ArevaEPRDCPEm Resource

From: WELLS Russell (AREVA) [Russell.Wells@areva.com]
Sent: Wednesday, February 23, 2011 5:51 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (AREVA); ROMINE Judy (AREVA); BENNETT Kathy (AREVA); BRYAN Martin (EXTERNAL AREVA); NOXON David (AREVA)
Subject: Response to U.S. EPR Design Certification Application RAI No. 419, FSAR Ch. 18, Supplement 5
Attachments: RAI 419 Supplement 5 Response US EPR DC.PDF

Getachew,

On July 19, 2010, AREVA NP submitted a response for 2 questions, as well as a schedule for providing the Human System Interface Design Implementation Plan as part of one of these questions (18-172). On September 30, 2010, October 28, 2010, and November 28, 2010 a revised schedule was provided. On December 16, 2010 a final response was sent for the remaining questions associated with this RAI. The attached file, "RAI 419 Supplement 5 Response US EPR DC.pdf" provides revised responses to Questions 18-171 and 18-172, which supersede the previous responses.

The AREVA NP U.S. EPR Task Analysis (TA) Implementation Plan supporting RAI 419, has been revised, and the plan is submitted under a separate cover letter.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 419 Questions 18-171, and 18-172.

The following table indicates the respective pages in the response document, "RAI 419 Supplement 5 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 419 — 18-171	2	2
RAI 419 — 18-172	3	3

This concludes the formal AREVA NP response to RAI 419, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Russ Wells
U.S. EPR Design Certification Licensing Manager
AREVA NP, Inc.
3315 Old Forest Road, P.O. Box 10935
Mail Stop OF-57
Lynchburg, VA 24506-0935
Phone: 434-832-3884 (work)
434-942-6375 (cell)
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Russell.Wells@Areva.com

From: BRYAN Martin (External RS/NB)
Sent: Thursday, December 16, 2010 2:22 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); NOXON David (RS/NB); PANNELL George (CORP/QP); 'Miernicki, Michael'; 'Ford, Tanya'
Subject: Response to U.S. EPR Design Certification Application RAI No. 419, FSAR Ch. 18, Supplement 4

Getachew,

On July 19, 2010, AREVA NP submitted a response for 2 questions, as well as a schedule for providing the Human System Interface Design Implementation Plan as part of one of these questions (18-172). On September 30, 2010, October 28, 2010, and November 28, 2010 a revised schedule was provided. The attached file, "RAI 419 Supplement 4 Response US EPR DC.pdf" provides technically correct and complete responses to the 1 remaining question, as committed and a revised response to Question 18-171.

The AREVA NP U.S. EPR Task Analysis (TA) Implementation Plan and the AREVA NP U.S. EPR Human Interface Design Implementation Plan supporting RAI 419, have been revised, and the plans are submitted under a separate cover letter.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 419 Questions 18-171, and 18-172.

The following table indicates the respective pages in the response document, "RAI 419 Supplement 4 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 419 — 18-171	2	2
RAI 419 — 18-172	3	3

This concludes the formal AREVA NP response to RAI 419, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Sunday, November 28, 2010 6:45 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); PANNELL George (CORP/QP)
Subject: Response to U.S. EPR Design Certification Application RAI No. 419, FSAR Ch. 18, Supplement 3

Getachew,

On July 19, 2010, AREVA NP submitted a response for 2 questions, as well as a schedule for providing the Human System Interface Design Implementation Plan as part of one of these questions (18-172). On September 30, 2010 and October 28, 2010 a revised schedule was provided. To provide additional time to interact with the NRC staff the response date is revised.

The schedule for a technically correct and complete response to this question is changed and is provided below.

Question #	Response Date
RAI 419 — 18-172	December 16, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Thursday, October 28, 2010 6:12 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); PANNELL George (CORP/QP)
Subject: Response to U.S. EPR Design Certification Application RAI No. 419, FSAR Ch. 18, Supplement 2

Getachew,

On July 19, 2010, AREVA NP submitted a response for 2 questions, as well as a schedule for providing the Human System Interface Design Implementation Plan as part of one of these questions (18-172). On September 30, 2010, a revised schedule was provided. To provide additional time to interact with the NRC staff the response date is revised.

The schedule for a technically correct and complete response to this question is changed and is provided below.

Question #	Response Date
RAI 419 — 18-172	November 30, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Thursday, September 30, 2010 10:02 AM
To: 'Tesfaye, Getachew'

Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); PANNELL George (CORP/QP)
Subject: Response to U.S. EPR Design Certification Application RAI No. 419, FSAR Ch. 18, Supplement 1

Getachew,

On July 19, 2010, AREVA NP submitted a response for 2 questions, as well as a schedule for providing the Human System Interface Design Implementation Plan as part of one of these questions (18-172). To provide additional time to interact with the NRC the response date is revised.

