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.:	**317-8271**
SRP Section:	**14.03.05 – Instrumentation and Controls – Inspections, Tests, Analyses, and Acceptance Criteria**
Application Section:	**14.03.05**
Date of RAI Issue:	**11/17/2015**

Question No. 14.03.05-13

Identify the safety functions performed by each safety-related instrumentation and control (I&C) systems in the APR1400 Final Safety Analysis Report (FSAR) Tier 1 descriptions.

10 CFR 52.47(b)(1) requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and should operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations. NUREG 0800, Standard Review Plan (SRP) Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," (ITAAC) provides guidance on the type of information that should be provided in Tier 1 of the application in order to meet the requirements of 10 CFR 52.47(b)(1), including top-level information that describe the principal performance characteristics and safety functions of the structures, systems and components (SSCs). Based on the description of Tier 1 information included, the staff finds that additional information is needed to demonstrate that safety functions performed by I&C systems are adequately described. Specifically, the staff requests the applicant to include the safety functions performed by each safety-related I&C system in the APR1400 FSAR Tier 1 descriptions.

Response

The following description of the APC-S, CPCS, ENFMS, PPS, and RTSS safety functions will be added to Section 2.5.1.1 of DCD Tier 1:

> The APC-S provides signal conditioning/splitting for the safety field sensor signals and transmits the signals to safety systems (PPS, CPCS, QIAS-P, and ESF-CCS) and non-safety systems (NPCS, DPS, and DIS).

The CPCS monitors pertinent reactor core conditions and calculates Departure from Nucleate Boiling Ratio (DNBR) and Local Power Density (LPD). If the calculated DNBR goes below the pre-determined trip setpoint, a DNBR trip signal is generated. If the calculated LPD exceeds the pre-determined trip setpoint, an LPD trip is generated. The DNBR and LPD trip signals are sent to the PPS for reactor trip initiation.

The ENFMS provides signal conditioning for the detector signals and transmits the signals to the PPS and CPCS.

The PPS automatically generates signals for reactor trip and ESF initiation whenever the monitored processes exceed predefined limits or the LPD/DNBR trip signals are received from the CPCS.

The RTSS opens the reactor trip circuit breaker to shut down the reactor upon receiving the reactor trip initiation signal from the PPS.

The descriptions for the ESF-CCS and QIAS-P in DCD Tier 1 Section 2.5.4 and Section 2.5.3, respectively, currently provide adequate summary of the safety function.

Impact on DCD

Section 2.5.1.1 of DCD Tier 1 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.

2.5 Instrumentation and Control

2.5.1 Reactor Trip System and Engineered Safety Features Initiation

2.5.1.1 Design Description

The reactor trip system (RTS) consists of four channels of sensors, auxiliary process cabinet-safety (APC-S) cabinets, ex-core neutron flux monitoring system (ENFMS) cabinets, and four divisions of core protection calculator system (CPCS) cabinets, the reactor protection system (RPS) portion of plant protection system (PPS) cabinets, and reactor trip switchgear system (RTSS) cabinets.

The engineered safety features (ESF) system consists of four sensors, APC-S cabinets, and four divisions of the engineered safety features actuation system (ESFAS) portion of the PPS cabinets and engineered safety feature-component control system (ESF-CCS) cabinets. The ESF initiation is performed in sensors, APC-S cabinets and the ESFAS portion of the PPS cabinets.

The Subsection 2.5.1 describes the RTS and ESF initiation. The ESF-CCS is described in Subsection 2.5.4.

The RTS and ESF initiation equipment is located in the auxiliary building and reactor containment building.

Insert the descriptions of the next page.

The operator module (OM), the maintenance and test panel (MTP), and the interface and test processor (ITP) which are part of the safety I&C system, provide monitoring and testing for the safety-related plant components and instrumentation.

The RTS and ESF initiation is designed as follows:

1. The seismic Category I equipment, identified in Table 2.5.1-1 withstand seismic design basis loads without loss of safety function.

2. The Class 1E equipment identified in Table 2.5.1-1 withstand the electrical surge, electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.

The APC-S provides signal conditioning/splitting for the safety field sensor signals and transmits the signals to safety systems (PPS, CPCS, QIAS-P and ESF-CCS) and non-safety systems (NPCS, DPS and DIS).

The CPCS monitors pertinent reactor core conditions and calculates Departure from Nucleate Boiling Ratio (DNBR) and Local Power Density (LPD). If the calculated DNBR goes below the pre-determined trip setpoint, a DNBR trip signal is generated. If the calculated LPD exceeds the pre-determined trip setpoint, an LPD trip is generated. The DNBR and LPD trip signals are sent to the PPS for reactor trip initiation.

The ENFMS provides signal conditioning for the detector signals and transmits the signals to the PPS and CPCS.

The PPS automatically generates signals for reactor trip and ESF initiation whenever the monitored processes exceed predefined limits.

The RTSS opens the reactor trip circuit breaker to shut down the reactor upon receiving the reactor trip initiation signal from the PPS.

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Application Section:	**14.03.05**
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Question No. 14.03.05-14

Provide design descriptions and corresponding inspections, tests, analyses, and acceptance criteria (ITAAC) to verify the as-built plant protection system (PPS) is provided with the minimum number and locations of sensors required for protective variables that have spatial dependence.

10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for design certifications 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 4.6, states that for those variables in Clause 4.4 that have a spatial dependence (that is, where the variable varies as a function of position in a particular region), the minimum number and locations of sensors required for protective purposes shall be identified. The staff could not identify design descriptions and corresponding ITAAC in APR1400 FSAR Tier 1 to verify the as-built PPS is provided with the minimum number and locations of sensors required for protective variables that have spatial dependence to meet the requirements of IEEE Std. 603-1991, Clause 4.6. As such, the staff requests the applicant to provide this information in Tier 1 of the APR1400 FSAR.

Response

As described in Item 6 of A.4 in the Safety I&C System technical report, the number and location of the sensors provided to monitor those variables specified in Clause 4.4 of IEEE Std. 603-1991 are given in Tables 7.2-3 and 7.3-4 of the DCD Tier 2.

A design description and its corresponding ITAAC item will be added to DCD Tier 1 Section 2.5.1 for identification of the number and locations of the sensors required for protective purposes that have spatial dependence to meet the requirements of IEEE Std. 603-1991, Clause 4.6.

Impact on DCD

DCD Tier 1 Section 2.5.1 and Table 2.5.1-5 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.

