as follows:

a. The ESWS has the capability to dissipate the heat loads for safe shutdown. LOOP results in the shutdown and restarting of the ESWS pumps in accordance with the EDG load sequencing. The EDG load capacity and sequencing times are compatible with ESWS requirements. Thus, the safe shutdown operation is supported by the ESWS.

b. Nonessential portions of the system such as the ESW debris filter backwash discharge piping, [[ESW blowdown discharge piping to plant discharge,]] and drain and vent piping after the isolation valves are non-safety-related. The

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nonessential portions have normally closed isolation valves to separate safety-related and non-safety-related portions. ESW blowdown operation is terminated by engineered safety features actuation signal (ESFAS), ESW pump stop signal, or UHS basin low-level signal. ESW blowdown isolation valves are designed to fail closed. Thus, in the event of a failure of a non-safety-related portion of the system, there is no effect on the operation of the ESWS.

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c. The ESWS maintains the CCW supply temperature at or below 43.3 °C (110 °F) for the design basis accident.

d. The ESWS consists of two physically separate, independent, full-capacity divisions, each of which is powered from a separate Class 1E ac power distribution system and separate EDGs. This provides reasonable assurance that a single failure does not impair system safety functions. The failure modes and effects analysis (FMEA) is shown in Table 9.2.1-2.

e. The COL applicant is to provide the evaluation of the ESW pump at the high and low water levels of the UHS. In the event of approaching low UHS water level, the COL applicant is to develop a recovery procedure (COL 9.2(5)).

f. The COL applicant is to provide measures to prevent long-term corrosion and organic fouling that may degrade system performance in the ESWS (COL 9.2(6)).

g. The ESWS is designed as one unit and does not share systems for multi-unit facilities.

h. The ESW pumps are located in a seismic Category I structure to protect the pumps against adverse environmental occurrences.

i. The essential portions of the ESWS are designed as seismic Category I. All openings at the operating floor in the ESW building are sealed to prevent water entry and preclude flooding of the ESW pumps and other safety-related equipment within the structure.

The UHS design provides the cooling water inventory for a minimum of 30 days without makeup to mitigate the consequences of a design basis event.

The UHS supplies cooling water to the ESWS at a maximum temperature of 32.1 °C (89.8 °F) under all normal operating modes and a maximum of 33.2 °C (91.8 °F) under accident and safe shutdown conditions to provide assurance of sufficient cooling capacity.

[[The required basin water volume is based on the total evaporation and drift during accident and safe shutdown conditions within a 30-day period. The maximum 30-day cooling water capacity is approximately 38,460 m^3 (10.16 million gal).]]

The UHS provides the source of cooling water to the ESWS and dissipates heat rejected from the ESWS. The cooling water does not contain radioactive materials nor release radioactive contaminants to the environment. Radiation monitors are provided in each ESW division. The radiation monitor design is described in Subsection 9.2.1.2.1.

[[The UHS arrangement provides assurance that failures and postulated events in one division do not affect the safety-related functions of the other division. During normal operation, at least one division is required to be operable to meet single failure criteria. During accidents and other design basis events, such as a LOCA or safe shutdown with a LOOP, a postulated single active component failure in one division does not prevent the UHS from performing its safety-related functions with the remaining operable division. Instrumentation is also provided independently and not shared between the divisions.]]

~~[[The water influent into the UHS cooling tower from the ESWS is 71,923 L/min (19,000 gpm) (excluding blowdown) for normal operating conditions except shutdown and refueling conditions. During shutdown and refueling conditions, 100,692 L/min (26,600 gpm) (excluding blowdown) is circulated through the UHS. The water influent into the UHS cooling tower from ESWS is 75,708 L/min (20,000 gpm) during accident and safe shutdown conditions. The ESW blowdown operation is terminated by an engineered safety features actuation signal (ESFAS), ESW pump stop signal, or UHS basin low-level signal.]]~~

The water influent into the UHS [[cooling tower]] from the ESWS is 71,923 L/min (19,000 gpm) [[excluding blowdown]] for normal operating conditions except shutdown and refueling conditions. During shutdown and refueling conditions, 100,692 L/min (26,600 gpm) [[excluding blowdown]] is circulated through the UHS. The water influent into the UHS [[cooling tower]] from ESWS is 75,708 L/min (20,000 gpm) during accident and safe shutdown conditions. [[The ESW blowdown operation is terminated by an engineered safety features actuation signal (ESFAS), ESW pump stop signal, or UHS basin low-level signal.]]