The schedule for a technically correct and complete response to this question is provided below.

Question #	Response Date
RAI 419 — 18-172	October 29, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Tuesday, July 20, 2010 5:47 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); RYAN Tom (AREVA NP INC); PANNELL George L (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 419, FSAR Ch. 18

Getachew,

The proprietary and non-proprietary versions of RAI 419 are submitted via AREVA NP Inc. letter, "Response to U.S. EPR Design Certification Application RAI No. 419" NRC10:066, dated July 19, 2010. An affidavit to support withholding of information from public disclosure, per 10CFR2.390(b), is provided as an enclosure to that letter.

The following table indicates the respective pages in the response document that contain AREVA NP's responses to the subject questions.

Question #	Start Page	End Page
RAI 419 — 18-171	2	3
RAI 419 — 18-172	4	5

A complete answer is not provided for one of the questions. The schedule for technically correct and complete response to this question is provided below.

Question #	Response Date
RAI 419 — 18-172	October 1, 2010

Sincerely,
Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, June 22, 2010 10:17 AM
To: ZZ-DL-A-USEPR-DL
Cc: Bongarra, James; Walker, Jacqwan; Marble, Julie; Junge, Michael; Eudy, Michael; Steckel, James; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 419 (4727,4780),FSAR Ch. 18

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on June 14, 2010, and discussed with your staff on June 17, 2010. Drat RAI Question 18-173 was deleted as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 2594

Mail Envelope Properties (1F1CC1BBDC66B842A46CAC03D6B1CD410401A6A4)

Subject: Response to U.S. EPR Design Certification Application RAI No. 419, FSAR Ch. 18, Supplement 5
Sent Date: 2/23/2011 5:51:01 PM
Received Date: 2/23/2011 5:51:05 PM
From: WELLS Russell (AREVA)

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Tracking Status: None
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MESSAGE	9735	2/23/2011 5:51:05 PM
RAI 419 Supplement 5 Response US EPR DC.PDF		145211

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Priority: Standard
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Response to

Request for Additional Information No. 419(4727, 4780), Revision 1, Supplement 5

6/22/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 18 - Human Factors Engineering
Application Section: Ch.18.0

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

Question 18-171:

Follow-up to RAI 4016 (336), question 18-73 (15535):

The staff has determined that the applicant's response to parts (a.1) and (a.2) of this RAI acceptably addresses the staff's questions concerning defining and assessing a meaningful job and providing information related to assessing cognitive workload by providing a definition of meaningful job and describing the application of the GOMS technique to assess cognitive workload. This portion of the RAI question has been satisfactorily addressed and can be closed.

However, the staff has the following additional questions concerning the applicant's response to parts (b.1) and (b.2). While the applicant has provided a generic description of what a task timeline is, the response does not provide an explanation of how the technique is/will be used to develop the EPR task analysis (e.g., an example of a task timeline that is related to the EPR TA has not been provided). In addition, the applicant's response does not clearly explain how the timeline developed for the EPR TA will be used to address issues of workload and response timing related to EPR operators. The staff requests for the applicant to please explain how the task timeline technique is used to develop the EPR TA and how the timeline is used to address issues of workload and response timing related to EPR operators.

Response to Question 18-171:

The AREVA NP U.S. EPR Task Analysis (TA) Implementation Plan has been revised, and the proprietary plan is submitted under a separate cover letter. Additional detail has been added to Section 3.2.1 of the plan to address this question. Clarifying changes were made in U.S. EPR FSAR Tier 2, Section 18.4 and 18.5 for consistency with the revised plan..

FSAR Impact:

U.S. EPR FSAR Tier 2, Sections 18.4 and 18.5 will be revised as described in the response and indicated on the enclosed markup.

Question 18-172:

NUREG-0711, Criterion 8.4.5, "HSI Detailed Design and Integration," sub-criterion 8, states that HSI characteristics should support human performance under the full range of environmental conditions. In support of this criterion, AREVA submitted, as part of its HSI IP, a description for developing the minimum inventory of alarms, controls, and displays for the MCR and the RSS. With respect to the applicant's IP Rev 3., page 24, AREVA states that, "The minimum inventory development process, is iterative similar to the other U.S. EPR™ HFE program elements. Design inputs to MI development are revised as the design evolves and the MI list is re-evaluated and adjusted as necessary until the design is finalized." The staff requests for the applicant to please clarify what is meant by the last sentence, "Design inputs to MI development are revised as the design evolves and the MI list is re-evaluated and adjusted as necessary until the design is finalized."

