# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**APR1400 Design Certification**

**Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD**

**Docket No. 52-046**

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| **RAI No.:** | **323-8281** |
| **SRP Section:** | **07.03 – Engineered Safety Features Systems** |
| **Application Section:** | **07.03** |
| **Date of RAI Issue:** | **11/30/2015** |

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## Question No. 07.03-7

Describe how the voting logic for both reactor trip and engineered safety features systems in the APR1400 design will be automatically changed when one channel identifies a single failure and a second channel is in maintenance bypass. Also describe where the maintenance bypass mode will be set and reset for a channel.

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." IEEE Std. 603-1991, Clause 6.7 requires, in part, that capability of a safety system to accomplish its safety function shall be retained while sense and command features equipment is in maintenance bypass. During such operation, the sense and command features shall continue to meet the requirements of Clauses 5.1 and 6.3.

APR1400 FSAR Tier 2, Sections 7.2 and 7.3, and Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, "Safety I&C System," identify two-out-of-four coincidence logic for safety I&C systems would be changed to a two-out-of-three control logic if one channel is tripped. However, there is lack of design information describing how the coincidence voting logic will be modified to meet the above regulatory requirements for both reactor trip and engineered safety features systems in the APR1400 design when one channel is in a maintenance mode and at the same time another channel is tripped. Also it is not clear in the application where the bypass mode will be set and reset for a channel. Describe how the voting logic would be altered for all reactor trip and ESF functions for cases of single failure, maintenance bypass, and both simultaneously. In addition, provide design information on where the maintenance bypass mode will be set and reset for a channel.

**Response**

[Response to ‘Describe how the voting logic would be altered for reactor trip and ESF functions for a single failure of one channel’]

Section 3.4.4 of the Safety I&C System technical report states that the prevention of a spurious trip due to a single failure is assured by 2-out-of-3 voting logic in conjunction with a channel bypass function.
Also, Section 7.2.2.1 of DCD Tier 2 states the 2-out-of-4 voting logic prevents a system-level spurious actuation due to any single failure.

In conclusion, a channel bypass is applied to the channel where a single failure has occurred to avoid spurious reactor trip and ESF initiation due to that channel, resulting in 2out-of-3 voting logic. If the channel bypass is not applied to the channel experiencing a single failure, then the resulting voting logic would remain as 2-out-of-4, if the single failure does not cause a spurious trip condition. However, the resulting voting logic would become 1-out-of-3 if the single failure causes a spurious trip condition.

[Response to ‘Describe how the voting logic would be altered for reactor trip and ESF functions for the maintenance bypass mode of one channel’]

Section 7.2.1.6 of DCD Tier 2 and Section 4.2.1.6 of the Safety I&C System technical report provide the design information that a trip channel bypass results in the system performing 2-out-of-3 coincidence logic.

[Response to ‘Describe how the voting logic would be altered for reactor trip and ESF functions for a single failure of one channel and the maintenance bypass mode of another channel’]

Based on the information presented above, the resulting voting logic would become 1-out-of-2 if the single failure of one channel causes a spurious channel trip condition while another channel is placed in bypass. However, the resulting voting logic would become 2-out-of-2 if a single failure does not cause a spurious channel trip condition while another channel is placed in bypass.
Most likely, a single failure of one channel occurs in either side of the two redundant PPS cabinets within one channel. If a single failure occurs in one PPS cabinet of that channel and does not cause a spurious channel trip condition, then the resulting voting logic would remain as 2-out-of-3 while another channel is placed in bypass because the other PPS cabinet of the channel with the single failure is capable of performing its safety function.

[Response to ‘Provide design information on where the maintenance bypass mode will be set and reset for a channel’]

The terms ‘maintenance bypass’ and ‘trip channel bypass’ are identical in meaning.
The following sections of the application documents provide information regarding where the maintenance bypass mode can be set and removed.

