SUPPLEMENTAL 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.:	**198-8208**
Review Section:	**14.02 – Initial Plant Test Program – Design Certification and New License Applicants**
Application Section:	**14.2**
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Question No. 14.02-31

Justify why all the automatic functions performed by the diverse protection system (DPS) are not verified in the DPS test described in APR1400 FSAR Tier 2, Section 14.2.12.1.49.

General Design Criterion (GDC) 1, “Quality standards and records” of Appendix A, “General Design Criteria for Nuclear Power Plants” to 10 CFR Part 50 states, in part, that structures, systems, and components important to safety shall be tested to quality standards commensurate with the importance of the safety functions to be performed.

APR1400 FSAR Tier 2, Section 14.2.12.1.49 provides the initial test description for the DPS. The objective of this test is to verify the proper operation of the DPS. However, the test methods for this test only verify the operation of the reactor trip switch system (RTSS) trip circuit breaker and operation of the alternate auxiliary feedwater actuation signals using simulated input signals. It is not clear to the staff whether the simulated signals will be injected into the DPS. The staff requests the applicant to clarify this in the test methods description of this section. In addition, APR1400 FSAR Tier 2, Section 7.8 and the referenced technical reports identify additional automatic safety actuation signals performed by the DPS. The staff requests the applicant to justify why these functions are not verified in this initial test.

Response

KHNP has reviewed the subject question and understands the staff’s request. KHNP is in the process of upgrading the test plans presented in Section 14.2 of the DCD. This effort is focused on adding additional SSCs that are important to safety and risk significant as well as increasing the level of detail described in the DCD for test prerequisites, test methods, and acceptance criteria for the various tests. It has been determined that the actions to be taken as a result of this question are within the scope of the upgrade effort. Therefore, KHNP will

address the noted items in the upgrade effort, which is scheduled to be completed by February 1, 2016. A revised response to this question that incorporates the results of the upgrade effort will be submitted to the NRC after completion.

Response – (Rev. 1)

As described in Section 7.8.1.1 of DCD Tier 2, the major function of the diverse protection system (DPS) is the generation of reactor trip signal, turbine trip signal, auxiliary feedwater actuation signal (AFAS), and safety injection actuation signal (SIAS) when required. Since Section 14.2.12.1.49 of DCD Tier 2 (Revision 0) did not include the initial test description for all functions of the DPS, the test plan was upgraded as part of the program described in the original response. The plan for 14.2.12.1.49 was changed to include the automatic actuation signals of the DPS and was previously submitted to the NRC (refer to KHNP submittal MKD/NW-16-0156L dated February 24, 2016; ML16056A003). Subsequent review has determined that additional clarifications pertaining to the DPS signals, (in particular the turbine trip signal), and other editorial changes should be made to enhance the initial test program (ITP). Therefore, the previously submitted ITP is being changed to include the more detailed information.

Supplemental Response

The ITP for the diverse manual ESF actuation (DMA) switches is addressed in the test descriptions in DCD Tier 2, Section 14.2.12.1.23, “Engineered Safety Features – Component Control System Test,” which was added in the revised response to RAI 198-8208, Question 14.02-20 (ref. KHNP submittal MKD/NW-16-0893L dated August 17, 2016; ML16230A478); refer to pages 1 through 5 in the Attachment to this response.

The plan described in Section 14.2.12.1.49 was changed to include the automatic actuation signals of the DPS and was previously submitted to the NRC (refer to KHNP submittal MKD/NW-16-0156L dated February 24, 2016; ML16056A003); refer to pages 6 through 8 of the Attachment to this response.

The ITP for the diverse indication system (DIS) is addressed in Section 14.2.12.1.139, “Diverse Indication System Test,” which was added to DCD Tier 2 in KHNP submittal MKD/NW-16-0156L dated February 24, 2016; ML16056A003; refer to pages 9 and 10 of the Attachment to this response.

Impact on DCD

DCD Tier 2, Section 14.2.12.1.49 will be revised as indicated in the Attachment to this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on the Technical/Topical/Environmental Report.

14.2.12.1.23 Engineered Safety Features – Component Control System Test

The internal functions of the ESF-CCS are confirmed through factory acceptance testing. The basis of this in-plant test is to confirm the correct installation of the ESF-CCS, including inter-cabinet cable interfaces, and interfaces to other I&C systems, plant instrumentation and the controlled plant components. This test includes samples that overlap the digital functions previously tested in the factory to confirm that the correct operation of those functions has not been adversely affected by plant installation activities.

