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.: 400-8425

SRP Section: 18 – Human Factors Engineering

Application Section:

Date of RAI Issue: 02/04/2016

Question No. 18-115

Regulations in 10CFR 50.34(f)(2)(iv) describe requirements for a safety parameter display system (SPDS). NUREG-0711, Criterion 8.4.4.2, "Main Control Room," (1) SPDS, describes an acceptable method for complying with the regulation. This criterion states, “Identification of critical safety functions (CSFs) – The CSFs needed to meet the requirement for an SPDS should be identified.” It also states, "the applicant should identify the plant parameters personnel will use to monitor each CSF.”

1. APR1400-E-I-NR-14003-P, “Functional Requirements Analysis and Function Allocation Implementation Plan” (FRA/FA IP), describes a process to be used to identify the APR1400 CSFs. However, DCD Tier 2, Section 7.7.1.4(d)(1), “SPADES+,” lists the CSFs that the SPADES+ program will display on the CSF displays. Because the APR1400 CSFs have already been identified in the application, and it is not clear to the staff why the FRA/FA IP, Section 4.2, "Analysis Updates (Iterations)," requires the COL applicant to use a process to identify the CSFs. Further, the HD IP, Section 4.2.1, "Critical Safety Function Displays," states that CSFs identified by the FRA/FA process is an input to the HSI design. If the DCD Tier 2, Section 7 has already identified the CSFs then the input to the HSI design process has already been identified, and the HD IP should identify the correct input.

   Align the information in the FRA/FA IP, HD IP, and DCD Tier 2, Section 7.7.1.4(d)(1). Revise the submittal as necessary.

2. APR1400-E-I-NR-14003-P, FRA/FA IP, states that parameters will be identified for each CSF. However, the Basic HSI TeR (APR1400-E-I-NR-14011-P, Rev. 0), Section 3.5.2, “Situation Awareness,” says that the minimum variables used to monitor the CSFs are the Type B variables listed in DCD Tier 2, Table 7.5-1, “Accident Monitoring Instrumentation Variables.” This table lists Type B, C, D, and E variables, and some of the Type D variables also are credited with monitoring CSFs (e.g., vital auxiliaries). Therefore, it appears to the staff that the parameters have been identified in the

application, and it is not clear to the staff why the FRA/FA IP requires the COL applicant to use a process to identify the parameters. Further, the HD IP, Section 4.2.1, "Critical Safety Function Displays," states that parameters used to monitor the CSFs identified by the FRA/FA process are an input to the HSI design. If the DCD Tier 2, Section 7 has already identified these parameters, then the input to the HSI design process has already been identified, and the HD IP should identify the correct input.

Align the information in the FRA/FA IP, HD IP and DCD Tier 2, Table 7.5-1. Revise the submittal as necessary.

Response

1. As Stated in the FRA/FA IP, the APR1400 is an evolution of predecessor plants which have established standard CSFs. CEN-152 Combustion Engineering Emergency Procedure Guidelines (CE EPGs) (Reference 3) identify the standard CSFs and provide the bases for the CSFs contained in the Functional Recovery Guideline (FRG) of the APR1400 Emergency Operating Guidelines (EOGs). These Top level functions are used as a starting point for hierarchal FRA which will, as described in DCD section 18.3.2.1, “account for:

   a. Any changes in critical functions

   b. Evolutionary design changes resulting modifications to the functional hierarchy (i.e., changes to processes, systems, and components)

   c. Increased detail in the definition of the functional hierarchy to the level of control actions

   d. Operating experience incurred subsequent to the System 80+ evaluation

   e. Additional information needs to facilitate review to the criteria of NUREG-0711”

   Section 7.7.1.4.d.1), “SPADES+” and “Table 7.5-1” will be revised as shown in the attachment associated with this response, to align with FRA/FA and HD IPs the status of identification and confirmation of the CSFs.