[[To prevent freezing, the UHS cooling tower bypass lines, through which hot water from the ESWS travels directly to the UHS cooling tower basin, are provided. Heaters are also provided.]]

[[The fans in the UHS cooling towers are powered from its associated division of the Class 1E ac power distribution system. In the event of a LOOP, the UHS cooling tower fans are powered by the respective emergency diesel generator.]]

The COL applicant is to provide the design of the UHS cooling tower basin so the minimum water level provides adequate NPSH to ESW pumps under accident conditions (COL 9.2(21)).

The COL applicant is to provide the non-safety-related makeup water source and capacity for normal operation loss and evaporation in the UHS (COL 9.2(22)).

The COL applicant is to specify the following UHS chemistry for bio-fouling and chemistry control (COL 9.2(23)):

a. A chemical injection system to provide non-corrosive, non-scale forming conditions to limit biological film formation

b. The type of biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor, and silt dispersant, if necessary to maintain system performance, based on site conditions

[[As part of the water chemistry management program for the UHS cooling towers and basins, an ESWS blowdown line is installed at the ESW pump discharge piping.]] The COL applicant is to verify the piping layout of the ESWS and UHS to prevent water hammer and to develop operating procedures to provide reasonable assurance that the ESWS and UHS water pressure are above saturation conditions for all operating modes (COL 9.2(24)). The COL applicant is to develop maintenance and test procedures to monitor debris buildup, and flush out and remove the debris in the UHS (COL 9.2(25)).

9.2.5.2.2 [[Component Description]]

[[The UHS cooling towers, including all of their safety-related components and piping, are enclosed and supported by a seismic Category I reinforced concrete structure. The UHS cooling tower components are safety related and designed according to the Quality Group C requirement.]]

independent, redundant, safety-related divisions and does not share components between divisions. The UHS is designed for a single nuclear power unit and is not shared between units.]] The COL applicant is to provide the detailed evaluation for UHS capacity with consideration of site-specific conditions and meteorological data (COL 9.2(29)).

The heat loads for LOCA and safe shutdown conditions with a LOOP for up to 30 days are provided in Table 9.2.5-2. The minimum required UHS cooling water inventory is based on the heat loads for LOCA and safe shutdown conditions to maintain the ESW supply water temperature and to meet the ESW pump NPSH requirements in accordance with NRC RG 1.27.

The UHS provides cooling capacity for at least 30 days in accordance with NRC RG 1.27 without makeup water assuming the worst meteorological data. Each UHS basin provides a minimum 30-day capacity.

The UHS is capable of withstanding the effect of the design loading and natural phenomena such as the safe shutdown earthquake (SSE), tornadoes, tornado missiles, hurricanes, and the probable maximum flood (PMF) considering Sections 3.3, 3.4, 3.5, and 3.7. Site-specific UHS design features to address limiting hydrology-related events are addressed as required by DCD Section 2.4. The UHS is designed as seismic Category I structure meeting design acceptance following NRC RG 1.27.

The UHS is designed to prevent long-term fouling and mitigate short-term clogging anticipated at the site that may degrade system performance. [[The UHS basin screen is provided to prevent debris from entering the ESWS and located in water passage between the UHS cooling tower basin and ESW pump suction.]] The COL applicant is to provide chemicals and blowdown to prevent bio-fouling and long-term corrosion, considering site water quality in the UHS (COL 9.2(30)). Chemicals will include biocide, algaecide, pH adjuster, corrosion inhibitor, and silt dispersant.

[[Failure modes and effects analysis (FMEA) of the UHS is described in Table 9.2.5-4. FMEA is to provide reasonable assurance that redundancy of the UHS system function exists in case of single failure.]]