1.0 OBJECTIVES

1.1 To verify the operation of the manual controls for each ESF component from the MCR, including the correct ESF component response and status feedback.

1.2 To verify bumpless transfer of control from the MCR to the RSR, and the operation of the RSR manual controls, including the correct ESF component response.

1.3 To verify the interface of the PPS ESF actuation signals with associated alarms, including the correct ESF component response, for actuation and reset.

1.4 To verify the operation of the ESF actuation signals generated internally within the ESF-CCS with associated alarms, including the correct ESF component response, for actuation and reset. This test does not confirm instrument calibration.

1.5 To verify the operation of the emergency diesel generator (EDG) Load Sequencer with associated alarms. This test does not confirm instrument calibration.

1.6 To verify the operation of all ESF system process interlocks and automatic control signals with associated alarms, including the correct ESF component response for actuation and reset. This test does not confirm instrument calibration.

1.7 To verify the interface of the diverse protection system (DPS) actuation signals with associated alarms, including the correct ESF component response, for actuation and reset.

1.8 To verify the interface of the diverse manual ESF actuation (DMA) switches, for each ESF component with a DMA interface, including the correct ESF component response.

1.9 To verify the operation of redundant ESF-CCS power supplies.

2.0 PREREQUISITES

2.1 Factory acceptance tests have been completed for the ESF-CCS.

2.2 Construction activities for the ESF-CCS have been completed. This includes:

Installation and power-up of ESF-CCS electronic components, including digital controllers and I/O modules.

Connection of digital data communication interfaces, both wired and fiber-optic, between ESF-CCS internal components (e.g., operator modules) and to/from other plant systems.

Connection of wired interfaces between ESF-CCS internal components (e.g., conventional switches and indicators), to/from other plant systems, and to/from plant sensors and controlled plant components. Instrument calibration is not a prerequisite.

2.3 There are no unexpected ESF-CCS self-diagnostic alarms. Self-diagnostic alarms may exist for temporary test conditions; any self-diagnostic alarms are justified.

2.4 Electrical and mechanical systems, which contain the plant components controlled by the ESF-CCS, are configured to allow short term component state changes during the ESF-CCS tests. These state changes confirm correct ESF control and correct component status feedback processing.

3.0 TEST METHOD

The ESF-CCS tests are conducted to confirm the correct ESF-CCS control of the ESF plant components, not to confirm the performance of the plant's mechanical and electrical systems. Each method, below, corresponds to the test objective with the corresponding 1.X/3.X number designation. To verify redundancy and electrical independence within the ESF-CCS, these tests are conducted separately for each safety division with observations within the division under test and concurrent observations of the other divisions.

3.1 Manually change the state of each ESF plant component using each unique MCR human systems interface. This includes manual control from an ESF-CCS soft control module (ESCM), and control from each minimum inventory (MI) control for ESF components that have MI control. Distribute the tests across all ESCMs; but any single component is controlled from only one ESCM. Observe component status feedback and alarms.

3.2 Manually transfer control between the MCR and RSR using the master transfer switches. Manually change the state of the ESF plant components credited for safe shutdown using the ESCMs in the RSR. Observe component status feedback and alarms. This test is conducted on a sample basis, at least one component in each plant electrical and mechanical system, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1.

3.3 Manually initiate each ESF actuation signal generated by the PPS using the MCR system-level MI switches, then manually reset the signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in each ESF actuation group, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23,

subsection 3.1.

3.4 Manually initiate each ESF actuation signal generated directly by the ESF-CCS using the MCR MI switches, then manually reset the signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in each ESF actuation group, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1. In addition, stimulate the sensor inputs to the ESF-CCS to generate these same ESF actuation signals automatically.

3.5 Stimulate the loss of offsite power (LOOP) and EDG sensor inputs to the ESF-CCS to initiate load shed and group sequence signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in each sequence group, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1.

3.6 Stimulate the sensor inputs to the ESF-CCS for process interlocks and automatic control signals, then manually reset the signals. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be monitored. This monitoring is conducted on a sample basis, at least one component actuated by each interlock/control signal, since the ability to change the state of all ESF components was confirmed in Section 14.2.12.1.23, subsection 3.1.

3.7 Stimulate the DPS to generate each diverse actuation signal. Observe component status feedback and alarms. This test repositions multiple ESF plant components concurrently; if multiple ESF plant components cannot be repositioned during this test, the ESF-CCS component outputs can be disconnected and monitored. This monitoring is conducted on a sample basis, at least one component in each DPS actuation group, since the ability to change the state of all ESF components was confirmed in 14.2.12.1.23, subsection 3.1.