   Section 4.2 of the FRA/FA IP does not require the COL Applicant to use a process to identify CSFs. DCD section 18.3.4 states that no COL information is required. The IP only states that the analysis is performed in a manner that allows the COL holder to continue to keep the database results from the analysis current. The intent is to provide the ability to comply with NUREG 0711 criteria 4.4 (9) for future modifications.

2. As noted in the Basic HSI, Type B variables represent a minimum set of parameters to monitor CSFs. As is the case for the identification of the high level CSFs, the FRA /FA process input to the HD process has the purpose of confirming, and if appropriate supplementing, the list of parameters. Table 7.5-1 will be revised, as shown in the attachment associated with this response, to align with FRA/FA and HD IPs regarding the AMI variables. Since the Basic HSI refers to Table 7.5-1 no change will be made to that document.

The staff is correct that there is no reason why the FRA/FA IP should requires the COL applicant to use a process to identify the parameters. It was not intended that FRA/FA IP contain a requirement that the AMI variables provided by the COL Applicant be identified using the FRA/FA process, nor is there a requirement to that effect.As noted above, section 18.3.4 states that no COL information is required for the FRA/FA. In addition DCD section 7.5.4 (COL Item 7.5(1)) states that “The COL applicant is to provide a description of the site-specific AMI variables such as wind speed and atmosphere stability temperature difference.” These types of site specific variables are not part of the functional hierarchy and are not identified in the FRA/FA.

Impact on DCD

Design Control Document (DCD) Tier 2, Rev. 0, “Chapter 7 Instrumentation and Controls,” Section 7.7.1.4.d.1), “SPADES+” and “Table 7.5-1” will be revised as indicated in the attachment associated with this response, to align with FRA/FA and HD IPs status of identification and confirmation of CSFs.

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.

parameter display system (SPDS) set forth in NUREG-0696 and NUREG-0737, Supplement No.1 (Reference 14).

SPADES+ monitors the status of the critical safety functions during normal, abnormal, and emergency operating conditions and provides alarms when any of the critical safety functions is not being maintained.

SPADES+ provides the capability to display the status of the following critical safety functions:

critical safety function identified by the Functional Requirements Analysis (FRA) described in section 18.3, including at a minimum the

a) Core reactivity control

b) Maintenance of vital auxiliaries

c) Reactor coolant system inventory control

d) Reactor coolant system pressure control

e) Core heat removal

f) Reactor coolant system heat removal

g) Containment isolation

h) Containment temperature and pressure control

i) Containment combustible gas control (radioactive emissions control)

SPADES+ provides the capability to display the success path status for each critical safety function and initiates an alarm when the function becomes inoperable.

2) Core operating limit supervisory system

The COLSS consists of process instrumentation and algorithms used to continually monitor the limiting conditions for operation (LCO). A description of COLSS algorithms and a discussion of the treatment of COLSS input information are provided in the Functional Design Requirements for a Core Operating Limit Supervisory System for APR1400 Technical Report (Reference 5). The COLSS continuously calculates departure from nucleate

Table 7.5-1 (1 of 5)

(1)