Response to Question 18-172:

The AREVA NP U.S. EPR Human Interface Design Implementation Plan has been revised and the proprietary plan is submitted under a separate cover letter. Additional detail has been added to Section 6.1 of the plan to address this question. Additional clarifying changes were made in U.S. EPR FSAR Tier 2, Section 18.7 for consistency with the revised plan.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 18.7 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

18.4 Task Analysis

The functions allocated to plant personnel define their roles and responsibilities; human actions (HA) accomplish these functions. HAs can be further divided into tasks or groups of related activities which have common objectives or goals. Task analysis (TA) identifies requirements for accomplishing these tasks; specifically, for the displays, data processing, controls, and job support aids needed to accomplish tasks. The results of the TA are identified as inputs in ~~many HFE~~several activities in accordance with NUREG-0711 (Reference 1), ~~such as~~as listed:

RAI 419, Q 18-171

- Job design, and training.
- Human system interface (HSI), procedure, and training program design.
- Defining task support verification and validation criteria.

The scope and methodology for TA for the U.S. EPR are summarized in the U.S. EPR Task Analysis Implementation Plan (Reference 2).

18.4.1 Task Analysis Objectives and Scope

RAI 419, Q 18-171

The objective of the U.S. EPR TA is to identify the specific tasks needed to accomplish the safety significant functions that are allocated to personnel. The TA also identifies the information, control, and support requirements for those tasks. TA is used to develop the inventory of alarms, displays, and controls necessary for operators to perform tasks, and to evaluate the number and qualifications of personnel. The scope of personnel is defined in Section 18.1.1.5.

The TA considers a full range of plant operating modes (i.e., startup, normal power, abnormal and emergency operations, as well as transient, low-power, and shutdown conditions) including selected representative and important tasks from the areas of operations, maintenance, test, inspection, and surveillance that directly support critical safety function. The TA also considers HAs that involve monitoring and backup of automatic functions. Risk important HAs are identified via the probabilistic risk assessment (PRA) Level I and II analyses (see Sections 18.6 and Chapter 19). Also included in the scope of the TA are the analyses of tasks with automated critical functions, including monitoring the automated system and executing backup actions if the system fails.

RAI 419, Q 18-171

18.4.2 Task Analysis Methodology

TA is performed on functions identified during the FRA/FA process which includes the automatic actions and operator backup to the automation. A graded approach to TA coupled with a screening process is used to select functions to be subject to TA as described in the TA Implementation Plan.~~A sampling process similar to the operational conditional sampling process described in Section 18.10 (verification and~~

~~validation) is used to select functions subject to TA.~~ The requirements for accomplishing each task are identified~~, such as~~ as follows: the activity sequence, task prerequisites, operational limitations on other trains/systems during task performance, as well as information and controls required to initiate, monitor, terminate, and verify task completion, communication requirements, operator skills, operator qualifications, and job support aids needed.

OER, FRA/FA, HRA, and system data provide input into the TA process. The TA Implementation Plan (Reference 2) provides additional detail on the identification and analysis process for tasks.

The output from TA covers system level and plant level functions for normal, abnormal (including emergency and severe accident events), and surveillance and testing activities performed by licensed and non-licensed operators. The system level TA identifies the tasks required to operate systems during each mode of operation.

The plant level TA identifies the strategy required to accomplish the plant safety and power generation goals. System-level tasks are sequenced based on plant-level strategy and functional requirements.

TA includes workload analysis to evaluate the number of crew members and the skills and qualification in the staffing and qualification assumptions against the sets of concurrent tasks required to implement plant-level operating strategies. Workload values are assigned to tasks allocated to each crew member to determine if changes are required to the initial function allocation among:

- Manual, automatic, group control.
- Shift manager, control room supervisor, licensed operator, non-licensed operator and non-operator plant personnel.
- Control room and local control.

RAI 419, Q 18-171

If changes are made to the FA, the TA and workload are reassessed to confirm that the staffing and qualification assumptions remain valid.

The TA process is iterative and progressively more detailed. The results are maintained in ~~a~~the functional branch tree data structure which maps the plant safety objectives to individual operator tasks and plant equipment used to accomplish safety-related functions. This data structure facilitates requirement traceability as well as clearly defined outputs for other ~~HFE~~ activities~~, such as~~ as follows: the design of the HSI, the plant operating procedures, and plant personnel training program.

RAI 419, Q 18-171

18.4.3 Results Summary

RAI 419, Q 18-171

A summary report is generated describing the scope of TA and implementation details (e.g., qualification of individuals performing analysis, out of process issues, process outputs). These outputs include:

- Identified specific tasks that are needed to accomplish the analyzed functions that are allocated to personnel covering the modes of operation.
- Information, control, and support requirements defined for each task.
- An inventory of alarms, displays, and controls necessary for operators to perform the tasks.
- Identification of risk-significant HAs and their incorporation into the design.
- Determination of necessary number and skill levels of crew members.
- Documentation of necessary changes to the crew compliment as specified in the initial staffing assumption for the U.S. EPR design.
- Allocation of monitoring and control tasks for crew members.