3.8 Manually change the state of each ESF plant component with a DMA interface, using the DMA switches in the MCR. Observe component status feedback and alarms.

3.9 De-energize each set of ESF-CCS logic power supplies (one at a time for each pair). Repeat this test for I/O power supplies. Observe component status feedback or ESF-CCS outputs. This monitoring is conducted on a sample basis, at least one component controlled from each I/O rack of the ESF-CCS or one ESF-CCS output from each I/O rack of the ESF-CCS.

4.0 DATA REQUIRED

4.1 Component status feedback and alarms

4.2 Component status feedback or ESF-CCS outputs

5.0 ACCEPTANCE CRITERIA

Each acceptance criteria, below, corresponds to the test objective in Section 14.2.12.1.23 subsection 1.0 and the test method in Section 14.2.12.1.23 subsection 3.0 , with the corresponding 1.X/3.X/5.X number designation. Test acceptance is confirmed for each separate safety division under test, with confirmation of no unexpected interactions with other safety divisions.

5.1 Each ESF plant component responds correctly to the manual control command from a MCR ESCM. Each ESF plant component with a MI control responds correctly to the MCR manual control command from the MI control.

5.2 There are no component state changes when the master transfer switches are activated. Each sampled ESF plant component responds correctly to the manual control command from a RSR ESCM.

5.3 ESF actuation alarms are generated and each ESF plant component, or ESF-CCS sampled output, responds correctly to the ESF actuation signal from the PPS. When the signals are reset all components remain in their actuated position.

5.4 ESF actuation alarms are generated and each ESF plant component, or ESF-CCS sampled output, responds correctly to the ESF actuation signal from the internally generated ESF actuation signals from the SLS. When the signals are reset all components remain in their actuated position. These same ESF actuation signals are generated through sensor stimulation.

5.5 LOOP alarms are generated and each ESF plant component that is controlled by load shed or group sequence signals, or ESF-CCS sampled output, responds correctly to the LOOP load shed and group sequence signals. Load shed signals result in ESF plant components going to their de-energized state. Group sequence signals energize the ESF plant component directly or allow the component to be energized by other ESF actuation signals.

5.6 Interlock alarms are generated and each ESF plant component, or ESF-CCS sampled output, responds correctly to the interlock and control signals. When an interlock is reset all components remain in their interlock demanded position, unless there is a specific reset reposition command in the component's control logic.

5.7 Each ESF plant component, or ESF-CCS sampled output, responds correctly to the diverse actuation signal from the DPS.

5.8 Each ESF plant component with a DMA control responds correctly to the manual control command from a MCR DMA switch.

5.9 Power supply failure alarms are generated. There are no state changes for the controlled plant components or the ESF-CCS outputs.

3.2 During preoperational post-core hot functional tests, perform a full transfer of control from the MCR and perform a controlled cooldown from the remote shutdown console.

4.0 DATA REQUIRED

4.1 RCS temperatures and pressures

5.0 ACCEPTANCE CRITERIA

5.1 The ~~ability to cool~~plant can be cooled down ~~using remote~~and stabilized in the cold shutdown ~~instrumentation and controls has been demonstrated~~condition within the design limits from outside the main control room.

5.2 The remote shutdown console performs as described in ~~Subsection 7.4.1~~the related design specification.

14.2.12.1.49 Diverse Protection System Test

1.0 ~~OBJECTIVE~~OBJECTIVES

1.1 To demonstrate the proper operation of the diverse protection system (DPS)

1.2 To verify [the] operation of DPS alarms and indications

1.3 To verify for each DPS channel, the channel bypass logic will ~~not produce initiation signals~~ [block its trip outputs] while the DPS is in "Bypass". [Delete period.]

1.4 To verify the operation of coincidence logic for steam generator 1 low level, steam generator 2 low level, high pressurizer pressure, low pressurizer pressure, high containment pressure, reactor trip on turbine trip, and DPS manual reactor trip signals. [Delete period.]

1.5 To verify that the DPS trip and pretrip setpoints have been installed properly, and are within the acceptable tolerances.

Delete period.

