

KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Monday, February 01, 2016 9:07 AM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Andy Jiyong Oh; Erin Wisler
Cc: Kent, Lauren; Junge, Michael; Ward, William; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 383-8458 (18 - Human Factors Engineering)
Attachments: APR1400 DC RAI 383 COLB 8458.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, the following RAI question response times. We may adjust the schedule accordingly.

18-104: 45 days
18-105: 45 days
18-106: 60 days
18-107: 45 days
18-108: 60 days
18-109: 60 days
18-110: 60 days
18-111: 60 days
18-112: 60 days
18-113: 60 days

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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REQUEST FOR ADDITIONAL INFORMATION 383-8458

Issue Date: 02/01/2016
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 18 - Human Factors Engineering
Application Section:

QUESTIONS

18-104

NUREG-0711, Rev. 3, "Human Factors Engineering Program Review Model," Criterion 8.4.4.2(15), "Computer-Based Procedure Platform," states that the applicant's computer-based procedures should be consistent with the design review guidance in NUREG-0700, Section 8, "Computer-Based Procedure System." NUREG-0700, Section 8, Criterion 8.1.2-5 states that words from standard American English should be used, and Criterion 8.1.2-6 states that punctuation should conform to standard American English.

APR1400-E-I-NR-14012-P, "Style Guide," Items 5.2.1.2(e) and (f), state that words from standard Korean should be used, and punctuation should conform to standard Korean usage.

Revise the Style Guide so that standard American English words and punctuation are used in the computer-based procedure system.

18-105

NUREG-0711, Criterion 8.4.4.2(15), "Computer-Based Procedure Platform," states that the applicant's computer-based procedures should be consistent with the design review guidance in DI&C-ISG-5, "Highly-Integrated Control Rooms - Human Factors issues (HICR - HF)," Section 1 (NRC, 2008).

The staff reviewed APR1400-E-I-NR-14011-P, Rev. 0, "Basic Human-System Interface (HSI)," TeR, Section 4.8, "Computer-based Procedures," the HD IP, 4.2.6, "Computer-Based Procedures," and DCD Tier 2, Section 7.7.1.4(d)(6), "Computer-based procedure system," and found that the design of the computer-based procedures is consistent with the guidance in DI&C-ISG-5, Section 1, except for the following review criteria: #3, #4, #7, #15, #16, #17, #19, #22, and #24.

Please describe how the computer-based procedures are consistent with these review criteria, or describe why these were not addressed.

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18-106

NUREG-0711, Criterion 8.4.4.5(1), states, "The applicant should describe *how* the HSI provides a design capability for remote shutdown of the reactor outside the main control room." 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, Table 7.4-1, "Remote Shutdown Console Instrumentation and Controls for Hot Shutdown," lists the indications and controls provided in the remote shutdown room (RSR). The inventory includes manual reactor trip switches (i.e., conventional switches). The Basic HSI TeR, Section 4.11.3, "Conventional Switch Configuration," states that some spatially dedicated and continuously visible (SDCV) switches will be available on the safety console (SC) or remote shutdown console (RSC); however, The Basic HSI TeR, Section 4.16.4, "Remote Shutdown Console," does not list conventional switches as being available on the RSC. This seems to contradict the information in Section 4.11.3 and DCD Tier 2, Table 7.4-1. Also, the HD IP, Section 4.2.8, "Central Facilities," does not include the inventory listed in DCD Tier 2, Chapter 7, as an input to the detailed design documentation for the remote shutdown console. Because the inventory for the RSC has already been identified in DCD Tier 2 Table 7.4-1, it's not clear to the staff why the HD IP does not point to this information or provide it.

Align the information in DCD Tier 2, Table 7.4-1, with the information in the Basic HSI TeR and HD IP. Provide the RSC inventory in the HD IP either by listing where it can be found or by including the information directly. Revise the submittal as necessary.

18-107

NUREG-0711, Criterion 8.4.5(1), states that an applicant should identify degraded HSI conditions.

