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. 09.02.01-1

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.

Per SRP Section 9.2.1, Subsection III.1, the essential service water system (ESWS) description was reviewed for its design adequacy. The staff finds some inadequacies in the DCD Tier 2 ESWS description.

The applicant is requested to provide additional detail on the following issues. DCD Tier 2 should be modified accordingly:

a) DCD Tier 2, Section 9.2.1.2.1 indicates that ESW pumps are located in the ESW building. However, ESW pump coolers and ESW building coolers are not addressed. Discuss the design of the ESW pump coolers and building coolers to maintain safety function of the ESWS pumps.

b) In DCD Tier 2, Table 9.2.1-2, “ESWS Failure Modes and Effects Analysis,” ESW pump discharge isolation MOVs SX-045, -046, -047, -048 are not included. Include these MOVs in the table.

c) In DCD Tier 2, Table 9.2.1-2, “ESWS Failure Modes and Effects Analysis,” check valves in pump discharge V1001, V1002, V1003, V1004 are identified. However, the valve numbers are inconsistent with the numbers listed in DCD Tier 1, Table 2.7.2.1-2, “Essential Service Water System Components List,” which shows the valve numbers of SX-1001 through 1004 for the check valves in pump discharge. Clarify the inconsistency of the valve numbering between these two tables.

d) Discuss the ESWS pump discharge MOV logic for opening and closing during any accident conditions. Describe the results if the MOV does not open with the pump operating, which system alarms in the MCR could provide operators information, and what the operator could do to mitigate the consequences.

e) DCD Tier 1 Section 2.7.2.1.1, Item 8.d states that all displays and alarms exist in the remote shutdown room (RSR) as defined in Tables 2.7.2.1-2 and 2.7.2.1-3. Tier 2 of the DCD Section 9.2.1 does not indicate any instrument and control for monitoring or control in the RSR. Tier 2 information should include all Tier 1 information. Provide in DCD Tier 2 a description of the ESWS instrument and control in the RSR.

f) The DCD does not discuss valve isolation and other means (such as procedures) that would be used to isolate the leakage in the event of radioactive leakage from the CCWS to ESWS. Provide a discussion to address the isolation of the radioactive contamination event in accordance with SRP Section 9.1 Subsection III.3.D.

Response

a) The ESW pump is not equipped with a pump cooler, but the ESW pump is air cooled by the room air, which is controlled by the ESW building HVAC system. The ESW building HVAC system design is a COL item as described in DCD Tier 2, Subsection 9.4.5.

b) The failure mode and effect for the SX-045, 046, 047, and 048 will be added into Table 9.2.1-2.

c) The valve number in Table 9.2.1-2 will be changed from V1001, V1002, V1003, and V1004 to SX-1001, SX-1002, SX-1003, and SX-1004.

d) The ESWS pump discharge MOVs are locked-open valves, and the valves are remained in the open position during normal operation and during any accident condition. If any malfunction in the MOV, located downstream of the operating pump in a division, occurs and leads the MOV to be closed, then it could affect the cooling function of component cooling water (CCW) heat exchangers in that division of the CCW system. However, since there are alarms in the MCR that would alert the operator of any trouble with the MOV, the operator can take adequate actions, such as stop the operating pump and initiate the operation of the other pump in the same division, in order to achieve the safety function of the ESWS.

e) All ESWS instrument and control in the MCR is also provided in the RSR. For clarification Subsection 9.2.1 will be revised.

f) In order to address the isolation of the radioactive containment event for ESWS, DCD Tier 2 Subsection 9.2.1.2.4 will be revised, and a COL item will be added.

Impact on DCD

Table 1.8-2, Subsection 9.2.1.2.4, and 9.2.10 of DCD Tier 2 will be revised as indicated in attachment 1 and 3. And, the RSR in Subsection 9.2.1 of DCD Tier 2 will be added as indicated in the Attachment 2.

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.

SX-1001, SX-1002, SX-1003, SX-1004

Table 9.2.1-2

SX-3101, SX-3103

Essential Service Water System Failure Modes and Effects Analysis

Components	Failure Mode/Cause	Effect on System	Method of Detection	Inherent Compensating Provision
ESW Pumps PP01A, PP01B, PP02A, PP02B	One pump inoperable/ mechanical or electrical failure	None; a redundant pump is available.	Motor status and flow indication in the MCR	Two redundant divisions are provided.
ESW debris filters and backwash isolation valves FT01A, FT01B, FT02A, FT02B, FT03A, FT03B, ~~V3101, V3103~~	One debris filter or one backwash isolation valve is inoperable in a mechanical or electrical failure	None; a redundant debris filter and backwash isolation valve are available.	Debris filters differential pressure is alarmed in MCR	Two redundant divisions are provided, and debris filters and valves are started manually.
Check ~~valve~~ in pump discharge ~~V1001, V1002, V1003, V1004~~	Check valve stays closed/mechanical failure	None; a redundant division is available.	Flow and pressure indication in MCR	Two redundant divisions are provided.
ESW pump discharge isolation valves SX-045, SX-046, SX-047, SX-048	Valve fails to open/ mechanical or electrical failure	None; a redundant division is available	Flow and pressure indication in MCR	Two redundant divisions are provided

valves

Added

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.]]

