52-001

Chet
To docket
Clare

GE Nuclear Energy

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ABWR

Date 5/22/92

To

Fax No. -

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NRC - WHITEPLINT

This page plus 68 page(s)

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Subject HFE DAC - REVISION 1 OF ELEMENTS A, C, D, E, F, G AND H.

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

THANKS

Monty (FOR JN FOX)

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A PDR

5/22/92

CLARE -

ATTACHED IS THE COMPLETE REVISION 1 TEXT (DATED 5/21/92) OF THE HFE ITAAC/DACs AS THEY CURRENTLY EXIST. THIS SET INCORPORATES ALL THE CHANGES PREVIOUSLY IDENTIFIED. THE NEXT ACTIONS PLANNED ARE TO INCORPORATE THE LISTS OF APPLICABLE CODES/STANDARDS AND THE LIST OF "PREDECESSOR DESIGN ISSUES/ETC." AS SOON AS THEY ARE AVAILABLE FROM BNL. IF THERE ARE ANY OTHER QUESTIONS OR COMMENTS FROM THE NRC STAFF, PLEASE LET US KNOW SO THAT WE MAY DISCUSS AND RESOLVE, ASAP.

Regards,

Monty Ross

5/22/92

DESIGN COMMITMENT:

Human-system interfaces (HSI) shall be developed, designed, and evaluated based upon a structured top-down human factors systems analysis and shall reflect state-of-the-art human factors principles. ~~using accepted human factors engineering (HFE) principles~~. The HSI shall include ~~all~~ operations; maintenance, test, and inspection interfaces; operations technical procedures; and training needs of the main control room and remote shutdown system functions and equipment.

INSPECTION/TEST/ANALYSIS:

To assure the integration of HFE into system development: (1) a HFE Design Team shall be established; and (2) a HFE Program Plan shall be established to assure the proper development, execution, oversight, and documentation of the human factors engineering program.

DESIGN ACCEPTANCE CRITERIA:

1. The HFE design team shall include the following expertise:

a. Technical Project Management
b. Systems Engineering
c. Nuclear Engineering
d. Control and Instrumentation Engineering
e. Architect Engineering
f. Human Factors
g. Plant Operations
h. Computer Systems Engineering
i. Plant Procedure Development
j. Personnel Training

2. The Human Factors Engineering (HFE) Program Plan shall establish:

a. Human-System Interface (HSI) design and evaluation methods and criteria which are consistent with accepted HFE practices and principles.

b. ~~1.~~ The primary objectives of the HFE Program shall include, at the minimum, the objective ~~be~~ to develop an HSI which makes possible safe, efficient, and reliable operator performance .

c. 2. The goals of ~~this~~ the HFE Program which shall be stated in "operator-centered" terms and ~~which shall~~ serve as criteria for test and evaluation activities. These "operator-centered" HFE design goals shall include:

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

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

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

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

(v) ~~e.~~ The system will minimize operator memory load.

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

~~HFE Design Team~~

~~d.~~ The HSI design and evaluation scope ~~of the Team's responsibility for~~ which consists of the Main Control Room and Remote Shutdown System ~~shall include~~:

~~e. all~~ operations; maintenance, test, and inspection interfaces; operating technical

~~b.~~ procedures; and identification of personnel

~~c.~~ training ~~requirements development~~ needs.

e. The HFE Design Team ~~shall be~~ as being responsible for:

(i) ~~(1)~~ the development of ~~all~~ HFE plans and procedures;

(ii) ~~(2)~~ the oversight and review of ~~all~~ HFE design, development, test, and evaluation activities;

(iii) ~~(3)~~ the initiation, recommendation, and provision of solutions through designated channels for problems identified in the implementation of the HFE activities;

(iv) ~~(4)~~ verification of implementation of team recommendations,

(v) ~~(5)~~ assurance that all HFE activities comply to the HFE plans and procedures, and

(vi) ~~(7)~~ scheduling of activities and milestones.

f. The HFE Design Team ~~shall have~~ having the authority and organizational freedom to accomplish its ~~ensure that all its areas of~~ responsibilities, ~~are accomplished and to identify problems in the implementation of the HSI design.~~ 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. ~~The HFE Design Team shall~~

~~report to a level of management such that required authority and organizational freedom are provided, including sufficient independence from cost and schedule considerations.~~

g. ~~1.~~ ~~The~~ An HFE issue tracking system ~~shall~~ which monitors the identification and closure of human factors issues. ~~that are identified throughout the development and evaluation of the main control room and remote shutdown system design implementations.~~ 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 ~~review~~ Team.

h. ~~e.~~ 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.