The Basic HSI TeR, Section 3.1.3, "Safety Console," says that the Safety Console (SC) will have one information flat panel display (IFPD). DCD Tier 2, Figure 7.1-1, "APR1400 I&C System Overview Architecture," includes a drawing of the SC, but the staff did not see an IFPD or an interface with the Information Processing System (IPS) included in the graphic. Also, the Control System CCF Analysis Technical Report (APR1400-Z-J-NR-14012-P, Rev. 0), Section 4.4.4.2, "Design Features to Cope with Spurious Component Selection Commands," indicates that IFPDs are not on the SC.

Clarify whether or not an IFPD is available on the Safety Console. Revise the submittal as necessary.

18-108

NUREG-0711, Criterion 8.4.5(4) states, "the applicant should determine the necessary compensatory actions and supporting procedures to ensure that personnel effectively manage degraded I&C and HSI conditions, and the transition to back-up systems."

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The HD IP, Appendix A, states that this criteria is satisfied by identifying these actions and procedures during the task analysis (TA). The TA IP (APR1400-E-I-NR-14004-P), Section 2, "Scope," says that procedures from predecessor designs and predecessor plants are used to identify certain tasks for tasks analysis, including those tasks required to mitigate three kinds of degraded HSI conditions.

The predecessor design and predecessor plants, as defined in the HFE program plan (APR1400-E-I-NR-14001-P), don't include digital I&C systems in their design. Thus, the staff does not have reasonable assurance that the compensatory actions needed to manage the degraded I&C and HSI conditions that may occur in the APR1400, which are described in the DCD Tier 2, Chapter 7 and in additional detail in the Control System CCF Technical Report and the CCF Coping Analysis, are included in these procedures and will therefore be included in the task analysis and HSI design processes.

Describe how (1) the necessary compensatory actions and supporting procedures to ensure that personnel effectively manage degraded I&C and HSI conditions, and (2) the transition to back-up systems, will be determined. For example, if procedures from the reference plant will used, then describe whether or not those procedures address the same degraded HSI conditions that can occur in the APR1400, and how those procedures would be translated or made available to a COL applicant in the US.

Revise the submittal as necessary.

18-109

NUREG-0711, Criterion 8.4.5(1), states that the applicant should identify the effects of automation failures and degraded conditions on personnel and plant performance.

The staff reviewed the HD IP, Section 4.1.3.5, "Failure of I&C Components;" the Basic HSI TeR; DCD Tier 2, Chapter 7, Table 7.7-1, "Control Groups for the NSSS Control Functions,;" the Control System CCF Analysis; and the CCF Coping Analysis. The staff did not find where the application addresses the effects of automation failures and degraded conditions (in automated control processes) on personnel performance.

Provide a description of how automation failures and degraded I&C conditions identified in DCD Tier 2, Chapter 7 and associated technical reports effect personnel performance. Revise the submittal as necessary.

18-110

NUREG-0711, Criterion 8.4.5(2), states that the applicant should specify the alarms and other information personnel need to detect degraded I&C and HSI conditions in a timely manner, and to identify their extent and significance.

The staff reviewed the HD IP, Section 4.1.3.5, "Failure of I&C Components," which includes a general statement that alarms and other information will be used to inform the operators of degraded I&C conditions. However, the HD IP does not include a detailed method for how these alarms and information will be designed and presented to the operator. Additionally, some of the alarms appear to be identified in other sections of the application (e.g., the Control System CCF Analysis Technical Report, Table 5.1-2, "Multiple Failure due to a Single Failure of Shared Signals").

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Provide a detailed method in the HD IP to ensure that the alarms and other information that personnel will need to detect and identify the extent and significance of degraded I&C systems,, automation failures, and degraded HSI conditions will be specified. If the alarms and other information have already been identified in another section of the application, then the HD IP should include this information or identify where it can be found in the application.

Revise the submittal as necessary.

18-111

NUREG-0711, Criterion 8.4.6.2(2) states that the applicant should base the general approach to testing on the test's objective(s). The following aspects of the tests should be described: tasks or scenarios used, performance measures, test procedures, and data analyses. Also, NUREG-0711, Section 1.2.2, states that an IP is acceptable if it is verifiable, i.e., the final results can be evaluated using NUREG-0711 criteria, and the IP describes the products (expected results from executing the methodology).

