52-001

GE Nuclear Energy

(FAX: 301-504-2260) ABWR

Date 9/11/92

To CLARE GOODMAN
NRC - WHITEFLINT

Fax No. MAR 920911-3

This page plus 24 page(s)

From MONTY ROSS

Mail Code 765
175 Curtner Avenue
San Jose, CA 95125

Phone (408) 925-6930

FAX (408) 925-1193
or (408) 925-1587

Subject UPDATE OF HFE "TIER 2 DAC"

Message 1) PLEASE PASS A COPY OF THIS ALONG TO CHET POSLUSNY.

2) ATTACHED IS THE DRAFT OF THE SUBJECT "TIER 2 DAC" WHICH HAS BEEN REVISED TO INCORPORATE THE RELEVANT LISTINGS OF GUIDANCE DOCUMENTS. THOSE AREAS OF THE DOCUMENT WHICH HAVE BEEN MODIFIED ARE INDICATED WITH A BOLD "CHANGE BAR" IN THE LEFT MARGIN. LET US KNOW IF YOU HAVE ANY FURTHER QUESTIONS OR COMMENTS.

17:139

Regards
Monty
9/11/92

D050

18E.2 MMIS IMPLEMENTATION REQUIREMENTS

Section 18E.1 describes a process which is typical of those that will be followed in the implementation of ABWR Man-Machine Interface Systems (MMIS). As part of the Table 18E.1.1 discussion of the implementation process, the results of key activities are identified as being the subject of an NRC conformance review. Tables 18E.2.1 through 18E.2.4 of this section define the requirements that are to be met by the MMIS design implementation activities that are to be made available for review by the NRC. The MMIS design implementation-related Design Acceptance Criteria (DAC) which are established through Rule Making, (refer to Sections 3.5 and 3.6 of the Tier 1 Design Certification material for the GE ABWR design), are defined such that there exists a direct correspondence between the DAC entries and requirements imposed herein on those design activities whose results are to be made available for NRC conformance reviews as identified in Table 18E.1.1. Those requirements presented in Table 18E.2.1 through 18E.2.4 which correspond to individual Tier 1 DAC acceptance criteria are specifically identified. Therefore, satisfaction of those specific requirements shall result in full compliance with the Certified Design Commitment and the corresponding Acceptance Criteria presented in the Tier 1 (Rule Making) DAC established for the MMIS design implementation.

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

I. HFE DESIGN TEAM COMPOSITION

(Satisfaction of the requirements presented herein shall result in the creation of an HFE Design Team which is in full compliance with the Item 1a Acceptance Criteria presented in Table 3.6 of the Tier 1 Design Certification Material for the GE ABWR design).

1. The composition of the Human Factor Engineering (HFE) Design Team shall include, as a minimum, the technical skills presented in Article (4), below.

2. The education and related professional experience of the HFE Design Team personnel shall satisfy the minimum personal qualification requirements specified in Article (4), below, for each of the areas of required skills. In those skill areas where related professional experience is specified, qualifying experience of the individual HFE Design Team personnel shall include experience in the ABWR main control room and remote shutdown system Human System Interface (HSI) designs and design implementation activities. The required professional experience presented in those personal qualifications of Article (4) are to be satisfied by the HFE Design Team as a collective whole. Therefore, satisfaction of the professional experience requirements associated with a particular skill area may be realized through the combination of the professional experience of two or more members of the HFE Design Team who each, individually, satisfy the other defined credentials of the particular skill area but who do not possess all of the specified professional experience. Similarly, an individual member of the HFE Design Team may possess all of the credentials sufficient to satisfy the HFE Design Team qualification requirements for two or more of the defined skill areas.

3. Alternative personal credentials may be accepted as the basis for satisfying the minimum personal qualification requirements specified in Article (4), below. Acceptance of such alternative personal credentials shall be evaluated on a case-by-case basis and approved, documented and retained in auditable plant construction files by the COL Applicant. The following factors are examples of alternative credentials which are considered acceptable.

   a. A Professional Engineer's license in the required skill area may be substituted for the required Bachelor's degree.

   b. Related experience may substitute for education at the rate of six semester credit hours for each year of experience up to a maximum of 60 hours credit.

   c. Where course work is related to job assignments, post secondary education may be substituted for experience at the rate of two years of education for one year experience. Total credit for post secondary education shall not exceed two years experience credit.

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

4.	Required Skill Area	Personal Qualification
a.	Technical Project Management	a. - Bachelor's degree, and five years experience in nuclear power plant design operations, and - three years management experience
b.	Systems Engineering	b. - Bachelor's of Science degree, and - four years cumulative experience in at least three of the following areas of systems engineering; design, development, integration, operation, and test and evaluation
c.	Nuclear Engineering	c. - Bachelor's of Science degree, and - four years nuclear design, development, test or operations experience
d.	Control and Instrumentation (C&I) Engineering	d. - Bachelor's of Science degree, and - four years experience in design of process control systems, and - experience in at least one of the following areas of C&I engineering; development, power plant operations, and test and evaluation
e.	Architect Engineering	e. - Bachelor's of Science degree, and - four years power plant control room design experience