18.4.4 References

1. NUREG-0711, "Human Factors Engineering Program Review Model," Revision 2, U.S. Nuclear Regulatory Commission, February 2004.
2. U.S. EPR Task Analysis Implementation Plan, AREVA NP Inc., ~~2009~~2011.

RAI 419, Q 18-171

Next File

- Functional allocation (FA) decisions, Section 18.3, are evaluated to achieve maximized performance without placing excessive demands upon the operators, and to determine the monitoring tasks required of operators when functions are automated.

- Task analysis (TA), Section 18.4, provides input to the MCR staffing levels by including workload analysis as part of the overall TA process. The objective is to verify that the control room HSI adequately supports operator performance. Workload analysis must carefully consider assumed roles and responsibilities and qualification requirements of operators.

- Human reliability analyses (HRA), Section 18.6, provides input to the consideration of staffing levels on plant safety and reliability. In particular, risk-significant or time critical human actions (HA) are examined during the TA to determine the need for reassignment, changes to operator roles, or the need to change the number of operators required.

- The role of the operator is an important consideration in the HSI design process. Section 18.7 addresses the engineering process of optimizing coordinated operator actions, ~~such as~~ the demand on operators during the use of control elements and display elements concurrently, and the design of effective support.

18.5.2 Staffing and Qualifications Analysis Methodology

To obtain an optimum staffing level, the initial staffing assumption (Reference 1) ~~may~~is ~~be~~ iterated as a result of task analysis. Initially, tasks are assigned to crew members based on ~~U.S. EPR predecessor~~ operating experience and on established roles and responsibilities as noted in Reference 1. The process then builds on these assumptions. Changes in team roles and responsibilities ~~may~~ result from the adjustments to individual crew member responsibilities. Finally, individual team member qualification requirements ~~may~~ evolve with changes in team and individual roles.

18.5.3 Results

The staffing and qualification analysis is summarized within task analysis (Reference 2) and includes an evaluation of the number and qualifications of personnel needed to operate and test the U.S. EPR based on the HSI design features for normal, abnormal, and emergency conditions.

18.5.4 References

1. U.S EPR HFE Program Management Plan, AREVA NP Inc., ~~2009~~2010.

2. U.S. EPR Task Analysis Implementation Plan, AREVA NP Inc., ~~2009~~2011.

RAI 419, Q 18-172

Next File

18.7 Human System Interface Design

The human system interface (HSI) design process translates function and task requirements into HSI characteristics and functions. The HSI uses a structured methodology that guides designers in identifying and selecting candidate HSI approaches, defining the detailed design, and performing HSI tests and evaluations. The HSI promotes the development and use of human factors engineering (HFE) guidelines that are tailored to the unique aspects of the design (e.g., an HSI style guide that defines design-specific conventions). The HSI also promotes standardization and consistency in applying HFE principles. The process and the rationale for the HSI design is documented and controlled under the design control process described in the AREVA Quality Assurance Program (QAP) Topical Report (Reference 1).

RAI 419, Q 18-172

This section describes how HFE activities and analyses described in Sections 18.2, 18.3, 18.4, ~~and~~ 18.5, and 18.6 are performed as part of the overall HSI design process.

18.7.1 Human System Interface Design Inputs

RAI 419, Q 18-172

The HSI design is developed based on various design inputs. The HFE program element design inputs (i.e., operating experience review (OER), functional requirements analysis (FRA) and functional allocation (FA), task analysis (TA) human reliability analysis (HRA), and staffing analysis) are used by the HSI design team to make design decisions. Additionally, the HSI design team considers applicable regulatory documents and codes as well as generic HFE standards and industry guidelines.

18.7.1.1 Analysis of Personnel Task Requirements

Several analyses are performed in the early stages of the design process to identify HSI design requirements.

RAI 419, Q 18-172

18.7.1.1.1 Operating Experience Review

An OER is performed as described in Section 18.2 to identify any HFE-related safety issues as well as any positive HFE experiences with HSIs and control rooms~~to determine how the strengths and weaknesses of the HSI technology concept impact the effectiveness of the operator when using the technology~~. The goal of the OER is to compare the analysis of current work practices, operational problems and issues in current designs, and industry experience with candidate technological approaches to system and HSI technology and specific supplier solutions.

At the onset of OER activities, the first HFE task is to identify how candidate functions, tasks, and HSIs are different from predecessor designs. Plant specific and industry experience is sought from a variety of data sources, including: available

automated. The FRA inputs lead to the definition of concept of operations (see Section 18.7.2) with respect to the role of personnel. The inputs define potential changes to functions and allocations, but are to be evaluated against the established automation criteria. Changes to functions and tasks that are inherently expected to be accomplished by humans or those that are required to be automated either require review by the design review board or are subject to other design change control processes.