3. (Tier 2 criteria only) The Human Factors Engineering (HFE) Program Plan shall establish the methods and criteria for the development and evaluation of the Main Control Room (MCR) and Remote Shutdown System (RSS) Human-System Interface (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. (From BNL later)

b. (From BNL later)

...

...

...

x. (From BNL later)

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.

4. ~~2.~~ (Tier 2 criteria only)

Criteria regarding the composition of the HFE Design Team are as presented in Attachment I to the HFE ITAAC/DAC

5. (Tier 2 criteria only) The HFE Program Plan shall establish:

a. That each HFE issue/~~-~~concern ~~that meets or exceeds the threshold effects established by the HFE Design Team~~ 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 Design Team, shall be documented in detail, along with information regarding HFE Design Team acceptance (eg., person accepting, date, etc.)

~~(Tier 2 criteria only)The HFE issues tracking system procedures shall specify~~

~~b.~~ 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

c. That the HFE Issue Tracking System shall address:

(i) Human factors issues that are identified throughout the development and evaluations of the Main Control Room and Remote Shutdown System HSI Design implementation, and

(ii) The following generic human factors issues which have been identified as the result of post-TMI control room design reviews and other evaluations of nuclear power plant operations and existing HSI designs:

(1) (From BNL Later)

(2) (From BNL Later)

...

...

...

(10) (From BNL Later)

HFE Program Plan

1. An HFE Program plan shall be developed to describe how the human factors program shall be accomplished, i.e., the plan shall describe the HFE Design Team's organization and composition, define the scope of the work to be undertaken by the HFE Design Team and provides a the technical approach, schedule, and management control structure and technical interfaces required to achieve the HFE program objectives. The HFE Program Plan Generally, it shall establish:

a. The process through which the HFE Design Team executes its responsibilities.

b.The processes through which findings of the HFE Design Team are resolved including how equipment design changes that may be necessary for resolution of HFE issues are incorporated.

c.The members and qualification of the team members

d. The process through which the HFE Design Team activities will be assigned to individual team members, the responsibilities of each team member and the procedures that will govern the internal management of the team

~~f. The procedures and documen- tation requirements of the HFE Issues Tracking System.~~

~~6.~~ 2. (Tier 2 criteria only) The HFE Program Management Plan shall include: ~~the following~~:

a. The purpose and organization of the plan

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

~~(vii)~~ 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. HFE requirements~~

~~(i) Identification and description of the HFE requirements imposed on the design implementation process which shall include the defined design implementation technologies and associated applicable codes and standards as presented in Attachment 2 to the HFE ITAAC/DAC.~~

~~(ii) Identification of the standards and specifications which are the sources of the HFE requirements identified~~

~~f.g. HFE program~~ Identification and description of the following implementation plans ~~which are~~ 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) ~~HF~~ Human Factors Verification and Validation

g.h. 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.i. Definition of HFE documentation requirements and (i) Identification of procedures for retention and retrieval, and

~~(j) Communication of HFE program requirements~~

~~(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.

ATTACHMENT 1 TO HFE ITAAC/DAC
(TIER 2 CRITERIA ONLY)

HFE DESIGN TEAM COMPOSITION

(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 technologies and techniques, of the particular skill area, utilized 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) Successful completion of all technical portions of an engineering, technology or related science college degree program may be substituted for the Bachelor's degree. The courses shall be in appropriate technical subjects relevant to the required skill areas of the HFE Design Team for which the individual will be responsible.~~

(B) ~~(C)~~ 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) ~~(D)~~ 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.

(4)	Required Skill Area	Personal Qualification
	(A) Technical Project Management	(A) - Bachelor's degree, and - five years experience in nuclear power plant design or 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

(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 lease 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 license, and - 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
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 methods

DESIGN COMMITMENT:

System requirements shall be analyzed to identify those functions which must be performed to satisfy the objectives of each functional area. System function analysis shall: (1) determine the objective, performance requirements, and constraints of the design; and (2) establish the functions which must be accomplished to meet the objectives and required performance.