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

	Required Skill Area		Personal Qualification
f.	Human Factors	f.	- Bachelor's degree in human factors engineering, engineering psychology or related science, and - four years cumulative experience related to the human factors aspects of human-computer interfaces. Qualifying experience shall include experience in at least two of the following human factors related activities; design, development, and test and evaluation, and - four years cumulative experience related to the human factors field of ergonomics. Again, qualifying experience shall include experience in at least two of the following areas of human factors activities; design, development, and test and evaluation
g.	Plant Operations	g.	- Have or have held a Senior Reactor Operator two years experience in BWR nuclear power plant operations
h.	Computer System Engineering	h.	- Bachelor's degree in Electrical Engineering or Computer Science, or graduate degree in other engineering discipline (e.g., Mechanical Engineering or Chemical Engineering), and - four years experience in the design of digital computer systems and real time systems applications

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

Required Skill Area	Personal Qualification
i. Plant Procedure Development	i. • Bachelor's degree, and • four years experience in developing nuclear power plant operating procedures
j. Personnel Training	j. • Bachelor's degree, and four years experience in the development of personnel training programs for power plants, and • experience in the application of systematic training development [illegible]

II HUMAN FACTORS ENGINEERING PROGRAM PLAN

1. (Satisfaction of the requirements presented herein shall result in the creation of a Human Factors Engineering Program Plan which is in full compliance with the Item 1.b. Acceptance Criteria presented in Table 3.6 of the Tier 1 Design Certification material for the GE ABWR design). The Human Factors Engineering (HFE) Program Plan shall establish:

   a. Methods and criteria, for the development and evaluation of the Main Control Room (MCR) and Remote Shutdown System (RSS) HSI which are consistent with accepted HFE practices and principles. Within the defined scope and content of the HFE Program Plan, accepted HFE methods and criteria are presented in the following documents:

      a. AR 602-1, Human Factors Engineering Program, 1983, (Dept. of Defense)

      b. DI-HFAC-80740, Human Engineering Program Plan, 1989, (Dept. of Defense)

      c. DOD-HDBK-763, Human Engineering Procedures Guide, Chapters 5-7 and Appendices A and B, 1991, (Dept. of Defense)

      d. EPRI NP-3659, Human Factors Guide for Nuclear Power Plant Control Room Development, 1984, (Electric Power Research Institute)

      e. IEEE Std. 1023-1988, IEEE Guide to the Application of Human Factors Engineering to Systems, Equipment and Facilities of Nuclear Power Generating Stations, 1988, (IEEE)

      f. MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment and Facilities, 1979, (Dept. of Defense)

      g. NUREG-0700, Guidelines for Control Room Design Reviews, 1981, (U. S. Nuclear Regulatory Commission)

h. NUREG-0737, Clarification of TMI Action Plan Requirements (Item I.C.5, "Feedback of Operating Experience to Plant Staff"), 1983, (U. S. Nuclear Regulatory Commission)

NUREG-0899, Guidelines for the Preparation of Emergency Operating Procedures, 1982, (U. S. Nuclear Regulatory Commission)

j. NUREG/CR-3331, A Methodology for Allocating Nuclear Power Plant Control Functions to Human and Automated Control, 1983, (U. S. NRC)

k. TOP 1-2-610, Test Operating Procedure - Part 1, 1990, (Dept. of Defense)

Note that within the set of documents listed above, differences may exist regarding specific methods and criteria applicable to the HFE Program Plan. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for elements of the HFE Program.

b. The primary objectives of the HFE Program shall include, at the minimum, the objective to develop an HSI which makes possible safe, efficient, and reliable operator performance.

c. The goals of the HFE Program which shall be stated in "operator-centered" terms and serve as criteria for test and evaluation activities. These "operator-centered" HFE design goals shall include:

(i) The operating team can accomplish all assigned tasks within system defined time and performance criteria.

(ii) The system and allocation of functions will provide acceptable workload levels and facilitate operator vigilance.

(iii) The system will support a high degree of operating crew "situation awareness."

(iv) Signal detection and event recognition requirements will be kept within the operators' information processing limits and will minimize the need for operators to manually transform data in order to be usable.

(v) The system will minimize operator memory load.

(vi) The operator interfaces will minimize the potential for operator error.

d. HSI design and evaluation scope which consists of the Main Control Room and Remote Shutdown System operations, maintenance, test, and inspection interfaces, operating technical procedures, and identification of personnel training needs.

e. The HFE Design Team as being responsible for:

(i) the development of HFE plans and procedures;

(ii) the oversight and review of HFE design, development, test, and evaluation activities;

(iii) the initiation, recommendation, and provision of solutions through designated channels for problems identified in the implementation of the HFE activities;

(iv) verification of implementation of team recommendations,

(v) assurance that all HFE activities comply to the HFE plans and procedures, and

(vi) scheduling of activities and milestones.

f. The HFE Design Team having the authority and organizational freedom to accomplish its responsibilities. The team shall have the authority to determine where its input is required and to access work areas, and design documentation. The Team shall have the authority to control further processing,delivery, installation or use of HFE/HSI products until the disposition of a non-conformance, deficiency or unsatisfactory condition has been achieved.

g. An HFE issue tracking system which monitors the identification and closure of human factors issues. The HFE issue tracking system shall document and track human factors engineering issues and concerns, from identification until elimination or reduction to a level acceptable to the HFE Design Team.

h. The Design Control procedures through which the results of the iterative design development activities are documented and processed to maintain integration of design activities and assure that the design, design analyses and documentation are consistent and appropriately reflect the details of design implementation decisions.