The results of the FRA and FA are used to identify the personnel role in performance of functions to reveal the task requirements and identify the HSI design implications. These HSI design implications include insight into the information that is to be displayed and how that information is presented. This information is used in the HSI procedure and training design to make sure that adequate task support is available to the operators.

18.7.1.1.3 Task Analysis

For the U.S. EPR HSI design, TA is performed for procedure development and is iterated as the HSI design detail evolves as described in Section 18.4.

TA involves determining the requirements for plant personnel to successfully perform complex real-time control actions that stem from functions assigned to them as a result of the FA design effort. Actions performed by plant personnel to accomplish a common-purpose group of activities or functions are called tasks. TA requirements are a primary consideration in design of the HSI.

RAI 419, Q 18-172

The TA must select appropriate tasks for analysis. When the tasks are selected, high-level descriptions of the tasks based on basic information can be developed. For example, the purpose, relationship to other tasks, and timing are considered. Using the high-level descriptions, more detailed descriptions of a task are developed to decompose the task into detailed steps. As these details emerge, task resource requirements (i.e., the process data and controls required) ~~become apparent~~are identified. Resource requirements such as alarms, displays, and controls affect the HSI design requirements. Task resource requirements are also beneficial for determining what should be displayed, how information should be grouped, and the sequences of how users will use the information.

18.7.1.1.4 Staffing and Qualifications and Job Analysis

As described in Section 2.2.2.1 of the U.S. EPR HFE Program Management Plan (Reference 2), each member of an operating crew has a unique role and a unique set of responsibilities. The crew members must interact with each other and with the plant in order to fulfill their roles and responsibilities. The number of crew members assigned to an operating shift is based on the need for personnel to accomplish real-time operational goals with a reasonable workload. Workload analysis considers the

components. A dedicated QDS capable of receiving all four trains of data is used to give the operator an overview of the plant. The dedicated overview QDS is for monitoring only, with one way communication, and cannot impact the plant. See Section 7.1.1.2.1 for more information on safety-related HSI.

18.7.1.2.1 Alarm Management Hierarchy

The alarms on the PICS are prioritized into levels. The PICS provides the ability to display, record, and acknowledge alarms and warnings that are necessary for the operators. A color scheme is associated with the prioritization of the alarm to inform the operator of the nature of the alarm and the priority level. The operator uses the alarm text to view alarm details. A direct navigation link associated with the alarm is also available to the operator. Direct navigation links are used along with the alarm management system to allow the operator quick access to related information and controls.

18.7.1.2.2 Loss of Non-Safety Computerized HSIs

The U.S. EPR is normally controlled from PICS, the non-safety HSI. An independent safety-related HSI back-up, SICS, provides the ability to control and monitor the plant for a limited amount of time to keep it in a safe and steady power condition. If PICS is not available or directly recoverable, the plant is shut down. The SICS consists of QDSs and selected hardwired controls and alarms. The QDS is also safety qualified for controlling and monitoring the plant.

SICS is safety-related and is designed and qualified in accordance with IEEE Class 1E standards. The PICS is a non-safety-related system. The main difference between achieving safe shutdown from the different HSI systems is that more non-safety-related plant equipment can be operated from the PICS. The SICS includes the basic functional capabilities for the operator to monitor plant conditions and control appropriate plant systems to perform the credited safe shutdown path. However, more flexibility in the path to safe shutdown is available from the PICS due to the increase in HSI for both safety-related and non-safety-related systems.

Failures in PAS will be indicated on PICS. PAS failures resulting in the unavailability of the PICS need not be distinguished from failures in PICS resulting in the unavailability of PICS. The PICS will be used in all plant conditions, as long as it is available. The PICS is declared unavailable if less than two of the four operator workstations are in an available condition. A PICS workstation is declared unavailable if one or more of the following conditions exist:

- Three or more monitors at a workstation are unusable. The workstation in the Shift ~~Supervisor~~Manager office is not considered an operator workstation.

RAI 419, Q 18-172

the HSI considers task loading for each individual operator as well as the time it takes to communicate with others while performing those tasks. To reduce the burden on the operator and validate the minimum staffing requirement assumptions, training the operators to communicate efficiently, effective layout of the control rooms, and a well designed HSI are required. Furthermore, flexibility in the layout of the control rooms and design of the HSI allows for ease of change as communication methods improve with new technology.