INSPECTION/TEST/ANALYSIS:

- A System Functional Requirements Analysis Implementation Plan shall be developed to assure that the analysis is conducted according to accepted HFE principles.

- An analysis of system functional requirements shall be conducted in accordance with the System Functional Requirements Analysis Implementation Plan and the findings will be documented in System Functional Requirements Analysis Results Report.

- The analyses of the system functional requirements shall be reviewed by the HFE Design Team and shall be documented in System Functional Requirements Analysis Evaluation Report.

DESIGN ACCEPTANCE CRITERIA:

1. The System Functional Requirements Analysis Implementation Plan shall establish: ~~that~~:

a. Methods and criteria for conducting the System Functional Requirements Analysis which are consistent with accepted HFE practices and principles.

~~b.a~~ That system requirements shall define the system functions and those system functions shall provide the basis for determining the associated human and system performance requirements.

~~c.b~~. 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.e. that safety functions shall be identified and any functional interrelationship with non-safety systems shall also be identified.

e.d.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.e.that functions shall be described initially in graphic form. Function diagramming shall be done at ~~several levels~~, 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.f.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.

2.5. The system functional requirements analyses shall be conducted in accordance with the requirements of the Human Factors Engineering Program Plan and the System Functional Requirements Analysis Implementation Plan.

3. (Tier 2 criteria only) The system functional requirements analyses methods and criteria established in the System Functional Requirements Analysis Implementation Plan shall be consistent with accepted HFE methods and criteria. Within the context of system functional requirements analysis, accepted HFE methods and criteria are presented in the following documents:

a. (From BNL later)

b. (From BNL later)

...

...

...

x. (From BNL later)

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.

~~mentation Plan~~

4.2. (Tier 2 criteria only) 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 ~~measure/~~ 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 result of the subfunction control actions,

(v) The parameters necessary for evaluation of the subfunction

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

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

5.3 (Tier 2 criteria only) The results of the system functional requirements analyses shall be documented in a report that includes the following:

a. Objectives of the system functional requirements analyses

b. Description of the methods employed in the conduct of system functional requirements analyses

c. Identification of any deviations from the System Functional Requirements Analysis Implementation Plan

d. Presentation and discussion of the results of the system functional requirements analysis including discussion of any design change recommendations derived from these analyses and/or negative implications that the current design may have on safe plant operations

e. Conclusions regarding the conduct of the analyses and the analysis results

~~HFE Design Team Evaluation Report~~

6.4 (Tier 2 criteria only) The results of the HFE Design Team's evaluation of the conduct and results of the system functional requirements analyses shall be documented in a report that includes the following:

a. The methods and procedures used by the HFE Design Team in their review of the system functional requirements analyses,

b. The HFE Design Team's evaluation of the completed system functional requirements analyses including evaluation of the compliance with the System Functional Requirements Analysis Implementation Plan, and

c. Presentation and discussion of the HFE Design Team's Review findings.

ITAAC/DAC
Element D - Allocation of Function

Design Commitment

To facilitate an ~~The~~ allocation of functions to the human ~~shall~~ which capitalize upon areas of human strengths and avoids areas of ~~by~~ human limitations, ~~The allocation of function shall be conducted in accordance with accepted HFE principles, through~~ a structured and well-documented methodology of allocating functions to personnel, system elements, and personnel-system combinations, shall be established and implemented.

Inspections/Tests/Analyses

An Allocation of Function Implementation Plan shall be developed to assure that the allocation of function ~~analysis~~ is conducted according to accepted HFE principles.

An analysis of the allocation of function shall be conducted in accordance with the Allocation of Function Implementation Plan and the findings will be documented in an Analysis of Function Analysis Results Report

The analyses of the allocation of function shall be reviewed by the HFE Design Team and the results of that review shall be documented in an Allocation of Function Evaluation Report.

Design Acceptance Criteria

1. The Allocation of Function Implementation Plan Shall establish; ~~that~~:

a. The methods and criteria for the execution of function allocation which are consistent with accepted HFE practices and principles.