2. The HFE Program Plan shall also establish:

a. That each HFE issue/concern shall be entered on the HFE Issue Tracking System log when first identified, and each action taken to eliminate or reduce the issue/concern should be documented. The final resolution of the issue/concern, as accepted by the HFE DesignTeam, shall be documented in detail, along with information regarding HFE Design Team acceptance (e.g., person accepting, date, etc.) the individual responsibilities of the HFE Design Team members when an HFE issue/concern is identified, including definition of who should log the item, who is responsible for tracking the resolution efforts, who is responsible for acceptance of a resolution, and who shall enter the necessary closeout data, and

b. That the HFE Issue Tracking System shall address human factors issues that are identified throughout the development and evaluations of the Main Control Room and Remote Shutdown System HSI Design implementation.

3. The HFE Program Management Plan document shall include:

a. The purpose and organization of the plan

TABLE 18.5.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

b. The overall HFE program goals and objectives

c. The relationship between the HFE program and the overall plant equipment procurement and construction program (organization and schedule).

d. Definition of the HFE Design Team and their activities including:

(i) Description of the HFE Design Team function within the broader scope of the plant equipment procurement and construction program, including charts to show organizational and functional relationships, reporting relationships, and lines of communication;

(ii) Description of the responsibility, authority and accountability of the HFE Design Team organization;

(iii) Description of the process through which management decisions will be made regarding HFE;

(iv) Description of the process through which technical decisions will be made by the HFE Design Team

(v) Description of the tools and techniques (e.g., review forms, documentation) to be utilized by the HFE Design Team in fulfilling their responsibilities

(vi) Description of the the HFE Design Team staffing, job descriptions of the individual HFE Design Team personnel and their personal qualifications, and;

(vii) Definition of the procedures that will govern the internal management of the HFE Design Team.

e. Definition of the HFE Issue Tracking System and its implementation including:

(i) Individual HFE Design Team member responsibilities regarding HFE issue identification, logging, issue resolution, and issue closeout;

(ii) Procedures and documentation requirements regarding HFE issue identification. These shall include description of the HFE issue,effects of the issue if no design change action is taken and an assessment of the criticality and likelihood of the identified HFE issue manifesting itself into unacceptable HSI performance, and;

(iii) Procedures and documentation requirements regarding HFE issue resolution. These procedures shall include evaluation and documentation of proposed solutions, implemented solutions, evaluated residual effects of the implemented solution and the evaluated criticality and likelihood of the implemented resolution of the HFE issue manifesting itself into unacceptable HSI performance.

f. Identification and description of the following implementation plans to be developed;

(i) System Functional Requirements Development,

(ii) Allocation of Function,

(iii)Task Analysis,

(iv) Human-system Interface Design,

(v) Plant and Emergency Operating Procedure Development, and

(vi) Human Factors Verification and Validation

g. Definition of HFE program milestones including:

(i) Identification of HFE milestones at which evaluations of the effectiveness of the HFE effort are to can be made, and the relationship of the milestones to the integrated plant construction sequence of events;

(ii) A program schedule of HFE tasks which addresses the relationships between HFE elements and activities, the development of HFE reports and the conduct of HFE reviews, and

(iii)Identification of other plant equipment procurement and construction activities which are related to HFE Design Team activities but outside the scope of the team (e.g., C&I equipment manufacture)

h. Definition of HFE documentation requirements and procedures for retention and retrieval, and

i. Description of the manner in which HFE Program requirements will be communicated to all applicable personnel and organizations, including those which may be subcontracted, who are responsible for the performance of work associated with the Main Control Room and Remote Shutdown System design implementation.

III. SYSTEM FUNCTIONAL REQUIREMENTS ANALYSIS IMPLEMENTATION PLAN

1. (Satisfaction of the requirements presented herein shall result in the creation of a System Functional Requirements Analysis Implementation Plan which is in full compliance with the Item 2.a acceptance criteria presented in Table 3.6 of the Tier 1 Design Certification material for the GE ABWR design). The System Functional Requirements Analysis Implementation Plan shall establish:

a. Methods and criteria for conducting the System Functional Requirements Analysis which are consistent with accepted HFE practices and principles. Within the context of system functional requirements analysis, accepted HFE methods and criteria are presented in the following documents:

a. AD/A233 168, System Engineering Management Guide 1990, (Dept. of Defense - Defense Systems Management College, Kockler, F., et al)

b. AR602-1, Human Factors Engineering Program, 1983, (Dept. of Defense)

c. EPRI NP-3659, Human Factors Guide for Nuclear Power Plant Control Room Development, 1984, (Electric Power Research Institute)

d. IEC 964, Design for Control Rooms of Nuclear Power Plants, 1989, (Bureau Central de la Commission Electrotechnique Internationale)

e. IEEE Std. 1023-1988, IEEE Guide to the Application of Human Factors Engineering to Systems, Equipment and Facilities of Nuclear Power Generating Stations, 1988, (IEEE)

f. MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment and Facilities, 1979, (Dept. of Defense)

g. NUREG-0700, Guidelines for Control Room Design Reviews, 1981, (U. S. Nuclear Regulatory Commission)

h. NUREG/CR-3331, A Methodology for Allocating Nuclear Power Plant Control Functions to Human and Automated Control, 1983, (U. S. NRC)