17. The Class 1E equipment listed in Table 2.5.1-1 is protected from accident related hazards such as missiles, pipe breaks, and flooding.

18. The RTS and ESF initiation instrumentation (referenced in Tables 2.5.1-2 and 2.5.1-3) monitors the normal operating, anticipated operational occurrence (AOO), and postulated accident (PA) events.

19. The Class 1E instrument identified in Table 2.5.1-1 as being qualified for a harsh environment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.

20 The PPS providing RTS and ESF initiation signals has the testing functions.

21 A single channel of RTS and ESF initiation is bypassed to allow testing, maintenance or repair and this capability does not prevent the RTS and ESF initiation from performing its safety function.

22. Input sensors from each channel of the RTS and ESF initiation as identified in Tables 2.5.1-2 and 2.5.1-3 are compared continuously in the information processing system (IPS) to allow detection of out-of-tolerance sensors.

23. Two sets of RTSS which consists of four RTSGs are diverse each other.

24. The minimum number and locations of sensors for those variables that have a spatial dependence are identified.

2.5.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.1-5 specifies the inspections, tests, analyses, and associated acceptance criteria for the RTS and ESF initiation.

Table 2.5.1-5 (10 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
21. A single channel of RTS and ESF initiation is bypassed to allow testing, maintenance or repair and this capability does not prevent the RTS and ESF initiation from performing its safety function.	21. A test will be performed on the 2-out-of-4 voting logic in the as-built RTS and ESF initiation by providing simulated process signals, identified in Tables 2.5.1-2 and 2.5.1-3, to at least two of three non-bypassed channels of the as-built RTS and ESF initiation input under the manual single division bypass operation from the as-built the maintenance and test panel (MTP) in the MCR.	21. When the 2-out-of-4 voting logic in the non-bypassed divisions of each as-built RTS and ESF initiation receives at least two of three actuation signals, identified in Tables 2.5.1-2 and Table 2.5.1-3, from the respective non-bypassed channels, the 2-out-of-4 voting logic in the non-bypassed divisions of each as-built RTS and ESF initiation provides the actuation signal for the reactor trip and automatic ESF functions identified in the tables.
22. Input sensors from each channel of the RTS and ESF initiation as identified in Tables 2.5.1-2 and 2.5.1-3 are compared continuously in the information processing system (IPS) to allow detection of out-of-tolerance sensors.	22. A test of the as-built IPS will be performed by providing The simulated inputs for each monitored variable identified in Tables 2.5.1-2 and 2.5.1-3 which includes one out-of-tolerance , at the as-built RTS and ESF initiation input.	22. An alarm for the out-of-tolerance sensor detection is displayed on the as-built IPS in the MCR when the IPS receives simulated input signals for each monitored variable identified in Tables 2.5.1-2 and 2.5.1-3 which includes one out-of-tolerance signal.
23. Two sets of RTSS which consists of four RTSGs are diverse each other.	23. Inspection of the as-built RTSS equipment will be performed.	23. Two sets of the as-built RTSS which consists of four RTSGs are diverse each other.: One set of RTSGs is supplied from a different manufacturer than the other set of RTSGs.
24. The minimum number and locations of sensors for those variables that have a spatial dependence are identified.	24. An inspection of design documents will be performed.	24. The documentation exists and identifies the minimum number and locations of sensors for those variables that are required to perform a safety-related function and have a spatial dependence.

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Question No. 14.03.05-15

Provide design descriptions and corresponding ITAACs to verify the as-built reactor protection system (RPS) and Engineered Safety Features Actuation System (ESFAS) provide interlocks when associated conditions are met.

10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for design certifications 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 4.12, requires the identification of any special design basis that may be imposed on the system design (example: diversity, interlocks, regulatory agency criteria). The staff finds the applicant did not provide design descriptions and corresponding ITAACs to verify that the as-built RPS and ESFAS provide interlocks when associated conditions are met in order to meet the requirements of IEEE Std. 603-1991, Clause 4.12. As such, the staff requests the applicant to provide this information in Tier 1 of the APR1400 FSAR.

Response

The response to RAI 46-7897, Question No.07.06-2 has been submitted (ref. MKD/NW-15-0058L dated July 22, 2015; ML15203A420) and includes the related design description, a table, and ITAAC items to be inserted into DCD Tier 1 Section 2.5.4 for interlock systems important to safety and are applicable to this question

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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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Application Section:	**14.03.05**
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Question No. 14.03.05-16

Provide design descriptions and corresponding ITAAC to verify that failures of the PPS that result in lockup of the PPS and engineered safety feature-component control system (ESF-CCS) processors would be detected (e.g. via watchdog timers) and the PPS and ESF-CCF would fail in a safe state upon these conditions.

IEEE Std. 603-1991, Clause 5.5, requires the safety system accomplishes its safety functions under the full range of applicable conditions enumerated in the design basis. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 23, requires the protection system be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy, or postulated adverse environments are experienced. Based on APR1400 FSAR Tier 1, Section 2.5 descriptions, the staff finds additional information is needed to verify that the as built PPS and ESF-CCF will fail in a safe state upon conditions indicative of PPS or ESF-CCF processor lock-up. As such, the staff requests the applicant provide design descriptions and corresponding ITAAC in APR1400 FSAR Tier 1, Section 2.5 to verify failures within the as-built PPS and ESF-CCS resulting in lock-up of PPS or ESF-CCF processors would be detected (e.g. via watchdog timers) and the PPS and ESF-CCF would be designed to fail in a safe state upon these conditions.

Response

The processor failure modes are analyzed in Tables 7.2-7 and 7.3-8 of DCD Tier 2 for PPS and ESF-CCS, respectively.

Item 13 of the design description in DCD Tier 1 Section 2.5.1.1 and item 10 of the design description in DCD Tier 1 Section 2.5.4.1 will be revised to include descriptions of PPS and ESF-CCS testing to ensure the fail-safe condition on a processor lock-up.

The corresponding ITAAC in DCD Tier 1 will also be revised to demonstrate acceptability of the as-built systems.

Impact on DCD

DCD Tier 1 Section 2.5.1.1, Section 2.5.4.1, Table 2.5.1-5, and Table 2.5.4-4 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.

7.c The PPS provides indications of the bypassed or inoperable status indication (BISI) on the OM in the MCR for the variables identified in Tables 2.5.1-2 and 2.5.1-3 for RT and ESF initiation.

