REVISED 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.:	**323-8281**
SRP Section:	**07.03 - Engineered Safety Features Systems**
Application Section:	
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Question No. 07.03-12

Provide design information on how the control functions are implemented for auxiliary safety systems to support safe shutdown functions, including essential service water system (ESWS), component cooling water system (CCWS), essential chilled water system (ECWS), Class 1E power system, and the heating, ventilation, and air conditioning (HVAC) system.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” Clause 5.12, "Auxiliary Features," of IEEE Std. 603-1991 requires auxiliary supporting features meet all requirements of IEEE Std. 603-1991, and Clause 8.1, "Electrical Power Sources," requires those portions of the Class 1E power system that are required to provide the power to the many facets of the safety system are governed by the criteria of IEEE Std. 603-1991.

The staff was not able to identify in Chapter 7 of APR1400 FSAR Tier 2 on how the control functions are implemented for auxiliary systems that support safe shutdown functions, such as ESWS, CCWS, ECWS, Class 1E power system, and HVAC system. Provide adequate design information accordingly in the application on how the control functions for those auxiliary systems are implemented to support the safe shutdown systems. In addition, describe the impact of the loss of HVAC for the safety-related I&C equipment and any mitigating measures to address such loss. This would include the amount of time for I&C equipment to fail due to rising temperatures.

Response – (Rev. 1)

Discrete control and modulation control functions for auxiliary safety systems such as essential service water system (ESWS), component cooling water system (CCWS), Class 1E power system, and heating, ventilation, and air conditioning (HVAC) system are implemented in the engineered safety features-component control system (ESF-CCS) loop controller (LC). Each

ESF-CCS LC cabinet is distributed in I&C equipment rooms or remote multiplexer rooms throughout the plant.

The manual component control of these auxiliary support systems is performed by divisionalized ESF-CCS soft control modules (ESCMs) which are located on the operator consoles and the safety console, or by the minimum inventory switches, which are located on the safety console. Also, the automatic control function is provided for these auxiliary support systems to ensure adequate auxiliary supporting features for the safety function. All components of the auxiliary support systems that are required for a safety function receive the engineered safety features (ESF) actuation signal from the ESF-CCS group controller (GC) for automatic actuation.

To meet the requirements of Clause 5.6, “Independence” of IEEE Std. 603-1991, the physical separation and electrical isolation of the divisions within the auxiliary support systems are provided. In general, the component in one division of the auxiliary support system does not receive an interlock signal from another division.

However, there are a few instances where the component in one division of the auxiliary support system receives an interlock signal from another division through hardwired signals with fiber optic isolation. The complete list of interdivisional hardwired signals in the ESF-CCS will be provided in a revised response to RAI 348-8279, Question 07.09-9.

The safety-related HVAC systems connected to the I&C equipment rooms or remote multiplexer rooms of each division maintain the mild (non-harsh) environments to meet the cabinet environmental design requirements specified in Table 7-2 of WCAP-16097-P-A, “Common Qualified Platform Topical Report”, Rev. 3.

The long-term loss of safety-related HVAC system may result in the loss of safety-related I&C equipment. However, divisional redundancy ensures that if there is a loss of safety-related I&C equipment that takes one safety division out of service, the second safety division will remain in service to perform the required safety function.

DCD Tier 2, Subsections 7.4.1 and 7.4.3 will be revised to include the information, as indicated in the attachment associated with this response.

Impact on DCD

DCD Tier 2, Subsections 7.4.1 and 7.4.3 will be revised as indicated in the attachment associated with this response.

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.

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b. Component cooling water system (CCWS)

c. Class 1E emergency diesel generator (EDG) system

d. Emergency diesel engine fuel storage and transfer system

e. Class 1E power system

f. Heating, ventilation, and air conditioning (HVAC) systems

7.4.1 System Description

~~Discrete control and modulation control functions for auxiliary safety systems are implemented in the engineered safety features-component control system (ESF-CCS) loop controller (LC).~~

The instrumentation, information displays, and controls of the auxiliary support system for safe shutdown are provided in the main control room (MCR) and are described in their respective system description sections. Information systems important to safety that are necessary to achieve safe shutdown are described in Section 7.5.

a. Auxiliary feedwater system

The safe shutdown features of these systems are described in Subsection 10.4.9. The I&C for the AFWS are described in Subsections 10.4.9.2.4 and 10.4.9.5.

b. Main steam system – atmospheric dump

The main steam atmospheric dump valves (MSADVs) are described in Subsection 10.3.2.2.4. The valves are located outside the containment upstream of the main steam isolation valves (MSIVs).

The valves are used to remove decay heat from the SG in the event that the main condenser is unavailable for certain reasons including loss of ac power. Under such a condition, the decay heat is removed by venting steam to the atmosphere. In this way, the RCS can either be maintained at hot standby conditions or cooled down.

The MSADV control circuits are designed so that no single failure prevents the operation of at least one valve on each SG.

c. Shutdown cooling system

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Discrete control and modulation control functions for these auxiliary support systems are implemented in the engineered safety features-component control system (ESF-CCS) loop controller (LC).

The manual component control of these auxiliary support systems is performed by divisionalized ESF-CCS soft control modules (ESCMs) which are located on the operator consoles and the safety console, or by the minimum inventory switches, which are located on the safety console. Also, the automatic control function is provided for these auxiliary support systems to ensure adequate auxiliary supporting features for the safety function. All components of the auxiliary support systems that are required for a safety function receive the ESF actuation signal from the ESF-CCS group controller (GC) for automatic actuation.