Note that within the set of documents listed above, differences may exist regarding the specific methods and criteria applicable to the conduct of system functional requirements analysis. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for the system functional requirements analysis.

b. that system requirements shall define the system functions and those system functions shall provide the basis for determining the associated HSI performance requirements.

c. that critical functions shall be defined (i.e., those functions required to achieve major system performance requirements; or those functions which, if failed, could pose a safety hazard to plant personnel or to the general public),

d. that safety functions shall be identified along with any functional interrelationship these safety functions may have with non-safety systems.

e. that functions shall be defined as the most general, yet differentiable means whereby the system requirements are met, discharged, or satisfied. Functions shall be arranged in a logical sequence so that any specified operational usage of the system can be traced in an end-to-end path.

f. that functions shall be described initially in graphic form. Function diagramming shall be done starting at a "top level", where major functions are described, and continuing to decompose major functions to lower levels until a specific critical end-item requirement emerges, e.g., a piece of equipment, software, or an operator.

g. that detailed narrative descriptions shall be developed for each of the identified functions and for the overall system configuration design itself. Each function shall be identified and described in terms of inputs (observable parameters which will indicate system status) functional processing(control process and performance measures required to achieve the function), functional operations (including detecting signals, measuring information, comparing one measurement with another, processing information, and acting upon decisions to produce a desired condition or result such as a system or component operation actuation or trip) outputs, feedback (how to determine correct discharge of function), and interface requirements from the top down so that subfunctions are recognized as part of larger functional elements.

HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

2. The System Functional Requirements Analysis Implementation Plan shall include:

a. The methods for identification of system level functions based upon system performance requirements

b. The methods for developing graphic function descriptions (e.g., Functional Flow Block Diagrams and Time Line Diagrams)

c. The method for developing detailed function narrative descriptions which encompass:

(i) observable parameters that indicate system status,

(ii) control process and data required to achieve the function, and

(iii) how to determine the manner in which proper discharge of function is to be determined

d. Analysis methods which define the integration of closely related subfunctions so that they can be treated as a unit

e. Analysis methods which divide identified subfunctions into two groups according to whether:

(i) Common achievement of the subfunction is an essential condition for the accomplishment of a higher level function, or

(ii)The subfunction is an alternative supporting functions to a higher level function or the subfunction's accomplishment is not necessarily a requisite for a higher level function.

f. Requirements to identify for each integrated subfunction:

(i) The basis for why accomplishment of the subfunction is required,

(ii) The control actions necessary for accomplishment of the subfunctions,

(iii) The parameters necessary for the subfunction control actions,

(iv) The criteria for evaluating the resultof the subfunction control actions,

(v) The parameters necessary for evaluation of the subfunction

(vi) The criteria to be used to evaluate the subfunction, and

(vii) The criteria for selecting alternative function assignments if the evaluation criteria is not satisfied.

IV. ALLOCATION OF FUNCTION IMPLEMENTATION PLAN

1. (Satisfaction of the requirements presented herein shall result in the creation of an Allocation of Function Implementation Plan which is in full compliance with the Item 3.a Acceptance Criteria presented in Table 3.6 of the Tier 1 Design Certification material for the GE ABWR design). The Allocation of Function Implementation Plan Shall establish:

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

a. The methods and criteria for the execution of function allocation which are consistent with accepted HFE practices and principles. Within the context of function allocation, accepted HFE practices and principles are presented in the following documents:

   a. AD/A223 168, System Engineering Management Guide 1990, (Dept. of Defense - Defense Systems Management College, K ckler, F., et al)

   b. AR 602-1, Human Factors Engineering Program, 1983, (Dept. of Defense)

   c. EPRI NP-3659, Human Factors Guide for Nuclear Power Plant Control Room Development, 1984, (Electric Power Research Institute)

   d. IEC 964, Design for Control Rooms of Nuclear Power Plants, 1989, (Bureau Central de la Commission Electrotechnique Internationale)

   e. NUREG-0700, Guidelines for Control Room Design Reviews, 1981, (U. S. Nuclear Regulatory Commission)

   f. NUREG/CR-3331, A Methodology for Allocating Nuclear Power Plant Control Functions to Human and Automated Control, 1983, (U. S. NRC)

   Note that within the set of documents listed above, differences may exist regarding the specific methods and criteria applicable to the conduct and analysis of function allocation. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for conducting the function allocation and analysis.

b. That all aspects of system and functions definition shall be analyzed in terms of resulting human performance requirements based on the expected user population.

c. That the allocation of functions to personnel, system elements, and personnel system combinations shall reflect :

   (i) sensitivity, precision, time, and safety requirements,

   (ii) required reliability of system performance, and

   (iii) the number and the necessary skills of the personnel required to operate and maintain the system.

d. The allocation criteria, rational, analyses, and procedures shall be documented.

e. Analyses shall confirm that the personnel elements can correctly perform tasks allocated to them while maintaining operator situation awareness, acceptable personnel workload, and facilitating personnel vigilance.