[[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.]] 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.

MCR and RSR

The ESWS together with the UHS is designed to minimize the potential for water hammer by implementing the features described in NUREG-0927 (Reference 10). Vents are installed at high points, and drains are installed at low points in the ESWS. Vents are located to provide reasonable assurance that the piping is filled with water to reduce the potential for water hammer after pump starts. When a division is restarted after shutdown of the division, one pump in the division is initially energized to fill the system with water. Because the system is initially empty, the pump discharge valve is throttled to prevent the pump from the runout condition and water hammer. In addition, pump discharge valve opening/closing times are selected to minimize water hammer effects when a pump is switched to standby pump operation in the same division or when a standby pump starts due to operating pump trip or control signal.

The ESW pipe layout also minimizes water hammer. To prevent the void formation in the pipe and to minimize water hammer, ESW piping continuously goes up from the pump discharge to the UHS. The COL applicant is to develop procedures for system filing, venting, and operational procedures to minimize the potential for water hammer; to analyze the system for water hammer impacts; to design the piping system to withstand potential water hammer forces; and to analyze inadvertent water hammer events in accordance with NUREG-0927 in the ESWS (COL 9.2(1)). The COL applicant is to develop the layout of the site-specific portion of the system to minimize the potential for water hammer in the ESWS (COL 9.2(2)).

Low pressure signal of ESW pump discharge header is interlocked to enable the automatic start of the standby ESW pump. A low pressure signal of ESW pump discharge header caused by failure or tripping of ESW operating pump is alarmed in the ~~MCR~~. When the low pressure alarm of ESW pump discharge header is annunciated, the standby ESW pump automatically initiates to provide reasonable assurance that heat is removed continuously.

MCR and RSR

UHS water chemistry management to minimize the degradation of ESWS is described in Subsection 9.2.5.

9.2.1.2.2 Component Description

Table 9.2.1-1 lists component design parameters. Each component is also described in the following sections.

9.2.1.2.2.1 ESW Pumps

MCR and RSR

Four identical ESW pumps, two per division, are provided. Manual start and stop actuations of the ESW pumps are provided from the ~~MCR~~ to override automatic actuation. Each pump provides 100 percent of the required flow for post-loss-of-coolant-accident (LOCA) conditions. During normal plant operation, one pump per division is operational. The second pump in the respective division starts automatically on a low pump discharge pressure signal that indicates a failure of the operating pump.

The pumps are of the vertical turbine type and are installed in the ESW building. The pump motors are powered from its associated division of the Class 1E ac power distribution system. In the event of loss of offsite power (LOOP), the pumps are stopped and restarted in accordance with the emergency diesel generator (EDG) load sequencing.

The capacity of the ESW pumps is based on the following operating mode requirements:

Normal power operation	One pump in each division
Normal shutdown	Four pumps in both divisions
Safe shutdown	One pump in a single division
Post-LOCA	One pump in a single division

During normal power operation, the standby pumps may also be in service during hot summer weather as heat load or temperature of basin water in the UHS increases.

Each ESW pump is designed to provide 75,708 L/min (20,000 gpm) flow at the required total dynamic head (TDH).

The ESW pumps are provided with at least 7 percent margin in head at the pump design point. The pump head continuously rises as flow decreases from the design point to shutoff.

The available NPSH is based on the lowest probable water level in the UHS basin and the basin water design temperature at the end of the 30-day-accident mitigation without makeup. The COL applicant is to (1) determine the required pump design head, using

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.

MCR and RSR

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.

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.]]

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.

9.2.1.2.3.3 Refueling Operation

Four ESW pumps and six CCW heat exchangers in both divisions are in service during refueling. The RCS is at a refueling temperature of 48.89 °C (120 °F) within 96 hours after reactor shutdown.

9.2.1.2.3.4 Emergency Operation

One ESW pump and two CCW heat exchangers in a division operate in a single failure of the other division during emergency operating conditions such as a LOCA or a safe shutdown with a LOOP.

