

Response to

Request for Additional Information No. 350 (4185), Revision 0

02/02/2010

U. S. EPR Standard Design Certification

AREVA NP Inc.

Docket No. 52-020

SRP Section: 18 - Human Factors Engineering

Application Section: FSAR Chapter 18

**QUESTIONS for Operating Licensing and Human Performance Branch
(AP1000/EPR Projects) (COLP)**

Question 18-112:

FSAR Tier 2, Revision 1, Section 18.7, "Human System Interface Design" describes the EPR human-system interface design. In addition, AREVA submitted the "Human System Interface Design Implementation Plan" (document No. 118-9042375-002). However, the FSAR does not reference the Human System Interface Design (HSI) Implementation Plan, specifically. Reconcile the inconsistency between the FSAR and the HSI Plan.

Response to Question 18-112:

The Response to RAI 322, Supplement 1, Question 18-52 revised U.S. EPR FSAR Tier 2, Chapter 18 to include references to the U.S. EPR Human System Interface (HSI) Design Implementation Plan (IP) and the other referenced human factors engineering (HFE) implementation plans.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-113:

To address the criterion of HSI Design Inputs, and sub-criterion, Analysis of Personnel Task Requirements, the applicant states in several places in the FSAR (e.g., sub-sections 18.1.1.2, 18.7.1) that these different types of analyses are used to develop the design of HSIs. In the HSI Design Implementation Plan, AREVA explains how these analyses provide input to design HSIs. For example, sub-section 2.1.1 of the HSI Plan explains that using OER results during HSI design, avoids choosing HSI options previously shown to be undesirable. OER results also help to select acceptable HSI design options from other HFE designs. While this explanation provides a sufficient level of detail to understand how AREVA uses the OER in the design of HSIs, AREVA's explanations for the other analyses (i.e., FRA/FA; TA; HRA; and staffing and qualifications) do not provide comparable detail. For example, sub-section 2.1.5, "Staffing and Qualifications Analysis," states that staffing and qualifications analysis considers the allocation of assigned operational activities, the impact of those activities on crewmember roles and responsibilities, and the impact of changes on operational requirements for the operating crew as a whole. How the results of staffing and qualification analysis provide input for the layout of the overall control room and the allocation of controls and displays to individual consoles, panels and workstations is not explained. Nor does the HSI Plan explain how these analyses establish the basis to accommodate the minimum and maximum number of personnel and requirements for coordinating activities among personnel. The staff requests further explanation (supplemented by examples) for how the FRA/FA; TA; HRA; and staffing and qualifications will satisfy the applicable criteria stated in the Criterion and Sub-Criterion.

Response to Question 18-113:

U.S. EPR Human Factors Engineering (HFE) Program Management Plan, Figure 1-1 illustrates the relationships between program elements of the HFE process. The results of operating experience review (OER), functional requirements analysis (FRA)/functional allocation (FA), and human reliability analysis (HRA) flow into task analysis (TA). During TA, staffing and qualifications are analyzed, and the outputs of TA are used as a direct input to human system interface (HSI) design.

The subject matter addressed in this response contains representative information from the revised U.S. EPR HSI Design Implementation Plan (IP). Section 2.1.2 of the U.S. EPR HSI Design IP, which discusses FRA inputs into HSI design, will add the following:

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U.S. EPR Human System Interface Design IP, Section 2.1.3 regarding FA inputs into HSI design will be revised with the following representative information:

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HSI task support requirements are the group of HSI components that enable the completion of each task. This is verified in HSI task support verification. See the Response to RAI 328, Supplement 3, Question 18-65 for more information.

U.S. EPR Human System Interface Design IP, Section 2.1.4 regarding TA inputs into HSI design will be revised with the following representative information:

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U.S. EPR Human System Interface Design IP, Section 2.1.5 regarding staffing and qualification (S&Q) inputs into HSI design will be revised with the following representative information:

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U.S. EPR Human System Interface Design IP, Section 2.1.6 regarding HRA inputs into HSI design will be revised with the following representative information:

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Document Number	Commitment Date
U.S. EPR HSI Design Implementation Plan	4/24/2010

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-114:

The HSI Plan, in Section 4.0, explains that functional requirements are translated into lower level design inputs and the functional requirements for the plant systems are documented in the SDDs for the system. This is accomplished using AREVA NP Procedure, "Development of I&C Interface Requirements" document and incorporated into the plant SDDs. The HSI Plan further states that the functional requirements are translated into functional requirements for the HSI using the EPR Display Design Desktop Guide and inputs from documents cited elsewhere in the HSI Plan. Although AREVA has provided references to the supplemental documents used to establish requirements for various types of HSIs in response to this sub-criterion, the process for accomplishing this "translation" is unclear. The NRC staff requests that AREVA provide a concise and clear description of how these requirements are established and explain the relationships that exist among the various supplemental documents.

