

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.: 68-7892
SRP Section: 7.7 – Control Systems
Application Section: 07.07
Date of RAI Issue: 07/10/2015

Question No. 07.07-2

Explain the differences in controller group arrangements between the APR1400 FSAR, Tier 1, Table 2.5.5-1, and Table 5.2-1 of Technical Report APR1400-Z-J-NR-14012-P, Rev. 0, "Control System CCF [common cause failure] Analysis."

10 CFR 52.47(b)(1) requires, in part, that if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Act, and the Commission's rules and regulations. Standard Review Plan (SRP) Section 7.7 states, in part, the failure of any control system component or any auxiliary supporting system for control systems should not cause plant conditions more severe than those described in the analysis of anticipated operational occurrences in Chapter 15 of the safety analysis report (SAR).

The content of APR1400 FSAR Tier 1, Table 2.5.5-1, "Controller Group Arrangement of The PCS and NPCCS", and Table 5.2-1, "Control Group Segmentation" of Technical Report APR1400-Z-J-NR-14012-P do not align. Table 5.2-1 has a wider scope of design detail, while the Table 2.5.5-1 does not seem to be updated to match the number of systems described in the technical report. For example, Table 5.2-1 of the "Control System CCF Analysis" technical report contains information about controller groups such as the Turbine Control System (TCS), Condenser Vacuum control and Non-1E AC power. Table 2.5.5-1 does not contain these individual controller groups. Though the technical report would be expected to convey a larger amount of detailed design information, Table 2.5.5-1 of the Tier 1 FSAR would be an incomplete representation of the non-safety control system controller arrangement.

1. Is the intent of APR1400 FSAR, Tier 1, Table 2.5.5-1, to convey the total number of control groups within the non-safety I&C architecture or only a limited set?

2. Explain why the APR1400 FSAR, Tier 1, Design Description, does not contain a table that establishes all of the control groups (essentially the control group segmentation), which would align with Technical Report APR1400-Z-J-NR-14012-P to adequately describe the design of the control system architecture.

Response

1. DCD Tier 1, Table 2.5.5-1 currently contains control groups for the nuclear steam supply system (NSSS) which are important with regards to limiting the effects of common cause failure (CCF) of the control system software. The table will be revised to contain all the non-safety control groups, as indicated in Attachment 1. Also, editorial corrections have been made to technical report APR1400-Z-J-NR-14012-P for clarity, as indicated in Attachment 2.
2. As described in DCD Tier 1, Subsection 2.5.5.1, Table 2.5.5-1 shows major control groups for the NSSS control functions, because the segmentation of these groups are important to limit the effects of control system software common cause failure (CCF). However, the control group segmentation of DCD Tier 1, Table 2.5.5-1 does not include all control groups presented in Table 5.2-1 of technical report APR1400-Z-J-NR-14012-P. DCD Tier 1, Subsection 2.5.5.1, Table 2.5.5-1 and 2.5.5-2, and DCD Tier 2, Table 7.7-1 will be revised, as indicated in Attachment 1, to align with technical report APR1400-Z-J-NR-14012-P.

Impact on DCD

DCD Tier 1, Subsection 2.5.5.1, Table 2.5.5-1 and Table 2.5.5-2, and DCD Tier 2, Table 7.7-1 will be revised as indicated in Attachment 1.

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

Technical report APR1400-Z-J-NR-14012-P/NP, Rev.0 will be revised as indicated in Attachment 2.

APR1400 DCD TIER 1


2.5.5 Control System Not Required for Safety2.5.5.1 Design Description

Control system which is not required for safety consists of power control system (PCS) and process-component control system (P-CCS).

The PCS includes the reactor regulating system (RRS), the digital rod control system (DRCS), and the reactor power cutback system (RPCS). The P-CCS includes nuclear steam supply system (NSSS) process control system (NPCS) and balance of plant (BOP) control systems. The NPCS consists of the feedwater control system (FWCS), the steam bypass control system (SBCS), the pressurizer pressure control system (PPCS), the pressurizer level control system (PLCS), and other miscellaneous NSSS control systems which include reactor makeup control function of the chemical and volume control system (CVCS).

The PCS and P-CCS provide control of functions to maintain the plant within its normal operating range for all normal modes of plant operation.

Control and display interface devices for the PCS and P-CCS are provided in the main control room (MCR) and in the remote shutdown room (RSR) for control and monitoring of the PCS and P-CCS.

1. The ~~major~~ controllers of the PCS and ~~NPCS~~ are arranged in separate controller groups as identified in Table 2.5.5-1. 
2. The digital equipment and software used in the PCS and P-CCS are independent from those of the plant protection system (PPS) and the engineered safety features-component control system (ESF-CCS).
3. The PCS and P-CCS are controlled from either the MCR or RSR, as selected from master transfer switches.

2.5.5.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the PCS and P-CCS are specified in Table 2.5.5-2..