Accident Monitoring Instrumentation Variables

Variable	Range	Monitored Function or System	Channel Number	Type	Ambiguity (Division)
Pressurizer Pressure (Wide Range)	0 to 210.9 kg/cm^2A (0 to 3,000 psia)	Pressurizer	2	B	C,D (PPS OM)
Pressurizer Level	0 to 100 % (0 to 562.15 in)	Pressurizer	2	B	C,D (PPS OM)
Reactor Coolant Hot Leg Temperature (Wide Range)	0 to 400°C (32 to 752 °F)	RCS	4	B	2 Hot Leg signals per division (QIAS-P)
Reactor Coolant Cold Leg Temperature (Wide Range)	0 to 400°C (32 to 752 °F)	RCS	4	B	2 Cold Leg signals per division (QIAS-P)
Steam Generator Pressure	0 to 105 kg/cm^2A (0 to 1,494 psia)	Steam Generator	2/SG	B	C,D (PPS OM)
Steam Generator Level (Wide Range)	0 to 100 % (0 to 1117.6cm (0 to 440 in tap span)	Steam Generator	2/SG	B	C,D (PPS OM)
Core Exit Temperature	0 to 1260 °C (32 to 2,300 °F)	Inadequate Core Cooling	2	B, C	Validation (QIAS-P)
Degrees of Subcooling	RCS Temp Saturation Margin: -399 to 358.3 °C Upper Head (or CET) Temp Saturation Margin: -1,260 to 368.3 °C RCS (or Upper Head or CET) Press Saturation Margin: -225.5 to 210.9 kg/cm^2	Inadequate Core Cooling	2	B	C,D (PPS OM)
Reactor Vessel Coolant Level	0 to 100 %	RCS	2	B	Validation (QIAS-P)
RCS Pressure (Wide Range)	0 to 281.23 kg/cm^2G (0 to 4,000 psig)	RCS	2	B, C	C,D (PPS OM)
IRWST Level	0 to 100 %	IRWST	4	B	C,D (ESCM)

(1)

Table 7.5-1 (2 of 5)

Variable	Range	Monitored Function or System	Channel Number	Type	Ambiguity (Division)
IRWST Temperature	10 to 177 °C (50 to 350 °F)	IRWST	4	B	C,D (ESCM)
Holdup Volume Tank Level	0 to 100 %	IRWST	4	B	C,D (ESCM)
Containment Level	0 to 100 %	Containment monitoring system	2	B	C,D (ESCM)
Containment Pressure (Wide Range)	-400 to 5,600 cmH_2O (-5.7 to 79.5 psig)	Maintaining containment integrity	2	B	C,D (PPS OM)
Reactor Cavity Level	0 to 100%	Maintaining containment integrity	4	B	C,D (ESCM)
Containment Isolation Valve Position	N/A	Maintaining containment integrity	1 pair/ valve	B, D	Validation (QIAS-P)
Logarithmic Reactor Power	2×10^{-8} to 200 % power	Reactor power	2	B	C,D (PPS OM)
Control Rod Position	0 to 381 cm (0 to 150 in)	Reactivity control	1/rod	B	C,D (CPCS OM)
Containment Pressure (Extended Wide Range)	-500 to 14,500 cmH_2O (-7.1 to 206.2 psig)	Fission product release	2	C	PPS Containment pressure A,B,C,D (PPS OM)
Containment Operating Area Radiation	10^{-3} to 10^{2} mSv/hr	Monitoring fueling handling accident	2	C	C,D (ESCM)
Spent Fuel Pool radiation	10^{-3} to 10^{2} mSv/h	Monitoring fueling handling accident	2	C	C,D (ESCM)
Containment Upper Operating Area Radiation	10 to 10^{8} mSv/hr	Monitoring LOCA	2	C	C,D (ESCM)

(1)

Table 7.5-1 (3 of 5)

Variable	Range	Monitored Function or System	Channel Number	Type	Ambiguity (Division)
POSRV Position	N/A	Verifying status of a safety system	1/valve	D	N/A
CS Flow	0 to 28,400 lpm (0 to 7,500 gpm)	Monitoring CS operation	2	D	N/A
Containment Atmosphere Temperature	4.44 to 204.44 °C (40 to 400 °F)	Monitoring accomplishment of cooling	13	D	N/A
SI Hot Leg Injection Flow Rate	0 to 5,678.12 lpm (0 to 1,500 gpm)	Monitoring the operating status for a safety system	2	D	N/A
Wide Range Safety Injection Tank Level	0 to 100 % (402 inch full scale)	Monitoring the operating status for a safety system	4	D	N/A
Wide Range Safety Injection Tank Pressure	0 to 53kg/cm^{2}G (0 to 750 psig)	Monitoring the operating status for a safety system	4	D	N/A
Emergency Ventilation Damper Position	N/A	Prevention of radiation effluent release	1 pair/ damper	D	N/A
DC Bus Voltage	0 to 150 Vdc	Electrical power supplies for safety system and safe shutdown system	4	D	N/A
Emergency Diesel Generator Voltage	0 to 5,250 Vac	Electrical power supplies for safety system and safe shutdown system	4	D	N/A
Emergency Diesel Generator Current	0 to 2,000 Amps	Electrical power supplies for safety system and safe shutdown system	4	D	N/A
4.16 kV Switchgear Voltage	0 to 5,250 Vac	Electrical power supplies for safety system and safe shutdown system	4	D	N/A
4.16 kV Switchgear Current	0 to 2,000 Amps	Electrical power supplies for safety system and safe shutdown system	4	D	N/A