9.2.1.2.3.5 Loss of Offsite Power

A LOOP results in the shutdown and restarting of the ESW pumps in accordance with the EDG load sequencing. EDG load sequencing is addressed in Subsection 8.3.1.

9.2.1.2.4 Design Features for Minimization of Contamination

The ESWS is designed with features that meet the requirements of 10 CFR 20.1406 (Reference 8) and NRC RG 4.21 (Reference 9). The basic principles of NRC RG 4.21 and the methods of control suggested in the regulations are delineated into four design objectives and two operational objectives and are addressed in Subsection 12.4.2.

The ESWS consists of essential service water pumps and essential service water debris filters that are located away from any radiological areas. With the exception of the CCW heat exchangers, the ESWS is designed to avoid contact with potentially radiologically contaminated components. Additionally, the CCW heat exchangers are plate type and constructed of titanium material, which minimizes the potential for pinhole leaks. The heat exchanger seals are designed to leak toward the outside of the heat exchangers where leakage is collected in the building sump. A radiation monitor is provided at the outlet of the CCW heat exchangers to detect any radioactive leakage from the CCWS to the ESWS. The monitor is indicated and alarmed in the ~~MCR~~. Based on the design and its low potential for contamination, the ESWS design is in compliance with the requirements of NRC RG 4.21.

MCR and RSR

The COL applicant is to conduct periodic inspections, monitoring, maintenance, performance testing, functional testing, and verification of the function of the ESWS pipes and components such as the heat transfer capability of the CCW heat exchangers based on GL 89-13 and GL 89-13 Supplement 1 (Reference 17) (COL 9.2(8)).

9.2.1.4.1 Preoperational Testing and Inspection

Prior to initial plant startup, a comprehensive performance test as detailed in Section 14.2 is performed to verify the design performance of the system and individual components.

9.2.1.4.2 Inservice Testing and Inspection

a. System-level tests

After the plant is brought into operation, periodic tests and inspections of the ESW components and subsystems are performed to provide reasonable assurance of proper operation. Scheduled tests and inspections are necessary to verify system operability. A complete schedule of tests and inspections of the ESWS is detailed in the Technical Specifications in Chapter 16.

b. Component testing

In addition to the system-level tests, tests to verify proper operation of the ESW components are also conducted. These tests supplement the system-level tests by verifying acceptable performance of each active component in the ESWS.

Pumps and valves are tested in accordance with ASME Section XI. Various flow rate testing up to and including the design point of the ESW pumps can be performed.

9.2.1.5 Instrumentation Requirements

The ESW instrumentation facilitates automatic operation, remote control, and continuous indications of system parameters (i.e., ESW temperature and flow, both locally and in the ~~MCR~~).

MCR and RSR

Process indications and alarms are provided to enable the operator to evaluate the ESWS performance and detect malfunctions. ESW pump discharge pressure is monitored and alarms for abnormally low pressure due to a pump failure or a pipe break. The ESW discharge temperature from the CCW heat exchangers is monitored.

9.2.1.5.1 Pressure

Local pressure indication is provided for the ESW pump discharge pressure and ESW debris filters differential pressure. Pressure test points are provided for the CCW heat exchanger inlet and outlet pressures.

Indications of the ESW pump discharge pressure are provided in the ~~MCR~~. ESW pump low discharge pressure, ESW pump motor air filters high differential pressure, and ESW debris filter high differential pressure are alarmed in the ~~MCR~~. The respective standby ESW pump in each division automatically starts on a low ESW pump discharge pressure.

9.2.1.5.2 Temperature

MCR and RSR

~~MCR~~ and local indications are provided for the CCW heat exchanger outlet temperatures.

9.2.1.5.3 Flow

~~MCR~~ indication and alarm are provided for the ESW pump discharge common header flow.

9.2.1.5.4 Current

ESW pump motor currents are indicated in the ~~MCR~~.

9.2.1.5.5 ESWS Operational Logic

The ESWS operational logic, associated initiation and actuation controls, and instrumentation are summarized as follows:

a. Both divisions and all four ESW pumps start automatically when one or both of the following occur:

1) Manual start by the operator in the ~~MCR~~

2) Low ESW pump discharge pressure

MCR and RSR

b. Manual start and stop actuation from the ~~MCR~~ override the automatic mode. Manual start and stop controls are provided for each ESWS division to permit the removal of a division from operation after automatic operation actuation, if that division is not required.

c. The only components that are manually actuated by the ~~MCR~~ operator are the ESW pumps and the ESW pump discharge isolation valves. The other isolation valves except the check valves are either locked open or locked closed depending on plant status and requirements.

d. The ESW pumps operate in the following manner during emergency conditions:

1) Following an engineered safety features actuation signal (ESFAS), the operating ESW pumps remain running using normal power.