8. Each PPS division is controlled from either the MCR or the RSR as selected from master transfer switches.

9. The PPS utilizes a 2-out-of-4 coincidence logic when no channels are in trip channel bypass. The PPS converts to a 2-out-of-3 coincidence logic whenever a trip channel bypass is present.

10. Accuracy, response time testing, surveillance testing, and maintenance are applied to determine setpoints for variables of RT and ESF initiation.

11. RTS and ESF initiation software is implemented according to the software life cycle process.

12. The cabinets listed in Table 2.5.1-1 have key locks and door open alarms, and are located in a vital area of the facility.

a processor lock-up or

13. The RT logic of the PPS is designed to fail to a safe state such that loss of electrical power to a division of PPS results in a trip condition for that division but the ESFAS logic of the PPS is designed to fail to a safe state such that loss of electrical power to a division of PPS does not result in ESF initiation for that division.

14. Redundant safety equipment listed in Table 2.5.1-1 is provided with means of identification.

15. The input signals of PPS through APC-S or ENFMS are derived from RT and ESF measurement instrumentation that measures monitored variables identified in Tables 2.5.1-2 and 2.5.1-3.

16. The PPS provides RT and ESF initiation signals to meet the required response time for trip and initiation conditions identified in Tables 2.5.1-2 and 2.5.1-3.

Table 2.5.1-5 (7 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
12. The cabinets listed in Table 2.5.1-1 have key locks and door open alarms, and are located in a vital area of the facility.	12.a A test of the as-built cabinets listed in Table 2.5.1-1 for key lock capability, and a test of door open alarms, will be performed.	12.a Each as-built cabinet listed in Table 2.5.1-1 has key locking capability, and alarms are received in the as-built MCR when cabinet doors are opened.
	12.b Inspection of the cabinets listed in Table 2.5.1-1 will be performed.	12.b The cabinets listed in Table 2.5.1-1 are located in a vital area of the facility.
13. The RT logic of the PPS is designed to fail to a safe state such that [a processor lock-up or] loss of electrical power to a division of PPS results in a trip condition for that division but the ESFAS logic of the PPS is designed to fail to a safe state such that loss of electrical power to a division of PPS does not result in ESF initiation for that division.	13. A test will be performed by [making a processor lock-up or] disconnecting the electrical power to each division of the as-built PPS.	13. Each division of the as-built RT logic of the as-built PPS fails to a safe state upon [a processor lock-up or] loss of electrical power to the division and does not result in ESF initiation.
14. Redundant safety equipment listed in Table 2.5.1-1 is provided with means of identification.	14. An inspection of the as-built equipment for conformance with the identification requirements will be performed.	14. The as-built equipment listed in Table 2.5.1-1 and related field equipment complies with the labeling and color coding requirements.
15. The input signals of PPS through APC-S or ENFMS are derived from RT and ESF measurement instrumentation that measures monitored variables identified in Tables 2.5.1-2 and 2.5.1-3.	15. Tests will be performed to verify the electrical continuity between the as-built PPS and the as-built RT and ESF measurement instrumentation that measures monitored variables identified in Tables 2.5.1-2 and 2.5.1-3.	15. The input signals of PPS through APC-S and ENFMS are derived from RT and ESF measurement instrumentation that measures monitored variables identified in Tables 2.5.1-2 and 2.5.1-3.

when the BOP ESF actuation signal has been cleared. Once the initiating condition is cleared, the BOP ESF actuation is manually reset.

10. Loss of power in an ESF-CCS division results in the respective ESF-CCS division output assuming fail-safe output condition.

    or a processor lock-up

11. Manual ESF actuation switches are provided in the MCR and RSR for the manual ESF actuations identified in Table 2.5.4-3.

12. The operator modules (OMs) in the MCR display ESF actuation status, manual ESF actuation status, and ESF-CCS status information including the test status for ESF actuations identified in Tables 2.5.4-2 and 2.5.4-3.

13. The component interface module (CIM) provides state-based priority logic to prioritize the ESF-CCS and DPS signals.

14. The CIM provides system-based priority logic for the front panel control switch signals on the CIM, the signals generated by the DMA switches, the signals from the ESF-CCS, and the signals from the DPS. The front panel control switches have the highest priority, and the signals from the DMA switches have priority over signals from the ESF-CCS and DPS.

15. The ESF-CCS software is implemented according to the software lifecycle process.

16. The ESF-CCS equipment and components identified in Table 2.5.4-1 withstand the electrical surge, electromagnetic interference (EMI), radio-frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis event without loss of its safety function for the time required to perform the safety function.

17. Redundant safety equipment and components of the ESF-CCS listed in Table 2.5.4-1 and related field equipment are provided with means of identification.

Table 2.5.4-4 (4 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
9. Once a BOP ESF actuation has been actuated (automatically or manually), the actuation logic is latched in the actuated state and is not reset automatically when the BOP ESF actuation signal has been cleared. Once the initiating condition is cleared, the BOP ESF actuation is manually reset.	9.a A test will be performed by returning simulated signals to a level within the predetermined limits of plant process signals at the as-built RMS input for BOP ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the BOP ESF actuation.	9.a Each BOP ESF actuation signal of the as-built ESF-CCS remains upon return of simulated signals to a level within the predetermined limits of plant process signals for BOP ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the ESF actuation
	9.b A Tests of the as-built BOP ESFAS reset function is performed manually to reset the actuated BOP ESFAS function.	9.b The BOP ESF actuation is manually reset once the initiating condition is cleared.
10. Loss of power in an ESF-CCS division results in the respective ESF-CCS division output assuming fail-safe output condition. or a processor lock-up	10. A test will be performed simulating loss of power in each as-built ESF-CCS division. or a processor lock-up	10. Loss of power in each ESF-CCS division results in the assumed fail-safe output condition. or a processor lock-up
11. Manual ESF actuation switches are provided in the MCR and RSR for the manual ESF actuations identified in Table 2.5.4-3.	11. A test will be performed to verify the actuation of the as-built ESF-CCS manual ESF actuation using the manual ESF actuation switches in the MCR and RSR.	11. Each as-built ESF-CCS manual ESF actuation identified in Table 2.5.4-3 actuates upon receipt of a signal from its respective manual ESF actuation switches in the MCR and RSR.
12. The operator modules (OMs) in the MCR display ESF actuation status, manual ESF actuation status, and ESF-CCS status information including the test status for ESF actuations identified in Tables 2.5.4-2 and 2.5.4-3.	12. A test of the as-built OM in the MCR will be performed to demonstrate the display capability.	12. Each as-built OM in the MCR displays ESF actuation status, remote manual ESF actuation status, and ESF-CCS status information including the test status for actuations identified in Tables 2.5.4-2 and 2.5.4-3.