(1)

Table 7.5-1 (4 of 5)

Variable	Range	Monitored Function or System	Channel Number	Type	Ambiguity (Division)
480 V L/C Voltage	0 to 600 Vac	Electrical power supplies for safety system and safe shutdown system	4	D	N/A
480 V L/C Current	0 to 3,000 Amps	Electrical power supplies for safety system and safe shutdown system	4	D	N/A
CCW Temperature	0 to 100 °C (32 to 212 °F)	Monitoring CCWS operation	1/division	D	N/A
CCW Flow	0 to 110% design flow	Monitoring CCWS operation	1/pump	D	N/A
ESW Temperature	0 to 50 °C (32 to 122 °F)	Monitoring ESW operation	1/division	D	N/A
ESW Flow	0 to 120% design flow	Monitoring ESW operation	1/pump	D	N/A
Charging Line Flow	0 to 749.43 lpm (0 to 198 gpm)	Monitoring the status of boric acid flow to RCS	1	D	N/A
Charging Line Pressure	0 to 220 kg/cm^2G (0 to 3,129 psig)	Monitoring the status of boric acid flow to RCS	1	D	N/A
Shutdown Cooling Heat Exchange Outlet Temperature	0 to 200°C (40 to 392°F)	Monitor the operating status for a safety system	2	D	N/A
Shutdown Cooling Pump Flow Rate	0 to 25,000 lpm (0 to 6,604 gpm)	Monitor the operating status for a safety system	2	D	N/A
SIT Isolation Valve	N/A	Monitor the operating status for a safety system	4	D	N/A
SIP DVI Flow Rate	0 to 5,678 lpm (0 to 1,500 gpm)	Monitor the operating status for a safety system	4	D	N/A
Backup Heater Status	N/A	Monitor the operating status for a safety system	N/A	D	N/A
RCP Motor Current	0 to 700 A	Verifying status of RCS flow and core cooling	4	D	N/A

(1)

Table 7.5-1 (5 of 5)

Variable	Range	Monitored Function or System	Channel Number	Type	Ambiguity (Division)
Containment Purge Effluent	3.7×10^{-2} to 3.7×10^{9} Bq/cc	Monitoring gaseous effluent in containment building	1	E	N/A
Auxiliary Building Controlled Area HVAC Effluent	3.7×10^{-2} to 3.7×10^{7}Bq/cc	Monitoring gaseous effluent of controlled area in AUX. building	2	E	N/A
Compound Building HVAC Effluent	3.7×10^{-2} to 3.7×10^{3} Bq/cc	Monitoring gaseous effluent in compound building	1	E	N/A
Liquid Radwaste System Radiation	3.7×10^{-2} to 3.7×10^{3} Bq/cc	Monitoring liquid radwaste system radiation	2	E	N/A
Condenser Vacuum Vent Effluent Radiation	3.7×10^{-2} to 3.7×10^{3} Bq/cc	Monitoring SG tube leakage	1	E	N/A
MCR and TSC Area Radiation	10^{-3} to 10^{2} mSv/hr	Monitoring area radiation level	1	E	N/A
Primary Sampling Room Area Radiation	10^{-3} to 10^{2} mSv/hr	Monitoring area radiation level	1	E	N/A
Chemistry Lab. Area Radiation	10^{-3} to 10^{2} mSv/hr	Monitoring area radiation level	1	E	N/A
Wind Direction	0 to 360°	Release assessment	1	E	N/A
Wind Speed	0 to 50 mph	Release assessment	1	E	N/A
Atmosphere Stability Temperature Difference	-22.78 to -7.78°C (-9 to +18°F) Delta-T	Release assessment	2	E	N/A
Main Steam Line Radiation	10^{-3} to 10^{2} mSv/hr	Monitoring leakage of steam generator	4	E	N/A