2) In the event of LOOP or LOOP coincident with a DBA, the ESW pumps stop running and restart in accordance with the EDG load sequencing. If the ESW pump chosen by the sequencer fails to start, the sequencer starts the other pump immediately.

3) Manual control of the ESW pumps remains functional during emergency conditions.

9.2.1.5.6 Radiation Monitor

Radiation monitors are located downstream of the CCW heat exchanger, and the radiation level signal is displayed locally and in the ~~MCR~~. When the radiation level exceeds the setpoint, an alarm is transmitted both locally and to the ~~MCR~~.

MCR and RSR

9.2.2 Component Cooling Water System

The component cooling water system (CCWS) is a closed-loop cooling water system that removes heat from the plant's essential and nonessential components that are connected to the CCWS. Heat transferred from these components to the CCWS is transferred to the essential service water system (ESWS) through the CCW heat exchangers and then rejected to the ultimate heat sink (UHS).

9.2.2.1 Design Bases

The CCWS is designed in accordance with the requirements of GDC 2, 4, 5, 44, 45, and 46.

9.2.2.1.1 Safety Design Bases

Safety design bases applicable to the CCWS are as follows:

a. The CCWS, in conjunction with the ESWS, is capable of removing heat from the essential components to provide reasonable assurance of a safe shutdown and cooling following a postulated accident coincident with a LOOP.

b. The CCWS, in conjunction with the ESWS, is capable of maintaining the temperature at the outlet of the CCW heat exchanger between 18.3 °C (65 °F) and 43.3 °C (110 °F) during a design basis accident with a LOOP pursuant to the requirements of GDC 44.

c. A single failure of any component in the CCWS does not impair the ability of the CCWS to meet its functional requirements of mitigating the consequences of an accident pursuant to GDC 44.

Table 1.8-2 (14 of 29)

Item No.	Description
COL 9.2(23)	The COL applicant is to specify the following UHS chemistry requirements for bio-fouling and chemistry control: 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.
COL 9.2(24)	The COL applicant is to verify the piping layout of the ESWS and UHS to prevent water hammer and 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(25)	The COL applicant is to develop maintenance and testing procedures to monitor debris buildup and flush out and to remove the debris in the UHS.
COL 9.2(26)	The COL applicant is to evaluate the potential wind and recirculation effects of cooling towers based on meteorological condition.
COL 9.2(27)	The COL applicant is to provide the material specifications for piping, valves, and fittings of the UHS system based on site-specific conditions and meteorological conditions.
COL 9.2(28)	The COL applicant is to provide the evaluation of maximum evaporation and other losses based on the site-specific conditions and meteorological conditions in the UHS.
COL 9.2(29)	The COL applicant is to provide the detailed evaluation for UHS capability with consideration of site-specific conditions and meteorological data in the UHS.
COL 9.2(30)	The COL applicant is to provide chemical and blowdown to prevent biofouling and long-term corrosion, considering site water quality in the UHS.
COL 9.2(31)	The COL applicant is to provide the inspection and testing of the UHS to demonstrate that fouling and degradation mechanisms applicable to the site are effectively managed to maintain acceptable heat sink performance and integrity.
COL 9.2(32)	The COL applicant is to provide the alarms, instrumentation, and controls required for the safety-related functions of the UHS.
COL 9.2(33)	The COL applicant is to develop the following procedures for the water system: filling, venting, keeping it full, and operating it to minimize the potential for water hammer. The COL applicant is also to analyze the system for water hammer impacts, design the piping system to withstand potential water hammer forces, and analyze inadvertent water hammer events in the ECWS in accordance with NUREG-0927.
COL 9.2(34)	The COL applicant is either to prepare or to include operational procedures and maintenance programs.
COL 9.2(35)	The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.
COL 9.2(36)	The COL applicant is to include a site-wide radiological environmental monitoring program to monitor both the horizontal and vertical variability of the onsite hydrogeology and the potential effects of the construction and operation of the plant.
COL 9.3(1)	The COL applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control.
COL 9.2(38)	The COL applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control in the ESWS.

Prevention/Minimization of Unintended Contamination

a. The ESW facility is designed not to be in close contact with radioactively contaminated components and is located away from contamination areas to prevent unintended contamination.

b. All openings at the pump house floor are sealed to prevent water entry and preclude the flooding of the ESW pumps and other safety-related equipment within the structure.

Adequate and Early Leak Detection

a. ~~Radiation monitors are provided to detect contamination after the exchanging heat with CCW heat exchangers. This design approach provides early detection of contamination.~~ replace with 'A' in next page

b. The ESWS is designed to be readily accessible for inspection and maintenance.