Communication of orders for plant operation is initiated using a chain of command structure. For example, the SM provides orders to the CRS, the CRS provides orders to the RO, the ALO, or the NLOs, and the RO provides orders to the ALO or NLOs. Verbal communications not directly related to plant operation are minimized in the MCR to avoid interference or disruption. Communicating other types of information, such as authorization and work plans for normal maintenance or testing, is conducted during pre-shift or pre-job briefings if the MCR operators have a need to know. The SM is generally the point of contact for emergent or non-operational communications.

Face-To-Face Communication

Face-to-face communication is the most effective form of communication because it allows the most information to be conveyed. This form of communication is the preferred method and, when possible, is used for orders related to the operation of the plant safety systems.

Other Forms of Two-Way Communications

RAI 419, Q 18-172

Telephones, electronic devices, or other forms of visual two-way communication are used when face-to-face communication is not possible or not efficient. Orders are acknowledged with repeat-backs to confirm the accuracy of the message. Several forms of ~~three~~two-way communication are provided within the MCR of which the plant operators are trained.

The use of one-way communication (i.e., general public-announcing systems) is limited to emergency situations or when the information is of interest to others not in the audible vicinity of the person conducting the announcement.

18.7.2.5.2 Control Rooms Traffic

Unescorted entry into the control room is only permitted to individuals with proper authorization. Electronic security devices are used to restrict access into the MCR, TSC, RSS, or I&CSC. Permission from the CRS or responsible licensed operator is also required to enter these control rooms.

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TSC and RSS

The RSS is generally not occupied except in the event of an MCR evacuation. Electronic measures are used to restrict access to the RSS to only authorized personnel. Access to the RSS will be in accordance with the emergency plan.~~The SM or CRS shall authorize access to the RSS as necessary.~~

The TSC is part of an integrated operations area which is normally in use during power operations. When the TSC is activated during an emergency, all other uses of the integrated operations area are suspended. The emergency coordinator assumes responsibility for controlling access to the TSC when it is activated.

I&CSC

The I&CSC is not continuously occupied. It is staffed by I&C engineers and technicians, I&C system administrators, and trained and authorized personnel designated to operate specialized systems such as the loose parts, vibration monitoring, leakage monitoring, and the Aeroball and PowerTrax core monitoring systems. Several forms of communication are provided in the I&CSC allowing operators immediate communication with the technicians. Access to the I&CSC is controlled by the CRS.

18.7.3 Functional Requirements Specification

As described in Section 4.5 of the EPR HFE Program Management Plan (Reference 2), design documents are produced for each of the control rooms (i.e., MCR, TSC, RSS, I&CSC) and HSIs (i.e., PICS and SICS) to track requirements and design specifications. These design documents capture the functional requirements as well as the HFE requirements and provide a uniform philosophy and design consistency among HSIs, including screen style and layout guide, hierarchy of and navigation between screens, alarm system operation, electronic procedure system, plant information system, and hard-wired control integration in panels and workstations.

Section 18.7.4.3 describes how the inventory of alarms, displays, and controls needed to operate the U.S. EPR is determined.

18.7.4 HSI Concept Design

The U.S. EPR implements a modern I&C design based on experience gained internationally in new plant designs and retrofits in existing plants with digital I&C equipment. The HSI concepts are further based on predecessor designs and utilize similar control of system functions and I&C concepts. The concepts for the HSI design for the U.S. EPR are described in Section 7.5, Section 2.2.1.2 of the EPR HFE Program Management Plan (Reference 2), and Section 5.1.2 of the U.S. EPR Human System Interface Design Implementation Plan (Reference 15).

18.7.4.1 Safety Parameter Display System

The parameters required to be displayed as part of the SPDS are made available on the PICS and SICS. For more details refer to Section 7.5.

18.7.4.2 Operation and Control Centers System

The MCR, TSC, RSS, I&CSC and the HSIs (i.e., PICS and SICS) including the bases for layout of the control rooms and organization of the HSIs within them are described in Section 2.2 of the EPR HFE Program Management Plan (Reference 2).

18.7.4.3 Inventory of Alarms, Displays, and Controls

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The process data inventory, setpoints, and equipment layout needed to operate the U.S. EPR is determined by the system engineers for each piping and instrumentation system and documented in various piping and instrumentation diagrams (P&IDs) or one-line diagrams. The corresponding design documents capture the functions and functional requirements as well as the design basis for each function. These design documents are then used as inputs to the FRA and TA processes.

~~The HFE and Control Room Design Team translates the functions from the P&IDs, one-line diagrams, and design documents into the required inventory of alarms, displays, and controls.~~Through the FRA/FA and TA processes, the required inventory of alarms, displays, and controls are identified and documented. The U.S. EPR Human System Interface Design Implementation Plan (Reference 15) describes how the HFE and Control Room Design Team organizes and presents the alarms, displays, and controls on the HSIs in an effective context so that the operators can safely and efficiently operate the plant. Hardware and software requirements to implement this inventory and the subsequent HSI designs are verified as described in Section 18.10.