Response to Question 18-114:

The design control process is described in U.S. EPR Human Factors Engineering (HFE) Program Management Plan, Section 4.5. The human system interface (HSI) design element of the HFE program follows this process. Plant requirements (including high level HSI requirements) are documented in the Plant Technical Requirements Document (PTRD). System design requirements documents (SDRDs) are created for plant systems, each operation and control center (i.e., main control room (MCR), technical support center (TSC), remote shutdown station (RSS), and instrumentation and control service center (I&CSC)), and each HSI (the process information and control system (PICS) and the safety information and control system (SICS)). These documents specify the design requirements for each of these systems/control rooms. System description documents (SDDs) are created for each system, control room, and HSI based on their parent SDRD. The SDDs contain a more detailed system description based on the SDRD.

Each plant SDD contains a section with I&C requirements. These I&C functional requirements (some of which are used as input to the HSI design) are developed and documented in each plant SDD using the "development of I&C requirements" procedure.

Functional requirements are identified, analyzed, and documented as described in the U.S. EPR Functional Requirements Analysis and Functional Allocation Implementation Plan (IP) and detailed work plans for plant- and system-level functional requirements analysis. The HFE functional requirements are identified from the SDRDs and SDDs and are documented in the requirements management tool (RMT).

The functions are divided into tasks, which are analyzed and documented as described in the U.S. EPR Task Analysis (TA) IP and the detailed TA work plan. Staffing and qualification requirements are addressed during TA. The outputs from TA are used as an input to HSI design through the identification of displays, controls, and alarms needed for each task. Additional HFE documents, such as the concept of operations and style guides (HSI and local control stations (LCS)), are used as input to the HSI design process.

The Display Desktop Guide referenced in the U.S. EPR HSI Design IP has been replaced with the U.S. EPR HSI Design Work Plan. This work plan provides the detailed steps for designing the HSI, including displays, conventional panels, and workstations. The HSI Work Plan

provides instructions for collecting the requirements from the inputs for HSI design, including SDRDs, SDDs, and the outputs of TA.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-115:

FSAR sub-section 18.7.1 describes using a variety of inputs (e.g., OER, task analysis, staffing analysis, etc) AREVA uses to design the EPR HSIs. HSI Plan, Section 5.3, states that throughout the design process, AREVA proposes alternative designs to meet the requirements defined in the SDRDs. These alternative designs may include aspects such as a different MCR layout or identifying multiple HSI solutions (trackball or touch display as an input device). Additionally, feedback given on the conceptual HSI design may result in varying styles of display or conventional I&C layout. The HSI design methodology analyzes and evaluates alternative designs to determine which leads to a better, more efficient design. The HSI Plan provides detailed explanation of how the evaluations are conducted throughout the design process and in conjunction with the HFE verification and validation effort using various technologies and techniques such as mock-ups, simulators, trade-off evaluations, user feedback, etc. The HSI Plan explains the application of these techniques and their strengths and limits. The FSAR and the HSI Plan, using the process described, is appropriate to address this sub-criterion.

Although AREVA identifies alternative approaches addressing HSI functional requirements, neither the FSAR nor the HSI Plan mentions, specifically, conducting a survey of state-of-the-art HSI technologies to identify any new or unique advances for this type of evaluation. For example, it does not appear that AREVA has considered using task network modeling or virtual reality as possible evaluation techniques in the design of the EPR HSIs. Therefore, AREVA should explain how a survey was used to support the development of concept designs that incorporate advanced HSI technologies, provide assurance that proposed designs are technically feasible, and support the identification of human performance concerns and tradeoffs associated with various HSI technologies.

Response to Question 18-115:

NUREG-0711, Section 2.1 defines "state-of-the-art human factors engineering (HFE) principles" as principles currently accepted by human factors practitioners. "Current" is defined with reference to the time when the program management implementation plan is prepared. Using this criterion, AREVA NP applies a survey of state-of-the-art HFE principles and tools during initial human system interface (HSI) design and evaluation.

U.S. EPR Operating Experience Review (OER) Implementation Plan, (IP) Section 3.2.3 includes a survey of advanced HFE technology, nuclear and non-nuclear industries, as a part of the OER process. HFE-related technology is not restricted to HSI hardware/software and includes HSI evaluation tools. AREVA NP conducts a survey of state-of-the-art HFE technologies as part of the HFE process.