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

(i) ~~(1)~~ sensitivity, precision, time, and safety requirements,

(ii) ~~(2)~~ required reliability of system performance, and

(iii) ~~(3)~~ the number and the necessary ~~level of~~ skills of the personnel required to operate and maintain the system.

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

e. d. 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.

2. 5. The function allocation analyses shall be conducted in accordance with the requirements of the Human Factors Engineering Program Plan and the Allocation of Functions Implementation Plan.

3. (Tier 2 criteria only) The methods and criteria established in the Allocation of Function Implementation Plan for the conduct and analysis of function allocation, shall be 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. (From BNL later)
b. (From BNL later)
...
...
...
x. (From BNL later)

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.

~~Implementation Plan~~

4. 2. (Tier 2 criteria only) 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.

Analysis Results Report

5. 3. (Tier 2 criteria only) The results of the function allocation analysis shall be documented in a report that includes the following:

a. Objectives of the function allocation analyses.

b. Description of the methods employed in the conduct of the function allocation analyses.

c. Identification of any deviations from the Allocation of Function Implementation Plan

d. Presentation and discussion of the results of the function allocation analyses including discussion of any design change recommendations derived from these analyses and/or any negative implications that the current designmay have on safe plant operations.

e. Conclusions regarding the conduct of the analyses and analysis results.

HFE Design Team Evaluation Report

6. 4. (Tier 2 criteria only) The results of the HFE Design Team's evaluation of the conduct and results of the function allocation analyses shall be documented in a reports that includes the following:

a. The methods and procedures used by the HFE Design Team in their review of the function allocation analyses.

b. The HFE Design Team's evaluation of the completed function allocation analyses including an evaluation of the compliance with the Allocation of Function Implementation Plan.

c. Presentation and discussion of the HFE Design Team's review findings.

DESIGN COMMITMENT:

Task analysis shall be conducted and used to identify the behavioral requirements of the tasks the personnel subsystem is required to perform in order to achieve the functions allocated to them. A task shall be a group of activities that have a common purpose, often occurring in temporal proximity, and which utilize the same displays and controls. The task analysis shall:

~~a. provide one of the bases for making design decisions (e.g. determining before equipment manufacture to the extent practicable, whether system performance requirements can be met by combinations of anticipated equipment, and personnel);~~

a. ~~b.~~ be used to maintain human performance requirements within human capabilities,

b. ~~c.~~ be used as an input for developing personnel skill, personnel training, and system communication requirements and as an input to the evaluation of established plant operations control room staffing levels, and

c. ~~d.~~ form the basis for specifying the requirements for the displays, data processing and controls needed to carry out tasks.

INSPECTION/TEST/ANALYSIS:

- A Task Analysis Implementation Plan shall be developed to assure that the analysis is conducted according to accepted HFE principles.

- An analysis of tasks shall be conducted in accordance with the Task Analysis Implementation Plan and the findings will be documented in a Task Analysis Results Report.

- The task analyses shall be reviewed by the HFE Design Team and the results of that review shall be documented in a Task Analysis Evaluation Report.

DESIGN ACCEPTANCE CRITERIA:

1. The Task Analysis Implementation Plan shall establish: ~~that:~~

a. The methods and criteria for conduct of the task analyses which are consistent with accepted HFE practices and principles.

b. ~~a.~~ 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. ~~maintenance, test and inspection tasks.~~ 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. ~~include tasks~~

c. ~~b.~~ That the analysis shall link the identified and described tasks in operational sequence diagrams. ~~A review of~~ The task descriptions and operational sequence diagrams shall be used to identify which tasks ~~can be considered~~ 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." ~~Where critical functions are automated, the analyses shall consider associated human tasks such as the monitoring of automated safety system operation and the execution of back up actions by the operator if the automated function fails.~~

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

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

~~2.~~ ~~5.~~ The task analyses shall be conducted in accordance with the requirements of the Human Factors Engineering Program Plan and the Task Analysis Implementation Plan.

3. (Tier 2 criteria only) The Task Analysis Implementation Plan shall establish the methods and criteria, for performing task analysis, 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. (from BHL later)
b. (from BNL later)
...
...
...
x. (from BNL later)

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.

