

Response to Request for Additional Information – ANP-10279
“U.S. EPR Human Factors Engineering Program Topical Report”
(TAC No. MD4252)

RAI-2: Open Clarify use of should General Comment: Use of a combination of verb tenses "should"/"should be" vs "will"/"will be," vs "are", etc., make it difficult to determine whether a commitment is made or not. For example, on p.2-3, "The acoustic environment and the mean noise level in the MCR should aid operator alertness..." versus "The lighting in the control rooms provide optimum working conditions..."

Evaluation: AREVA's response did not fully address the question. Not all instances of the "should" use were addressed in response. There are still several inappropriate uses, e.g., in 2.2, 2.2.1, 4.1.2, 4.1.3.4 and 4.1.4. There is also a "similar" in 4.1.4 that needs to be addressed. This is inappropriate in regulatory document. Please update the report and commitments to clarify those areas where should and similar are used.

Follow-up RAI: In RAI 2, the staff requested clarification of the use of a combination of verb tenses "should"/"should be" vs "will"/"will be," vs "are", etc. These make it difficult to determine whether a commitment is made or not. For example, on p.2-3, "The acoustic environment and the mean noise level in the MCR should aid operator alertness..." versus "The lighting in the control rooms provide optimum working conditions..." AREVA's response did not address all instances of the "should." There still appear to be several inappropriate uses, e.g., in 2.2, 2.2.1, 4.1.2, 4.1.3.4 and 4.1.4. There is also a "similar" in 4.1.4 that needs to be addressed. This is inappropriate in regulatory document. Please update the report and commitments to clarify those areas where should and similar are used. This is follow-up RAI 2, Clarify ambiguous terminology.

Response 2:

AREVA NP submits the attached changes to pages i, 2-1, 2-3, 2-4, 2-6, 2-7, 2-8, 3-6, 3-7, 4-1 through 4-5, 4-7, 4-8, 5-2, 5-7, 5-10, 5-20, 5-24, 5-25, 5-27, 5-29, 5-30 through 5-33, 5-36 through 5-40, 5-42, 6-1, and A-6 of ANP-10279 to address ambiguous terminology.

Also see response to RAI 41 related to the difference between design goals and bases (TR Section 2.2) and standard design features (TR Section 3).

RAI-11: Open Appendix A, Table A-2, p. A-4: Will the Implementation Plan(s) for HSI be included as part of the DCD/FSAR for the U.S. EPR?

Evaluation: AREVA's response did not fully clarify the staff's concern.

Follow-up RAI: In RAI 11 the staff asked if the Implementation Plan(s) for HSI identified in Appendix A Table A-2 p. A-4 will be included as part of the DCD/FSAR for the U.S. EPR. AREVA's response did not fully address the request. Table A-2 indicates that several of the implementation plans will be complete in CY07. The FSAR mentions implementation plans for several of the HFE elements, but does not directly cite the title or date of the implementation plan and the references at the end of each FSAR subsection do not include the implementation plans. In past completed design certifications the implementation plans have been designated as Tier 2*. Please indicate which of the plans have been completed and when they will be submitted to the staff for review (as described in RG 1.206, Section C.I.18).

Response 11:

In the FSAR, references included only those which were available in the public domain.

As described in ANP-10279 and U.S. EPR FSAR Tier 2, Chapter 18, implementation plans fit into the design control process and are thus actual guidelines for doing HFE work. Activities to be completed for each of the HFE program elements are described in ANP-10279 and in U.S. EPR FSAR Tier 2, Chapter 18.

Implementation plans for staffing, human reliability analysis, human-system interface design, verification and validation, design implementation, and human performance monitoring are complete and available for inspection at AREVA offices. An implementation plan describing how information inherited from predecessor designs (see paragraph 1 of response to RAI 31) will be integrated into the U.S. EPR design process. This implementation will specifically address activities which apply the regulatory guidance for the analysis activities used as input to the design (i.e., operating experience review, functional requirements and function allocation analyses, and task analysis).

RAI 13: New *The abstract and Section 2.1 note that the goal of the HFE program is to provide reasonable assurance that operators can access the required information and controls to enable safe and efficient control and monitoring for plant processes and equipment. This goal does not address nearly the scope and depth expected of an HFE program as referenced in 10CFR50.34(f)(C)(iii) and as described in NUREG-0711. Please clarify the goals of the HFE program.*

Response 13:

In the abstract and in Section 2.1 of ANP-10279, the statement “to provide reasonable assurance that operators can access the required information and controls to enable safe and efficient control and monitoring of plant processes and equipment” is a high-level goal. The rest of Section 2.1 lists lower level program goals. See also the responses to RAI 2 and RAI 41.

RAI 14: *New* Section 2.1 identified general principles that address time requirements, situation assessment, and error tolerance. Workload is discussed as a consideration in other sections of the report, in the context of staffing, automation, and HSI design. What is not addressed is personnel vigilance. Please provide information related to the treatment of personnel vigilance in the EPR HFE program.

Response 14:

From NUREG-0711, the generic "human-centered" human factors engineering (HFE) design goal that "the plant design and allocation of functions will maintain operation vigilance" is a desirable goal, however nearly impossible to scientifically measure. The plant design cannot make an operator more effectively monitor plant status. Nor can any allocation ensure that personnel remain vigilant, vigilance is a fundamental element of operator training.

An HFE program is established with the aim of producing a human machine interface (HMI) design which meets the goals established to: 1) help the operator maintain situation awareness, 2) make tasks executable, 3) make actions verifiable, 4) make errors recoverable, etc. (see ANP-10279, Section 2.1). If these goals are reached, they *enhance* the operator's ability to remain vigilant because any HMI deficiencies are less distracting. The goals themselves cannot ensure vigilance. The goal to enhance the operator's ability to maintain vigilance is inherent in the other goals and an objective of operator training.

RAI 15: New *Assumptions and constraints are not explicitly addressed in the report. However, the report does identify specific analyses and design features that will not be addressed in the U.S. EPR because they were conducted and identified in the OL3 development effort. Thus, they are inputs to the U.S. EPR design effort. The staff has specific questions regarding some of these analyses/design features that are identified in other RAIs. However, since assumptions and constraints are not explicitly identified, please identify any other assumptions and constraints that may not be captured by the analyses and design features derived from the OL3 effort and identified in the report.*

Response 15:

Assumptions and constraints are listed in U.S. EPR FSAR, Tier 2, Section 18.1.1.2.

The following additional “assumptions and constraints” will be added to U.S. EPR FSAR, Tier 2, Section 18.1.1.2:

- The platforms for both the safety-related and non-safety-related HMIs (Safety Information and Control System (SICS) and Process Information and Control System (PICS), respectively) were selected prior to determining all HFE requirements. Development activities for both platforms have been identified based on HFE requirements as defined for SICS and PICS.
- For the U.S. EPR, the SICS platform concept involves extensive use of the Qualified Display System (QDS)—a series of touch-screen capable, seismically qualified, 1E supplied visual display units (VDU). The QDS is an AREVA NP product and development activities have been identified for the QDS to support these needs. Because the QDS will replace many conventional indications and controls and to maintain divisional separation requirements, each control QDS is assigned to manage a respective electrical division or mechanical train. This design creates potential additional burden on the operator when the SICS is used to monitor and control the plant.
- To minimize differences between HMI platforms in the control rooms, local control stations (LCS) which allow for communication with computer-based HMIs (e.g., turbine-generator and emergency diesel generator controls) will be integrated with the PICS. As discussed in Section 2.1.1 of ANP-10279, LCSs designed by other disciplines will follow guidelines established by the HFE and Control Room Design Team.

RAI 16: New *Applicable facilities are discussed in Section 2.1.2. The report indicates that the HFE program will be applied to “HSIs, procedures, and training associated with monitoring and control I&C functions.” These functions will include those ranging from normal to accident conditions. Not specifically included in the scope are non-I&C systems that can include manual valves and specific LCSs (note that the abstract omits LCSs from those areas to which the HFE program applies). Instead, the report indicates that the design of these systems “should” follow the guidance developed by the team: “HSIs associated with non-I&C systems (e.g., manual valve operators and other LCSs) should follow guidelines established by the HFE and Control Room Design Team.” Section 18.1.1.4 of the FSAR, Applicable Human System Interfaces, Procedures, and Training, states “HSIs associated with non-I&C systems (e.g., manual valve operators and other LCSs) follow guidelines established by the HFE and Control Room Design team.”*

These discussions raise two potential concerns: First, the wording does not suggest a requirement for including them in the HFE program. Further, using a “should” statement, suggests some uncertainty in how they will be addressed in the HFE program. It is the staff’s belief that any HSI should be addressed in the HFE program. Second, if HSIs (like manual valves) are not included within the scope of the program, it seems unlikely they will be addressed in the HFE program. Thus, guidance will be unavailable for the design of these HSIs. Please clarify the relationship between the HFE program and non-I&C HSIs.