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Question No. 14.03.05-17

Modify APR1400 FSAR Tier 1, Table 2.5.1-5, "Reactor Trip System and Engineered Safety Features Initiation ITAAC," Items 3.b.ii and 3.b.iii to clarify that qualified isolation devices used between interfaces of redundant Class 1E divisions and between safety and non-safety interfaces are Class 1E as required by IEEE Std. 603-1991, Clause 5.6. In addition, amend the inspection, test, and analysis (ITA) and the corresponding acceptance criterion to verify that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems.

10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for design certifications 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 5.6.1, requires redundant portions of safety systems provided for a safety function be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function. IEEE Std. 603-1991, Clause 5.6.3, requires the safety system design to be such that credible failures in and consequential actions by other systems, as documented in Clause 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard. IEEE Std. 603-1991, Clause 5.6.3.1, states, in part, “isolation devices used to effect a safety system boundary shall be classified as part of the safety system.”

APR1400, FSAR, Tier 1, Section 2.5.1.1, "Design Description," Item 3.a and the associated ITAAC state “Class 1E equipment identified in Table 2.5.1-1, "Reactor Trip System and Engineered Safety Features Initiation Equipment Location and Classification," is powered from its respective Class 1E train.” FSAR, Tier 1, Section 2.5.1.1, Item 3.b states “Redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment are physically separated and electrically independent from each other and physically separated and electrically independent from non-Class 1E equipment.” The associated acceptance criterion in FSAR Tier 1, Table 2.5.1-5, Item 3.b.ii states, “A report exists and concludes that independence of as-built redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment is achieved by independent power sources and electrical circuits for each division, and by fiber optic cable interfaces, qualified isolation devices at interfaces between redundant divisions, and at interfaces between safety and non-safety systems.” The acceptance criterion for Item 3.b.iii states, "A report exists and concludes that the electrical isolation devices prevent credible faults from propagating into a safety system division."

The staff finds that additional information is needed to clarify whether the qualified isolation devices at interfaces between redundant safety divisions and at interfaces between safety and non-safety systems are Class 1E. In addition, it is not clear that an inspection will be performed as part of this ITAAC to verify that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems. As such, the staff requests the applicant to modify the FSAR Tier 1, Table 2.5.1-5, Items 3.b.ii and 3.b.iii to clarify that these qualified isolation devices are Class 1E as required by IEEE Std. 603-1991, Clause 5.6, and to amend the ITA and acceptance criterion to verify that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems.

Response

The design description Item 3.b of Section 2.5.1.1 in DCD Tier 1 provides the design commitment for physical separation and electrical isolation between redundant portions of the safety systems and between safety and non-safety systems. The isolation devices used to achieve the electrical isolation are Class 1E qualified isolation devices.

The Acceptance Criteria for Items 3.b.ii and 3.b.iii in DCD Tier 1 Table 2.5.1-5 will be modified to clarify that the qualified isolation devices that pertain to the item are Class 1E.

Impact on DCD

Table 2.5.1-5 of DCD Tier 1 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.

Table 2.5.1-5 (2 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3.a Class 1E equipment identified in Table 2.5.1-1 is powered from its respective Class 1E division.	3.a Tests of the as-built Class 1E equipment will be performed using a simulated test signal.	3.a The Class 1E equipment identified in Table 2.5.1-1 is powered from its respective Class 1E division .
3.b Redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment are physically separated and electrically independent from each other and physically separated and electrically independent from non-Class 1E equipment.	3.b.i Inspection for separation of the as-built redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment will be performed.	3.b.i The physical separation of as-built redundant Class 1E divisions identified in Table 2.5.1-1 and associated field equipment is provided by distance or barriers in accordance with NRC RG 1.75.
	3.b.ii Analyses, tests or a combination of analyses and tests of the as-built redundant Class 1E divisions listed in Table 2.5.1-1and associated field equipment will be performed to verify its electrical independence.	3.b.ii A report exists and concludes that independence of as-built redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment is achieved by independent power sources and electrical circuits for each division, and by fiber optic cable interfaces, qualified [Class 1E qualified] isolation devices at interfaces between redundant divisions, and at interfaces between safety and non-safety systems.
	3.b.iii Testing, analysis or combination of testing and analysis will be performed for the electrical isolation devices.	3.b.iii A report exists and concludes that the electrical isolation devices [are Class 1E qualified and] prevent credible faults from propagating into a safety system division.

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.:	**317-8271**
SRP Section:	**14.03.05 – Instrumentation and Controls – Inspections, Tests, Analyses, and Acceptance Criteria**
Application Section:	**14.03.05**
Date of RAI Issue:	**11/17/2015**

Question No. 14.03.05-20

Demonstrate that the response time for the RT and ESF actuation functions are adequately verified in the as-built RTS and ESFAS.

10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for design certifications 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 4.10, requires the identification of critical points in time or the plant conditions, after the onset of a design basis event. APR1400 FSAR Tier 1, Section 2.5.1.1, Item 16 states that “The PPS provides RT and ESF initiation signals to meet the required response time for trip and initiation conditions identified in Tables 2.5.1-2 and 2.5.1-3.” The acceptance criterion for the corresponding ITAAC in FSAR Tier 1, Table 2.5.1-5, Item 16a states, “A report exists and concludes that the PPS initiates the RT and the ESF initiation signals identified in Tables 2.5.1-2 and 2.5.1-3 within the response time requirements as described in the design basis.” In addition, the acceptance criterion in FSAR Tier 1, Table 2.5.1-5, Item 16b, states, “The as-built RTS and ESF initiation signals identified as monitored variables in Tables 2.5.1-2 and 2.5.1-3 with response time requirements are bounded by the test.” APR1400 FSAR Tier 1, Section 2.5.4.1, Item 20 states, “The ESF-CCS provides ESF actuation within required response time for ESF functions identified in Table 2.5.4-2 ["Functions Automatically Actuated by the ESF-CCS"].” The acceptance criterion in the corresponding ITAAC in FSAR Tier 1, Table 2.5.4-4, [ESF-CCS ITAAC] Item 20a, states, “A report exists and concludes that the ESF-CCS actuates the ESF functions identified in Table 2.5.4-2, within the response time requirements.” The acceptance criterion in the corresponding ITAAC in FSAR Tier 1, Table 2.5.4-4, Item 20b, states, “The as-built ESF actuation function identified in Table 2.5.4-2 with response time requirements are bounded by type tests or a combination of a type test and analysis."