1.6 To verify the ~~auxiliary feedwater initiation and safety injection initiation~~

initiation of reactor trip, turbine trip, auxiliary feedwater actuation, and safety injection actuation signals

1.7 To verify the DPS response time

2.0 PREREQUISITES

2.1 Construction activities on the ~~reactor trip switch system (~~RTSS~~)~~ and the DPS have been completed.

2.2 DPS instrumentation has been calibrated.

2.3 External test instrumentation is available and calibrated.

2.4 Support systems required for operation of the RTSS and DPS are operational.

3.0 TEST METHODS

input signals into the DPS

3.1 Energize power supplies and verify output voltage.

the

3.2 Using simulated ~~signals~~, trip each reactor trip circuit breaker with the breaker in the test position. Observe RTSS trip circuit breaker operation.

into the DPS

the initiation of

3.3 Using simulated input signals, observe ~~alternate~~ auxiliary feedwater actuation ~~signals~~signal, and safety injection actuation signal.

3.4 Observe the turbine trip signal which is automatically generated with a 3-second time delay after the initiation of DPS reactor trip signal.

4.0 DATA REQUIRED

4.1 Power supply voltages

4.2 Resistance for ground fault detector operation

4.3 Trip setpoints

5.0 ACCEPTANCE CRITERIA

~~5.1 The DPS performs as described in Section 7.8.~~

logics

actuation signal caused by low steam generator level

5.1 Initiation ~~logic~~ and bypass ~~logic~~ for steam generator 1 auxiliary feedwater ~~valves~~ ~~are~~ perform~~s~~ as specified in the related design specification.

5.2 Initiation ~~logic~~ and bypass ~~logic~~ for steam generator 2 auxiliary feedwater ~~valves~~ ~~are~~ perform~~s~~ as specified in the related design specification.

reactor trip signal caused by

5.3 Initiation ~~logic~~ and bypass ~~logic~~ for the high pressurizer pressure ~~trip~~ ~~are~~ perform~~s~~ as specified in the related design specification.

safety injection actuation signal caused by

5.4 Initiation ~~logic~~ and bypass ~~logic~~ for the low pressurizer pressure trip ~~are~~ perform~~s~~ as specified in the related design specification.

reactor trip signal caused by

5.5 Initiation ~~logic~~ and bypass ~~logic~~ for the high containment pressure ~~trip~~ ~~are~~ perform~~s~~ as specified in the related design specification.

5.6 Initiation ~~logic~~ and bypass ~~logic~~ for the reactor trip on turbine trip ~~are~~ perform~~s~~ as specified in the related design specification.

logics

5.7 Initiation and bypass for the manual reactor trip ~~are~~ perform~~s~~ as specified in the related design specification.

5.8 Indication and alarms for DPS should operate as specified in the related design specification.

the

System

limit

5.9 ~~DPS~~ response time should be within design ~~value~~ as specified in the related design specification.

5.10 Initiation and bypass logics for the turbine trip signal perform as specified in the related design specification.

14.2.12.1.139 Diverse Indication System Test

1.0 OBJECTIVES

1.1 To verify that the DIS is installed properly, responds correctly to external input signals, and display plant parameters on the DIS display device.

2.0 PREREQUISITES

2.1 Construction activities on the system to be tested are complete.

2.2 Vendor and owner manuals are available and up-to-date.

2.3 External test equipment and instrumentation are available and calibrated.

2.4 Plant systems required to support this test are operable to the extent necessary to perform the test.

3.0 TEST METHOD

3.1 Verify power sources to all related equipment.

3.2 Using appropriate test equipment, simulate and vary input signals to the DIS.

3.3 Verify that input signals are received and processed correctly by the appropriate system devices.

3.4 Verify the operability of the DIS application software

3.5 Verify the calculation of part of parameters by the DIS application software.

3.6 Verify that displays respond correctly to actual or simulated input signals.

3.7 Verify the correct operation of the DIS switch on the Safety Console.

3.8 Verify the calculation of the heated-junction thermocouple (HJTC) heater power control signal.

3.9 Verify the control of the HJTC heater power via the DIS switch.

4.0 DATA REQUIRED

4.1 All simulated input signal values, appropriate intermediate values, and outputs

4.2 HJTC heater power control status receiving from the interfacing system (QIAS-P).

5.0 ACCEPTANCE CRITERIA

5.1 The DIS performs as described in Subsection 7.8.2.3.

5.2 The test results of the DIS should meet the acceptance criteria for each test case that is specified in related design document.

14.2.12.2 Post-Core Hot Functional Tests

14.2.12.2.1 Post-Core Hot Functional Test Controlling Document

1.0 ~~OBJECTIVE~~OBJECTIVES

1.1 To demonstrate the proper integrated operation of plant primary, secondary, and auxiliary systems with fuel loaded in the core