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

2. The Allocation of Function Implementation Plan shall include:

a. Establishment of a structured basis and criteria for function allocation

b. Definition of function allocation analyses requirements including:

(i) Definition of the objectives and requirements for the evaluation of function allocations

(ii) Development of alternative function allocations for use in the conduct of comparative evaluations

(iii) Development of criteria to be used as the basis for selecting between alternative function allocations

(iv) Development of evaluation criteria weighting factors

(v) Development of test and analysis methods for evaluating function allocation alternatives

(vi) Definition of the methods to be used in conducting assessments of the sensitivity of the comparative function allocation alternatives analyses results to the individual analysis inputs and criteria

(vii) Definition of the methods to be employed in selecting individual function allocation for incorporation into the implemented design.

V. TASK ANALYSIS IMPLEMENTATION PLAN

1. (Satisfaction of the requirements presented herein shall result in the creation of a Task Analysis Implementation Plan which is in full compliance with the Item 4.a Acceptance Criteria presented in Table 3.6 of the Tier 1 Design Certification material for the GE ABWR design). The Task Analysis Implementation Plan shall establish:

a. The methods and criteria for conduct of the task analyses which are consistent with accepted HFE practices and principles. Within the context of performing task analysis, accepted HFE methods and criteria are presented in the following documents:

a. AD/A223 168, System Engineering Management Guide 1990, (Dept. of Defense - Defense Systems Management College, Kockler, F., et al)

b. DOD-HDBK-763, Human Engineering Procedures Guide, Chapters 5-7 and Appendices A and B, 1991, (Dept. of Defense)

c. EPRI NP-3659, Human Factors Guide for Nuclear Power Plant Control Room Development, 1984, (Electric Power Research Institute)

d. IEC 964, Design for Control Rooms of Nuclear Power Plants, 1989, (Bureau Central de la Commission EElectrotechnique Internationale)

e. IEEE Std. 1023-1988, IEEE Guide to the Application of Human Factors Engineering to Systems, Equipment and Facilities of Nuclear Power Generating Stations, 1988, (IEEE)

f. MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment and Facilities, 1979, (Dept. of Defense)

g. MIL-STD-1478, Task Performance Analysis, 1991, (Dept. of Defense)

h. NUREG-0700, Guidelines for Control Room Design Reviews, 1981, (U. S. Nuclear Regulatory Commission)

i. NUREG/CR-3331, A Methodology for Allocating Nuclear Power Plant Control Functions to Human and Automated Control, 1983, (U. S. NRC)

j. NUREG/CR-3371, Task Analysis of Nuclear Power Plant Control Room Crews (Vol. 1), 1983, (U. S. NRC)

Note that within the set of documents listed above, differences may exist regarding the specific methods and criteria applicable to the conduct of HFE task analysis. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for the task analysis.

b. The scope of the task analysis which shall include all operations performed at the operator interface in the main control room and at the remote shutdown system. The analyses shall be directed to the full range of plant operating modes, including startup, normal operations, abnormal operations, transient conditions, low power and shutdown conditions. The analyses shall also address operator interface operations during periods of maintenance test and inspection of plant systems and equipment and of the HSI equipment.

c. That the analysis shall link the identified and described tasks in operational sequence diagrams. The task descriptions and operational sequence diagrams shall be used to identify which tasks are "critical" in terms of importance for function achievement, potential for human error, and impact of task failure. Human actions which are found to affect plant risk in PRA sensitivity analyses shall also be considered "critical".

d. Task analysis shall begin with the development of detailed narrative descriptions of the personnel activities required for successful completion of the task. Task analyses shall define the input, process, and output required by and of personnel.

e. The task analysis shall be in detail sufficient enough to identify information and control requirements such that requirements for alarms,displays, data processing, and controls for human task accomplishment may be specified.

f. The task analysis results shall be made available as input to the personnel training programs.

2. The Task Analysis Implementation Plan shall include:

a. The methods and data sources to be used in the conduct of the task analysis

b. The methods for conducting the initial (high level) task analysis including:

(i) converting functions to tasks,

(ii) developing narrative task descriptions,

(iii) developing the basic statement of the task functions,

(iv) decomposition of tasks to individual activities, and

(v) development of operational sequence diagrams

c. The methods for developing detailed task descriptions that address;

(i) information requirements (i.e., information required to execute a task, including cues for task initiation)

(ii) decision-making requirements (i.e., decisions that are probable based on the evaluations, description of the decisions to be made and the evaluations to be performed),

(iii) response requirements (i.e., actions to be taken, frequency of action, speed/time line requirements, any tolerance/accuracy requirements associated with the action, consideration of any operational limits of personnel performance or of equipment body movements required by an action taken, and any overlap of task requirements such as serial vs. parallel task elements)

(iv) feedback requirements (i.e., feedback required to indicate adequacy of actions taken),

(v) personnel workload (i.e., both cognitive and physical workload and the estimation of the level of difficulty associated with a particular workload condition,

(vii) any associated task support requirements (i.e., special/protective clothing, job aids or reference materials required, any tools and equipment required or any computer processing support aids)

(vii) workplace factors (i.e., the workspace envelope required by the action taken, workspace environmental conditions, location that the work is to be performed, the physical/mental attributes of the work),

(viii) staffing and communication requirements (i.e., the number of personnel, their technical specialty, and specific skills, the form and content of communications and other personnel interaction required when more than one person is involved), and

(ix) the identification of any hazards involved in execution of the task. .

d. The methods for identification of critical tasks. The identified critical tasks shall include,at the minimum, those operator actions which have significant impact on the PRA results as presented in Section 19D.7 of the SSAR.

e. The methods for establishing information and control requirements

f. The methods for conducting alarm, display, processing, and control requirements analysis

g. The methods through which the application of task analysis results are assembled and documented to provide input to the development of personnel training programs

h. the methods to be used to evaluate the results of the task analysis.