Response 16:

The human factors engineering (HFE) program portion of the U.S. EPR schedule includes activities to develop multiple style guides for HSIs. One such style guide is for local control stations (LCS). The LCS style guide will provide direction to disciplines outside of instrumentation and controls (I&C) for design of non-computer based human system interfaces (HSI).

The style guide for the Process Information and Control System (PICS) screen development will be implemented as an internal U.S. EPR Project Design Guideline Document which is applicable to all disciplines. This type of document is a middle tier document within the AREVA NP document hierarchy. Refer to Section 5.0 of ANP-10279 and the Quality Assurance Plan (ANP-10279, reference 13) for details of the design control process. The standard structure for Project Design Guideline Documents includes a section on implementation responsibilities. Guidance will be provided to the engineering disciplines responsible for design of LCSs.

RAI 17: *New* The categories of plant personnel whose functions and tasks will be addressed by the HFE program are not discussed in the TR. Please provide this information.

Response 17:

Plant personnel addressed by the AREVA NP human factors engineering (HFE) program include licensed control room operators as defined in 10 CFR Part 55 and the following categories of personnel defined by 10 CFR 50.120:

- Non-licensed operators.
- Shift supervisor.
- Shift technical advisor.
- Instrument and Control technicians.
- Electrical maintenance personnel.
- Mechanical maintenance personnel.
- Radiological protection technicians.
- Chemistry technicians.
- Engineering support personnel.

U.S. EPR FSAR Tier 2, Section 18.1.1.5, will be revised to include this level of detail.

RAI 18: New *HFE team responsibility is addressed in Section 5.4.2.1.1 of the plan. The responsibilities listed include most of the items listed in the staff's criterion except the development of all HFE plans and procedures and the scheduling of activities and milestones. Please clarify the HFE teams responsibilities with respect to development of all HFE plans and procedures and the scheduling of activities and milestones.*

Response 18:

In ANP-10279, Section 5.4.2.1.2, "the Program Manager of HFE and Control Room Design acts as the technical project manager" is intended to address generic responsibilities. On U.S. EPR projects, schedule items belonging to the Program Manager of human factors engineering (HFE) and Control Room Design are coded as such. These schedule items include development of plans and procedures.

RAI 19: New *The composition of the team is described in Section 5.4.2.1.3. The technical disciplines listed generally meet the staff's criterion. Clarification is needed as to why Safety Engineering is not included on the team.*

Response 19:

Appendix A of NUREG-0711, Rev. 2 lists the typical contributions of the Systems Safety Engineer on the human factors engineering (HFE) and Control Room Design Team as:

- Identifies safety concerns and perform a system safety hazard analysis.
- Provide results of system safety hazard analysis to probabilistic risk assessment/HRA and human factors analyses.

In ANP-10279, Section 5.4.2.1.4 (which describes the Team Member Responsibilities and Qualifications), the Reliability and Availability Engineering function provides this expertise.

RAI 20: *New* HFE team staffing is not specifically addressed in the TR. Please provide information on HFE team staffing, including job descriptions and assignments of team personnel to HFE activities.

Response 20:

The details of U.S. EPR human factors engineering (HFE) and Control Room Design Team assignments and job descriptions evolve as the project progresses. All present members of the team have been involved in development of implementation plans (processes and procedures) in order to build a collective understanding of what the expectations are in order to achieve the end goal. Maintenance and ownership of this program level documentation remains the responsibility of the Program Manager of HFE and Control Room Design.

The team is currently split into two separate functions, each run by a task manager. One function involves design of the control rooms while the other team focuses on human system interface (HSI) development. The HSI design task manager is responsible for the system platform design and specification of the equipment. This task manager will also be responsible for HSI layout (which includes conventional and screen-based HSIs). The control room design task manager is responsible for interface with other disciplines related to control room design (e.g., HVAC, radiological protection, control room habitability, security).

Senior members of the team are assigned as system engineers or system managers for each of the control rooms and the HSI platforms. These system managers conduct the analysis and design activities as part of the evolution of their design as described in Section 5.4 of ANP-10279. Other members of the team support the system managers, task managers, and program manager as needed. Integration of these activities is the responsibility of the Program Manager of HFE and Control Room Design.

RAI 21: New Section 5.1 indicates that the HFE program falls under the general management processes provided in "AREVA NP Inc. Quality Assurance Plan (QAP) for Design and Deployment of the U.S. Evolutionary Power Reactor." Section 5.2 describes the HFE design control processes. Section 5.1 describes the general process and configuration management used to prepare design documentation. Design reviews are performed by independent individuals to ensure completeness and technical quality of the work. The process includes a variety of verification methodologies including design review boards and design verification testing. While an overview of these processes is presented, additional detail as to how the processes are managed is needed and may be in the QAPs. Please provide a copy of the appropriate document for staff review. ADAMS Document No. ML070650256, ANP-10266, Revision 1, "AREVA NP Inc. Quality Assurance Plan (QAP) for Design Certification of the U.S. EPR Topical Report." Specifically describes the Quality Assurance Plan applicable to the Design Certification of the U.S. EPR. However, the scope of this design certification document does not include fabrication, erection, installation or operations. Please discuss any overlaps that may exist between ANP-10266 and the AREVA NP QAM throughout the HFE Program lifecycle.

Response 21:

ANP-10266 implements the AREVA NP Inc. Quality Management Manual; AREVA NP Inc. implementing procedures and instructions implement the QAP. The AREVA Quality Management Manual addresses fabrication erection, installation and operations. The AREVA Quality Management Manual will be invoked for human factors engineering (HFE) activities that occur beyond the process of design certification.

In ANP-10279, references to the QAP (ANP-10266) are limited to the discussion of the overall design control process as found in Section 5.1. Aside from QA processes such as preparer/reviewer/approver responsibilities for document preparation and control of released documents, no technical overlap between the QAP and ANP-10279 is implied; only typical QA process controls are invoked by the QAP as with any other design process.

RAI-22: **New** *Section 5.1 states that the HFE program is conducted using the guidance provided in AREVA's QAP. This document is requested for review in RAI 21. Please identify any other process management descriptions to support the staff's review.*

Response 22:

See response to RAI 21. No other process management descriptions to support the staff review of ANP-10279 have been identified.

RAI-23: New Section 5.4.2.1.2 states that the Program Manager for HFE is responsible for integration of the HSI with the overall plant design, but the report does not specify what that integration involves. Please identify the inputs from other plant design activities to the HFE program and the outputs from the HFE program to other plant design activities.

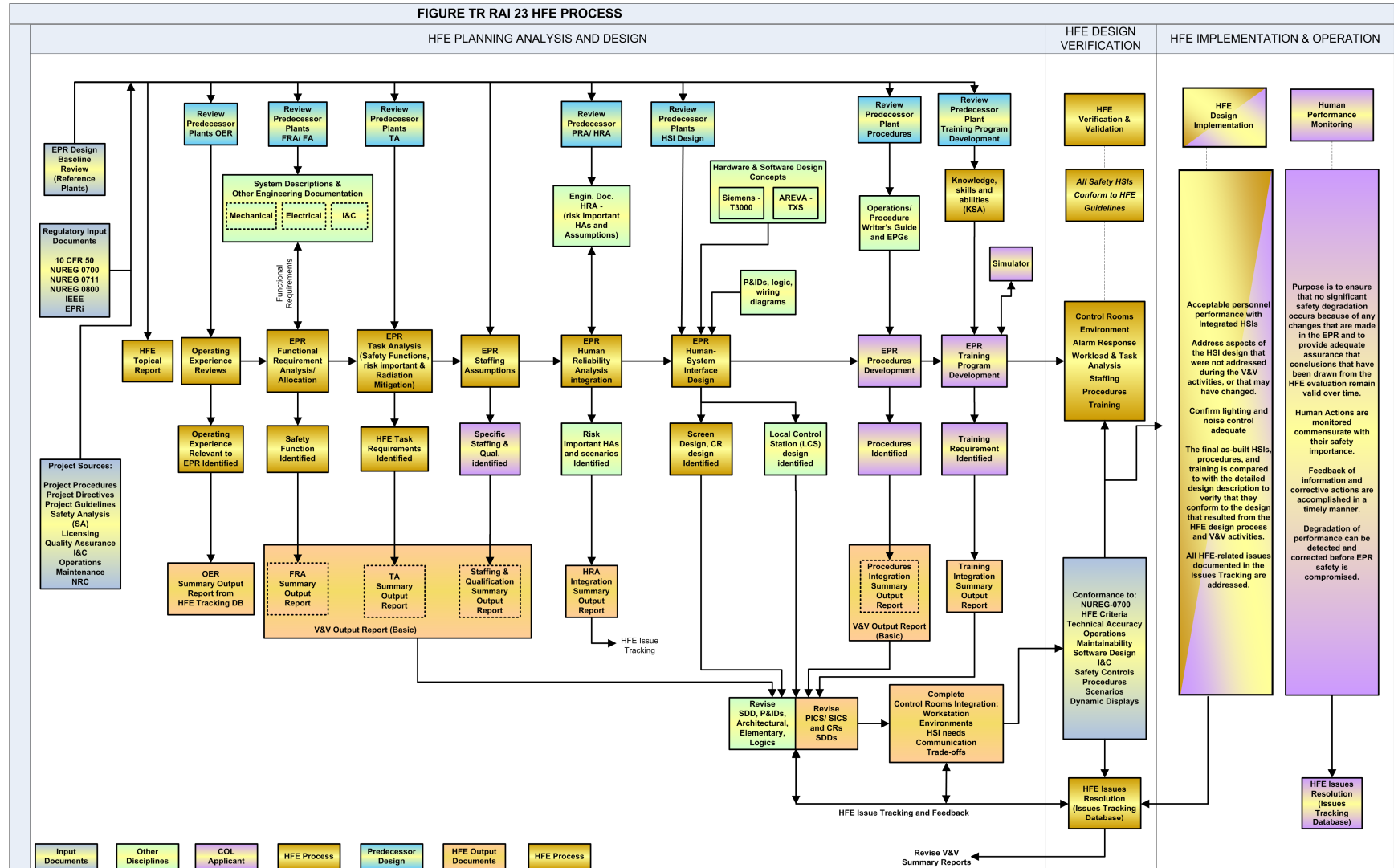
Response 23:

Logic ties between engineering discipline deliverables and the procurement and construction needs are shown in the overall project schedule. With respect to HFE program inputs and outputs, activities which require integration during the engineering phases include, as a minimum:

- Use of plant and information drawings, logic diagrams, etc. for defining functional requirements.
- Analyzing tasks based on operationally defined roles and responsibilities for HSI users.
- Procedure development.
- Probabilistic and human reliability analyses.
- Training program development.

Please see the attached figure, Figure “TR RAI 23—HFE Process” for flow of work. It is similar to U.S. FSAR Tier 2, Section 18.1, Figure 18.1-1— “HFE Program Milestones” and Figure 18.1-2— “HFE Design Control Process”, but shows more ties to other engineering disciplines.

HFE Process



RAI-24: New *Section 5 identifies the classes of documents governed by the QAP including: plant technical requirements, system design requirements, system descriptions, design drawings, design analyses, computer program documentation, and specifications and procedures. Section 5.3 discusses HFE documentation, including plant technical requirements, system design requirements, system descriptions, and specifications. However, no mention is given to design drawings, design analyses, and computer program documentation. These three areas are also not specifically mentioned in FSAR Section 18.1.3.2. Please clarify whether HFE documentation will be developed for these types of design documentation.*

Response 24:

Figure 5.3-1 of ANP-10279 and U.S. EPR FSAR Tier 2, Figure 18.1-2, show more details regarding expected HFE program documentation. Design drawings are done for Main Control Room (MCR) layout/ergonomic studies and for individual panel and screen layouts; they are included in the system-descriptions and specifications. Design analyses done as described for functional requirements and allocation analyses and task analyses are recorded in a standard AREVA document format. The software tools to be used for screen design are described in the human machine interface (HMI) specifications.

RAI-26: New *With respect to system design requirements, Section 5.3.2 indicates that “For the U.S. EPR HFE program, SDRDs are produced for the control rooms (i.e., MCR, TSC, RSS, and I&CSC) and the HSIs (i.e., PICS and SICS).” Are system descriptions for the EOF and LCSs to be developed as part of the HFE program? Please explain.*

Response 26:

As stated in ANP-10279, Section 2.1.1 and in U.S. EPR FSAR Tier 2, Section 18.1.1.3, the emergency operations facility (EOF) is the responsibility of the COL applicant. The human system interface (HSI) style guide(s) (ANP-10279, Section 5.4.8.5 and U.S. EPR FSAR Tier 2, Section 18.7.6.1) support development of EOF HSIs. AREVA recognizes the importance of overall integration for the purpose of emergency management.

The design and layout of local control stations (LCS) is also governed by the HSI style guide(s) developed by the human factors engineering (HFE) program. Local control stations (LCS) will be described in the system descriptions for the associated systems. For example, the HSI style guide must be referenced for the design of the controls and indications for local starting and running of an emergency diesel generator, but the overall system description for the emergency diesel generators includes a description of the LCS.

RAI-27: New *The contribution of subcontractors is not discussed in the report. Please identify what aspects of the HFE program will be performed by subcontractors, how HFE requirements are communicated to subcontractors, and how their compliance with HFE requirements is verified.*

Response 27:

Section 7.3 of ANP-10266 describes how subcontractors are subject to compliance with the AREVA NP quality assurance (QA) program:

“The acceptability of suppliers of safety related materials, items, or services are based on the following items:

- A direct evaluation of their QA Program to 10 CFR 50 Appendix B and NQA-1 to determine the capability to supply materials, items, or services meeting all procurement document requirements
- A survey/audit of the supplier’s facility.

Suppliers are required to ensure that their products meet the requirements of the procurement documents. These methods are reviewed by the cognizant Manager/Supervisor with an overview by the QA organization. Additionally, AREVA NP Inc. may verify acceptance of products by independent analysis.

Reviews of the vendor quality program, performance of audits, performance of preaward evaluations and annual evaluations are performed in accordance with an administrative procedure which follows the guidance of Regulatory Guide 1.28 and 1.144; these methods are used to verify the quality of the products and services provided by subcontractors/sub-vendors. As part of this program subcontractors/subvendors are required to furnish documents such as QA Data Packages, procedures, source audit and surveillance reports, and QAP documents. Sub-vendor/subcontractor QAP’s are reviewed and accepted during the pre-award evaluation of the sub-vendor/subcontractor prior to placement on the Approved Suppliers Listing (ASL).”

Subcontractors receive the same project-specific training as other engineers assigned. The Program Manager of human factors engineering (HFE) and Control Room Design approves and is ultimately responsible for any work products from the HFE and Control Room Design Team.

RAI-28: New Section 5.5 describes the HFE issues tracking system. This section states that the AREVA NP corrective action program is used as a database to track issues and that it is accomplished within the framework of the QAP. Applications of the issues tracking system are contained elsewhere. Section 5.4.3 references an “HFE Issues Tracking System” with respect to the management of OER findings and it is referenced in Section 5.4.12.1 with respect to Final Plant HFE Design Verification. No specific details of how the tracking system functions are provided. Section 5.3.1 of the Plan does state that the HFE Program Plan to be provided in the DCD/FSAR will include descriptions of the HFE issues tracking. Please provide a description of the HFE Issues Tracking System’s availability, methodology, means of issue documentation, and assignment of responsibility.

Response 28:

The AREVA NP corrective action tracking program is “within the framework of the quality assurance program (QAP)” in that the software is maintained and the entered data is managed by quality assurance (QA) processes (specifically, Section 6, “Document Control” and Section 17 “Quality Assurance Records” of ANP-10266).

The AREVA NP corrective action tracking program is also used as the HFE Issues Tracking Database. The AREVA NP corrective action tracking program may be accessed by any AREVA NP employee. Only the employee assigned to evaluate or resolve any individual database item has “write” capability. Search capability is available to locate individual or multiple items.

Human factors engineering (HFE) issues take many forms. Once an issue has been identified, that issue is entered into the database and receives a unique tracking number. Issues may be entered individually or collectively under the unique tracking number. Supporting documentation in electronic format may be attached to the database item. The issue is screened and evaluated as appropriate considering the severity level. Corrective actions to resolve the issue are assigned as necessary. As applicable, due dates for resolution of the overall evaluation or for each corrective action are assigned by the database administrator or the issue evaluator. Issues and due dates may be reassigned by the database administrator or the Program Manager HFE and Control Room Design as necessary, but approval of the corrective action tracking program administrator is required for this type of reassignment. Issue closeout with proper documentation is approved by both the Program Manager HFE and Control Room Design and the corrective action tracking program administrator.

RAI-29: New Section 7 provides a list of documents that will support the development of the U.S. EPR HFE program. The list includes appropriate NRC documents, the AREVA QA plan, and a small selection of industry documents. Please clarify if the list provided in Section 7 is complete.

Response 29:

The references listed in ANP-10279, Section 7 are applicable to the development of this topical report and not to all U.S. EPR human factors engineering (HFE) program documentation. U.S. EPR FSAR Tier 2, Section 18.7, describes in more detail the specific applicable requirements and the document which is the source of the requirement. Furthermore, the U.S. EPR HFE program requirements document describes the appropriate industry, regulatory, and AREVA requirements. The U.S. EPR HFE program requirements document is available for inspection at AREVA offices.