The results of the OER survey are used during the evaluation of alternative designs as shown in U.S. EPR HSI Design IP, Appendix A. These types of evaluations include trade-off studies and performance-based tests. Evaluations and test results contribute to HSI design optimization.

HSI Design IP, Section 7.2.1 provides an example of the use of advanced technology through virtual mockups. This includes evaluating the control rooms using a 3D virtual model.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-116:

Regarding Sub-criterion, "HSI design performance requirements should be identified for components of the selected HSI concept design. These requirements should be based on the functional requirement specifications but should be refined to reflect HSI technology considerations identified in the survey of the state of the art in HSI technologies and human performance considerations identified in the human performance research".

While AREVA uses alternative approaches to address HSI functional requirements that are based on a functional requirements specification, neither the FSAR nor the HSI Plan mentions, specifically, conducting a survey of state-of-the-art HSI technologies to identify any new or unique advances for this type of evaluation. Therefore, the NRC staff is unclear about how AREVA will refine the functional requirements specification to reflect state-of-the-art technology advances. AREVA should explain how the functional requirements specifications used to design HSIs, will be refined to take advantage of state-of-the-art technology and advances in human performance research.

Response to Question 18-116:

The Response to Question 18-115 discusses a survey of state-of-the-art human system interface (HSI) technologies and its application during the HSI design process. The HSI design is refined based on the HSI evaluations described in the U.S. EPR HSI Design Implementation Plan (IP). The alternative designs considered during the evaluations may result from the survey. The survey yields alternate design options that are evaluated and considered for HSI integration.

The HSI design process is iterative. Design changes identified during the HSI design evaluation phase follow the design change control process as described in U.S. EPR Human Factors Engineering (HFE) Program Management Plan, Section 4.5.1. U.S. EPR HSI Design IP, Appendix A shows the HSI design process.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-117:

Regarding Sub-Criterion, "HSI characteristics should support human performance under the full range of environmental conditions, e.g., normal as well as credible extreme conditions. For the main control room requirements should address conditions such as loss of lighting, loss of ventilation, and main control room evacuation. For the remote shutdown facility and local control stations, requirements should address constraints imposed by the ambient environment (e.g., noise, temperature, contamination) and by protective clothing (if necessary)"

FSAR, Section 18.7, "Human System Interface Design," does not address this criterion. The HSI Plan states that the HSIs are designed for all modes of operation; normal, abnormal, and emergency, during refueling, startup, and low power operation. The HSI Plan further explains that the MCR provides the capability for safe shutdown, even assuming a safe-shutdown earthquake (SSE), a loss of offsite power, and the most limiting single failure and that if evacuation of the MCR is required, the operators can establish and maintain a safe shutdown from outside the MCR through the use of the PICS and SICS in the RSS. The Concept of Operations document also specifies that diagnosing equipment failures is enhanced through the use of equipment self-diagnosis and self-monitoring systems. However, neither the FSAR, the HSI Plan, or other referenced documents such as the HSI Style Guide address how the loss of lighting, loss of ventilation, and main control room evacuation will be handled for the main control room. Also, neither the FSAR, HSI Plan, or other referenced documents explain how the remote shutdown facility and local control stations requirements address constraints imposed by the ambient environment (e.g., noise, temperature, contamination) and by protective clothing if needed. AREVA should explain how the loss of lighting, loss of ventilation, and main control room evacuation will be handled for the main control room. Also explain how the remote shutdown facility and local control stations requirements address constraints imposed by the ambient environment (e.g., noise, temperature, contamination) and by protective clothing if needed.

Response to Question 18-117:

U.S. EPR HFE Program Management Plan, Section 2.2.2.2.9 states:

"If the main control room (MCR) becomes uninhabitable, the plant is tripped as the operators leave the MCR. Operators will conduct further shutdown activities in the remote shutdown station (RSS). Emergency operations are not postulated from the RSS. Recovery operations will not be attempted from the RSS, considering the possibility of later emergency situations after the MCR is abandoned."

Extreme workplace conditions are evaluated during the development of task requirements of the task analysis (TA). TA considers workplace factors, such as normal and extreme workplace conditions, that can be expected for the work environment. Examples of these factors include lighting/glare, heat, temperature, noise, humidity, radiation/contamination, unsafe floors (oily, wet, icy), pressure differentials between zones, confined spaces, and working at heights (fall potential).

Regulatory requirements related to extreme environmental conditions are considered during human system interface (HSI) design. This includes emergency lighting, loss of ventilation, and the need for access to personal protective equipment (such as clothing and breathing apparatus). These requirements are documented in system design requirements documents

(SDRDs) using the standard design control process described in the U.S. EPR Human Factors Engineering (HFE) Program Management Plan. These requirements are incorporated into HSI design.