Based on the design commitment and the associated ITAAC provided, it is not clear to the staff where the response time will be measured from (e.g. from output of sensors to the RTSS breakers and the output of the component interface module (CIM)). The staff requests the applicant to clarify where the response time will be measured from in order to verify this design commitment. In addition, it is not clear whether there is sufficient overlap coverage between FSAR Tier 1, Table 2.5.1-5, Item 16, and FSAR Tier 1, Table 2.5.4-4, Item 20, to cover the entire ESFAS actuation path. Specifically, it is unclear where the data communication links between the ESFAS portion of the PPS to the input of the ESF-CCS are included in these two response time verification ITAACs. As such, the staff requests the applicant to modify these ITAACs to demonstrate full coverage of the ESFAS actuation path.

Response

The abstract of the Response Time Analysis of Safety I&C System technical report describes that the response time of the reactor trip (RT) function is defined as the time interval from when the monitored parameter exceeds the trip setpoint value at the input to the sensor until electrical power is interrupted to the control element assembly (CEA) drive mechanism, and that the response time of the ESF actuation function is defined as the time interval from when the monitored parameter exceeds the trip setpoint value at the input to the sensor until the final component, such as a pump, valve, damper or fan actuates.

As described in Section A.3.1 of the Response Time Analysis of Safety I&C System technical report, the allocated response time covers not only the internal and external communication delays caused by communication modules and cables, but also includes adequate communication margins between equipment. Accordingly, the descriptions of the inspections, tests, analyses and the acceptance criteria for Item 16.a in Table 2.5.1-5 will include the communication delays from the BP to the LCL. The description of the acceptance criteria for Item 20.a in Table 2.5.4-4 will include the communication delays from the LCL of the PPS to group controllers of the ESF-CCS.

Impact on DCD

DCD Tier 1 Tables 2.5.1-5 and 2.5.4-4 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.

Table 2.5.1-5 (8 of 10)

(including the communication delays from the BP to the LCL)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
16. The PPS provides RT and ESF initiation signals to meet the required response time for trip and initiation conditions identified in Tables 2.5.1-2 and 2.5.1-3.	16.a Type tests and analyses will be performed on PPS to verify that the PPS initiates RT and the ESF initiation signals identified in Tables 2.5.1-2 and 2.5.1-3 within response time requirements described in the design basis.	16.a A report exists and concludes that the PPS initiates the RT and the ESF f initiation signals identified in Tables 2.5.1-2 and 2.5.1-3 within the response time requirements as described in the design basis.
	16.b Inspections will be performed on the as-built RTS and ESF initiation signals identified as monitored variables in Tables 2.5.1-2 and 2.5.1-3 with response time requirements.	16.b The as-built RTS and ESF initiation signals identified as monitored variables in Tables 2.5.1-2 and 2.5.1-3 with response time requirements are bounded by the tests.
17. The Class 1E equipment listed in Table 2.5.1-1 is protected from accident related hazards such as missiles, pipe breaks, and flooding.	17. Inspections and analyses will be performed on the locations of the as-built Class 1E equipment listed in Table 2.5.1-1.	17. A report exists and concludes that the as-built equipment listed in Table 2.5.1-1 is protected from accident related hazards such as missiles, pipe breaks and flooding.
18. The RTS and ESF initiation instrumentation (referenced in Tables 2.5.1-2 and 2.5.1-3) monitors the normal operating, anticipated operational occurrence (AOO), and postulated accident (PA) events.	18. An inspection of the as-built RTS and ESF initiation instrumentation will be performed.	18. The as-built RTS and ESF initiation instrumentation (referenced in Tables 2.5.1-2 and 2.5.1-3) functions during normal operation, AOO, and PA conditions.

Table 2.5.4-4 (7 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
18. The Class 1E equipment and components listed in Table 2.5.4-1 are protected from accident related hazards such as missiles, pipe breaks and flooding.	18. An inspection and analysis will be performed on the locations of the as-built Class 1E equipment and components listed in Table 2.5.4-1.	18. A report exists and concludes that the as-built equipment and components listed in Table 2.5.4-1 are protected from accident related hazards such as missiles, pipe breaks and flooding.
19. The ESF-CCS cabinets listed in Table 2.5.4-1 have key locks and door position alarms, and are located in a vital area of the facility.	19.a A test of the as-built cabinets listed in Table 2.5.4-1 for key lock capability, and a test of door position alarms, will be performed.	19.a Each as-built cabinet listed in Table 2.5.4-1 has key lock capability, and door position alarms are received in the as-built MCR when cabinet doors are opened.
	19.b An inspection of the cabinets listed in Table 2.5.4-1 will be performed.	19.b The cabinets listed in Table 2.5.4-1 are located in a vital area of the facility.
20. The ESF-CCS provides ESF actuation within required response time for ESF functions identified in Table 2.5.4-2.	20.a A type test and analysis will be performed on the ESF-CCS to verify that the ESF-CCS actuates the ESF functions identified in Table 2.5.4-2.	20.a A report exists and concludes that the ESF-CCS actuates the ESF functions identified in Table 2.5.4-2 within response time requirements.
	20.b An inspection will be performed on the as-built ESF-CCS to determine if the response time of ESF actuation functions identified in Table 2.5.4-2.	20.b The as-built ESF actuation functions identified in Table 2.5.4-2 with response time requirements are bounded by type tests or a combination of a type test and analysis.
21. The ESF-CCS has the testing functions.	21. A type tests and analysis of the ESF-CCS will be performed using simulated failure condition.	21. A report exists and concludes that the ESF-CCS has the testing functions to detect malfunctioning components or modules and have them replaced, repaired, or adjusted.

(including the communication delays from the LCL of the PPS to group controllers of the ESF−CCS)

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.:	**317-8271**
SRP Section:	**14.03.05**
Application Section:	
Date of RAI Issue:	**11/17/2015**

Question No. 14.03.05-27

Provide design descriptions and ITAACs to verify that the as-built ESF-CCS meets completion of protection requirements for all ESFAS functions.