Notes:
(1) Parameters to moitor Critical Safety Funtions in SPADES+ as described in section 7.7 are confirmed by Functional Requirements Analysis as described in section 18.3

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Docket No. 52-046

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SRP Section: **18 – Human Factors Engineering**

Application Section:

Date of RAI Issue: **02/04/2016**

Question No. 18-119

Regulations in 10CFR 50.34(f)(2)(xi) require direct indication of relief and safety valve position (open or closed) in the control room. NUREG-0711, Criterion 8.4.4.2(3), "Relief and Safety Valve Position Monitoring," states that the applicant should describe how the HSI indicates the position of relief and safety valves. NUREG-0711, Section 1.2.2, "Review Elements, " also states that an acceptable implementation plan (IP) describes the methodology in a step-by-step format to ensure that design personnel can reliably use the IP consistent results will be obtained from executing the methodology.

The information in the HD IP and the DCD Tier 2, Section 7, "Instrumentation and Control," appear to be contradictory.

- The HD IP, Section 4.1.4.3, describes one display in the main control room that will continuously indicate the position of the relief and safety valves.
- DCD Tier 2, Table 7.5-1, "Accident Monitoring Instrumentation Variables," states that the pilot-operated safety relief valve (POSRV) position indication is a Type D variable. The HD IP, Section 4.1.4.7, "Post-Accident Monitoring Instrumentation," suggests that Type D variables are non-safety indications that will not be continuously displayed.
- DCD Tier 2, Table 7.1-1, "Regulatory Requirements Applicability Matrix," indicates that "direct indication of relief and safety valve position" is provided by the qualified indication and alarm system – post-accident monitoring (QIAS-P), which is a safety-related system. Also, DCD Tier 2, Section 5.2.5.1.2.1, "Pressurizer Pilot-Operated Safety Relief Valves," describes position indications that will be in the main control room.

Also, the staff did not find any actual direction in the HD IP to the SMEs to include indication of these valves in the design of any display.

1. Clarify which display(s) will satisfy the regulatory requirement for direct position indication of safety and relief valves. Align the information in the DCD Tier 2, Section 7 and the HD IP, if necessary.

2. Provide direction in the HD IP for the direct position indication of the relief and safety valves to be incorporated into the appropriate display. This ensures that the requirement will be satisfied.

3. Provide justification for why POSRV position indication is a Type D variable.

Response

1 To clarify the HSI design for display of relief and safety valve position, APR1400-E-I-NR-14007-NP, “HSI Design Implementation Plan” (HD IP), will be revised as follows:

4.1.4.7 Post-Accident Monitoring Instrumentation

Instrumentation and corresponding indications for various types of accident monitoring instrumentation (AMI) are required by 10 CFR 50.34(f)(2)(xix) – II.F.3 and NRC RG 1.97 (Reference 3). Class 1E SDCV indications are required for variables that prompt manual actions that are credited in the TAA for accident mitigation (Type A variables) and for key indications that represent the status of CSFs (Type B variables). Selectable Class 1E indications are required to indicate threats to fission product barriers (Type C variables). These requirements are fulfilled by the APR1400 QIAS-P. Other AMI requirements for non-safety related Type D and E variables, such as pilot-operated safety relief valve (POSRV) position indication, are fulfilled by selectable IFPDs <u>and LDP</u> from the APR1400 information processing system (IPS). <u>QIAS-N also provides back-up displays for all post-accident monitoring instrumentation. Additional non-safety SDCV indications are also provided on the LDP for selected accident monitoring variables. These indications fulfill the LDP design basis of providing SDCV indications for preferred emergency success paths for all CSFs, as identified in other subsections of Sections 4.1.4.</u>