Reduction of Cross-Contamination, Decontamination, and Waste Generation

a. The heat exchangers are constructed with titanium material to minimize the potential for pinhole leaks.

b. The heat exchanger seals are designed to leak toward the outside of the heat exchangers where leakage is collected in the building sump.

c. A sump is provided for collection of any leakage. The sump is designed with steel liners and is equipped with level instruments to initiate alarm signal for operator actions.

Decommissioning Planning

a. The ESWS is designed for the full service life and is fabricated as individual assemblies for easy removal.

A

Two radiation monitors, one for each division, are provided to continuously monitor contamination levels downstream of the CCW heat exchangers and indicate radiation activity in the MCR. In the event that radiation is detected above the pre-determined limit, an alarm is initiated by one of the monitors for operator action. Because the ESWS is segregated into two independent and parallel divisions, each division can be isolated for inspection, mitigation, and maintenance. This design approach provides early leak detection and minimizes the spread of contamination to other components, the facility, and the environment.

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

c. The COL applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control in the ESWS (COL 9.2(38)). Procedures and maintenance programs are to be completed before fuel is loaded for commissioning.

COL 9.2(31) The COL applicant is to provide the inspection and testing of the UHS to demonstrate that fouling and degradation mechanisms applicable to the site are effectively managed to maintain acceptable heat sink performance and integrity.

COL 9.2(32) The COL applicant is to provide the alarms, instrumentation, and controls required for the safety-related functions of the UHS.

COL 9.2(33) The COL applicant is to develop the following procedures for the water system: filling, venting, keeping it full, and operating it to minimize the potential for water hammer. The COL applicant is also to analyze the system for water hammer impacts, design the piping system to withstand potential water hammer forces, and analyze inadvertent water hammer events in the ECWS in accordance with NUREG-0927.

COL 9.2 (34) The COL applicant is either to prepare or to include operational procedures and maintenance programs.

COL 9.2 (35) The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.

COL 9.2(36) The COL applicant is to include a site-wide radiological environmental monitoring program to monitor both the horizontal and vertical variability of the onsite hydrogeology and the potential effects of the construction and operation of the plant.

9.2.11 References

1. 40 CFR Part 141, “National Primary Drinking Water Regulations,” Environmental Protection Agency.

2. 29 CFR 1910, “Occupational Safety and Health Standard,” Occupational Safety and Health Administration.

3. ASME B31.1-2010, “Power Piping,” The American Society of Mechanical Engineers, 2010.

COL 9.2(38) The COL applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control in the ESWS.

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. 09.02.01-3

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.

Per SRP Section 9.2.1, Subsection III.1, the ESWS description was reviewed for the design adequacy of the ESWS.

DCD Tier 2, Section 9.2.1.2.2.2 states that

> “piping is carbon steel pipe or internally lined carbon steel pipe depending on the ESW chemistry. Cathodic protection is applied to the pipe depending on the ESW chemistry.”

Such information about the ESWS piping is identified as conceptual design information, which the application does not seek certification.

The staff finds the application lacking a COL information item with detailed information about the materials that are being used for the ESWS piping.

The applicant is requested to establish a COL information item providing detailed information concerning materials that will be used for the ESWS including the basis for determining that the materials being used are appropriate for a given COL site location and for the fluid properties that apply.

Response

The ESW piping material is classified as a COL information item because it is determined in consideration of the COL site condition and fluid properties.

DCD Tier 2, Table 1.8-2, Subsection 9.2.1.2.2.2 and Subsection 9.2.10 will be revised to add the COL information item providing detailed information for ESW piping material.

Impact on DCD

DCD Tier 2, Table 1.8-2, Subsection 9.2.1.2.2.2 and Subsection 9.2.10 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.

Table 1.8-2 (14 of 29)