To meet the requirements of Clause 5.6, "Independence" of IEEE Std. 603-1991, the physical separation and electrical isolation of the divisions within the auxiliary support systems are provided. In general, the component in one division of the auxiliary support system does not receive an interlock signal from another division.

The shutdown cooling system (SCS) is described in Subsection 5.4.7. The SCS instrumentation and controls necessary to achieve and maintain cold shutdown are described below. The flow diagrams for SCS are shown in Figure 5.4.7-3 and Figure 6.3.2-1.

The SCS is designed to be manually initiated upon the attainment of the required reactor coolant system (RCS) conditions. The process instrumentation for MCR indication and status information are provided to enable the operator to determine system status, evaluate system performance, and detect malfunctions in the MCR. The control capability and valve position indication in the MCR are provided for the isolation valves and the heat exchanger inlet, outlet, and bypass valves. Indication is provided for low SCS pump discharge pressure and temperature, heat exchanger outlet temperature, and SCS flow and pressure. SCS pump operating status is also indicated in the MCR.

The SCS has overpressure protection interlocks as described in Section 7.6. The system sequencing is provided by the operating procedures available to the site operator for the manually controlled equipment. There are no bypasses in the SCS instrumentation that would jeopardize the protection afforded by the interlocks.

The SCS has two independent Class 1E power sources for their actuated equipment (e.g., pumps, valves). The SCS isolation valve interlocks are implemented via the ~~engineered safety features-component control system (ESF-CCS)~~ ESF-CCS using a redundant division configuration such that a single failure will not cause loss of shutdown cooling nor spuriously actuate it.

d. Safety injection system

Boron addition via the safety injection system (SIS) is used for the safe shutdown processes. The SIS I&C to achieve cold shutdown is described below.

The SIS logic and piping are provided in Section 7.3 and Figure 6.3.2-1.

1) Initiating circuits and logic

To aid in achieving cold shutdown, the required SIS component actuation steps are as follows:

7.4.2.6 System Drawings

The logic diagrams for the operations of the SCS are shown in Figures 7.6-1A, 7.6-1B, and 7.6-1C.

7.4.3 Analysis

7.4.3.1 Conformance with IEEE Std. 603 and IEEE Std. 7-4.3.2

Conformance with IEEE Std. 603 (Reference 2) and IEEE Std. 7-4.3.2 (Reference 3) is described in the Safety I&C System Technical Report (Reference 4).

7.4.3.2 Conformance with General Design Criterion 19

Conformance with GDC 19 is addressed in Subsection 3.1.15. Remote instrumentation enables hot standby to be achieved if the MCR is not habitable. Hot standby, as used here, means the reactor is subcritical at normal operating pressure and temperature. The reactor can be brought to cold shutdown outside the MCR by use of appropriate procedures, the RSC controls, and local controls.

7.4.3.3 Consideration of Selected Plant Contingencies

7.4.3.3.1 Loss of Instrument Air System

None of the essential control or monitoring instrumentation relies solely on instrument air. Where necessary, safety-related accumulator tanks are provided or the failure mode of pneumatic devices upon loss of air is designed to fail in the safe position. Therefore, loss of instrument air does not degrade the instrumentation and control associated with systems required for plant shutdown.

7.4.3.3.2 Loss of Cooling Water to Vital Equipment

Insert "A" on next page.

Loss of cooling water to vital equipment does not affect the safe shutdown function because the safety-related component cooling water system has two separate divisions of cooling water systems. Therefore, the loss of a single division does not hinder the safe shutdown function.

"A"

7.4.3.3.3 Loss of safety-related HVAC system

The safety-related HVAC systems connected to I&C equipment rooms or remote multiplexer rooms of each division maintain the mild (non-harsh) environments to meet the cabinet environmental design requirements.

A long-term loss of safety-related HVAC system may result in a loss of safety-related I&C equipment. However, divisional redundancy ensures that if there is a loss of safety-related I&C equipment that takes one safety division out of service, the second safety division will remain in service to perform the required safety function.

7.4.3.3.4

~~7.4.3.3.3~~ Plant Load Rejection, Turbine Trip, and Loss of Offsite Power

In the event of a LOOP associated with plant load rejection or turbine trip, the power for safe shutdown is provided by the EDGs. The EDGs provide power for operation of pumps and valves; the batteries or EDGs via the battery chargers provide power for operation of instrumentation and control systems required to actuate and control essential components.

7.4.3.3.5

~~7.4.3.3.4~~ Restrictive Setpoints

There are no restrictive setpoints for the APR1400.

7.4.4 Combined License Information

No combined license (COL) information is required with regard to Section 7.4.

7.4.5 References

1. Regulatory Guide 1.189, "Fire Protection for Nuclear Power Plants," Rev. 2, U.S. Nuclear Regulatory Commission, April 2009.

2. IEEE Std. 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 1991.

3. IEEE Std. 7-4.3.2-2003, "IEEE Standard Design for Digital Computers in Safety Systems of Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 2003.

4. APR1400-Z-J-NR-14001-P, "Safety I&C System," KHNP, November 2014.

5. 10 CFR 50.34(f)(2)(xx), "Power for Pressurizer Level Indication and Controls for Pressurizer Relief and Block Valves," [II.G.1], U.S. Nuclear Regulatory Commission.

6. 10 CFR 50.55a(a)(1), "Domestic Licensing of Production and Utilization Facilities, Codes and Standards, Quality Standards for systems Important to Safety," U.S. Nuclear Regulatory Commission.

7. 10 CFR 50.55a(h), "Codes and Standards, Protection and Safety Systems," U.S. Nuclear Regulatory Commission.