4.2.1 Critical Safety Function Displays

Changes to this section, which include direction to provide direct position indication of the relief and safety valves, are identified in the response to RAI 18-125.

2 Since POSRV position indication is a Type D variable, which is displayed on QIAS-N, DCD Tier 2, Table 7.1-1, "Regulatory Requirements Applicability Matrix", item 5 has been revised in the response to RAI 07.01-13 to identify the applicability for “Direct Indication of Relief and Safety Valve Position” to QIAS-N, not QIAS-P.

3 Variable “Types” are defined in IEEE Std. 497™-2002 “IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations”. POSRV position indication is a Type D variable, because its primary purpose is to provide the status of a safety system for emergency RCS depressurization.

POSRV position indication could also be considered a Type C variable, because it provides indication of an actual breach in the reactor coolant system (RCS) pressure boundary. But

an RCS breach could occur from many sources, and without any change in the POSRV position indication. Therefore, a breach in the RCS pressure boundary is more appropriately indicated by Pressurizer Pressure. Therefore, there is no need to identify POSRV position indication as a Type C variable.

POSRV position indication is not a Type A variable, because it is not a prompting indication for a credited manual action in APR1400 DCD Chapter 15. Inadvertent opening of a POSRV can be the source of a small break LOCA, as described in Chapter 15 Section 6.5. But the small break LOCA analysis credits a decrease in RCS pressure as the prompting indication for the long term cooldown manual actions, not POSRV position; RCS pressure is indicated by Pressurizer Pressure.

POSRV position indication is not a Type E variable, because it does not provide information to monitor radiation release.

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-E-I-NR-14007-NP, Rev.0, “HSI Design Implementation Plan,” Section 4.1.4.7 will be revised, as indicated in the attachment associated with this response.

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4.1.4.3 Relief and Safety Valve Position Monitoring

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4.1.4.4 Manual Feedwater Control

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4.1.4.5 Containment Monitoring

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4.1.4.6 Core Cooling

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4.1.4.7 Post-Accident Monitoring Instrumentation

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Docket No. 52-046

RAI No.:	**400-8425**
SRP Section:	**18 – Human Factors Engineering**
Application Section:	
Date of RAI Issue:	**02/04/2016**

Question No. 18-122

Regulations in 10 CFR 50.34(f)(2)(xxvi) require an applicant to provide for leakage control and detection in the design of systems outside containment that contain or might contain radioactive materials. Also, NUREG-0711, Section 1.2.2, “Review Elements, “ also states that an acceptable implementation plan (IP) describes the methodology in a step-by-step format to ensure that design personnel can reliably use the IP consistent results will be obtained from executing the methodology.

DCD Tier 2, Section 5.2.5.4, “Intersystem Leakage,” lists several systems connected to the reactor coolant system that could potentially contain radioactivity following an accident. The HD IP, Section 4.1.4.10, “Leakage Control,” states that a generic type of display will be used to provide leakage detection. The HD IP does not provide direction for the SMEs to use DCD Tier 2, Section 5.2.5.4 as an input in the design of the HSI, and it also does not specify the type of HSIS (i.e., of those listed in the HD IP, Section 3.2, "APR1400 HSIS") that will provide these indications. Therefore, the staff cannot conclude that the information in DCD Tier 2, Section 5.2.5.4 will be incorporated into the HSI design process.