APR1400 DCD TIER 1

Table 2.5.5-1

Controller Group Arrangement of the PCS and NPCS

Control Function Description	Controller Group Distribution
SG1 feedwater control (FWCS 1)	Each control is in a separate controller group
SG2 feedwater control (FWCS 2)	Each control is in a separate controller group
Pressurizer pressure control (PPCS)	Each control is in a separate controller group
Pressurizer level control (PLCS)	Each control is in a separate controller group
Turbine bypass control (SBCS Main)	Each control is in a separate controller group
Turbine bypass control (SBCS Permissive)	Permissive is in a separate controller group
Reactor makeup control (CVCS) RRS/RPCS	Each control is in a separate controller group
Control rod control (RRS)	Each control is in a separate controller group
Control rod control (DRCS)	Each control is in a separate controller group

Reactor coolant pump control	Each control is in a separate controller group
Feedwater HP heater train A control	Each control is in a separate controller group
Feedwater HP heater train B control	Each control is in a separate controller group
Feedwater HP heater bypass line control	Each control is in a separate controller group
Feedwater pumps On/Off	Each control is in a separate controller group
Non-1E AC power to the station auxiliaries (13.8kV Non-Class 1E System)	Each control is in a separate controller group
Condenser vacuum control	Each control is in a separate controller group
Turbine control (TCS)	Each control is in a separate controller group
Miscellaneous BOP control - Circulating water pump - Condensate pump	Each control is in a separate controller group

APR1400 DCD TIER 1

Table 2.5.5-2

Control System Not Required for Safety ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
<p>1. The major controllers of PCS and NPCS are arranged in separate controller groups as identified in Table 2.5.5-1.</p>	<p>1. Inspection of the as-built PCS and NPCS will be performed.</p>	<p>1. The as-built PCS and NPCS are arranged in separate controller groups as identified in Table 2.5.5-1.</p>
<p>2. The digital equipment and software used in the PCS and P-CCS are independent from those of the plant protection system (PPS) and the engineered safety features-component control system (ESF-CCS).</p>	<p>2. Inspection of the as-built PCS and P-CCS equipment will be performed. Inspection of the design documentation will be performed to confirm that the software is developed by independent design groups.</p>	<p>2. The as-built digital equipment and software used in the PCS and P-CCS are independent from those of the PPS and ESF-CCS based on:</p> <ul style="list-style-type: none"> • PCS and P-CCS use a platform which is independent from the platform used in the PPS and ESF-CCS and • The design group(s) which developed the PCS and P-CCS software is independent from the design group(s) which developed the PPS and ESF-CCS software.
<p>3. The PCS and P-CCS are controlled from either the MCR or RSR, as selected from MCR/RSR master transfer switches.</p>	<p>3. A test of the as-built system will be performed to demonstrate the transfer of control capability between the MCR and RSR.</p>	<p>3. The as-built MCR/RSR master transfer switches transfer controls between the MCR and the RSR for as-built PCS and P-CCS, as follows:</p> <ul style="list-style-type: none"> • Controls at the RSR are disabled when controls are active in the MCR for the as-built PCS and P-CCS. • Controls at the MCR are disabled when controls are active in the RSR for the as-built PCS and P-CCS.

P-CCS

P-CCS

P-CCS

APR1400 DCD TIER 2

Table 7.7-1

Control Groups for the NSSS Control Functions

Control Group ⁽³⁾	Postulated Events Due to a Single Failure in the Corresponding Control Group ⁽¹⁾				
	Excessive or Deficient Feedwater Flow	Full Open of Any One TBV	Excessive Charging Flow or Excessive PZR Spray	Uncontrolled CEA Withdrawal	Inadvertent Deboration
SG 1 FW Control (FWCS 1)	×				
SG 2 FW Control (FWCS 2)	×				
PZR Pressure Control (PPCS)			× (Excessive PZR Spray)		
PZR Level Control (PLCS)			× (Excessive Charging Flow)		
Turbine Bypass Control (SBCS Main)		× ⁽²⁾			
Turbine Bypass Control (SBCS Permissive)		×			
Reactor Makeup Control (CVCS)					×
Control Rod Control (RRS)				×	
Control Rod Control (DRCS) RRS/RPCS				× ⁽²⁾	

- (1) This table describes that one control group failure does not cause credible failures in other control groups.
- (2) An interlock signal is provided for this control group from a separate control group or safety systems, to limit the failure effect of the control group.
- (3) Each control group consists of at least one separate controller. A detailed description of all control groups including BOP control functions is provided in the Control System CCF Analysis technical report.
- (4) Postulated events due to a single failure of non-safety control system do not cause plant conditions more severe than those described in the analysis of AOO in Chapter 15. Refer to the Control System CCF Analysis technical report.