RAI 30: *New* Section 6 of the report discusses simulator design activities. This discussion pertains to a full-scope simulator suitable for operator training. Will any other simulation or other tools be available for use to support the HFE design team during the design process?

Response 30:

Responsibility for simulator development resides with the COL applicant. The full fidelity simulator is expected to be developed in stages. One of the early simulator stages will involve simulating the plant thermal-hydraulic model and a basic human machine interface (HMI). A later stage brings in the emulated instrumentation and control (I&C) platform and HMI; at this stage many of the verification and validation (V&V) activities described in Section 5.4.11 of ANP-10279 and in U.S. EPR FSAR Tier 2, Section 18.10, commence. A full scope simulator is attained when the I&C is fully simulated and the HMI design is complete.

RAI-33: New *Table A-2 indicates that the implementation plan is complete and that the internal assumptions are documented and will be summarized in the DCD/FSAR. In Section 5.4.6, no mention is made of an implementation plan. Section 18.5 of the FSAR provides a discussion of staffing analyses, but no reference is made to a staffing implementation plan. Please clarify the status of the implementation plan and whether the plan will be submitted to the NRC, or where the staff can review the implementation plan.*

Response 33:

The implementation plan for staffing and qualifications is complete and available for inspection at AREVA offices. It contains the initial staffing assumptions. U.S. EPR FSAR Tier 2, Section 18.5.2 describes, in general terms, the types of evaluations of staffing needs and qualifications which will be conducted throughout the design effort. The initial staffing assumption is based on operational experience from designs preceding the U.S. EPR. Few changes to the numbers of staff, their qualification requirements, or their roles and responsibilities are expected because the model is considered to be well defined. Verification and validation activities related to staffing analysis include:

- Establishment of human system interface (HSI) adequacy for achieving human factors engineering (HFE) program goals.
- Confirmation of function allocation and task structure assigned to personnel.
- Establishment of the adequacy of control room staffing levels and the adequacy of the various HSIs to support the staff in accomplishing their tasks.
- Integration of operating procedures.
- Confirmation of the dynamic aspects of the HSI for task accomplishment.
- Evaluation and demonstration of error tolerance to human and system failures.

RAI-34: New *Table A-2 indicates that the output results will be available in Detailed Design. However, the table explanation states that the results “Consists of justification (within V&V output) that operating staff numbers are able to cope in all situations.” While this is an appropriate validation, it does not address the documentation of the output of analyses conducted in accordance with a Staffing and Qualifications Implementation Plan. Please indicate how the results of their Staffing and Qualifications analyses will be documented.*

Response 34:

From U.S. EPR FSAR Tier 2, Section 18.5.3:

“If it is determined from the integrated system validation that plant staffing and HSI design goals are not achieved, a decision is made to redesign the appropriate system, modify the roles and responsibilities of effected staff (taking into account the effect on plant safety and reliability), or adjust staffing numbers. A final check is then performed to verify that the staffing numbers and configuration are still in compliance with the requirements of 10 CFR 50.54 (i) through (m). The staffing and qualification analysis is summarized in conjunction with the V&V results and includes an evaluation of the number and qualifications of personnel needed to operate, maintain, and test the U.S. EPR based on the HSI design features for normal, abnormal, and emergency conditions.”

RAI-35: New Section 5.4.6 states “The initial MCR staffing level is established based on experience with previous four loop PWR plants and takes into account the increased levels of automation and the minimum number of operators required by 10 CFR 50.54(m).” Please identify how the increased automation is accounted for in the U.S. EPR design.

Response 35:

The assumed U.S. EPR minimum staffing level is based on an increase in automation in a highly integrated digital control room which provides the operators with the ability to manage the plant safely during all conditions.

While the extent of large scale automation for the U.S. EPR has not been fully realized, the initial staffing assumptions account for operator design studies indicating the need to automate such cognitive load functions as letdown and steam generator level control without reducing operator situation awareness. A U.S. EPR control room operator will be expected to *monitor* automated plant functions as opposed to actually controlling those plant functions. When the operator trusts the automation, monitoring generally requires less cognitive load than controlling; automation reduces operator workload somewhat.

During accident conditions, the U.S. EPR does not require manual operator action for the first 30 minutes. Operators will monitor the progress of the safety actuations and the alarm system is relied upon to indicate when functions do not perform correctly. Without the need to perform immediate actions or respond to alarm waterfalls, operators assume the role of cognitive oversight. This oversight role is enhanced by the amount of information available at the screen-based human system interfaces (HSI) on any individual workstation. With a well-designed system overview on a screen-based HSI, the decision making process is easier than it would have been using conventional panels because the "data collection" mode is simplified. Computer-based procedures also reduce operator administrative burden. This philosophy is supported by industry studies, such as NUREG/CR-6749 which states that a decrease in workload was found during observation of a highly integrated digital control room.

The staffing needs for currently operating single unit four loop PWR plants has been validated based on many hours of operating experience and the ability of this staffing level to meet the task requirements for all operating conditions. In addition to increased use of automation, the U.S. EPR digital control room relies on improvements in information presentation and reduction of administrative burden to decrease operator workload. It is reasonable to conclude that the decrease in operator workload could support a slight reduction in staffing.

RAI-36: New Section 5.4.6 states that “The functions of licensed operators for the OL3 EPR are expected to be slightly different than is typical for U.S. utilities today.” Please identify how the functions are different and what the implications are for task analysis, HSI design, procedures, and training.

Response 36:

In Section 5.4.6, the key difference implied between OL3 operator functions and operator functions at current U.S. nuclear plants is one of the operator license requirements and how that affects roles and responsibilities. Control room operators for OL3 are classified according to three types of license, Shift Supervisor, Reactor Operator (RO), and Turbine Operator (TO). The TO is considered an intermediate training level. A TO is only permitted to perform those operational tasks designated for TO action (a separate branch and authorization level in the HSI screen hierarchy). U.S. utilities have only two categories of license, RO and Senior Reactor Operator (SRO). An operator performing control room functions must hold at least the RO level license.

In order to take advantage of the OL3 concept of screen organization hierarchies established for definition of operator roles and responsibilities (see response to RAI 58), the U.S. EPR will use a similar structure for organization of screens. However, the roles and responsibilities of operators will not be limited or defined by level of license. The U.S. EPR operators who do the majority of human system interface (HSI) manipulation, the RO and Additional Licensed Operator (ALO), are able to switch roles to perform functions.

The U.S. EPR HSI makes significant use of graphical user interface (GUI) (screen-based) technology and increased levels of automation. The plant overview panels (POP) are intended to foster and enhance situational awareness and promote “big picture” thinking of plant status. Automation introduces a new operator task to monitor functions assigned to the computer (i.e., less active participation and more system monitoring).

Alarm system functionality (also see responses to RAIs 41, 51, and 53–56) requires operators to navigate via the common alarm indicator and alarm sequence display rather than the traditional fixed alarm annunciator tiles which allow pattern recognition for event analysis.

Computer based procedures (CBP) (also see response to RAI 65), while offering the benefits of place-keeping and one-step data retrieval, will require operators to think differently about forms of communication and the reader/performer model used for procedure command and control today.

As the EPR makes extensive use of screen-based technology for plant control and monitoring, the implications for task analysis, HSI design, procedures, and training are centered on the use of the screen-based technology. Regardless of the HSI technology used, task analysis activities would still involve identifying or specifying requirements for displays or controls, data processing and job support aids utilizing paper or table top scenarios. But when a screen-based digital technology is used for the HSI, the results of the task analysis are more readily incorporated into HSI design. It is likely that some task analysis and screen design are accomplished simultaneously (organize scenario, specify task needs, program task needs onto screen HSI,

test task needs by re-run of scenario). The nature of screen-based technology could result in more “tasks” to be analyzed due to the amount of information the technology can provide to the operator, so it is necessary to define the scope of task analysis in more detail for screen-based than for conventional HSIs.

The implications of screen-based technology on procedure and training development have to do with specifying “how to” and training the operators on the use of the HSI for “secondary” tasks such as managing the user interfaces to be able to extract the data and effect the control action on the process itself and tasks such as alarm acknowledgement and use of CBPs as described previously. The operators’ “primary” tasks (managing the plant functions) will also change slightly as increased automation results in more monitoring and less active control.

RAI-37: New *Section 5.4.6 does not address operator qualifications or how the applicable guidance in NUREG-0800 Section 13.1 is addressed. Please identify how operator qualifications and the applicable guidance in NUREG-0800 Section 13.1 are addressed in the U.S. EPR design.*

Response 37:

Operator qualification standards for the U.S. EPR are the same as for other plants operating in the U.S. and meet the guidance of Regulatory Guide 1.8, revision 3.

