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.: **46-7879**

SRP Section: **7.6 – Interlock Systems Important to Safety**

Application Section: **DCD Tier 1, Subsection 2.5.4, Tier 2, Section 7.6**

Date of RAI Issued: **06/23/2015**

Question No. 07.06-2

Provide inspections, test, analyses, and acceptance criteria (ITAAC) for all safety-related interlocks.

10 CFR 52.47(b)(1), requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (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 will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations. Safety-related interlocks provide important functions to prevent the occurrence of potential transients and accidents. However, the staff did not find ITAAC that would verify the development, construction, testing and operation of such interlocks for the APR1400. Provide ITAAC for all safety-related interlocks or provide reference to where these ITAAC are located within the application.

Response

The DCD currently includes ITAAC for valves which have interlocks which are important to safety. The interlocks for the aforementioned valves are tested during the ITAAC testing of the valves themselves. The following listing provides the valves which currently have ITAAC in the DCD which are to test the associated interlocks.

- Safety Injection Tank Isolation Valves, Tier 1, Subsection 2.4.3
- SCS Suction Line Isolation Valves, Tier 1, Subsection 2.4.4
- SCS Suction Line Relief Valves, Tier 1, Subsection 2.4.4
- CCW Supply and Return Header Isolation Valves, Tier 1, Subsection 2.7.2.2

In addition to those ITAAC already provided in the DCD, an ITAAC for those interlocks important to safety in DCD Tier 2, Section 7.6, "Interlock Systems Important to Safety" will be

added to DCD Tier 1, Subsection 2.5.4 as ITAAC 22. Also, the following changes will be made to Tier 1 of the DCD to facilitate the addition of the ITAAC:

- A new Table 2.5.4-4, "ESF-CCS Interlocks Important to Safety" will be added;
- Former Table 2.5.4-4, "Engineered Safety Features-Component Control System ITAAC" is changed to Table 2.5.4-5, and
- An Item 22 will be added to DCD Tier 1, Subsection 2.5.4.1, "Design Description".

Impact on DCD

DCD Tier 1, Subsection 2.5.4 will be revised as indicated on the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Reports.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

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 provides the interlocks important to safety identified in Table 2.5.4-4.

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 2.5.4-5.

Table 2.5.4-3

ESF-CCS Manual ESF Actuation Switches

Function	Systems Actuated
A. Main Control Room 1. NSSS ESF actuation • Containment spray actuation signal (CSAS) • Safety injection actuation signal (SIAS) • Main steam isolation signal (MSIS) • Containment isolation actuation signal (CIAS) • Auxiliary feedwater actuation signal (AFAS-1 and AFAS-2) 2. BOP ESF actuation • Fuel handling area emergency ventilation actuation signal (FHEVAS) • Containment purge isolation actuation signal (CPIAS) • Control room emergency ventilation actuation signal (CREVAS)	Actuated systems are same to the systems shown in Table 2.5.4-2.
B. Remote Shutdown Room 1. NSSS ESF Actuation • MSIS	

Table 2.5.4-4

ESF-CCS Interlocks Important to Safety

Interlocks	DCD Tier 2
Shutdown Cooling System Suction Line Isolation Valve Interlocks	7.6.1.1
Safety Injection Tank Isolation Valve Interlocks	7.6.1.3
Component Cooling Water Supply and Return Header Tie Line Isolation Interlocks	7.6.1.4

2.5.4-5

Table 2.5.4-4 (1 of 7)

Engineered Safety Features-Component Control System ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
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.	1.a An inspection will be performed to verify that the as-built seismic Category I equipment and components identified in Table 2.5.4-1 is located in a seismic Category I structure.	1.a The as-built seismic Category I equipment and components identified in Table 2.5.4-1 is located in a seismic Category I structure.
	1.b A type test, analysis, or a combination of a type test and analysis of seismic Category I equipment and components identified in Table 2.5.4-1 will be performed.	1.b A report exists and concludes that the seismic Category I equipment and components identified in Table 2.5.4-1 withstand seismic design basis loads without loss of safety function.
	1.c An inspection and analysis will be performed to verify the as-built seismic Category I equipment and components identified in Table 2.5.4-1, including anchorages, is seismically bounded by the tested or analyzed conditions.	1.c A report exists and concludes that the as-built seismic Category I equipment and components identified in Table 2.5.4-1, including anchorages, is seismically bounded by the tested or analyzed conditions
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.	2.a An inspection for separation of the as-built redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment will be performed.	2.a The physical separation of as-built redundant Class 1E divisions identified in Table 2.5.4-1 and associated field equipment is provided by distance or barriers in accordance with NRC RG 1.75.