Table 5.2-1 Control Group Segmentation (Continued)

TS

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.: 68-7892
SRP Section: 7.7 – Control Systems
Application Section: 07.07
Date of RAI Issue: 07/10/2015

Question No. 07.07-3

Provide an ITAAC that verifies the implementation of functional segmentation and component segmentation arrangements as described in Technical Report APR1400-Z-J-NR-14012-P, Revision 0, "Control System CCF Analysis" technical report.

10 CFR 52.47(b)(1) states, in part, that if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Act, and the Commission's rules and regulations. SRP Section 7.7 states, in part, that for the effect of control system failures, the failure of any control system component or any auxiliary supporting system for control systems does not cause plant conditions more severe than those described in the analysis of anticipated operational occurrences in Chapter 15 of the SAR.

Technical Report APR1400-Z-J-NR-14012-P, Section 4.5 "Segmentation" describes the grouping of control functions and components into segmented arrangements that directly support the quantitative and qualitative analysis provided in this report to address the safety issue of postulated failure(s) in the APR1400 control systems. Table 2.5.5-2, "Control System Not Required for Safety ITAAC," of the APR1400 FSAR, Tier 1, ITAAC Section 2.5.5, "Control System Not Required for Safety," does not provide an ITAAC that verifies that these segmentation arrangements have been adequately implemented to support the safety case made within Technical Report APR1400-Z-J-NR-14012-P. It is essential the programming and implementation of the functional and component segmentation as shown in the technical report be verified in order in order to maintain the validity of the CCF quantitative and qualitative analysis. Provide an ITAAC that verifies the segmentation arrangements for the APR1400 control systems or provide an explanation for why this design commitment is not necessary.

Response

To verify that the implementation of functional segmentation and component segmentation arrangements have been performed according to technical report APR1400-Z-J-NR-14012-P, DCD Tier 1, Subsection 2.5.5.1 and Table 2.5.5-1 will be revised as shown in the attachment associated with the response to RAI 68-7892, Question 07.07-2.

DCD Tier 1, Subsection 2.5.5.1, item 1 and Table 2.5.5-2, item 1 are used to verify the segmentation arrangements for the APR1400 control systems. Refer to the response to Question No. 07.07-2 of RAI 68-7892 for the modified control group arrangement of DCD Tier 1, Table 2.5.5-1, which reflect the evaluation results of technical report APR1400-Z-J-NR-14012-P.

Impact on DCD

DCD Tier 1, Subsection 2.5.5.1 and Table 2.5.5-2 will be revised as indicated in the attachment associated with RAI 68-7892, Question No. 07.07-2.

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 Reports.

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.: 68-7892
SRP Section: 7.7 – Control Systems
Application Section: 07.07
Date of RAI Issue: 07/10/2015

Question No. 07.07-7

Clarify the use of the word, "disappeared" in Technical Report APR1400-Z-J-NR-14012-P, Rev.0, "Control System CCF Analysis."

10 CFR 52.47(a)(2) requires, in part, that the description of structures, systems and components shall be sufficient to permit understanding of the system designs. Technical Report APR1400-Z-J-NR-14012-P uses the term, "disappeared" in multiple places in Section 5, "Evaluation Method and Results," which is confusing since it would not seem to convey the technical idea that is appropriate for the context in which the term is used. For example, in Sheet 9 of 18 of Table 5.1-10, "Multiple Failure due to a Single Failure of Shared Signals," of the technical report, it states the following, "The above temporary excessive feedwater by ... is disappeared by ..." Given the safety significance of this technical issue, it is essential that the design description be expressed in the most accurate way possible.

Clarify the use of the term "disappeared" in Technical Report APR1400-Z-J-NR-14012-P.

Response

In technical report APR1400-Z-J-NR-14012-P, the term "disappeared" is used to mean that an abnormal state of the feedwater flow due to a shared signal failure is recovered or cleared by a high pass filter function of the FWCS, because the high pass filter has a steady-state gain equal to zero. For clarification, the term "disappeared" will be changed to "recovered" in technical report APR1400-Z-J-NR-14012-P. Subsections 5.1.4.7 and 5.1.4.8, and Tables 5.1-9, 5.1-10, and 5.2-9 of technical report APR1400-Z-J-NR-14012-P will be revised as shown in the attachment associated with this response for clarification.

In Subsection 5.1.4.8 of technical report APR1400-Z-J-NR-14012-P, the evaluation is modified because the automatic withdrawal prohibit (AWP) function of the SBSCS stops the

CEA withdrawal when the steam dump induced by high pressurizer pressure or high steam header pressure is occurring.

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

Technical report APR1400-Z-J-NR-14012-P/NP, Rev.0 will be revised as indicated in the attachment associated with this response.

TS



Table 5.1-9 Multiple Failure due to a Single Failure of Shared Signals (8 of 18)

TS



Table 5.1-10 Multiple Failure due to a Single Failure of Shared Signals (9 of 18)

TS

Table 5.2-9 Multiple Failures of Single Control group (RRS/RPCS) (Sh. 1 of 2)

TS