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## 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.:** 500-8634  
**SRP Section:** 09.05.01 – Fire Protection Program  
**Application Section:** 9.5.1 Fire Protection  
**Date of RAI Issue:** 07/01/2016

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### **Question No. 09.05.01-43**

This is a follow up to RAI 8246 Question 39, the February 17, 2016 phone call, and RAI 8566 Question 41.

10 CFR 52.47(a)(18) requires a DC application to contain a description and analysis of the fire protection design features for the standard plant necessary to comply with 10 CFR 50.48 and GDC 3 in 10 CFR part 50, Appendix A.

In DCD Tier 2, Section 9.5.1, “Fire Protection Program,” the applicant states:

“In addition, in the final fire hazard analysis (FHA) and fire safe shutdown analysis (FSSA) a detailed post-fire safe shutdown circuit analysis is included, using a methodology that is similar to NEI 00-01.”

The staff reviewed NEI 00-01, “Guidance for Post Fire Safe Shutdown Circuit Analysis,” Revision 2, and finds that this document does not consider the effects of heat and smoke on digital equipment or digital I&C cabinets.

During the February 5, 2015 meeting of the Advisory Committee on Reactor Safeguards (ACRS), (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15049A189), the issue of the possible effects of heat and smoke on digital equipment and digital I&C cabinets was discussed.

In the ACRS’s letter to the Commission concerning the February 5, 2015, meeting (ADAMS Accession Number ML15039A006) the ACRS stated:

“Fire hazard analyses have not thoroughly evaluated the possibility of fire-induced spurious actuations that may result from heat or fire damage to digital instrumentation and control signal cabinets, when external connections to those cabinets are made via fiber optic cables. Staff consideration of this as a generic issue would be prudent.”

In RAI 8246 Question 39, the applicant was requested to state whether the final fire hazards analyses will evaluate/consider the effects from spurious actuations that may be caused by heat from a fire inside or nearby cabinets that contain digital signal processing circuitry, if the external connections to those cabinets are made via fiber optic cables. If applicable, the applicant was requested to provide justification for not evaluating these effects.

The staff reviewed the applicant's response dated November 11, 2015 and noted that there was no mention of the approach that would be used in order to perform the final fire hazard analysis and fire safe shutdown analysis. During the February 17, 2016 phone call with the applicant, the staff explained why the response was not sufficient and what type of information was needed by the staff. The applicant requested a separate RAI be written on this issue. The staff issued RAI 8566 – Question 41 requesting the applicant:

1. Describe the approach that will be used to evaluate the effects from spurious actuations that may be caused by heat from a fire inside or nearby cabinets that contain digital signal processing circuitry, if the external connections to those cabinets are made via fiber optic cables.
2. Describe any defense in depth measures that are provided to minimize the possibility of damage to circuitry inside cabinets or mitigate the consequences of a spurious actuation, should one occur.

The staff reviewed the applicant's response dated June 2, 2016, and noted that there was no description of the approach that will be used to evaluate the effects from spurious actuations or any description of defense in depth measures.

## **Response**

1. To evaluate the effects from spurious actuations that may be caused by heat from a fire inside or nearby cabinets that contain digital signal processing circuitry, the following approach is considered.

Fiber optic cables are used in between various logic, processing, and control cabinets. A fire inside or nearby cabinet is considered to be able to interrupt the signal through a fiber optic cable but cannot cause a spurious hot short. In other words, fire-induced failure of the fiber optic cable can only be equivalent of an open circuit and not a hot short.

The digitalized I&C system have controllers for signal processes transmitted in the plant via fiber optic cables. Undesired or spurious signals may be carried through a fiber optic cable if that spurious signal was caused by a fire not involving that fiber optic cable. Fiber optic supporting the Digital Instrumentation and Controls System is logically assigned to equipment that requires a valid signal from the Main Control Room (MCR) to operate a specific equipment. Fiber optic cables are associated with active equipment and any equipment that may spuriously operate upon loss of the input signal.

In case of spurious signal caused by fiber optic cable, the fiber optic cable is considered with the design concept as described in the following response.

2. To provide assurance that a fire will not damage redundant trains of I&C systems, the following criteria were applied: 1) Maintain separation of at least 50 ft (15 m) between redundant trains of cabling; 2) In regions of high cable tray density, if 50 ft (15 m) separation could not be maintained, one train of cabling is protected with a 3-hr rated fire wrap; 3) Inside the annular secondary shield wall, most cabling is routed in conduit. If 50 ft (15 m) separation could not be maintained, one train of conduit is protected with a 1-hr rated fire wrap and/or embedded in walls/floors.

For the main control room (MCR) design, I&C for divisions I, II, III, and IV safe shutdown systems are located in the control room area. In the event of a fire in the MCR, a reactor trip is initiated and CEA insertion is verified prior to evacuation of personnel. Transfer switches for divisions I, II, III, and IV I&C systems will be located at the remote shutdown panel (RSP) and at each of the channelized I&C equipment rooms such that instrumentation and controls for safe shutdown systems can be transferred to the remote shutdown panel. This will isolate controls in the MCR, which will prevent spurious operation of equipment due to fire damage to control cables and switches in the control room. Thus, safe shutdown of the plant can be accomplished from the RSP room in conjunction with local operation of equipment as needed.

Four I&C equipment rooms for safety system cabinets and two I&C equipment rooms for non-safety systems cabinets also are located in each area in division I, II, III, and IV each with separation from one another.

In addition, the controllers in the cabinets have the interface with other communication modules located in other safety system cabinets within the same safety division through the safety data network (SDN)'s communication module with fiber optic modem. The communication modules use a single twisted pair of wires and separate fibers for transmitting and receiving data. The fiber optic modem converts signals to be transmitted twisted shield pair inputs to optical signals, and optical signals received into twisted shielded pair outputs. The drivers in the fiber optic modem are under the control of PROM with fixed programming. If the fiber optic modem is damaged due to fire within or from a nearby cabinet, and then the driver cannot be operated by PROM. Also, fiber optic cables have no electrical power potential, and the fiber optic modem has a switch for adjusting optical power for varying transmitting distances. Therefore, the damage including fiber optic modem due to fire cannot cause a spurious actuation.

The safety data link (SDL) serves the communication interface within and between four safety divisions. The fiber optic modems of the SDL are configured for unidirectional operation (i.e., each modem is used either to transmit or to receive data). Fiber optic cables have no electrical power potential, and the fiber optic modem has a switch for adjusting optical power for varying transmitting distances. Therefore, the damage including fiber optic modem due to fire does not cause in spurious actuation.

In case of fiber optic modem for discrete signals, the receiver fiber optic modem contains a Normally Opened (NO) and Normally Closed (NC) contact which is used to signal when a fiber optic signal is present. When a fiber optic signal is present, the relay contact will switch the NO and NC contacts. If the transceiver fiber optic modem is damaged by fire within or nearby the cabinet, the fiber optic signal will not be present,

and then relay contact also will not switch the relay contact. Therefore, the damage including fiber optic modem due to fire does not cause in spurious actuation.

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**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 Environmental Report.