~~Implementation Plan~~

4. 2. (Tier 2 criteria only) The Task Analysis Implementation Plan shall include ~~address~~:

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) ~~and information available)~~

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

(iii) response ~~responsible~~ 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 criticaltasks shall include, at the minimum, those operator actions which have significant impact on the PRA results as presented in Section 19D.7 of the SSAB

e. The methods for establishing information and control requirements

f. The methods for conducting ~~initial~~ 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.

~~Analysis Results Report~~

~~5.~~ 3. (Tier 2 criteria only) The results of the task analyses shall be documented in a report that includes the following:

a. Objectives of the task analyses,

b. Description of the methods employed in the conduct of the task analyses,

c. Identification of any deviations from the Task Analyses Implementation Plan

d. Presentation and discussion of the results of the task analyses, including discussion of any design change recommendations derived from these analyses and/or any negative implications that the current design may have on safe plant operations, and

e. Conclusions regarding the conduct of the analyses and the analyses results.

~~6.4~~ (Tier 2 criteria only) The results of the HFE Design Team's evaluation of the conduct and results of the task analyses shall be documented in a report that includes the following:

a. The methods and procedures used by the HFE Design Team in their review of the completed task analyses,

b. The HFE Design Team's evaluation of the completed task analyses including an evaluation of the compliance with the Task Analysis Implementation Plan and

c. Presentation and discussion of the HFE Design Team's review findings

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Element F - Human-System Interface Design

DESIGN COMMITMENT:

Human engineering principles and criteria shall be applied in the design definition and evaluation of the Human-System Interface (HSI).

INSPECTION/TEST/ANALYSIS:

- A Human-System Interface (HSI) Design Implementation Plan shall be developed to assure that human factors analyses of the HSI Design is are conducted according to accepted HFE principles.

- An analysis of the human-system interface design shall be conducted in accordance with the HSI Design Implementation Plan and the findings will be documented in an a HSI Design Implementation Analysis Results Report.

- The analyses of the HSI Design Implementation shall be reviewed by the HFE Design Team and the results of that review shall be documented in an HSI Design Implementation Evaluation Report.

DESIGN ACCEPTANCE CRITERIA:

1. The HSI Design Implementation Plan shall establish:

a. HSI equipment design criteria which is consistent with accepted HFE practices and principles.

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 and design evaluation criteria which will assure that the HSI human performance design and associated workplace factors are in compliance with accepted HFE guidelines and 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.

1. 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.

2. The Human System Interface (HSI) Design Analyses shall be conducted in accordance with the requirements of the Human Factors Engineering Program Plan and the HSI Design Implementation Plan

3.(Tier 2 criteria only) The HSI Design Implementation Plan shall establish the methods and criteria for evaluation of the HSI equipment design and performance. Those HFE methods and criteria shall be consistent with accepted HSI design evaluation practices. Within the context of performing HSI design evaluations, accepted HFE methods and criteria are presented in the following documents:

a. (from BNL later)

b. (from BNL later)

...

...

...

x. (from BNL later)

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.

Implementation Plan

4. (Tier 2 criteria only) The Human System Interface Design Implementation Plan shall include:

a. b. 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. c. Definition of standardized HFE design conventions including:

(i) Video Display Unit (VDU) display format conventions

(ii) Color conventions

(iii) Alarm conventions

c. d. 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. e. 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.

~~Analysis Results Report~~

5. (Tier 2 criteria only) The results of the human system interface (HSI) design analyses shall be documented in a report that includes the following:

a. Objectives of the HSI design analyses,

b. Description of the methods employed in the conduct of the HSI design analyses,

c. Identification of any deviations from the HSI Design Implementation Plan,

d. Presentation and discussion of the results of the HSI design analyses, including discussion of any design change recommendations derived from these analyses and/or negative implications that the current design may have on safe plant operations, and

e. Conclusions regarding the conduct of the analyses and the analysis results.

6. (Tier 2 criteria only) The results of the HFE Design Team's evaluation of the conduct and results of the HSI design analyses shall be documented in a report that includes the following:

a. The methods and procedures used by the HFE Design Team in their review of the HSI design analyses,

b. The HFE Design Team's evaluation of the completed HSI design analyses, including an evaluation of the compliance with the HSI Design Implementation Plan, and

c. Presentation and discussion of the HFE Design Team's review findings.