18.7.4.4 Minimum Inventory of Main Control Room Alarms, Displays, and Controls

Minimum inventory is defined as the set of alarms, displays, and controls needed to implement the plant emergency operating procedures (EOP) (refer to Section 15.0), bring the plant to a safe condition, and to carry out those operator actions shown to be risk important by the applicant's probabilistic risk assessment.

The MCR minimum inventory includes the readily accessible HSIs that the operator needs to:

- Monitor the status of fission product barriers.
- Perform and confirm a reactor trip.
- Perform and confirm a controlled shutdown of the reactor using the normal or preferred safety means.

- Perform and confirm a reactor trip.
- Place and maintain the reactor in a safe condition using the normal or preferred safety means.

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Section 7.4.1.3 describes safe shutdown from outside the MCR by use of the RSS.

The methodology for selecting the minimum inventory for the RSS is described in the U.S. EPR HSI Design Implementation Plan (Reference 15).

18.7.4.6 Computer-Based Procedures

Operating procedures can be implemented in a screen-based format that provides access to process information by direct links. These electronic procedures also provide access to related information and direct the operator to the appropriate control screens. Refer to Section 6.2.9 of the U.S. EPR Human Factors Program Management Plan (Reference 1) for further details on the development of electronic procedures.

Paper-based procedures serve as backup to screen-based (i.e., electronic) procedures and contain the same guidance and format. Hard copy backups of operating procedures are provided in the main control room (MCR), remote shutdown station (RSS), and the Technical Support Center (TSC) in the event that a failure of the operating procedure computer occurs. Aside from differences in how electronic and hard copy procedures are used (i.e., the navigation and layout) as well as the availability of live data, electronic and hard copy procedures contain the same information in the same format. Adequate space is provided at appropriate workstations in the MCR and RSS for operators to display paper-based procedures, when required.

18.7.5 Guidance for Local Control Station Design~~Human Factors Design for the Non-Human System Interface Portion of the Plant~~

A style guide provided by the HFE and Control Room Design Team is used in the design of HSI features. It also provides guidance on such issues as general plant layout design, equipment accessibility requirements, coding and labeling, and environmental issues such as lighting, acoustics, personnel protection equipment, and ambient conditions suitable for personnel. The style guide is a design guideline applicable to engineering disciplines (e.g., structural engineers) who are required to follow the style guide for plant and equipment layout decisions.

18.7.5.1 Plant Layout Design and Equipment Accessibility

System engineers specify space requirements for their equipment during the plant layout phase taking into account maintenance, testing, and component replacement. The HFE style guide provides guidance for these space requirements. Location of interfaces also considers the general physical layout of the system. ~~HSIs~~LCSs (local

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control stations) are placed in easy to access locations (e.g., manual valve operators will not be located where access requires the use of a portable ladder or scaffold).

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18.7.5.2 Coding, Language, and Information Pre

Rules for coding, labeling, and presenting information on HSIs, local control stations, and on most equipment are specified in the ~~HSI~~LCS style guide. The nomenclature and terminology used in operating procedures and design documentation (e.g., system manuals and plant drawings) shall be consistent with those used for operator interfaces.

Unique equipment identifiers shall be established in the equipment database early in the design phase, and those identifiers shall be maintained throughout the design, manufacture, construction, testing, procedure development, and operational staff training. In conformance with NUREG-0711 (Reference 4) and consistent with NUREG-0700 (Reference 6), the ~~HSI~~LCS style guide specifies requirements for the use of symbols, abbreviations, syntax, and color schemes.

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18.7.5.3 Lighting of the ~~HMI~~Control Rooms and Workspaces

The lighting in the control rooms and workstations, including local control stations, provides suitable working conditions for personnel by:

- Providing adequate lighting for performance of their tasks (e.g., good contrast for easy discrimination of required information, good minimum lighting level for the preservation of alertness).
- Avoiding glare and reflection.

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18.7.5.4 Acoustic Environment

The acoustic environment and the mean noise level in the MCR and RSS aids operator alertness so that the monitoring and controlling of processes and the associated mental activities are performed in comfort, and communication between the members of the operating staff is not disrupted.

18.7.5.5 Personnel Protection Equipment

Though the use of personnel protection equipment such as hearing, eye, and head protection, anticontamination clothing, and self-contained air breathing apparatus is not postulated in the MCR; it is placed in locations providing easy access. The placement of this equipment is considered in the plant layout design.

18.7.5.6 Ambient Conditions

During normal operation at basic atmospheric conditions, the temperature and humidity in the MCR and associated ~~HSI~~control rooms are controlled to normal

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  - Display management.
  - Display hierarchy.
  - Navigating between displays.
- Workstation configuration:
  - Anthropometric data for equipment dimensions.
- Workplace environment:
  - Temperature and humidity.
  - Ventilation.
  - Illumination.
  - Sound levels.