Item No.	Description
COL 9.2(23)	The COL applicant is to specify the following UHS chemistry requirements for bio-fouling and chemistry control: 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.
COL 9.2(24)	The COL applicant is to verify the piping layout of the ESWS and UHS to prevent water hammer and 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(25)	The COL applicant is to develop maintenance and testing procedures to monitor debris buildup and flush out and to remove the debris in the UHS.
COL 9.2(26)	The COL applicant is to evaluate the potential wind and recirculation effects of cooling towers based on meteorological condition.
COL 9.2(27)	The COL applicant is to provide the material specifications for piping, valves, and fittings of the UHS system based on site-specific conditions and meteorological conditions.
COL 9.2(28)	The COL applicant is to provide the evaluation of maximum evaporation and other losses based on the site-specific conditions and meteorological conditions in the UHS.
COL 9.2(29)	The COL applicant is to provide the detailed evaluation for UHS capability with consideration of site-specific conditions and meteorological data in the UHS.
COL 9.2(30)	The COL applicant is to provide chemical and blowdown to prevent biofouling and long-term corrosion, considering site water quality in the UHS.
COL 9.2(31)	The COL applicant is to provide the inspection and testing of the UHS to demonstrate that fouling and degradation mechanisms applicable to the site are effectively managed to maintain acceptable heat sink performance and integrity.
COL 9.2(32)	The COL applicant is to provide the alarms, instrumentation, and controls required for the safety-related functions of the UHS.
COL 9.2(33)	The COL applicant is to develop the following procedures for the water system: filling, venting, keeping it full, and operating it to minimize the potential for water hammer. The COL applicant is also to analyze the system for water hammer impacts, design the piping system to withstand potential water hammer forces, and analyze inadvertent water hammer events in the ECWS in accordance with NUREG-0927.
COL 9.2(34)	The COL applicant is either to prepare or to include operational procedures and maintenance programs.
COL 9.2(35)	The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.
COL 9.2(36)	The COL applicant is to include a site-wide radiological environmental monitoring program to monitor both the horizontal and vertical variability of the onsite hydrogeology and the potential effects of the construction and operation of the plant.
COL 9.3(1)	The COL applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control.

COL 9.2(37) The COL applicant is to provide the detailed information for the ESWS piping material including the basis for determining that the materials being used are appropriate for a given site location and for the fluid properties that apply.

pressure drop from the certified design portion of the plant and adding site-specific head requirements, (2) determine the pump shutoff head to establish system design pressure, which does not exceed APR1400 system design pressure, and (3) evaluate the potential for vortex formation at the pump suction based on the most limiting applicable conditions in the ESWS (COL 9.2(3)).

9.2.1.2.2.2 Piping, Valves, and Fittings

~~[[Piping is carbon steel pipe or internally lined carbon steel pipe depending on the ESW chemistry. Cathodic protection is applied to the pipe depending on the ESW chemistry.]]~~ Piping is designed, fabricated, installed, and tested in accordance with the ASME Section III, Class 3, requirements for the safety-related portion. ~~Materials whose adequacy has been proven by a test at compatible operating temperatures with similar water chemistry are used for components and piping in this system.~~

The piping and components within a division are physically separated from those in the other division. The ESW piping to the CCW heat exchanger building is routed through a seismic Category I reinforced concrete pipe tunnels buried in the yard. The ESW piping to the UHS structures is routed through a seismic Category I reinforced concrete pipe tunnel. Access manholes are provided for periodic inspection.

Vents are installed at high points, and drains are installed at low points in the ESWS to allow proper filling and venting.

An isolation valve is installed on each CCW heat exchanger and debris filter inlet and outlet line. The ESW pump discharge isolation valves are interlocked with the ESW pumps. The ESW pump discharge isolation valves are preset to a partially open position before the pump startup to minimize water hammer effects.

Butterfly valves in the ESWS piping are not used to throttle the water flow excessively to avoid potential downstream pipe wall thinning. The valves are sized to be fully open during the various modes of operation. The opening margins of valve are considered to provide reasonable assurance of the design flow during all mode of operation.

The COL applicant is to provide the detailed information for the ESWS piping material including the basis for determining that the materials being used are appropriate for a given site location and for the fluid properties that apply (COL 9.2(37)).

COL 9.2(31) The COL applicant is to provide the inspection and testing of the UHS to demonstrate that fouling and degradation mechanisms applicable to the site are effectively managed to maintain acceptable heat sink performance and integrity.

COL 9.2(32) The COL applicant is to provide the alarms, instrumentation, and controls required for the safety-related functions of the UHS.

COL 9.2(33) The COL applicant is to develop the following procedures for the water system: filling, venting, keeping it full, and operating it to minimize the potential for water hammer. The COL applicant is also to analyze the system for water hammer impacts, design the piping system to withstand potential water hammer forces, and analyze inadvertent water hammer events in the ECWS in accordance with NUREG-0927.

COL 9.2 (34) The COL applicant is either to prepare or to include operational procedures and maintenance programs.

COL 9.2 (35) The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.

COL 9.2(36) The COL applicant is to include a site-wide radiological environmental monitoring program to monitor both the horizontal and vertical variability of the onsite hydrogeology and the potential effects of the construction and operation of the plant.

COL 9.2(37) The COL applicant is to provide the detailed information for the ESWS piping material including the basis for determining that the materials being used are appropriate for a given site location and for the fluid properties that apply.