VI. HSI DESIGN IMPLEMENTATION PLAN

1. (Satisfaction of the requirements presented herein shall result in the creation of an HSI Design Implementation Plan which is in full compliance with the Item 5.a Acceptance Criteria presented in Table 3.6 of the Tier 1 Design Certification material for the GE ABWR design). The HSI Design Implementation Plan shall establish:

a. The methods and criteria for HSI equipment design and evaluation of HSI human performance, equipment design and associated work place factors; which are consistent with accepted HFE practices and principles. Within the context of performing these HSI design evaluations, accepted HFE methods and criteria are presented in the following documents:

a. AD/A223 168, System Engineering Management Guide 1990, (Dept. of Defense - Defense Systems Management College, Kockler, F., et al)

b. ANSI HFS-100, American National Standard for Human Factors Engineering of Visual Display Terminal Workstations, 1988, (Am. Nat'l. Standards Institute)

c. EPRI NP-3659, Human Factors Guide for Nuclear Power Plant Control Room Development, 1984, (Electric Power Research Institute)

d. EPRI NP-3701, Computer-Generated Display System Guidelines, 1984, (Electric Power Research Institute)

e. ESD-TR-86-278, Guidelines for Designing User Interface Software, 1990, (Department of Defense)

f. IEC 964, Design for Control Rooms of Nuclear Power Plants, 1989, (Bureau Central de la Commission Electrotechnique Internationale)

g. MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment and Facilities, 1979, (Dept. of Defense)

h. MIL-HDBK-759A, Human Factors Engineering Design for Army Material, 1981, (Dept. of Defense)

i. DOD-HDBK-761A, Human Engineering Guidelines for Management Information Systems, 1990, (Dept. of Defense)

j. MIL-STD-1472D, Human Engineering Design Criteria for Military Systems, Equipment and Facilities, 1989, (Dept. of Defense)

k. NUREG-0696, Functional Criteria for Emergency Response Facilities, 1980, (U. S. Nuclear Regulatory Commission)

TABLE 18.E 2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

l. NUREG-0700, Guidelines for Control Room Design Reviews, 1981, (U. S. Nuclear Regulatory Commission)

m. NUREG-0800, Standard Review Plan, Rev. 1, 1984, (U. S. Nuclear Regulatory Commission)

n. NUREG-0899, Guidelines for the Preparation of Emergency Operating Procedures, 1982, (U. S. Nuclear Regulatory Commission)

o. NUREG/CR-5228, Techniques for Preparing Flowchart Format Emergency Operating Procedures (Vols. 1 & 2), 1989, (U. S. NRC)

p. NUREG/CR-4227, Human Engineering Guidelines for the Evaluation and Assessment of Video Display Units, 1985, (U. S. Nuclear Regulatory Commission)

Note that within the set of documents listed above, differences may exist regarding the specific methods and criteria applicable to the conduct of HSI design evaluations. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for the HSI design evaluations.

b. That the HSI design shall implement the information and control requirements developed through the task analyses, including the displays, controls and alarms necessary for the execution of those tasks identified in the task analyses as being critical tasks.

c. The methods which will assure that the HSI human performance equipment, design and associated workplace factors are consistent with those modeled and evaluated in the completed task analysis.

d. That the HSI design shall not incorporate any equipment (i.e., hardware or software function) which has not been specifically evaluated in the task analysis.

e. The HSI design criteria and guidance for control room operations during periods of maintenance, test and inspection of control room HSI equipment and of other plant equipment which has control room personnel interface.

f. The test and evaluation methods for resolving HFE/HSI design issues. These test and evaluation methods shall include the criteria to be used in selecting HFE/HSI design and evaluation tools which:

(i) may incorporate the use of static mockups and models for evaluating access and workspace related HFE issues, and

(ii) shall require dynamic simulations and HSI prototypes for conducting evaluations of the human performance associated with the activities in the critical tasks identified in the task analysis.

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

2. The Human System Interface Design Implementation Plan shall include:

   a. Identification of the specific HFE standards and guidelines documents which substantiate that the selected HSI Design Evaluation Methods and Criteria are based upon accepted HFE practices and principles.

   b. Definition of standardized HFE design conventions.

   c. Definition that the standard design features presented in Section 18.4.2 of the Standard Safety Analysis Report (SSAR), and the standard HSI equipment technologies, presented in Section 18.4.3 of the SSAR, shall be incorporated as requirements on the HSI design.

   d. Definition of the design/evaluation tools (e.g., prototypes) which are to be used in the conduct of the HSI design analyses, the specific scope of evaluations for which those tools are to be applied and the rationale for the selection of those specific tools and their associated scope of application.