The HD IP, Section 4.1.7, "Basic HSI Tests and Evaluations," describes a performance-based test of the APR1400 Basic HSI concept with US operators. This section lacks specific detail about the scenarios, the performance measures, the test procedures, and the data analyses.

To ensure that the IP will produce verifiable results, describe the following:

1. Guidelines for developing the specified scenarios and identifying objectives for the scenarios.
2. The specific, objective performance measures and specific, objective acceptance criteria that will be applied to determine if the results of the testing are acceptable or not.
3. Data analyses that will be performed.

Revise the submittal as necessary.

18-112

NUREG-0711, Criterion 8.4.6.2(2) states that the applicant should base the general approach to testing on the test's objective(s). The following aspects of the tests should be described: tasks or scenarios used, performance measures, test procedures, and data analyses. Also, NUREG-0711, Section 1.2.2, states that an IP is acceptable if it is verifiable, i.e., the final results can be evaluated using NUREG-0711 criteria, and the IP describes the products (expected results from executing the methodology).

The staff reviewed the performance-based tests identified for selected HSI resources in the HD IP, Section 4.2. Please clarify the following items:

1. Section 4.2.1, "Critical Safety Function Displays," Item 6b: The second sentence seems to not be in alignment with the first sentence.
2. Section 4.2.1, "Critical Safety Function Displays" Item 7: The meaning of this sentence is not clear. Please describe how the performance-based test be conducted and what specifically will be tested.
3. Section 4.2.3, "Task Displays" and Section 4.2.4, "Application Displays:" Section 3.2.7, "Performance-Based Tests," suggests that these types of HSI resources will be sampled for testing. Describe any criteria that will be used to determine the sample of displays that are selected.

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4. Sections 4.2.1, 4.2.3, 4.2.4, 4.2.5, 4.2.6, 4.2.7: Describe test procedures that will be used to verify that the acceptance criteria have been satisfied, or describe a method of development.
5. Sections 4.2.1, 4.2.3, 4.2.4, 4.2.5, 4.2.6, 4.2.7: These sections refer to a predecessor plant and predecessor design, and Section 4.2.4 4.b. identifies the predecessor design as SKN 3&4. However, the HFE PP, section 8, defines SKN 3&4 as the reference plant. Clarify whether or not the inputs to the design processes described in these sections are the reference plant (SKN 3&4) or the predecessor designs/plants.
6. Section 4.2.5, "Alarms:" For Item 7, describe any criteria that will be used to select alarms for sampling.
7. Section 4.2.6, "Computer-Based Procedures:" For Item 7, describe any criteria that will be used to select CBPs for sampling.
8. Section 4.2.7, "Safety Console:" For Item 7, describe any criteria that will be used to select CBPs for sampling and clarify if all IHAs are included in the sample or if they will be sampled (if so, describe how sampling is performed).

18-113

NUREG-0711 Section 1.2.2, "Review Elements," states that an acceptable implementation plan (IP) is complete, i.e., the IP describes the scope, inputs, analyses to be performed, outputs, and documentation. Also, NUREG-0711, Section 4, "Functional Requirements Analysis and Function Allocation (FRA/FA)," Criterion 4.4(3) states that the applicant should define, for each safety function and other plant function (e.g., electrical power generation), the set of system configurations or success paths that are responsible for, or able to carry out the safety functions.

The HD IP, Section 4.1.4.4, "Manual Feedwater Control" identifies specific equipment as part of an emergency success path. Also, the critical safety function (CSF) success paths and the equipment used to achieve those success paths are identified in other sections of the DCD Tier 2 application (e.g., Section 5.4.14.2, which describes pilot-operated safety relief valves). However, the FRA/FA IP (APR1400-E-I-NR-14003-P, Rev. 0) describes a process to determine the APR1400 success path equipment instead of identifying this equipment or identifying where it is located in the application. It's not clear to the staff why the FRA/FA describes a process instead of either identifying the equipment that form the normal and emergency success paths or identifying where the information is in the application.

In the FRA/FA IP, identify the normal and emergency success paths or state where the information is located. Revise the submittal as necessary.



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