2.5.4-5

Table 2.5.4-4 (2 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2. (cont.)	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.

2.5.4-5

Table 2.5.4-4 (3 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
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.	5. A test will be performed using simulated input signals for initiation input to each division of the as-built ESF-CCS.	5. Each ESF-CCS division receives ESFAS initiation signals from two divisions of the RMS, 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 for each BOP ESF actuation function identified in Table 2.5.4-2 and sends the control signals to the ESF components.
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.	6. A test will be performed using simulated input signals for initiation input to each division of the as-built ESF-CCS.	6. Each ESF-CCS division receives a SIAS, CSAS, or AFAS and initiate an automatic start of the EDGs and automatic 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.	7. A test will be performed using simulated input signals for initiation input to each division of the as-built ESF-CCS.	7. Each ESF-CCS division receives loss of power to Class 1E buses, and initiate an automatic start of the EDGs, shedding of electrical loads, transfer of Class 1E bus connections to the EDGs, and sequencing 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.	8. A test of the as-built system for one control within each ESF-CCS division will be performed to demonstrate the transfer of control capability between the MCR and RSR.	8. The as-built master transfer switches transfer controls between the MCR and RSR separately for each as-built ESF-CCS division, as follows: a. Controls in the RSR are disabled when controls are active in the MCR. b. Controls in the MCR are disabled when controls are active in the RSR.

2.5.4-5

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.

2.5.4-5

Table 2.5.4-4 (5 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
13. The component interface module (CIM) provides state-based priority logic to prioritize the ESF-CCS and DPS signals.	13. A test will be performed using simulated input signals concurrently to the CIM.	13. When the CIM receives conflicting component control input signals from the ESF-CCS and DPS, the CIM prioritizes the signals so that one direction of component control always has priority over the opposite direction, regardless of which system is commanding the priority direction.
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.	14. A test will be performed using simulated input signals concurrently to the CIM.	14. When the CIM receives input signals from the front panel control switch and DMA switches concurrently, the CIM prioritizes signals so that the signal of the front panel control switch has priority over signals of the DMA switches. 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.	15.a An inspection will be performed for the requirements phase result summary report of ESF-CCS software.	15.a The requirements phase result summary report exists and concludes that the plant requirements phase activities of ESF-CCS software are performed.
	15.b An inspection will be performed for the design phase result summary report of ESF-CCS software.	15.b The design requirements phase result summary report exists and concludes that the design phase activities of ESF-CCS software are performed.
	15.c An inspection will be performed for the implementation phase result summary report of ESF-CCS software.	15.c The implementation phase result summary report exists and concludes that the implementation phase activities of ESF-CCS software are performed.

2.5.4-5

Table 2.5.4-4 (6 of 7)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
15 (cont.)	15.d An inspection will be performed for the test phase result summary report of ESF-CCS software.	15.d The test phase result summary report exists and concludes that the test phase activities of ESF-CCS software are performed.
	15.e An inspection will be performed for the installation and checkout phase result summary report of ESF-CCS software.	15.e The installation phase result summary report exists and concludes that the installation and checkout phase activities of ESF-CCS software are performed.
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.	16.a A type test, analysis, or a combination of a type test and analysis will be performed.	16.a A report exists and concludes that the ESF-CCS equipment identified in Table 2.5.4-1 withstand the electrical surge, EMI, RFI, and 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.
	16.b An inspection and analysis of the as-built Class 1E equipment and components installation configuration and environment will be performed identified in Table 2.5.4-1.	16.b The as-built Class 1E equipment, components, and the associated wiring, cables, and terminations identified in Table 2.5.4-1 are bounded by a type test or a combination of a type test and analysis.
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.	17. An inspection of the as-built equipment for conformance with the identification requirements will be performed.	17. The as-built equipment and components listed in Table 2.5.4-1 and related field equipment comply with the labeling and the color coding requirements.

2.5.4-5

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.
22. The ESF-CCS provides the interlocks important to safety identified in Table 2.5.4-4.	22. A test of the as-built ESF-CCS will be performed.	22. The as-built ESF-CCS provides the interlocks important to safety identified in Table 2.5.4-4 when simulated signals reach the predetermined setpoints.