Environmental and lighting considerations for local control stations (LCSs) are addressed in U.S. EPR LCS Style Guide, Sections 13.0 and 14.0. These considerations include normal and emergency situations. Factors addressed by the U.S. EPR LCS Style Guide include the workstation envelope (e.g., access, reach, and so forth), radiation, heat, cold, noise, and lighting.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-118:

Regarding Sub-Criterion "The selection process should make explicit the relative benefits of design alternatives and the basis for their selection"

Neither the FSAR or the HSI Plan address this criterion. In sub-section 3.2.4 of the V&V Plan, AREVA states that, "Trade-off studies are also used to evaluate the integrated system design, although the extent of documentation of the relative benefits of design alternatives has not yet been defined." AREVA should provide an explanation of the process that will be used to determine the relative benefits of design alternatives derived from trade-off studies, the basis for their selection, and relative schedule for when the selection of design alternatives will be completed.

Response to Question 18-118:

The Response to RAI 328, Supplement 3 revised the U.S. EPR Human Factors Verification and Validation (V&V) Implementation Plan (IP). Human system interface (HSI) evaluations, including trade-off evaluations, are performed as part of the iterative HSI design process described in the U.S. EPR HSI Design IP. The HSI evaluations are completed independent of and before the human factors V&V.

U.S. EPR HSI Design IP, Section 7.4 will be revised with the following representative information to meet the sub-criterion:

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FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-119:

Regarding Sub-Criterion, "The general approach to testing should be based on the test objective. The design of performance-based tests should be driven by the purpose of the evaluation and the maturity of the design"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how the general approach to testing is based on the test objective and that the design of performance-based tests is driven by the purpose of the evaluation and the maturity of the design.

Response to Question 18-119:

The U.S. EPR Human System Interface (HSI) Design Implementation Plan (IP) will be revised to include the NUREG-0711 sub-criterion from 8.4.6.2. Information regarding performance measures, scenario selection, and performance evaluation is provided in the Response to RAI 328, Supplement 3, Question 18-62.

The following is representative of information included in the HSI IP revision:





FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-120:

Regarding Sub-Criterion, "The specific design features or characteristics of design features should be carefully defined. If the characteristics are to be manipulated in the test, i.e., systematically varied, the differences between test conditions should be specified in detail"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how the specific design features or characteristics of design features are carefully defined. If the characteristics are to be manipulated in the test, i.e., systematically varied, the differences between test conditions should be specified in detail.

Response to Question 18-120:

See the Response to Question 18-119.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-121:

Regarding Sub-Criterion, "the selection of testbeds for the conduct of performance-based tests should be based upon the requirements imposed by the test hypotheses and the maturity of the design"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how the selection of testbeds for the conduct of performance-based tests is based upon the requirements imposed by the test hypotheses and the maturity of the design.

Response to Question 18-121:

See the Response to Question 18-119.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-122:

Regarding Sub-Criterion, "The selection of performance measures should be based on a consideration of:

- measurement characteristics
- identification and selection of variables to represent measures of the aspects of performance under investigation
- development of performance criteria"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how the selection of performance measures is based on a consideration of: measurement characteristics, identification and selection of variables to represent measures of the aspects of performance under investigation, and development of performance criteria.

Response to Question 18-122:

See the Response to Question 18-119.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-123:

Regarding Sub-Criterion, "The selection of participants for HSI design tests should be based on the nature of the questions being addressed in test objectives and the level of design maturity"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how the selection of participants for HSI design tests is based on the nature of the questions being addressed in test objectives and the level of design maturity.

Response to Question 18-123:

See the Response to Question 18-119.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-124:

Regarding Sub-Criterion, "The test design should permit the observation of performance in a manner that avoids or minimizes bias, confounds, and error variance (noise)"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how the test design should permit the observation of performance in a manner that avoids or minimizes bias, confounds, and error variance (noise).

Response to Question 18-124:

See the Response to Question 18-119.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-125:

Regarding Sub-Criterion, "Test data should be analyzed using established analysis techniques"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how the test data is analyzed using established analysis techniques.

Response to Question 18-125:

See the Response to Question 18-119.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 18-126:

Regarding Sub-Criterion, "Design solutions, such as modifications of the HSIs or user training requirements, should be developed to address problems that are identified during the testing and evaluation of the HSI detailed design"

Neither the FSAR nor the HSI Plan address this sub-criterion nor provide reference to another section of the FSAR that addresses this sub-criterion. AREVA should provide an explanation for how design solutions, such as modifications of the HSIs or user training requirements, are developed to address problems that are identified during the testing and evaluation of the HSI detailed design.

Response to Question 18-126:

See the Response to Question 18-119.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.