RAI-38: *New* Section 4.1, Staffing, indicates that the responsibilities of the shift supervisor are described in ACAD 97-004. Please clarify the author or organization responsible for this document and provide a copy of this document to support the staff's staffing review.

Response 38:

The complete document citation is: "Guidelines for Shift Manager Selection, Training, Qualification, and Professional Development," INPO ACAD 97-004, National Academy for Nuclear Training, April 1997. This document is enclosed for use during staff review.

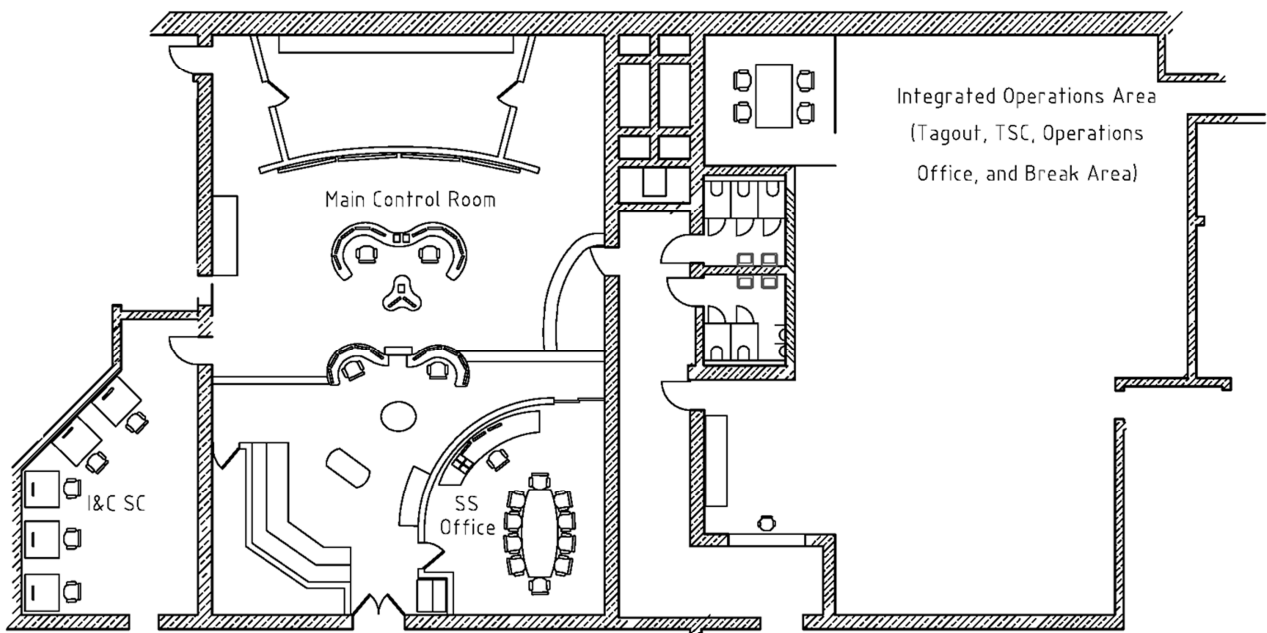
RAI-39: New Clarify displays available to the SS. Section 4.1.1 describes how the shift supervisors monitor plant activities and note they may use the auxiliary workstation in the MCR if not in use. Explain why the SS does not have a dedicated workstation available for their use in monitoring the plant and maintaining their overall situation awareness.

Response 39:

The updated control room layout drawing shown below replaces Figure 3.1-1 in ANP-10279.

The shift supervisor (SS) will normally use a dedicated Process Information and Control System (PICS) workstation located in the SS office. Administrative rules limit control of plant functions from this PICS workstation, though it is capable of displaying the same plant monitoring information as any other PICS workstations. To maintain overall situation awareness, the SS office offers a direct line of sight to the plant overview panels (POP). In addition to the PICS workstation, the SS office contains various types of communication equipment. In the event that the SS finds need of direct communication with the control room operators while continuing to monitor plant status, the auxiliary workstation is provided. If the licensee dedicates a separate shift technical advisor role, the auxiliary workstation is intended for that use.

Updated Control Room Layout



RAI-40: New *HRA is discussed in Section 5.4.7 of the TR. It mentions that risk-important human actions (R-I HAs) will be determined but does not address a method or acceptance criteria. Further this section notes that the R-I HAs will be addressed in various HFE activities. Missing from the list of activities is function allocation. Please add this. Section 18.6 of the FSAR discusses the HRA /HFE integration process and refers to Chapter 19 of the FSAR, but does not mention an HRA/HFE implementation. Is there such a plan and can it be provided to NRC for review?*

Response 40:

The method for identifying risk important human actions is within the scope of probabilistic risk assessment/human reliability analysis (PRA/HRA) engineering.

AREVA NP will update ANP-10279 Section 5.4.7 to include functional allocation in the list of activities which address risk-important human actions.

A summary of the human reliability analysis/human factors engineering (HRA/HFE) integration implementation plan is included in U.S. EPR FSAR Tier 2, Section 18.6.2. This implementation plan describes how risk important human actions are considered in the HFE design. The implementation plan is available for inspection at AREVA offices.

RAI-41: *New* HSI design is discussed in Section 5.4.8 of the report. The description of aspects of the design in Section 2.2, such as the alarm system (Section 2.2.8), consists of high-level characteristics that an alarm system should have. The descriptions of the standard features, such as the Plant Overview Panel (Section 3.2.2), have a similar level of description. What is the relationship between the design goals and bases listed in Section 2.2 and the CR and HSI standard features presented in Section 3?

Response 41:

Considering differences in regulatory codes and standards between countries where EPRs are to be deployed, rapid advances in technology related to instrumentation and control (I&C) platforms, and availability of standard I&C solutions in the global market, some differences in I&C architecture and human machine interface (HMI) implementation will exist between all EPRs. Standard features are generally labeled as such because they indicate commonality among all EPRs (i.e., these are input assumptions intended to be maintained from EPR to EPR). Standard features are less specifically defined but are expected to be common to all EPRs. For example, OL3, FA3, and all U.S. EPRs will utilize the plant overview panels (POP) described in Section 3.2.2 of ANP-10279. All EPR non-safety HMI platforms will be called Process Information and Control System (PICS). All EPR PICS platforms will also drive the POPs. It is possible that the supplier of the non-safety I&C/HMI platform will change for future EPRs, but the design specification for that platform will continue to require screen-based PICS, with the features described in Section 3.2.1 of ANP-10279, and POPs.

Design goals and bases are also considered input assumptions and are, for the most part, common to all EPRs (though differences in regulations may require minor adjustments). However, interpretation of how to implement the design goals is left open to the designers of each EPR. The bases for the design goal are included as supporting information. As an example, Section 2.2.8 of ANP-10279 lists an alarm system design goal (labeled as a principle) "Alarms are integrated with the HSI to assist the operator with situational awareness, alarm response, and any associated troubleshooting." This design goal is common to all EPRs being designed at present.

For OL3, the integrated alarm system design goal was interpreted such that alarms exist on both the PICS and the Safety Information and Control System (SICS). A common alarm indicator (CAI) (showing the priority level of the associated alarm) is displayed in the header of each PICS screen. From the CAI, operators can navigate to the alarm sequence display (ASD) or to the individual PICS screen which includes the component in alarm. OL3's SICS alarms are similar to the grid annunciator systems found in most U.S. control rooms with conventional I&C.

At FA3, the integrated alarm design goal is implemented in a different fashion. FA3 uses the same non-safety HMI platform as OL3 and the CAI is also included in the header of each PICS screen. However, at FA3, the CAI does not allow navigation to the ASD (though it may be reached with a single mouse click via a different path). FA3 does not utilize SICS alarms.

The U.S. EPR will achieve the integrated alarm design goal in yet another way. The U.S. EPR will implement a later version of the non-safety HMI used at OL3 and FA3 which has more

design flexibility. The CAI will be found in the header of each PICS screen and allows simultaneous navigation to both the ASD and the applicable control screen for the component in alarm (on different PICS monitors). Also, the U.S. EPR expects to implement some common highest priority SICS alarms on the integrated workstation.

Each of the current interpretations of the integrated alarm design goal meet the intent of the goal to “assist the operator with situational awareness, alarm response, and any associated troubleshooting” while satisfying the applicable regulatory requirements and/or customer needs. The design goal also helps to keep EPRs as standardized as possible while allowing for differences in regulatory, industry, or customer requirements.

RAI-42: *New* Procedure development is discussed in Section 5.4.9 of the report. The section discusses procedure development but does not include maintenance and test procedures. FSAR, Section 18.8.1, Objectives and Scope (of Procedure Development), includes maintenance procedures but not test procedures. Please add test procedures and make these consistent.