Provide, in a step-by-step format, directions to the SMEs to ensure that the information in the DCD is included in the HSI design. Specify which type of APR1400 HSIS will display these indications.

Response

To clarify that the HSI design will include the intersystem leakage instrumentation identified in DCD Tier 2, Section 5.2.5.4 and the type of displays that will be provided, the following sections of APR1400-E-I-NR-14007-NP, “HSI Design Implementation Plan” (HD IP) will be revised, as shown below. It is noted that intersystem leakage indications are included in System Displays which are applicable to IFPDs, ESCMs, and QIAS-N selectable displays; the step-by-step directions to the SMEs to create System Displays are provided in Section 4.2.2.

3.2.2 System Displays

System displays are applicable to IFPDs, ESCMs, and QIAS-N selectable displays. IFPD system displays are created for every APR1400 plant system, including systems with intersystem leakage potential, as described in APR1400 DCD Tier 2, Section 5.2.5.4.

3.6.2 Plant Systems

…for all plant systems, the P&IDs and plant system descriptions, including the descriptions of systems with intersystem leakage potential in APR1400 DCD Tier 2, Section 5.2.5.4, are the starting point input for creating the APR1400 HSIS during the HD. Any discrepancies between these HSI designs and the TA are identified during the design verification conducted during the V&V PE.

4.2.2 System Displays

The HD implementation requirements for system displays are applicable to IFPDs, ESCMs, and QIAS-N selectable displays…

3. Inputs from the APR1400 plant design

   a. P&IDs, electrical system one-line diagrams, system descriptions; include instrumentation for monitoring intersystem leakage, as described in APR1400 DCD Tier 2, Section 5.2.5.4.

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-E-I-NR-14007-NP, Rev.0, “HSI Design Implementation Plan,” Sections 3.2.2, 3.6.2 and 4.2.2 will be revised, as indicated in the attachment associated with this response.

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3.2.1 Critical Safety Function Displays

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3.2.2 System Displays

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3.2.3 Task Displays

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3.2.4 Application Displays

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3.5.8 Human Factors Verification and Validation

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3.5.9 Design Implementation

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3.6 HD Interfaces with the APR1400 Plant Design

The HD interfaces with the APR1400 plant design in the following key areas:

- I&C system designs
- Plant system designs

The interfaces are described in Subsections 3.6.1 and 3.6.2.

3.6.1 Instrumentation and Control System Designs

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3.6.2 Plant System Designs

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3.7 HD Input from Predecessor and Reference Plants

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Question No. 18-123

Regulations in 10CFR 50.34 (f)(2)(xxvii) require the applicant to provide for monitoring of inplant radiation and airborne radioactivity. NUREG-0711, Criterion 8.4.4.2(11) states that an applicant should describe how the HSI provides appropriate monitoring of inplant radiation.

The HD IP, Section 4.1.4.11, "Radiation Monitoring," provides an example of a type of radiation indication used to monitor a critical safety function (CSF). Plant parameters that provide information to the operator to monitor CSFs are Type B variables (as defined in IEEE Standard

497-2002). DCD Tier 2, Table 7.5-1, "Accident Monitoring Instrumentation Variables," lists radiation indications, including the example provided in the HD IP, Section 4.1.4.11, but all of them are labeled as Type C and E variables, not Type B variables.

Confirm that DCD Tier 2, Table 7.5-1 has appropriately identified main steam line radiation and containment radiation detectors as Type C and E variables instead of Type B variables. Revise the submittal as necessary.