VII. PLANT AND EMERGENCY OPERATING PROCEDURE DEVELOPMENT IMPLEMENTATION PLAN

1. (Satisfaction of the requirements presented herein shall result in the creation of a Plant and Emergency Operating Procedure Development Implementation Plan which is in full compliance with the Item 6.a Acceptance Criteria presented in Table 3.6 of the Tier 1 Design Certification material for the GE ABWR design). The Plant and Emergency Operating Procedure Development Implementation Plan shall establish :

   a. That operator actions identified in the task analysis shall be used as the basis for specifying the procedures for operations

      a. ANSI-N18.7-1976, Administrative Controls and Quality Assurance for the Operation Phase of Nuclear Power Plants, 1976, (Am. Nat'l. Stds. Instit.)

      b. EPRI NP-3659, Human Factors Guide for Nuclear Power Plant Control Room Development, 1984, Electric Power Research Institute

      c. IEC 964, Design for Control Rooms of Nuclear Power Plants, 1989, (Bureau Central de la Commission Electrotechnique Internationale)

      d. MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment and Facilities, 1979, (Dept. of Defense)

      e. NUREG-0899, Guidelines for the Preparation of Emergency Operating Procedures, 1982, (U. S. Nuclear Regulatory Commission)

      f. NUREG-1358, Lessons Learned from the Special Inspection Program for Emergency Operating Procedures, 1989, (U. S. Nucl. Regul. Commission)

g. NUREG/CR-5228, Techniques for Preparing Flowchart Format Emergency Operating Procedures (Vols. 1 & 2), 1989, (U. S. NRC)

h. MIL-M - 63035 (TM), Military Specifications Manuals, Technical: Front End Analysis, 1977, (Dept. of Defense)

Note that within the set of documents listed above, differences may exist regarding the specific methods and criteria applicable to the development of operating technical procedures. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for the operating technical procedure development.

b. That the procedures to be developed shall address normal, abnormal, and emergency plant operations including consideration of plant operations during periods when plant systems/equipment and primary operator interface (i.e., main control room) equipment is undergoing, test, maintenance or inspection.

c. Methods and criteria for development of the operating technical procedures which are consistent with accepted HFE practices and principles. Within the context of operating procedure development, accepted HFE methods and criteria are presented in the following documents:

d. That a Writer's Guide shall be developed which establishes the process for developing the technical procedures for normal plant and system operation, abnormal plant operations, emergency plant operations and for responding to plant alarm conditions. The Writer's Guide shall contain objective criteria which will require that the operations technical procedures developed are consistent in organization, style, content and usage of terms.

2. The Plant and Emergency Operating Procedure Development Implementation Plan shall include:

a. Identification of the task analyses' definition of required human actions as the data source to be used as the basis for procedure development,

b. Requirements for the development and use of a Technical Procedure Writer's Guide,

c. Definition of the methods through which specific operator skills and training needs, as may be considered necessary for reliable execution of the procedures, will be identified and documented as part of the technical procedures development activities, and

d. Requirement that the documented technical procedures developed shall include:

(i) Title of the procedure

(ii) Statement of the procedure's goal and applicability

(iii) Identification of any reference material necessary to support execution of the procedure

(iv) Identification of any prerequisites conditions which must be satisfied prior to execution of the procedure

(v) Identification of any precautions (i.e., warnings, cautions, and notes) that must be considered in the execution of the procedure

(vi) Identification of any operational limits

(vii) Definition of the specific human actions steps required, and

(viii) Identification of the specific criteria that the operator may use to judge that the goals of the procedure have been achieved

VIII. HUMAN FACTORS VERIFICATION AND VALIDATION IMPLEMENTATION PLAN

1. (Satisfaction of the requirements presented herein shall result in the creation of a Human Factors Verification and Validation Implementation Plan which is in full compliance with the Item ... Acceptance Criteria presented in Table 5.6 of the Tier 1 Design Certification material for the GE ABWR design). The Human Factors Verification and Validation (V&V) Implementation Plan shall establish:

a. Human factors V&V methods and criteria which are consistent with accepted HFE practices and principles. Within the context of performing human factors V&V, accepted HFE methods and criteria are presented in the following documents:

a. AD/A223 168, System Engineering Management Guide 1990, (Dept. of Defense - Defense Systems Management College, Kockler, F., et al)

b. DOD-HDBK-763, Human Engineering Procedures Guide, Chapters 5-7 and Appendices A and B, 1991, (Dept. of Defense)

c. DODI 5000.2, Defense Acquisition Management Policies and Procedures, 1991, (Dept. of Defense)

d. EPRI NP-3701, Computer-Generated Display System Guidelines, 1984, (Electric Power Research Institute)

e. IEC 964, Design for Control Rooms of Nuclear Power Plants, 1989, (Bureau Central de la Commission Electrotechnique Internationale)

f. IEEE Std. 845-1988, IEEE Guide to Evaluation of Man-Machine Performance in Nuclear Power Generating Station Control Rooms and Other Peripheries, 1988 (IEEE)

g. MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment and Facilities, 1979, (Dept. of Defense)

h. DOD-HDBK-761A, Human Engineering Guidelines for Management Information Systems, 1990, (Dept. of Defense)

i. NUREG-0700, Guidelines for Control Room Design Reviews, 1981, (U. S. Nuclear Regulatory Commission)

j. NUREG-0899, Guidelines for the Preparation of Emergency Operating Procedures, 1982, (U. S. Nuclear Regulatory Commission)

k. TOP 1-2-610, Test Operating Procedure - Part 1, 1990, (Dept. of Defense)

l. NSAC-39, Verification and Validation for Safety Parameter Display Systems, 1981, (Electric Power Research Institute)

m. NUREG/CR-4227, Human Engineering Guidelines for the Evaluation and Assessment of Video Display Units, 1985, (U. S. Nuclear Regulatory Commission)