10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for design certifications 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 5.2, states that the safety systems shall be designed so that, once initiated automatically or manually, the intended sequence of protective actions of the execute features shall continue until completion. Deliberate operator action shall be required to return the safety systems to normal. APR1400 FSAR Tier 1, Section 2.5.4.1, Item 9, and the corresponding ITAAC states “Once a BOP [(Balance of Power)] ESF actuation has been actuated (automatically or manually), the ESF actuation logic is latched in the actuated state and is not reset automatically.” The corresponding ITAAC in FSAR Tier 1, Table 2.5.4-4, Item 9, verifies this design commitment in the as-built ESF-CCS. This ITAAC verifies that the as-built ESF-CCS meet completion of protective action requirements for BOP ESF functions. However, the staff could not find design descriptions and corresponding ITAACs to verify the as-built ESF-CCS meets completion of protection requirements for other ESFAS functions (e.g. nuclear steam supply system (NSSS) ESF actuation functions identified in FSAR Tier 1, Table 2.5.4-2). As such, the staff requests the applicant to provide design descriptions and ITAACs to verify that the as-built ESF-CCS meets completion of protection requirements for these other ESFAS functions.

Response

Similar to the design description and ITAAC for BOP ESF actuation from ESF-CCS, a design description and ITAAC for the NSSS ESFAS actuation will be added in DCD Tier 1 Section 2.5.4.1 and Table 2.5.4-4. The description and ITAAC will confirm that once the NSSS ESFAS has been actuated, the logic is latched in the actuated state and can be manually reset once the initiating condition has been cleared.

Impact on DCD

Section 2.5.4.1 and Table 2.5.4-4 of DCD Tier 1 will be modified 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.

1. The seismic Category I equipment and components identified in Table 2.5.4-1 withstand seismic design basis loads without loss of the safety function.

2. Redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment are physically separated and electrically isolated from each other and physically separated and electrically isolated from non-Class 1E equipment.

3. The Class 1E equipment and components identified in Table 2.5.4-1 are powered from its respective Class 1E train.

4. Each ESF-CCS division receives ESFAS initiation signals from four divisions of the PPS and performs selective 2-out-of-4 coincidence logic to perform NSSS ESF actuation functions identified in Table 2.5.4-2.

5. Each ESF-CCS division receives ESFAS initiation signals from two divisions of the RMS as shown in Tables 2.7.6.4-2 and 2.7.6.5-2 and performs 1-out-of-2 logic taken twice except the fuel handling area emergency ventilation actuation signal which has one 1-out-of-2 logic to perform the BOP ESF actuation functions identified in Table 2.5.4-2.

6. Upon receipt of a SIAS, CSAS, or AFAS, the ESF-CCS initiates an automatic start of the EDGs and automatic EDG loading sequencer of ESF loads identified in Table 2.5.4-2.

7. Upon detecting loss of power to Class 1E buses, the ESF-CCS initiates startup of the EDGs, shedding of electrical loads, transfer of Class 1E bus connections to the EDGs, and EDG loading sequencer to the reloading of safety-related loads to the Class 1E buses.

8. Each ESF-CCS division is controlled from either the MCR or RSR, as selected from MCR/RSR master transfer switches.

~~9.~~ 9.b Once a BOP ESF actuation has been actuated (automatically or manually), the ESF actuation logic is latched in the actuated state and is not reset automatically

9.a Once a NSSS ESF actuation has been actuated (automatically or manually), the ESF actuation logic is latched in the actuated state and is not reset automatically when the NSSS ESF initiating condition has been cleared. After the initiating condition has been cleared, the NSSS ESF actuation is manually reset.

Replace with the following page

Table 2.5.4-4 (4 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
9. Once a BOP ESF actuation has been actuated (automatically or manually), the actuation logic is latched in the actuated state and is not reset automatically when the BOP ESF actuation signal has been cleared. Once the initiating condition is cleared, the BOP ESF actuation is manually reset.	9.a A test will be performed by returning simulated signals to a level within the predetermined limits of plant process signals at the as-built RMS input for BOP ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the BOP ESF actuation.	9.a Each BOP ESF actuation signal of the as-built ESF-CCS remains upon return of simulated signals to a level within the predetermined limits of plant process signals for BOP ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the ESF actuation
	9.b A Tests of the as-built BOP ESFAS reset function is performed manually to reset the actuated BOP ESFAS function.	9.b The BOP ESF actuation is manually reset once the initiating condition is cleared.
10. Loss of power in an ESF-CCS division results in the respective ESF-CCS division output assuming fail-safe output condition.	10. A test will be performed simulating loss of power in each as-built ESF-CCS division.	10. Loss of power in each ESF-CCS division results in the assumed fail-safe output condition.
11. Manual ESF actuation switches are provided in the MCR and RSR for the manual ESF actuations identified in Table 2.5.4-3.	11. A test will be performed to verify the actuation of the as-built ESF-CCS manual ESF actuation using the manual ESF actuation switches in the MCR and RSR.	11. Each as-built ESF-CCS manual ESF actuation identified in Table 2.5.4-3 actuates upon receipt of a signal from its respective manual ESF actuation switches in the MCR and RSR.
12. The operator modules (OMs) in the MCR display ESF actuation status, manual ESF actuation status, and ESF-CCS status information including the test status for ESF actuations identified in Tables 2.5.4-2 and 2.5.4-3.	12. A test of the as-built OM in the MCR will be performed to demonstrate the display capability.	12. Each as-built OM in the MCR displays ESF actuation status, remote manual ESF actuation status, and ESF-CCS status information including the test status for actuations identified in Tables 2.5.4-2 and 2.5.4-3.

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
9.a Once a NSSS ESF actuation (has been actuated (automatically or manually), the ESF actuation logic is latched in the actuated state and is not reset automatically when the NSSS ESF initiating condition has been cleared. After the initiating condition has been cleared, the NSSS ESF actuation is manually reset.	9.a.i A test will be performed by returning simulated signals to a level within the predetermined limits of plant process signals at the as-built PPS input for NSSS ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the NSSS ESF actuation.	9.a.i Each NSSS ESF actuation signal of the as-built ESF-CCS remains upon return of simulated signals to a level within the predetermined limits of plant process signals for NSSS ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the ESF actuation.
	9.a.ii A Test of the as-built NSSS ESFAS reset function is performed manually to reset the actuated NSSS ESFAS function.	9.a.ii The NSSS ESF actuation is manually reset after the initiating condition has been cleared.
9.b Once a BOP ESF actuation has been actuated (automatically or manually),the actuation logic is latched in the actuated state and is not reset automatically when the BOP ESF actuation signal has been cleared. Once the initiating condition is cleared, the BOP ESF actuation is manually reset.	9.b.i A test will be performed by returning simulated signals to a level within the predetermined limits of plant process signals at the as-built RMS input for BOP ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the BOP ESF actuation.	9.b.i Each BOP ESF actuation signal of the as-built ESFCCS remains upon return of simulated signals to a level within the predetermined limits of plant process signals for BOP ESFAS functions as identified in Tables 2.5.4-2 and 2.5.4-3 after simulating the ESF actuation
	9.b.ii A Tests of the as-built BOP ESFAS reset function is performed manually to reset the actuated BOP ESFAS function.	9.b.ii The BOP ESF actuation is manually reset once the initiating condition is cleared.

