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.:	**356-7881**
SRP Section:	**Section: 07 - Instrumentation and Controls - Overview of Review Process**
Application Section:	**Section 7.0**
Date of RAI Issue:	**01/04/2016**

Question No. 07-4

Provide clarification on the term “Non-DCS” on Table 4.5-2 of Technical Report APR1400-Z-JNR-14012-P, Rev.0, “Control System CCF Analysis.”

10 CFR 50.55a(h)(3) requires compliance to IEEE Std 603-1991. IEEE Std 603-1991, Clause 5.6.3, states, in part, the safety system design shall be such that credible failure in and consequential actions by other systems, as documented in Clause 4.8 of the design basis section of this standard, shall not prevent the safety systems from meeting the requirements of this standard. Table 4.5-2 of Technical Report APR1400-Z-J-NR-14012-NP, describes the control groups of the non-safety I&C architecture that were arranged through functional and component segmentation. The turbine bypass system is described as being part of the nonsafety I&C distributed control system (DCS) platform. The turbine control system is designated as non-DCS. This designation is consistent with Table 5.2-1 of Technical Report APR1400-Z-JNR-14012-P. In addition, for the control group, “Miscellaneous BOP control”, the platform is designated as DCS/Non-DCS. The applicant does not appear to define the term “non-DCS” in this technical report or in Chapter 7 of the APR1400 DCD.

1. Define the term “Non-DCS” and what it means in terms of control system implementation.

2. Explain what miscellaneous BOP controls are implemented through the DCS and which BOP controls are non-DCS.

3. Identify the miscellaneous BOP controls.

4. Are there any control groups that do not have separate controllers, as shown on Table 5.2-1?

Response – (Rev. 1)

TS

Impact on DCD

APR1400 DCD Tier 2, Subsection 7.7.1.1 will be revised as indicated in Attachment 1 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

Table 5.2-1 of technical report APR1400-Z-J-NR-14012-NP, Rev. 0, “Control System CCF Analysis” will be revised as indicated in Attachment 2 associated with this response.

7.7.1.1 Control Systems

The non-safety control systems consist of the power control system (PCS) and the process-component control system (P-CCS). The PCS includes the reactor regulating system (RRS), the digital rod control system (DRCS), and the reactor power cutback system (RPCS). The P-CCS includes the NSSS process control system (NPCS) and balance of plant (BOP) control systems. The NPCS consists of the feedwater control system (FWCS), steam bypass control system (SBCS), pressurizer pressure control system (PPCS), pressurizer level control system (PLCS), and other miscellaneous NSSS control functions.

The control systems are implemented on a digital platform that is diverse in both hardware and software from the safety common platform. Control of physical and electronic access to digital computer-based control system software and data prevents changes by unauthorized personnel. Insert "A"(next page)

The reactivity feedback properties of the NSSS inherently cause reactor power to match the total NSSS load. The resulting reactor coolant temperature is a controlled parameter that is adjusted by changes in the total reactivity implemented through the control element assembly (CEA) position changes or through the boric acid concentration changes in the primary coolant.

The ability of the NSSS to follow the turbine load changes is dependent on the ability of the control systems or the operator to adjust reactivity, feedwater flow, bypass steam flow, reactor coolant inventory, and energy content of the pressurizer such that NSSS conditions remain within normal operating limits.

Except as limited by the xenon conditions, the major control systems described below provide the capability to follow the load changes automatically. These automatic systems also provide the capability to accommodate load rejections of any magnitude.

a. Reactivity control systems

   The reactor reactivity is controlled by adjustments of CEAs for rapid reactivity changes or by adjustment of boric acid concentration for slow reactivity changes. The boric acid is used to compensate for the long-term effects of fuel burnup and changes in fission product concentration.