Response 42:

AREVA NP will update ANP-10279, Section 5.4.9 to include maintenance and test procedures in the scope for the operational guidelines to be developed by AREVA NP. U.S. EPR FSAR Tier 2, Section 18.8.1, will be revised to include test procedures.

RAI-43: New *Table A-2 indicates that the implementation plan has been completed and will be in the DCD/FSAR. The table also indicates that the output results are related to the task analysis use of procedures. However, the output of the procedure development plan should be a writer's guide and plant procedures. Please clarify the output of the procedure development activity.*

Response 43:

The implementation plan for human factors engineering (HFE) procedure development has not yet been completed as the U.S. EPR project is in the process of defining responsibilities for the various procedure development activities. U.S. EPR FSAR Tier 2, Section 18.8.2, describes the need for a writer's guide and scope of the implementation plan to be written. U.S. EPR FSAR Tier 2, Section 18.8.3, describes the expected results of procedure development activities.

AREVA NP will update ANP-10279 Table A-2 to reflect expected completion date of implementation plan for procedure development.

RAI-44: New Section 4.3.2 discusses the preparation of EPGs and emergency procedures. EPGs are not mentioned in Table A-2. Please provide a schedule for developing and submitting the EPGs.

Response 44:

The schedule for developing and submitting emergency procedure guidelines (EPG) is outside the scope of ANP-10279 and of the human factors engineering (HFE) program in general. Information about EPG development activities is included in U.S. EPR FSAR Tier 2, Section 13.5.

RAI-46: New *Table A-2 indicates that the implementation plan has been completed and will be in the DCD/FSAR as a COL applicant responsibility. Please clarify its role in training program development and what information will be provided to the COL applicant as the designer's input to training.*

Response 46:

The U.S. EPR Training Program implementation plan will be developed. This implementation plan will clarify what is to be provided to the COL applicant as designer's input.

AREVA NP will update ANP-10279 Table A-2 to reflect expected completion date of implementation plan for training program development.

RAI-47: New *Clarify Table A-2 refers to the Simulator Design Activities for the output results. However, these activities (discussed in Section 6 of the report) refer to simulator development. Please clarify what aspects of the training program it will develop, beyond a training simulator.*

Response 47:

The U.S. EPR Training Program implementation plan will be developed. This implementation plan will clarify roles of AREVA NP and a COL applicant with respect to development of the training program and discuss how the simulator, as it evolves, is used in the training program.

RAI-48: New HF V&V is discussed in Section 5.4.11 of the report. It states “HSI task support verification evaluates that the HSI supports personnel task requirements as defined by task analyses.” However, according to the plan, task analysis is not being conducted for the U.S. EPR. If there is not task analysis, how can task support verification be possible? As noted earlier in the task analysis evaluation, AREVA indicated that “For the U.S. EPR, the TA will consist of verification (see Section 5.4.11) that controls and displays are available and are organized to be compatible with the intended operations, including safety objectives as a subset, as defined in the procedures.” Such an activity is task support verification assuming the procedures were sufficiently comprehensive and detailed, but this approach is not mentioned in the V&V section. Please clarify how task support verification will be performed in the absence of task analysis criteria.

Response 48:

Neither ANP-10279 nor U.S. EPR FSAR Tier 2, Chapter 18 state that task analysis (TA) is not conducted for the U.S. EPR. Table A-2 shows that an implementation plan specifically describing TA will not be produced. Rather, an implementation plan will be produced which describes how information is incorporated from predecessor designs (see paragraph 1 of response to RAI 31). This implementation plan will specifically address how predecessor TA work will satisfy the intent of this human factors engineering (HFE) program element.

A gap analysis will be conducted against predecessor design TAs and address differences in plant design. The predecessor design TA and the gaps are used to support Task-Support Verification.

RAI-49: New *Figure 3.1-1 shows an “integrated operations area.” What is the purpose of this area?*

Response 49:

The integrated operations area (IOA) is a multi-use area. It supports the required space for a Technical Support Center (TSC) described in NUREG-0696 and includes the equipment (access to plant information for troubleshooting and communications equipment) as described in ANP-10279, Section 3.1.2. Administrative controls for maintaining the space and access to this equipment are necessary. The IOA will also be used for purposes such as shift turnover meetings, a gathering place for maintenance personnel, a work control office, and an operator break room.

RAI-50: New 3.1.4 describes the instrumentation and control service center (I&CSC). Does the architecture of the I&C SC provide the opportunity to control plant equipment during operations by unlicensed personnel? If not, please describe the aspects of this control room that prevent such actions.

Response 50:

The I&C service center (I&C SC) is located in a vital area, within the Main Control Room (MCR) envelope. The security controls for entry to the I&C SC are the same as those for the MCR. The I&C SC can only be accessed through the MCR (the second door is a fire door). Refer to the revised control room envelope drawing in the response to RAI 39. Only qualified/trained personnel are granted access to the I&C SC.

The main purpose of the I&C SC is to provide monitoring and maintenance equipment for instrumentation and control (I&C) technicians and other qualified plant staff. Equipment located in the I&C SC is used to modify I&C plant automation system and human machine interface (HMI) platform software and to perform maintenance and periodic testing of equipment. Administrative controls and physical key lock controls allow only the train of I&C which is off line and secured for maintenance to be accessed in the I&C SC. Testing of design changes performed in the I&C SC is also governed by administrative controls and applicable regulation. Changes to system software require proper design control approvals and multiple deliberate actions in order to implement (i.e., Changes are implemented in simulate mode and once tested are "committed" or saved. Additional administrative controls must be satisfied before the changes are then "activated"). Further, the service units in the I&C SC will be configured so that they are restricted by login access to only personnel who meet qualification requirements for the modification, maintenance, or testing to be performed. These activities are under strict control of the shift supervisor and qualified personnel must get permission from this position before proceeding. This approach is consistent with current practice in U.S. operating plants.

RAI-51: New *The I&CSC contains consoles for specialized systems (e.g., loose parts, leakage monitoring and core monitoring systems). Why are these separate and not a part of the overall computer-based screen display system?*

Response 51:

The nature of digital human machine interface (HMI) raises the possibility of information overload for the users of that HMI. Some of the functions contained in the Instrumentation and Control Service Center (I&C SC) systems do not require constant control and monitoring and are placed in the I&C SC to reduce operator burden. Also, as an example, the required sampling frequency for loose parts monitoring is significantly lower than for other systems providing input to the Process Information and Control System (PICS). General alarms are provided on the PICS to indicate issues in the I&C SC systems such as loose parts, vibration monitoring, and core monitoring; specially qualified operations support personnel are relied upon to analyze input from these systems and report to the control room operators. This concept reduces operator burden and is widely used in U.S. operating plants today.

RAI-52: New Section 4.3.3 discusses the loss of the main control room (MCR), and states “Recovery operations should not be attempted from the RSS, considering the possibility of later emergency situations after the MCR is abandoned.” Please explain why this is so.

Response 52:

The Remote Shutdown Station (RSS) contains the equipment necessary to bring the plant to a safe shutdown state during an event requiring evacuation of the Main Control Room (MCR), in addition to:

- A simultaneous single active failure (not required to accommodate a single failure in addition to equipment damage caused by a fire).
- A sustained loss of offsite AC power.

Consistent with 10 CFR 50 Appendix A, GDC 19, the RSS equipment at appropriate locations outside the MCR is provided with (1) a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

The U.S. EPR RSS is not an alternate control room. Therefore plant recovery operations are not performed. After the event which results in evacuation of the MCR, the RSS is used for plant shutdown only.

RAI-53: New Section 2.2.8 states that “Alarm signals are based on information that indicates the true cause of the reported event.” What is meant by this statement?

Response 53:

This statement is a design goal (see response to RAI 41) intended to reduce the complexity of the alarm hierarchy. Anticipatory alarms are included only to signify the impending initiation of a protective function or violation of a setpoint with safety significance. Therefore, anticipatory alarms precede actuation of plant protective functions which are then considered “true cause” of the mitigating action.

RAI-54: New Section 2.2.8 states that “Alarms are integrated with the HSI....” Please explain how they will be integrated?

Response 54:

See response to RAI 41.

High level alarms intending to indicate failures of automatic protective functions or the need for initiation of manual safety functions are displayed via the Safety Information and Control System (SICS). The majority of alarms in the overall alarm hierarchy, however, are displayed on Process Information and Control System (PICS). As PICS is quite flexible with regard to use of individual monitors and workstations, “integrated” in this case is used to describe the multiple means of displaying, acknowledging, and responding to alarms available on the PICS. In current plant designs, the alarm systems are typically physically separate and distinct from indications of process system status.

The PICS also includes a feature not described in the response to RAI 41. Each component displayed on an human system interface (HSI) screen which has an associated alarm will indicate an alarm status at the component level. Alarm messages (to improve understanding of the alarm status) are also available at the component level.