Section 4.2.1.6 of the Safety I&C System technical report provides the following:

"Trip channel bypass is activated by a hardwired trip channel bypass switch on the MTP switch panel. Trip channel bypass switches on the MTP switch panel in the MTP/ITP cabinet (MTC) are connected to the bistable processor (BP) digital input (DI) module."

Section 7.2.1.6 of the DCD Tier 2 provides the following:
"An individual trip channel bypass is possible on each MTP switch panel for each bistable trip. Trip channel bypass is used when removing a trip channel input from service for maintenance or testing."

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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.

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| **SRP Section:** | **7.3 - Engineered Safety Features Systems** |
| **Application Section:** | **7.3** |
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## Question No. 07.03-9

Clarify whether the ITAAC associated with equipment quality or qualification in APR1400 FSAR Tier 1, Tables 2.5.1-5, 2.5.3-3, and 2.5.4-4, include the Class 1E equipment in the scope of the Common-Q platform which will be used for the APR1400 system. Also, clarify whether type tests, analyses, or a combination of type test and analyses will be performed again for those types of Class 1E Common-Q equipment for plant-specific conditions or the qualification of the approved Common-Q platform will be credited during the closure stage of ITAAC.

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." IEEE Std. 603-1991, Clause 5.4, requires safety system equipment be qualified by type test, previous operating experience, or analysis, or any combination of these three methods, to substantiate that it will be capable of meeting, on a continuing basis, the performance requirements as specified in the design basis.

ITAAC associated with equipment quality or qualification in APR1400 FSAR Tier 1, Tables 2.5.1-5, 2.5.3-3, and 2.5.4-4, state, in part, that type tests, analyses, or a combination of type test and analyses will be performed for Class 1E equipment. Clarify whether the above ITAAC items include all Class 1E equipment in the scope of the Common-Q platform; whether type tests, analyses, or a combination of type test and analyses will be re-performed for all those types of Class 1E Common-Q equipment; and whether the qualification in the approved Common-Q platform will be credited for the APR1400 safety I&C system during the stage of ITAAC closure. Update the APR1400 FSAR Tier 1 and 2 accordingly.

## Response

The ITAAC associated with equipment quality or qualification in APR1400 DCD Tier 1, Tables 2.5.1-5, 2.5.3-3, and 2.5.4-4, includes all Class 1E equipment in the scope of the Common Q platform for the APR1400 system. The type tests, analyses, or combination of type test and analyses performed for all Class 1E equipment are not to be re-performed for the Common Q platform. The qualification of the NRC approved Common Q platform itself will be credited during the closure stage of the ITAAC.

To verify the installation of Common Q in accordance with the approved Common Q topical report, Section 2.5 of DCD Tier 1 and Section 7.1 of DCD Tier 2 will be revised, as the response of the Question No. 07.01-44 of the RAI 301-8280.

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**Impact on DCD**

Section 2.5 of DCD Tier 1, and Section 7.1 of DCD Tier 2 will be revised as indicated in the attachment associated with response to RAI 301-8280, Question 07.01-44.

**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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## Question No. 07.03-11

Provide design information on how the safety-related containment spray actuation signal (CSAS) is used in the four-channel safety I&C system to actuate the two trains of the containment spray system (CSS) and two shutdown cooling pumps.

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that information provided for each design basis item should be sufficient to enable the detailed design of the I&C system to be carried out, and all functional requirements for the I&C system and the operational environment for the I&C system should be described.

The logic diagram in Figure 7.3-5, "ESFAS Functional Logic (CSAS)," of APR1400 FSAR Tier 2 shows four divisions for the CSAS safety function. However, there are only two containment spray pumps used for the two containment spray trains, respectively. It is not clear in Section 7.3, "Engineered Safety Features Systems," of APR1400 FSAR Tier 2 how the two containment spray pumps are controlled. In addition, there is no design information in Section 7.3 of APR1400 FSAR Tier 2 on how the two shutdown cooling pumps will be controlled. Describe the control and interface of the containment spray and shutdown cooling pumps in relation to the safety-related I&C systems.