Response

DCD Tier 2, Table 7.5-1 has appropriately identified main steam line radiation and containment radiation detectors as Type C and E variables, because they indicate a breach in a fission product barrier and the magnitude of the release of radioactive materials. While radiation detectors may indicate an impeding threat to a critical safety function, they are not used to directly monitor the critical safety functions, therefore they are not Type B variables. To clarify this point APR1400-E-I-NR-14007-NP, "HSI Design Implementation Plan" (HD IP), will be revised as follows:

4.1.4.11 Radiation Monitoring

Monitoring of in-plant radiation and airborne radioactivity under a broad range of routine and accident conditions is required by 10 CFR 50.34(f)(2)(xxvii) – III.D.3.3. In the APR1400 HSIS, radiation indications and alarms that indicate an impending threat to CSFs, such as RCS integrity for detecting a steam generator tube rupture, are provided as SDCV displays on the LDP. It is noted that while radiation monitoring may indicate a threat to CSFs, they are not used to directly monitor the integrity of CSFs. Other radiation indications and alarms that are not indicative of impending threats to CSFs are provided via selectable HSI on IFPDs.

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-E-I-NR-14007-NP, Rev.0, “HSI Design Implementation Plan,” Section 4.1.4.11 will be revised, as indicated in the attachment associated with this response.

4.1.4.8 Auxiliary Heat Removal

TS

4.1.4.9 Reactor Level Monitoring

TS

4.1.4.10 Leakage Control

TS

4.1.4.11 Radiation Monitoring

TS

4.1.4.12 Manual Initiation of Protective Actions

TS

4.1.4.13 Diversity and Defense-in-Depth

TS

4.1.4.14 Important Human Actions

TS

4.1.4.15 Computer-Based Procedure Systems

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.:	**400-8425**
SRP Section:	**18 – Human Factors Engineering**
Application Section:	
Date of RAI Issue:	**02/04/2016**

Question No. 18-125

NUREG-0711, Section 1.2.2, “Review Elements, “ states that an acceptable implementation plan (IP) describes the methodology in a step-by-step format to ensure that design personnel can reliably use the IP consistent results will be obtained from executing the methodology.

The HD IP does not provide a method for the detailed design of the large display panel (LDP). Section 3.1, “APR1400 Basic HSI,” states that functional specifications for the LDP will be generated. The HD IP, Section 4.1.6.1, “Functional Specifications,” also says that functional specifications will be created for the LDP, but no method is provided (no inputs, outputs, or review criteria are listed).

Also, credit is given in Section 4.1.4.3, “Relief and Safety Valve Position Monitoring,” Section 4.1.4.4, “Manual Feedwater Control,” Section 4.1.4.5, “Containment Monitoring,” Section 4.1.4.6, “Core Cooling,” and Section 4.1.4.11, “Radiation Monitoring,” for complying with regulatory requirements by providing indications on fixed portion of the LDP. Also, Section 4.1.4.14, Important Human Actions," states that prompting alarms for IHAs will be displayed on the fixed portion of the LDP. However, no direction is provided in the HD IP to the SMEs to include thoserequirements as inputs into the design of the LDP.

Because a method is not provided for the detailed design of the LDP, the staff cannot conclude that the design process described in the HD IP will produce reliable results and that the regulatory requirements identified in the above sections of the HD IP will be included in the design of the LDP.

Revise the HD IP as necessary to provide the design methodology for the LDP in a step-by-step format to ensure that the regulatory requirements are identified as inputs to the design process.

Response

Section 4.1.1.1 of the Human-System Interface Design Implementation Plan, APR1400-E-I-NR-14007 will be revised to clarify that the SDCV section of the LDP is comprised of CSF displays, as indicated in the attachment associated with this response. Section 4.2.1 of the Human-System Interface Design Implementation Plan, APR1400-E-I-NR-14007, which provides the step-by-step methodology for CSF displays, will also be revised to clarify that CSF displays include parameters from the APR1400 design that require SDCV indications, as indicated in the Attachment associated with this response.

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-E-I-NR-14007-P/NP, Rev.0, “HSI Design Implementation Plan,” Sections 4.1.1.1 and 4.2.1 will be revised, as indicated in the Attachment associated with this response.

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4.1.1.1 LDP

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4.2.1 Critical Safety Function Displays

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