RAI-56: New Section 4.2.4 states that “The I&C systems include integral self-testing features. Operators have no responsibility with regard to these self-testing features other than monitoring and responding to alarms when the self-testing indicates problems.” Are all such alarms handled by operators rather than I&C maintenance personnel?

Response 56:

See responses to RAIs 41 and 54. Selection criteria will determine the level or type of alarms to be displayed in the control room. Operator information overload is considered when the alarm hierarchy is defined. Self-monitoring alarms are assumed to be on the lowest level of the alarm hierarchy. Such alarms or warnings, such as those for process equipment or system availability (instrumentation and controls (I&C) fault messages), will be shown only on engineering workstations in the information and control service center (I&C SC). A general fault alarm will indicate to Main Control Room (MCR) operators the need for I&C technician attention.

RAI-57: New Section 3.2.1 describes the process information and control system (PICS) and notes that it provides alarm sheets. Are these alarm response procedures that will meet the guidelines of NUREG-0700 Section 4.5?

Response 57:

Alarm sheets provided on the Process Information and Control System (PICS) will be developed in accordance with the alarm response procedure guidance of NUREG-0700 Section 4.5. Procedure development, as noted in Section 5.4.9 of ANP-10279 and in U.S. EPR FSAR Tier 2, Section 13.5, is the responsibility of the COL applicant.

RAI-58: New Section 3.2.1 states that “The control functions on the PICS are divided into hierarchies, and operator workstations should be logged in with responsibilities for selected hierarchies.” Please clarify this statement. Section 3.2.1 further states that “With the exception of the PICS workstation in the RSS, plant control functions are disabled outside the MCR.” However, Section 3.1.4 states that equipment control can be accomplished from the ICIS. Please clarify how equipment control is managed.

Response 58:

The statement about operator workstations and hierarchies is intended to describe how individual operator roles can be clearly defined by the design and layout of the human system interface (HSI) screens. This is done for OL3 because that plant will sometimes have operators licensed to control only turbine and switchyard functions (turbine operators) (see response to RAI 36). For the U.S. EPR, a screen hierarchy can also be used to divide operator roles between the Reactor Operator (RO) and Additional Licensed Operator (ALO) in the event that the ALO is required to control the plant (see ANP-10279 Section 4.1).

Generally, equipment control via the Process Information and Control System (PICS) is possible only from the Main Control Room or from the Remote Shutdown Station after the transfer function is activated. If local control stations utilize a PICS, then the local PICS is programmed with a login capability to provide control of only the associated local equipment (i.e., a hierarchy specific to that local control station). See also response to RAI 50.

RAI-59: New Section 4.3.1.1 indicates that one of the criteria for determining that the PICS is available is that “Data communication with the automation level is working satisfactorily.” What is meant by automation level in this criterion?

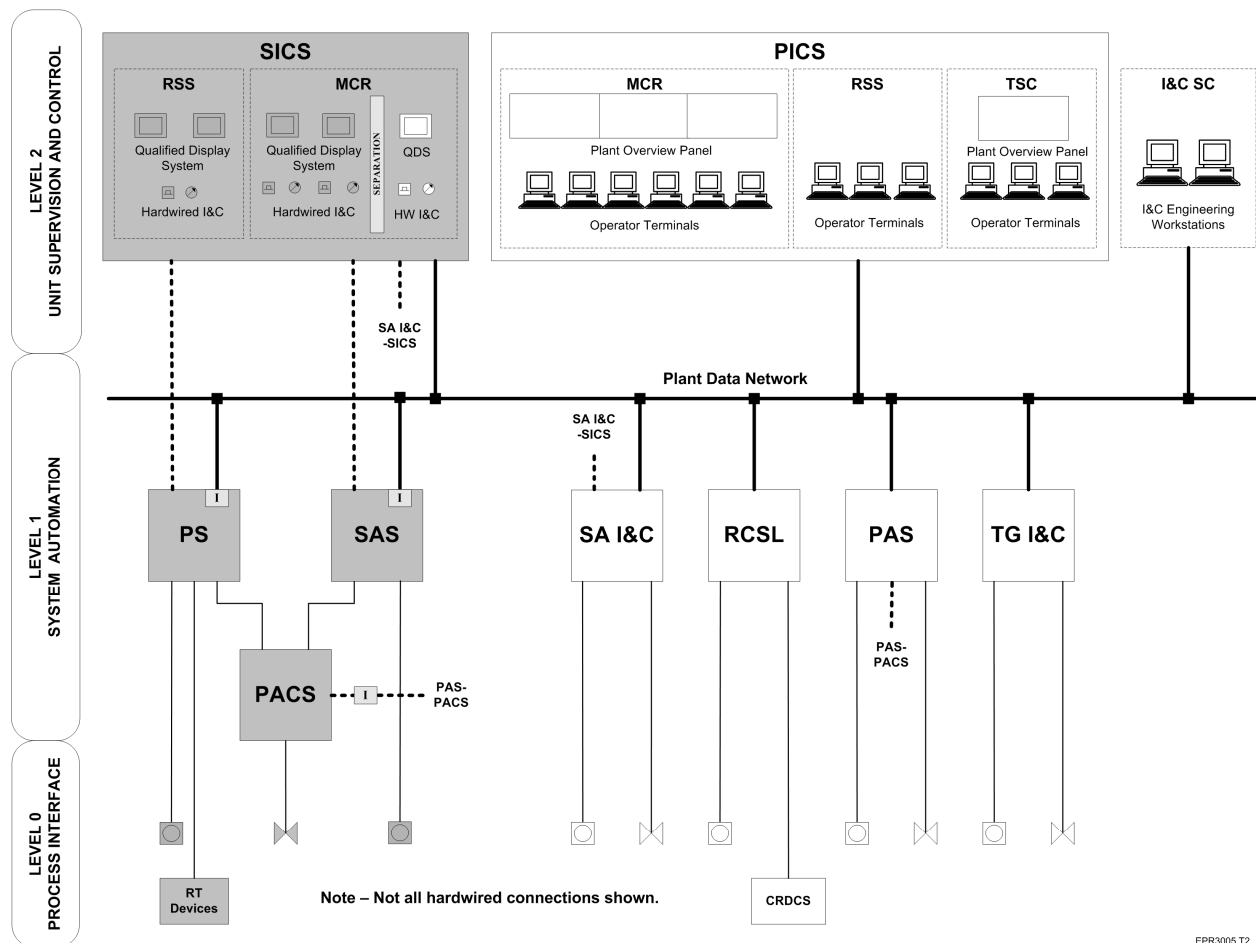
Response 59:

The following updated I&C system architecture drawing will replace Figure 3.2-1 of ANP-10279.

In the context of overall instrumentation and control (I&C) system architecture, automation level means level 1 plant automations systems. These level 1 systems are the Protection System (PS), the Safety Automation System (SAS), the Reactor Control Surveillance and Limitation System (RCSL), the Process Automation System (PAS), the Turbine Generator I&C (TG I&C) and the Severe Accident I&C (SA I&C).

In the AREVA NP I&C architecture, Level 1 systems contain the I&C systems that automatically control the plant actuators (process control components). Additionally, any manual control commands originating from other system levels are processed by the level 1 systems for interface to the actuators.

I&C Architecture



RAI-60: *New* Section 4.3.1.1 describes the criteria for determining that the PICS is available. If one of these criteria are not met, is the PICS declared unavailable?

Response 60:

To improve clarity, AREVA NP will revise ANP-10279 Section 4.3.1.1 with the following information:

The Process Information and Control System (PICS) in the Main Control Room (MCR) is declared unavailable if less than two of the four operator workstations are in a usable condition. A PICS workstation is declared unavailable if one or more of the following conditions exists:

- Three or more monitors at a workstation are unusable. The workstation in the Shift Supervisor (SS) office is not considered an operator workstation.
- Data communication is not working satisfactorily (i.e. expected feedback not received in the required time frame or inputs do not respond in the expected manner).
- Correlating information on PICS displays at the different workstations is not consistent.
- Information on PICS displays and relevant safety information and control system (SICS) indicators are not consistent (i.e. data on PICS differs significantly from data on SICS).

RAI-61: NEW *In new modern digital control rooms, the loss of the primary display and control system is a potential significant event that merits careful design consideration. Section 4.3.1.1 is titled, Loss of PICS, but does not address this event. Please address.*

Response 61:

The criteria for establishing that Process Information and Control System (PICS) is unavailable are described in response to RAI 60.

The strategy for mitigating loss of the “primary display and control system” (the PICS) will be defined by a multi-discipline engineering team later in the design process.

When the PICS is available, it is used for all monitoring and control regardless of operational situation. While the PICS is the preferred human machine interface (HMI) to be used for monitoring and control of the plant, it is a non-safety related system and is not relied upon for credited safety-related functions. The PICS may be credited for events that are *beyond* the design basis as these events are not required to be mitigated by safety-related equipment. If the PICS is unavailable, the Safety Information and Control System (SICS) contains the human system interfaces (HSI) necessary to maintain the plant in a safe condition. Operator transition from PICS to SICS is an evolution which requires substantial design consideration; the potential for this transition will be addressed in the system design and operator training.