RAI 356-7881 - Question 07-4_Rev.1

"A"

The control functions performed by non-safety control systems are assigned to separate control groups to enhance the plant availability. The main control groups are selected according to their important to availability control functions, such as turbine bypass control, feedwater control, pressurizer pressure/level control, reactor makeup control/reactor coolant pump (RCP) seal injection, control rod control, RCP control, non-1E alternating current (AC) power control, condenser vacuum control, turbine control, high pressure feedwater heater control. The other control functions that are not included in the main control groups are assigned to the miscellaneous BOP control group. The miscellaneous BOP control group includes: circulating water control, condensate pump control, condensate polishing control, low pressure feedwaer heater control, spent fuel pool cleaning control, radwaste control, extraction steam control, auxiliary steam control, non-safety HVAC control, non-essential chilled water control, instrument air control, service air control, alternate AC generator control, and deaerator control.

Table 5.2-1 Control Group Segmentation (Continued)

TS

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.:	**356-7881**
SRP Section:	**07 – Instrumentation and Controls – Overview of Review Process**
Application Section:	**7.0**
Date of RAI Issue:	**01/04/2016**

Question No. 07-13

Describe the environmental protections (e.g. high temperature equipment alarms or cooling) for the Power Control System (PCS), Process – Component Control System (P-CCS) and DAS.

10 CFR 50.55a(h)(3) requires compliance to IEEE Std. 603-1991. IEEE Std. 603-1991, Clause 5.6.3, states, in part, that the safety system design shall be such that credible failure in and consequential actions by other systems, as documented in Clause 4.8 of the design basis section of this standard, shall not prevent the safety systems from meeting the requirements of this standard. Standard review plan Section 7.7 states, in part, that I&C systems should include protection from environmental extremes. APR1400 FSAR Tier 2, Section 7.7.1.4.c, states that, for Information Processing System (IPS) cabinets, temperature switches and alarms exists to protect against high temperature conditions and to alert operators to the potential high temperature condition. Section 7.7 does not address similar design functionality for cabinets containing equipment that comprises the PCS, P-CCS and DAS. FSAR Tier 2, Section 9.4, "Heating, Ventilation and Air Conditioning Systems," does not appear to provide specific information on the cabinets for these systems as well.

1. Describe the environmental protection design attributes for the cabinets (and rooms that contain these cabinets) for the PCS, P-CCS and DAS systems (i.e. high temperature protections and alarms).

2. Do the safety I&C systems have similar equipment cabinet environmental protective design features as the non-safety equipment cabinets?

Response – (Rev. 1)

1. The non-Class 1E cabinets for power control system (PCS) and process- component control system (P-CCS) are designed and fabricated to operate without loss of function for the following environmental conditions of the room:

− Temperature (°F)	50-104 °F in auxiliary building area
	70-77 °F in non-safety I&C equipment rooms
	65-85 °F for DRCS power cabinets of PCS
− Relative humidity (%)	7-90 % in auxiliary building area
	40-60 % in non-safety I&C equipment rooms
	40-60 % for DRCS power cabinets of PCS
− Radiation (Gy)	Negligible

   The non-Class 1E cabinets for diverse protection system (DPS) and diverse indication system (DIS) are located in the non-safety I&C equipment rooms and are designed and fabricated to operate without loss of function for the following environmental conditions of the room:

− Temperature (°F)	70 – 77 °F
− Relative humidity (%)	40 – 60 %
− Radiation (Gy)	Negligible

   For these cabinets, the cooling and ventilation are provided by a fan mounted in the cabinet. Each cabinet contains a temperature sensor in the cabinet that is monitored. The fans are designed for continuous operation when the cabinet is powered. Though an alarm for loss of the fan is not provided, trouble alarms to indicate a high temperature in the cabinet are provided.

2. The Class 1E cabinets located in the main control room and safety I&C equipment rooms are designed and fabricated to operate without loss of function when exposed to the environmental design requirements specified in Table 6-1 of APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System.”

   The Class 1E cabinets located in the auxiliary building area, except main control room and safety I&C equipment rooms, are designed and fabricated to operate without loss of function when exposed to the following environmental conditions:

− Temperature (°F)	50-104 °F
− Relative humidity (%)	7-90 %

- Radiation (Gy) $\leq$ 10 Gy (Gamma)

For these cabinets, the cooling and ventilation are provided by a fan mounted in the cabinet. Each cabinet contains a temperature sensor in the cabinet that is monitored. The fans are designed for continuous operation when the cabinet is powered. Though an alarm for loss of the fan is not provided, trouble alarms to indicate a high temperature in the cabinet are provided.

Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” Section 6.1 will be revised to include the above design information that describes the protection design features of I&C cabinets.

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

Technical Report APR1400-Z-J-NR-14001-NP, Rev. 0, “Safety I&C System,” Section 6.1 will be revised, as indicated in the attachment associated with this response.

(3) Total integrated doses over equipment life time (40-yr TID Gy)

Insert "A" on the next page.

6.2 Seismic Qualification

The safety I&C system equipment is qualified by test, analysis or a combination of both methods to comply with the guidance of IEEE Std. 344-2004 as endorsed by RG 1.100. Functional operability tests are conducted during seismic qualification tests with the equipment energized and using simulated inputs and interfaces.

The safety I&C system is designated as seismic Category I meeting the guidance of RG 1.29. It is designed and qualified to maintain functional and physical integrity to withstand the cumulative effects of five (5) 1/2 SSE followed by one SSE. The 1/2 SSE and SSE at the safety I&C system cabinet and SC mounting points are characterized by the required response spectra , which envelope the I&C equipment room, multiplexer rooms and MCR SC.

The safety I&C system electro-mechanical components that have a significant aging mechanism, such as relays, are cycled to the end of operational life condition prior to qualification.

The seismic tests and/or analysis demonstrate that:

During the seismic events, no parts of the equipment will loosen, bend or crack in a manner that impairs proper operation. In addition, no parts of the equipment will become a missile hazard.
During and after the seismic event, the safety-related parameters of the equipment will be maintained.

6.3 EMI/RFI Testing

The safety I&C system equipment is qualified to comply with the guidance of MIL Std. 461E and IEC 61000 Part 4 Series as endorsed by RG 1.180. EMC testing of the equipment is performed for both conducted and radiated signals as follows:

- EMI/RFI emissions
- EMI/RFI susceptibility / immunity
- Surge withstand capability

The tests are performed on each system in various modes of operation such that successful completion of the test demonstrates that the safety system function has not been compromised and the equipment performs the function within its design specifications.

When conducting EMC equipment qualification, the test equipment represents the as-delivered configuration. The equipment grounding and power line filter are identical to the tested equipment.

The basis for selecting the specific tests and operating envelopes (test level, applicable frequency and limitations) is based on RG 1.180.

Non-Proprietary

RAI 356-7881 - Question 07-13_Rev.1

"A"

In regards to I&C cabinet protection design, the Class 1E cabinets located in the MCR and safety I&C equipment rooms are designed and fabricated to operate without loss of function when exposed to the environmental design requirements specified in Table 6-1.

The other Class 1E cabinets located in the auxiliary building area (except main control room and safety I&C equipment rooms) are designed and fabricated to operate without loss of function when exposed to the following environmental conditions:

- Temperature (°F)............................... 50 - 104 °F
- Relative humidity (%)......................... 7 - 90 %
- Radiation (Gy).................................. < 10 Gy (Gamma)

The non-Class 1E cabinets for DPS and DIS are located in the non-safety I&C equipment rooms and designed and fabricated to operate without loss of function for the following environmental conditions of the room:

- Temperature (°F)............................... 70 – 77 °F
- Relative humidity (%)......................... 40 – 60 %
- Radiation (Gy).................................. Negligible

The non-Class 1E cabinets for PCS and P-CCS are designed and fabricated to operate without loss of function for the following environmental conditions of the room:

- Temperature (°F)………………….…..... 50 - 104 °F in auxiliary building area
  70 - 77 °F in non-safety I&C equipment rooms
  65 - 85 °F for DRCS power cabinets of PCS
- Relative humidity (%)......................... 7 - 90 % in auxiliary building area
  40 - 60 % in non-safety I&C equipment rooms
  40 - 60 % for DRCS power cabinets of PCS
- Radiation (Gy).................................. Negligible

For these cabinets, the cooling and ventilation are provided by a fan mounted in the cabinet. Each cabinet contains a temperature sensor in the cabinet that is monitored. The fans are designed for continuous operation when the cabinet is powered. Though an alarm for loss of the fan is not provided, trouble alarms to indicate a high temperature in the cabinet are provided.