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.:	**317-8271**
SRP Section:	**14.03.05**
Application Section:	
Date of RAI Issue:	**11/17/2015**

Question No. 14.03.05-28

Clarify how verification of adequate electrical independence of the as-built ESF-CCF is achieved as required by the IEEE Std 603-1991, Clause 5.6.

10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for design certifications 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 5.6.1, requires redundant portions of safety systems provided for a safety function be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function. IEEE Std 603-1991, Clause 5.6.3, requires the safety system design to be such that credible failures in and consequential actions by other systems, as documented in Clause 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard. IEEE Std. 603-1991, Clause 5.6.3.1 states, in part, “Isolation devices used to effect a safety system boundary shall be classified as part of the safety system.”

APR1400 FSAR Tier 1, Section 2.5.4.1, Item 2 states that redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment are physically separated and electrically isolated from each other and physically separated and electrically isolated from non-Class 1E equipment. The associated acceptance criteria in FSAR Tier 1, Table 2.5.4-4, Items 2.b and 2.c, state “A report exists and concludes that independence of as-built redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment is achieved by independent power sources and electrical circuits for each division, and by fiber optic cable interfaces, qualified isolation devices at interfaces between redundant divisions, and at interfaces between safety and non-safety systems.” The staff finds that additional information is needed to clarify whether the qualified isolation devices at interfaces between redundant safety divisions and at interfaces between safety and non-safety systems are Class 1E qualified. In addition, it is not clear whether an inspection will be performed to verify that that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems in the as-built ESF-CCS. As such, the staff requests the applicant to modify the FSAR Tier 1,

Table 2.5.4-4, Item 2 to clarify that these qualified isolation devices are Class 1E qualified as required by IEEE Std 603-1991, Clause 5.6.3.1, and to verify via inspection that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems.

Response

The isolation devices used between redundant portions of safety systems and between safety and non-safety systems are to be Class 1E. The description in Section 2.5.4.1 Item 2 and the ITAAC in Table 2.5.4-4 Item 2 will be revised to clearly identify and verify that the isolators used in these applications are Class 1E.

Impact on DCD

Section 2.5.4.1 and Table 2.5.4-4 of the APR1400 DCD Tier 1 will be modified 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.

1. The seismic Category I equipment and components identified in Table 2.5.4-1 withstand seismic design basis loads without loss of the safety function.

2. Redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment are physically separated and electrically isolated from each other and physically separated and electrically isolated from non-Class 1E equipment.

3. The Class 1E equipment and components identified in Table 2.5.4-1 are powered from its respective Class 1E train.

4. Each ESF-CCS division receives ESFAS initiation signals from four divisions of the PPS and performs selective 2-out-of-4 coincidence logic to perform NSSS ESF actuation functions identified in Table 2.5.4-2.

5. Each ESF-CCS division receives ESFAS initiation signals from two divisions of the RMS as shown in Tables 2.7.6.4-2 and 2.7.6.5-2 and performs 1-out-of-2 logic taken twice except the fuel handling area emergency ventilation actuation signal which has one 1-out-of-2 logic to perform the BOP ESF actuation functions identified in Table 2.5.4-2.

6. Upon receipt of a SIAS, CSAS, or AFAS, the ESF-CCS initiates an automatic start of the EDGs and automatic EDG loading sequencer of ESF loads identified in Table 2.5.4-2.

7. Upon detecting loss of power to Class 1E buses, the ESF-CCS initiates startup of the EDGs, shedding of electrical loads, transfer of Class 1E bus connections to the EDGs, and EDG loading sequencer to the reloading of safety-related loads to the Class 1E buses.

8. Each ESF-CCS division is controlled from either the MCR or RSR, as selected from MCR/RSR master transfer switches.

9. Once a BOP ESF actuation has been actuated (automatically or manually), the ESF actuation logic is latched in the actuated state and is not reset automatically

Class 1E qualified isolators such as fiber optic modems or interposing relays are applied at interfaces between redundant safety divisions and at interfaces between safety and non-safety systems.

Table 2.5.4-4 (2 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2. (cont.) Class 1E qualified isolators such as fiber optic modems or interposing relays are applied at interfaces between redundant safety divisions and at interfaces between safety and non-safety systems.	2.b A test, analysis, or a combination of a test and analysis of the as-built redundant Class 1E divisions listed in Table 2.5.4-1and associated field equipment will be performed to verify its electrical independence.	2.b A report exists and concludes that independence of as-built redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment is achieved by independent power sources and electrical circuits for each division, and by fiber-optic cable interfaces, conventional isolators, or other qualified isolation methods or devices at interfaces between redundant divisions, and at interfaces between safety and non-safety systems.
	2.c A test, analysis, or a combination of a test and analysis will be performed for the electrical isolation devices.	2.c A report exists and concludes that the electrical isolation devices prevent credible faults from propagating into a safety system division.
3. The Class 1E equipment and components identified in Table 2.5.4-1 are powered from its respective Class 1E train.	3. A test of the as-built ESF-CCS will be performed by providing a simulated test signal in only one Class 1E train at a time.	3. The Class 1E equipment and components identified in Table 2.5.4-1 are powered from its respective Class 1E train.
4. Each ESF-CCS division receives ESFAS initiation signals from four divisions of the PPS and performs selective 2-out-of-4 coincidence logic to perform NSSS ESF actuation functions identified in Table 2.5.4-2.	4. A test will be performed using simulated input signals for ESF actuation signal input to each division of the as-built ESF-CCS.	4. Each ESF-CCS division receives ESFAS initiation signal from four divisions of the PPS and performs selective 2-out-of-4 coincidence logic for each NSSS ESF actuation function identified in Table 2.5.4-2 and sends the control signals to the ESF components.

The isolators used to affect safety system boundaries are Class 1E qualified.

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.:	**317-8271**
SRP Section:	**14.03.05**
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Question No. 14.03.05-29

Provide design descriptions and a corresponding ITAAC in APR1400 FSAR Tier 1, Section 2.5.4 to verify the priority scheme of demands from the manual controls and automatic safety system at the ESF-CCF loop controllers (LC).