9.2.11 References

1. 40 CFR Part 141, “National Primary Drinking Water Regulations,” Environmental Protection Agency.

2. 29 CFR 1910, “Occupational Safety and Health Standard,” Occupational Safety and Health Administration.

3. ASME B31.1-2010, “Power Piping,” The American Society of Mechanical Engineers, 2010.

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. 09.02.01-4

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.

GDC 2 requires that the ESWS SSCs providing essential cooling for safety-related equipment be designed to withstand the effects of seismic events.

The staff finds that DCD Tier 2, Section 9.2.1 lacks information such as demonstrating how the ESWS conforms to Position C.2 in RG 1.29 where the failure of nonsafety-related SSCs would not result in the failure of safety-related SSCs. Also missing is the identification of the boundary isolation valves separating the nonsafety- from the safety-related portions of the ESWS.

The applicant is requested to demonstrate that the ESWS conforms to RG 1.29 Position C.2 including the identification of boundary isolation valves. These valves should be listed in DCD Tier 2, Table 3.2-1, with their safety classification and seismic qualification. Also requested is a clarification on whether these boundary isolation valves are included for inservice testing and inspection.

Response

The ESWS, is designed to Safety Class 3 and Seismic Category I with the exception of the piping provided below, which is non-safety related and designed to Seismic Category II.

- ESW blowdown piping excluding the isolation valve SX-1063, SX1065 in the division I, and SX-1064, SX-1066 in the division II

- Radiation monitoring piping excluding the isolation valve SX-2071, SX-2073 in the division I, and SX-2072, SX-2074 in the division II

- Backwash discharge piping excluding the isolation valve SX-3102 and SX-3104

Based on the above,

The safety related SSCs in the ESWS are designed to Seismic Category I and non-safety related SSCs are designed to Seismic Category II, not Seismic Category III. Therefore, the failure of non-safety related SSCs would not result in the failure of safety-related SSCs.

The boundary isolation valves separating the non-safety related portions from the safety related portions are SX-1063 thru 1066, SX-2071 thru 2074, SX-3102 and 3104. These valves are classified safety related and Seismic Category I.

The boundary isolation valves are not included for in-service testing and inspection, because they are used only for system or component maintenance, in accordance with ASME ISTC code requirements.

DCD Tier 1, Table 2.7.2.1-1, and Tier 2, Table 3.2-1 will be revised to clarify the safety classification and seismic qualification for ESWS SSCs through the response to RAI 211-8236 Question 9.2.1-2.

Figure 9.2.1-1 will be revised to indicate the classification break of the piping portion to the radiation monitoring system.

Impact on DCD

Figure 9.2.1-1 will be revised as indicated on 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.