Note that within the set of documents listed above, differences may exist regarding the specific methods and criteria applicable to the conduct of human factors V&V. In situations that such differences exist, all of the methods and criteria presented within those documents are considered to be equally appropriate and valid and, therefore, any of the above listed documents may be selected as the basis for human factors V&V.

b. The methods and evaluation criteria for confirming that the performance of the integrated HSI, meets the HFE design goals as established in the HFE Program Plan.

c. The scope of the evaluations of the integrated HSI shall include:

(i) The Human-System Interface (including both the interface of the operator with the HSI equipment hardware and the interface of the operator with the HSI equipment's software driven functions)

(ii) The plant and emergency operating technical procedures, and

(iii) The overall HSI work environment

d. That static and/or "part-task" mode evaluations of the HSI equipment shall be conducted to confirm that the controls, displays, and data processing functions identified in the task analyses are provided and that those controls, displays and data processing functions are designed in accordance with accepted HFE practices and principles.

e. The integration of HSI equipment with each other, with the operating personnel and with the Operations Technical Procedures shall be evaluated through the conduct of dynamic task performance testing. The dynamic task performance testing and evaluations shall be performed over the full scope of the integrated HSI design using dynamic HSI prototypes (i.e., prototypical HSI equipment which is dynamically driven by real time plant simulation computer models), other evaluation tools and/or past dynamic task performance test and evaluation results. The methods for defining the scope and application of the dynamic HSI prototype, past test results and other evaluation tools shall be documented in the implementation plan. The dynamic task performance tests and evaluations shall have as their objectives:

(i) Confirmation that the integrated HSI design facilitates achievement of the identified safety functions and critical functions,

(ii) Confirmation that the allocation of function and the structure of tasks assigned to personnel is consistent with accepted HFE principles,

(iii) Confirmation of established main control room staffing and the HSI design and configuration provided to support that staff in accomplishing their assigned tasks,

(iv) Confirmation that Operations Technical Procedures are complete and accurate,

(v) Confirmation that the dynamic aspects of the HSI are sufficient for task accomplishment, and

(vi) Confirmation that the integrated HSI design is condusive to eliminating the potential for operator errors.

f. That dynamic task performance test evaluations shall be conducted over the full range of operational conditions and upsets, including:

(i) Normal plant operations, such as plant startup, shutdown, full power operations, and plant maintenance activities;

(ii) Plant system and equipment failures;

(iii) HSI equipment failures;

(iv) Plant transients, and;

(v) Postulated plant accidents conditions.

g. The HFE performance measures to be used as the basis for evaluating the dynamic task performance test results. These performance measures shall include:

(i) Operating crew primary task performance characteristics, such as task times and procedure violations,

(ii) operating crew errors and/or error rates,

(iii) operating crew situation awareness,

(iv) operating crew workload,

(v) operating crew communications and coordination,

(vi) anthropometry evaluations,

(vii) physical positioning and interactions, and

(viii) HSI equipment performance measures

h. The methods to confirm that HFE issues identified and documented in the Human Factors Issue Tracking System have been resolved in the integrated HSI design, and

TABLE 18.E.2.1 HUMAN FACTORS ENGINEERING DESIGN TEAM AND PLANS

i. The methods and criteria to be used to confirm that critical human actions, as defined by the task analysis, have been addressed in the integrated HSI design in a manner consistent with accepted HFE practices and principles.

j. The methods and criteria to be used to confirm that the operating technical procedures are correct and can be executed within the realm of accepted human performance capabilities.

2. The Human Factors Verification and Validation Implementation Plan shall include :

a. Definition of Test Objectives

b. Definition of Test methods and procedures

c. Identification of the participants in the dynamic task performance testing which shall include licensed operators as test subjects

d. Definition of dynamic task performance test conditions which shall include:

(i) plant startup operations

(ii) plant power operations

(iii) plant shutdown operations

(iv) plant refueling and maintenance operations

(v) individual plant system and equipment failures

(vi) individual HSI equipment failure (e.g., loss of VDU functions)

(vii) design basis transients (e.g., turbine trip, loss of feedwater)

(viii) design basis accidents (e.g., LOCAs)

(ix) execution of symptom based emergency procedures

(x) execution of task scenarios which contain critical tasks as identified in the task analyses

e. Methods for defining scope and configuration of the prototypical HSI required to support testing

f. Methods for defining criteria and performance measures to be used in evaluating test results

g. Method for conducting analysis of test data

h. Requirement that the HSI design shall be reviewed and confirmed:

(i) to have incorporated the inventory of controls, displays and alarms presented in Tables 18F-13.1, 2 and 3 of the ABWR Standard Safety Analysis Report (SSAR), and

(ii) that the implemented design is consistent with the standard design features and technologies as presented in Sections 18.4.2 and 18.4.3, respectively, of the SSAR

i. requirements for the development of documented test & evaluation plans and procedures

j. requirements for documenting test results.