10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for design certifications 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 5.6.1, requires redundant portions of safety systems provided for a safety function be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function. IEEE Std 603-1991, Clause 5.6.3, requires that the safety system design to be such that credible failures in and consequential actions by other systems, as documented in Clause 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard. DI&C-ISG-04, Section 2, “Command Prioritization” provides guidance on use of priority modules in safety I&C systems. Position 3 of this section states, “Safety-related commands that direct a component to a safe state must always have the highest priority and must override all other commands. Commands that originate in a safety-related channel but which only cancel or enable cancellation of the effect of the safe-state command (that is, a consequence of a Common-Cause Failure in the primary system that erroneously forces the plant equipment to a state that is different from the designated “safe state.”), and which do not directly support any safety function, have lower priority and may be overridden by other commands.…The priority module itself should be shown to apply the commands correctly in order of their priority rankings, and should meet all other applicable guidance.” APR1400 FSAR Tier 1, Section 2.5.4.1, Item 13, and the corresponding ITAAC in FSAR Tier 1, Table 2.5.4-4, Item 13 state, “The component interface module (CIM) provides state-based priority logic to prioritize the ESF-CCS and DPS signals.” APR1400 FSAR Tier 1, Section 2.5.4.1, Item 14 and the corresponding ITAAC in FSAR Tier 1, Table 2.5.4-4, Item 14 state “The CIM provides system-based priority logic for the front panel control switch signals on the CIM, the signals generated by the DMA switches, the signals from the ESF-CCS, and the signals from the DPS.

The front panel control switches have the highest priority, and the signals from the DMA switches have priority over signals from the ESFCCS and DPS.” The APR1400 FSAR appears to provide adequate design descriptions and corresponding ITAAC to verify the priority scheme of the as-built CIM to meet the requirements of 10 CFR 52.47(b)(1).

However, the staff could not find any design descriptions or corresponding ITAAC to verify the priority scheme of the ESF-CCS for commands originating from the automatic safety system and the manual controls from the ESF-CCF soft control module (ESCM) and Information Flat Panel Display (IFPD). Technical Report APR1400-Z-J-NR-14001, Rev. 0, "Safety I&C System Technical Report," Section 4.4.2 states, “The priority interlock in the LC [loop controller] is used to [withheld as proprietary]. The ESF actuation signals from the GC [(Group controller] [withheld as proprietary .]” As such, the staff requests the applicant to provide design descriptions and corresponding ITAAC to verify this design feature.

Response

The ESF-CCS Loop Controller (LC) performs prioritization logic between automatically actuated ESFAS signals and manually actuated component control signals from the MI switch and ESCM. The ESFAS signals always have priority over manually actuated component control signals from the MI switch and ESCM. The ESF-CCS LC implements this ESFAS signal priority by blocking the opposite state command from the MI switch and ESCM until the protective actions are completed.

A description will be added to Section 2.5.4.1 of APR1400 DCD Tier 1 to state that the ESF-CCS LC provides the priority logic to assure the actuation of automatically actuated ESFAS signals.

A corresponding ITAAC, Item 22, will be added to Table 2.5.4-4 to verify by test the prioritization logic of ESF-CCS LC.

Impact on DCD

Section 2.5.4.1 and Table 2.5.4-4 of APR1400 DCD Tier 1 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.

18. The Class 1E equipment and components listed in Table 2.5.4-1 are protected from accident related hazards such as missiles, pipe breaks and flooding.

19. The ESF-CCS cabinets listed in Table 2.5.4-1 have key locks and door position alarms, and are located in a vital area of the facility.

20. The ESF-CCS provides ESF actuation within required response time for ESF functions identified in Table 2.5.4-2.

21. The ESF-CCS has the testing functions.

22. The ESF-CCS LC provides the priority logic to assure the actuation of automatically actuated ESFAS signals.

2.5.4.2 Inspections, Tests, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the ESF-CCS are specified in Table 2.5.4-4.

Table 2.5.4-4 (7 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
18. The Class 1E equipment and components listed in Table 2.5.4-1 are protected from accident related hazards such as missiles, pipe breaks and flooding.	18. An inspection and analysis will be performed on the locations of the as-built Class 1E equipment and components listed in Table 2.5.4-1.	18. A report exists and concludes that the as-built equipment and components listed in Table 2.5.4-1 are protected from accident related hazards such as missiles, pipe breaks and flooding.
19. The ESF-CCS cabinets listed in Table 2.5.4-1 have key locks and door position alarms, and are located in a vital area of the facility.	19.a A test of the as-built cabinets listed in Table 2.5.4-1 for key lock capability, and a test of door position alarms, will be performed.	19.a Each as-built cabinet listed in Table 2.5.4-1 has key lock capability, and door position alarms are received in the as-built MCR when cabinet doors are opened.
	19.b An inspection of the cabinets listed in Table 2.5.4-1 will be performed.	19.b The cabinets listed in Table 2.5.4-1 are located in a vital area of the facility.
20. The ESF-CCS provides ESF actuation within required response time for ESF functions identified in Table 2.5.4-2.	20.a A type test and analysis will be performed on the ESF-CCS to verify that the ESF-CCS actuates the ESF functions identified in Table 2.5.4-2.	20.a A report exists and concludes that the ESF-CCS actuates the ESF functions identified in Table 2.5.4-2 within response time requirements.
	20.b An inspection will be performed on the as-built ESF-CCS to determine if the response time of ESF actuation functions identified in Table 2.5.4-2.	20.b The as-built ESF actuation functions identified in Table 2.5.4-2 with response time requirements are bounded by type tests or a combination of a type test and analysis.
21. The ESF-CCS has the testing functions.	21. A type tests and analysis of the ESF-CCS will be performed using simulated failure condition.	21. A report exists and concludes that the ESF-CCS has the testing functions to detect malfunctioning components or modules and have them replaced, repaired, or adjusted.

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22. The ESF-CCS LC provides the priority logic to assure the actuation of automatically actuated ESFAS signals.	22. A test will be performed by using simulated input signals from ESFAS signals and manual component control signals concurrently to LC in the as-built ESF-CCS.	22. When the ESF-CCS LC receives conflicting component control input signals between ESFAS signals and component control signals from MI switch and ESCM, the ESF-CCS LC prioritizes the signals so that ESFAS signals always block the command of opposite state from MI switch and ESCM until protective actions are completed.