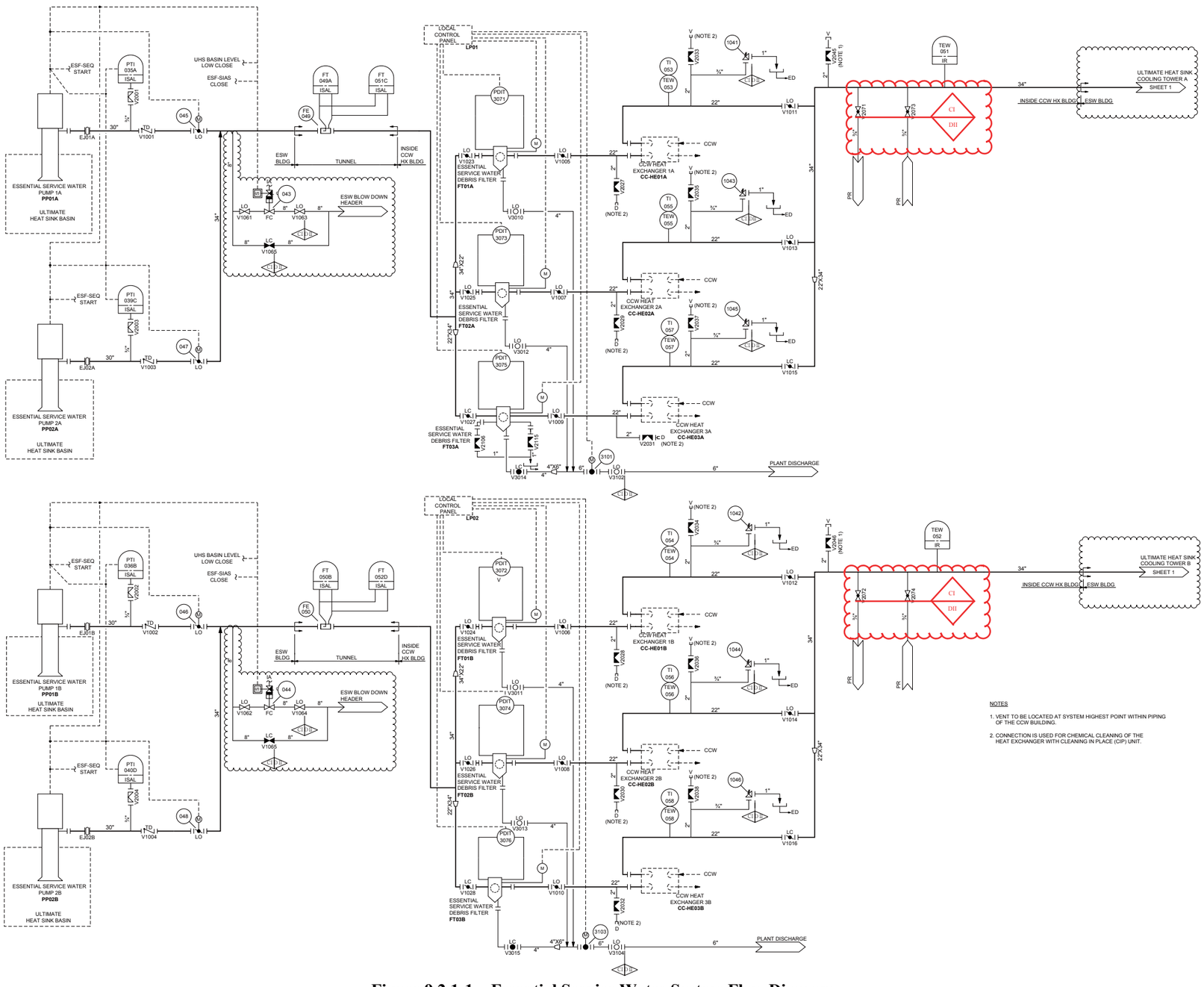

Figure 9.2.1-1 Essential Service Water System Flow Diagram

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. 09.02.01-5

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. SRP Section 9.2.1, Subsection II.2 indicates that the safety-related ESWS should be designed in accordance with GDC 4 to consider the environmental effects (such as flood hazards) of pipe failures. The safety-related ESWS is subject to flood protection, and is a water carrying system such that its failure could cause flood hazards.

The staff finds that DCD Tier 2, Section 9.2.1 is missing some important information regarding flooding.

The applicant is requested to describe:

a) How the system and components of ESWS are protected from internal and external flooding.

b) How the ESWS pumps are isolated in order to address the flooding protection.

c) What the design features are to mitigate the consequences of flooding from ESWS.

d) Why a failure of the ESWS piping would not result in the failure of its heat removal functional capability.

e) Why the failure of ESWS piping would not result in the internal flood hazards for other safety-related SSCs.

Response

a) The design basis flood level of the APR 1400 standard design is at least 0.3 m (1 ft) below the plant grade as specified in Table 2.0-1. All safety-related SSCs including ESWS components located on the dry site as defined in NRC RG 1.102 are protected from an external flood event as described in DCD Subsection 3.4.1.1. And, the COL applicant is to provide site-specific information on protection measures for the design basis flood, as described in COL 3.4(1).

   The internal flood analysis with protection and mitigation features of the site specific safety structures such as ESW building is to be provided by the COL applicant as described in COL 3.4(2).

b) The ESWS design consists of two independent 100% divisions, with two redundant pumps in each division. The divisions are located in two physically separated ESW/CCW Hx buildings as indicated in DCD Tier 2 Figure 1.2-1.Key characteristics of the protective provisions against internal flooding hazards are identified in ITAAC Table 2.2.5-1 and with COL 3.4(2) for the COL applicant to provide a flooding analysis with protection and mitigation features to address internal flooding. The external flooding is site specific and is to be addressed by the COL applicant (COL 3.4(1) and COL 3.4(3)).

c) The flood mitigation features from internal flooding are to be provided by the COL applicant as described in COL 3.4(2).

d) The ESWS consists of two totally independent 100% divisions, including two separate sets of pumps, piping, and instrument and control. The piping connecting from the ESW pumps, through the debris filters, CCW heat exchangers, to the UHS cooling towers, is independent and redundant. Hence, a single failure of the ESWS piping would not result in the failure of its heat removal functional capability.

e) All the ESWS components including the CCWS interface are located in the ESW/CCW Hx buildings. Components supporting safety-related SSCs are not in the ESW/CCW Hx buildings. The division isolation for the flooding protection is stated in the Response b).

Impact on DCD

There is no impact on the DCD.

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.