See also response to RAI 64.

RAI-62: NEW Section 4.3.1.2 addresses loss of I&C other than or in addition to the PICS. It states that “When the PICS is unavailable, the operator performs operations from the SICS including the QDS. Depending on plant conditions and the availability of systems, the operators may use the SICS and QDS to maintain steady state operations or commence shutdown to a safe state via conventional SICS controls. The operating manual should identify actions that are required for dealing with the loss of computerized I&C systems and measures that establish the priority of the actions implemented with the remaining conventional systems.” Please describe the operating manual. Are the procedures for managing this transition and establishing the priority of actions available for staff review?

Response 62:

There are procedure philosophy differences between OL3, FA3, and U.S. EPR instrumentation and control (I&C) and human machine interface (HMI) platforms that affect the transition from the Process Information and Control System (PICS) to the Safety Information and Control System (SICS). Thus, the predecessor design procedures are not applicable for the U.S. EPR.

Detailed U.S. EPR procedures for operating the plant upon a loss of a computerized I&C system will depend upon the details of the digital control system (DCS) design which will be completed later in the design process.

For DCS, the relationship between the operating manual and the actual procedures is similar to that between the emergency procedure guidelines and the actual emergency operating procedures (refer to U.S. EPR FSAR Tier 2, Section 13.5, for a guideline describing how to write the procedures).

RAI-63: New *The SICS contains “single-purpose” HSIs (p. 4-5). Please clarify the meaning of single purpose.*

Response 63:

For the U.S. EPR, the Safety Information and Control System (SICS) consists of conventional controls such as buttons and switches and screen-based indications and controls implemented on the Qualified Display System (QDS). An example of a “single-purpose” SICS conventional control would be a button which closes a containment isolation valve or group of valves (as in a backup to a protection system function). If the control to *open* the containment isolation valve(s) is needed in the control room, it is likely that that function is not safety-related and is therefore not included in the SICS inventory. The “single purpose” of the button would be to cause the valves to close.

RAI-64: New *The SICS contains HSIs for monitoring design basis accidents (p. 4-5). How are risk significant failures that are beyond design basis handled?*

Response 64:

When the Process Information and Control System (PICS) is available, it is used to monitor design basis accidents. If the PICS is unavailable, the Safety Information and Control System (SICS) contains human system interfaces (HSI) for monitoring design basis accidents.

For failures that are beyond the design basis, both the PICS and SICS are available for monitoring and control. The PICS is the preferred human machine interface (HMI); SICS is the credited HMI to be used when the PICS is not available. For beyond design basis events, the PICS may be credited as events that are beyond the design basis are not required to be mitigated by safety related equipment.

For postulated software common-cause failures (CCF) of the TXS platform as described in U.S. EPR FSAR Tier 2, Section 7.8, the SICS is not available (with the exception of a hardwired manual reactor trip). If SICS is unavailable due to CCF, the PICS is credited with providing a diverse platform to monitor the automatic functions of the diverse actuation system (DAS) and provide a means for manual control of plant systems to mitigate the event.

The role of the PICS and SICS within the instrumentation and control (I&C) architecture is described in U.S. EPR FSAR Tier 2, Section 7.1. Risk significant failures are described in U.S. EPR FSAR Tier 2, Chapter 19. A discussion of postulated software common cause failures and their effects on HMI usage is included in U.S. EPR FSAR Tier 2, Section 7.8.

RAI-65: New *Section 2.2.9 indicates that most operating procedures will be implemented as computer-based procedures. Several requirements are described, but little is said about the functionality of the procedures, e.g., will procedures step logic be automatically assessed? Will operators have control over the level of detail presented? Will the procedures monitor steps of continuous applicability? Will the procedures monitor operator action? Please provide a more complete description of the computerized procedures system's functionality*

Response 65:

The functionality of the computer-based procedures (CBP) is under development. However, the U.S. EPR draws significant input from FA3 (based on N4 and previous French PWR designs) in this area.

The CBPs will be implemented on the Process Information and Control System (PICS). They will present the relevant real-time plant data within the procedure for ease of retrieval and to aid decision making. Control functions will not be automated either individually or in multiple steps and control functions will not be incorporated into the procedures themselves. The procedures will ease navigation to the correct control screens by providing hyperlinks applicable to the control step. The PICS platform allows easy navigation back to the procedure after the control function or allows the control screen to be sent to a different workstation monitor while the procedure screen remains static. Multiple procedures may be displayed at one time.

The CBP will monitor system and plant parameters and provide indication of completeness of procedure step pre-requisites and control functions; the user maintains control over the completion of procedure steps. Any data entry or commenting on the CBP can be accomplished via keyboard and mouse/trackball at all PICS workstations.

Procedures will be maintained under the licensee's configuration control program; no manipulation of procedure content or appearance will be allowed without proper approvals.

RAI-66: New Sections 2.2.9 and 4.3.1.3 indicate that paper backup of computer procedures will be available. Upon loss of the computerized procedures in the middle of a complex event, is any support provided for operators to determine their location in the paper procedure? How has the effectiveness of this transition during complex procedure operations been demonstrated or validated?

Response 66:

The functionality of the computer-based procedures (CBP) is under development. However, the U.S. EPR draws significant input from FA3 (based on N4 and previous French PWR designs) in this area.

Paper based procedures (PBP) will be presented in a manner that is compatible with the presentation of the same procedure on the CBP system in both content and format. This will assist in training consistency and reduce the potential for confusion during a transition.

The CBP system monitors system and plant parameters and provides indication of completeness of procedure step prerequisites and control functions. An indication of the actual completeness of the procedure step (an operator input checkbox or similar) is under investigation.

Reports of industry studies (e.g., NUREG/CR-6634 and NUREG/CR-6749) found that transitions between CBPs and PBPs did not generally lead to significant errors among well-trained crews. But transitions during complex evolutions, specifically utilizing human machine interface (HMI) platforms to be implemented on U.S. EPR have not been studied. This issue will be included in the list of specific training objectives unique to the operation of the U.S. EPR provided to a COL applicant. Further, the effectiveness of operators during this scenario will be analyzed during verification and validation (V&V) activities in a simulated environment.

RAI-67: *New* Please indicate how the HSI design meets the staff's criteria for SPDS.

Response 67:

A Safety Parameter Display System (SPDS) provides the means to display a list of important safety related plant parameters during normal and abnormal operating conditions. SPDS parameters are available via the Process Information and Control System (PICS), thus all workstations containing PICS monitors have access to SPDS information. A seismically rated version of the SPDS will be provided on the Safety Information and Control System (SICS) in the Main Control Room (MCR) to cope with a failure of the PICS. The integrated SPDS will meet the functionality requirements of NUREG-0737, Supplement 1: "Requirements for Emergency Response Capability."

At a minimum, the following plant functions will be included on the SPDS:

- Reactivity control.
- Reactor core cooling and heat removal from primary system.
- Reactor coolant system integrity.
- Radioactivity control.
- Containment integrity.

RAI-68: New *Please clarify the role of TR ANP-10279 and the FSAR in the U.S. EPR design certification application.*

Response 68:

ANP-10279 is referenced in the U.S. EPR design certification FSAR and AREVA has requested a Safety Evaluation Report (SER) for ANP-10279.

AREVA recognizes that past reviews of human factors programs associated with design certification did not include a topical report describing the overall program. EPR is an evolutionary design and two EPRs are already being built outside the U.S. Therefore, AREVA assumes that high-level program information such as design inputs, standard features, and discussions about how the U.S. EPR human factors engineering (HFE) team will use inherited design information are useful to facilitate early review and issue resolution

AREVA NP will satisfy the intent of NUREG-0800 for HFE program documentation while capitalizing on work already completed for the OL3 and FA3 HMI and MCR designs. It is not cost effective nor is there a safety benefit to re-do HFE analysis for an EPR design which is "standardized"; this is the basis for discussions about relying on U.S. EPR predecessor design information. Use of OL3 and FA3 information also forms the foundation for in-house reviewer inspections rather than submission of various implementation plans.

There is significant overlap between U.S. EPR FSAR Tier 2, Chapter 18, and ANP-10279. As a topical report describing the overall HFE program is outside the realm of U.S. EPR FSAR review, and approval is not a prerequisite for certifying the EPR design, AREVA assumes that further discussion regarding availability and adequacy of design documentation for the HFE program will be requested as part of the FSAR review.

RAI-69: *New* What aspects of the U.S. EPR's HFE program will be COL items?

Response 69:

COL items are specified in Chapter 18 of the U.S. EPR FSAR.