## Response

The containment spray actuation signal (CSAS) initiation signal is generated from all four plant protection system (PPS) divisions A, B, C, and D. The CSAS initiation signal is transmitted to the group controllers (GCs) in all four engineered safety features-component control system (ESF-CCS) divisions, as shown in Figure 7.3-5 of DCD Tier 2.

The GCs in each ESF-CCS division perform a selective 2-out-of-4 coincidence logic based on the CSAS initiation signal received from the PPS and transmit the CSAS actuation signal to the loop controllers (LCs).

The outputs of the LC in ESF-CCS divisions A, B, C, and D are then transmitted via the component interface module (CIM) to the division A, B, C, and D components, respectively. This is shown in Figure 7.3-5 of DCD Tier 2 and described in Subsection 7.3.1.7 of DCD Tier 2: “Each ESF-CCS division actuates the ESF components assigned in that division.”

As described in Subsection 6.5.2.1 of DCD Tier 2, the containment spray system (CSS) is designed to have two independent divisions; divisions C and D, each containing one containment spray pump. The containment spray pumps are actuated by a CSAS or a safety injection actuation signal (SIAS) from the ESF-CCS LC via a dedicated CIM.

Two shutdown cooling pumps which are assigned to independent divisions A and B are aligned to perform the containment spray function if the following three conditions are met simultaneously:

1. CSAS actuation or SIAS actuation
2. The containment spray pump is in trouble or disabled
3. The cross-connection valves of the containment spray/shutdown cooling pumps are not fully closed

The above information will be added to DCD Tier 2 Section 7.3.1.9.

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**Impact on DCD**

DCD Tier 2 Section 7.3.1.9 will be revised as indicated 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.

protective action and safety function. The CSS instrumentation and controls are designed to operate under all plant conditions.

The CSAS is removed from service prior to the containment leak test at refueling period in order to prevent undesired system actuation. The removal from service is accomplished in accordance with procedures prepared by the site operator.

The ESF-CCS design accommodates realignment of a spray pump for use as a shutdown cooling pump and vice versa.

c. Actuation systems on receipt of the main steam isolation signal

Section 10.3 contains the description of the main steam system (MSS). Subsection 10.4.7 contains the description of the feedwater system. Subsection 10.4.8 contains the description of the steam generator blowdown system (SGBS).

Insert the descriptions shown on the next page.

The actuation systems are composed of redundant divisions A and B. The instrumentation and controls of the valves in division A are physically and electrically separate and independent of the instrumentation and controls of the valves in division B. The separation and independence are such that a failure of one division does not impair the protective action and safety function.

The main steam isolation valves (MSIVs), MSIV bypass valves, main feedwater isolation valves (MFIVs), and the isolation valves for the SG blowdown lines are actuated by an MSIS.

These valves effectively isolate the SGs from the MSS, feedwater system, and SGBS.

A variable SG pressure setpoint is implemented to allow controlled pressure reductions, such as shutdown depressurization, without initiating an MSIS. The pressure setpoint tracks the pressure until it reaches its normal setpoint value.

d. Safety injection system

Section 6.3 contains the description of the safety injection system (SIS). The SIS is actuated by an SIAS. The actuation system is composed of redundant divisions A, B, C, and D. The instrumentation and controls of each division are independent. The SIS can sustain the loss of an entire division and still provide its required

Two containment spray pumps are assigned to divisions C and D independently, and they are actuated by CSAS or SIAS signals from the ESF-CCS LC via dedicated CIM. Two shutdown cooling pumps which are assigned to divisions A and B independently are aligned to perform the function of containment spray if the following three conditions are met at the same time:

1. CSAS actuation or SIAS actuation

2. The containment spray pump is in trouble or disabled

3. The cross-connection valves of the containment spray/shutdown cooling pumps are not fully closed