The HSI design takes into account the use of HSIs over the duration of a shift where decrements in human performance due to fatigue may occur. Physical layout of the control room and workstations considers the distances operators are required to move to initiate manual actions. Excessive amounts of movement, including arm and hand movement, for long durations can impact the performance of the operator.

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18.7.6.3 HSI Modifications

As described in Section 18.12, HSI modifications should be consistent with the U.S. EPR utility operator's existing strategies for gathering and processing information and executing actions identified in the TA. Consistency reduces the need for retraining associated with a lack of proficiency because of modifications. Modifications to the HSIs should be done in accordance with the design change process of the operating utility. A check list of HSI technical considerations should be included in the design change work package for consistency with the U.S. EPR HSI standard design.

18.7.7 HSI Verification and Validation (Tests and Evaluations)

Verification and validation (V&V) (see Section 18.10) of the HSI design is performed so that the as-built HSIs:

- Are complete and operable.
- Conform to standard HFE principles and requirements.
- Are free of safety issues and human performance issues.
- Implement the design accurately in the final design output documentation.

Testing and evaluation is conducted throughout the HSI design at various stages of development so that the complex HSI design functions properly before the design process is resolved and validation occurs (see Figure 18.1-2).

Activities such as concept testing, mock-up activities, trade-off evaluations, and performance-based tests are utilized at various stages of the design. The criteria used to decide which type of testing or evaluation technique is applicable are described in the U.S. EPR Human Factors Verification and Validation Implementation Plan (Reference 17).

18.7.8 HSI Design Results and Documentation

As described in Section 4.5 of EPR HFE Program Management Plan (Reference 2), the HSI designs are documented using specific design control process requirements. The various configuration management, design change controls, design verification, and design quality control tools are also described in Reference 1.

18.7.9 References

1. ANP-10266NPA, Revision 0, "AREVA NP Inc. Quality Assurance Plan (QAP) for Design Certification of the U.S. EPR," AREVA NP Inc., December 2008.
2. U.S. EPR HFE Program Management Plan, AREVA NP Inc., ~~2009~~2010. RAI 419, Q 18-172
3. NUREG-0737, “Clarification of TMI Action Plan Requirements,” U.S. Nuclear Regulatory Commission, November 1980.
4. NUREG-0711, “Human Factors Engineering Program Review Model,” Rev. 2, U.S. Nuclear Regulatory Commission, February 2004.
5. ANP-10304, Revision 1, “U.S. EPR Diversity and Defense-in-Depth Assessment Technical Report,” AREVA NP Inc., December 2009.
6. NUREG-0700, “Human-System Interface Design Review Guidelines,” Revision 2, U.S. Nuclear Regulatory Commission, May 2002.
7. NUREG/CR-6633, “Advanced Information Systems: Technical Basis and Human Factors Review Guidance,” U.S. Nuclear Regulatory Commission, March 2000.
8. NUREG/CR-6634, “Computer-Based Procedure Systems: Technical Basis and Human Factors Review Guidance,” U.S. Nuclear Regulatory Commission, March 2000.
9. NUREG/CR-6635, “Soft Controls: Technical Basis and Human Factors Review Guidance,” U.S. Nuclear Regulatory Commission, March 2000.
10. NUREG/CR-6636, “Maintainability of Digital Systems: Technical Basis and Human Factors Review Guidance,” U.S. Nuclear Regulatory Commission, March 2000.

11. NUREG-0696, "Functional Criteria for Emergency Response Facilities," U.S. Nuclear Regulatory Commission, February 1981.

12. NUREG-0835, "Human Factors Acceptance Criteria for the Safety Parameter Display System," U.S. Nuclear Regulatory Commission, October 1981.

13. NUREG-1342, "A Status Report Regarding Industry Implementation of Safety Parameter Display Systems," U.S. Nuclear Regulatory Commission, April 1989.

14. U.S. EPR Human Factors Operating Experience Review Implementation Plan, AREVA NP Inc., ~~2009~~2010. RAI 419, Q 18-172

15. U.S. EPR Human System Interface Design Implementation Plan, AREVA NP Inc., ~~2009~~2010. RAI 419, Q 18-172

16. U.S. EPR Functional Requirements Analysis and Functional Allocation Implementation Plan, AREVA NP Inc., ~~2009~~2010. RAI 419, Q 18-172

17. U.S. EPR Human Factors Verification and Validation Implementation Plan, AREVA NP Inc., ~~2009~~2011. RAI 419, Q 18-172

Table 18.7-1—Table Deleted

Table 18.7-2—Table Deleted

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