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Element G - Plant and Emergency Operating Procedure Development

DESIGN COMMITMENT:

Plant and Emergency Operating Procedures shall be developed to support and guide human interaction with plant systems and to support and guide human interactions in the control of plant operations. Human engineering principles and criteria shall be applied in the procedures development.

INSPECTION/TEST/ANALYSIS:

- A Plant and Emergency Operating Procedure Development Implementation Plan shall be developed to assure that the development of the Plant and Emergency Operating Procedures is conducted according to accepted HFE principles.

- The Plant and Emergency Operating Procedures shall be developed in accordance with the Plant and Emergency Operating Procedure Development Implementation Plan and the results will be documented in a Plant and Emergency Operating Procedure Development Report.

- The Plant and Emergency Operating procedure development results shall be reviewed by the HFE Design Team and the results of that review shall be documented in a Plant and Emergency Operating Procedure Development Evaluation Report.

DESIGN ACCEPTANCE CRITERIA:

1. 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.

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 and remote shutdown system) 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.

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 development of the plant operations technical procedures shall be conducted in accordance with the requirements of the Human Factors Engineering Program Plan and the Plant and Emergency Operating Procedure Development Implementation Plan.

3. (Tier 2 criteria only) The methods and criteria established in the Plant and Emergency Operating Procedure Development Implementation Plan for the development of the plant and emergency operating technical procedures shall be consistent with accepted HFE methods and criteria. Within the context of operating procedure development, accepted HFE methods and criteria are presented in the following documents:

a. (From BNL later)

b. (From BNL later)

x. (From BNL later)

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.

~~Implementation Plan~~

4. (Tier 2 criteria only) 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. e. 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 and ~~Actions~~

(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

Procedure Development Report

5. (Tier criteria only) The results of the technical procedure develop-ment activities shall be documented in a report that includes the following:

a.Objectives of the technical procedure development,

b. Description of the methods employed in the development of the technical procedures,

c. Identification of any deviations from the Plant and Emergency Operating Procedure Development Implementation Plan,

d. Presentation and discussion of the results, including a list of the procedures developed, discussion of a representative sample of procedures, and a discussion of any design change recommendations derived during the course of technical procedure development and/or any negative implications that the current design may have on safe plant operations, and

e. Conclusions regarding the conduct of the procedures development and regarding the resultant procedures

HFE Design Team Evaluation Report

6. (Tier 2 criteria only) The results of the HFE Design Team's evaluation of the conduct and results of the technical procedures development shall be documented in a report that includes the following:

a. The methods and procedures used by the HFE Design Team in their review of the operating technical procedures development,

b. The HFE Design Team's evaluation of the completed technical procedures development, including an evaluation of the compliance with the Plant and Emergency Operating Procedure Development Implementation Plan and

c. Presentation and discussion of the HFE Design Team's review findings.

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Element H - Human Factors Verification and Validation

DESIGN COMMITMENT:

The HSI design shall be evaluated as an integrated system using HFE evaluation procedures, guidelines, standards, and principles.

INSPECTION/TEST/ANALYSIS:

- A Human Factors Verification and Validation Implementation Plan shall be developed to assure that the evaluation of the integrated HSI Design is conducted in accordance with accepted HFE principles.

- A human factors engineering analysis of the integrated HSI design shall be conducted in accordance with the Human Factors Verification and Validation Implementation Plan and the findings will be documented in Human Factors Verification and Validation Results Report.

- The analyses of the integrated HSI design shall be reviewed by the HFE Design Team and the results of that review shall be documented in Human Factors Verification and Validation Evaluation Report.

DESIGN ACCEPTANCE CRITERIA:

1. The Human Factors Verification and Validation (V&V) Implementation Plan shall establish:

a. Human factors V&V methods and criteria which are ~~is~~ consistent with accepted HFE practices and principles.

b. The methods and evaluation criteria for confirming that the performance of the integrated HSI, ~~(which includes the HSI equipment, the operators and the technical procedures that define the actions to be taken by the operators in execution of their assigned functions)~~, 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

c. 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.

d. 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~~ 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.

e. 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 start-up, 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.

f. 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, and

(vii) physical positioning and interactions

g. 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

h. 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.

i. 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. 6. The human factors verification and validation (V&V) of the human system interface (HSI) design shall be conducted in accordance with the requirements of the Human Factors Engineering Program Plan and the Human Factors V&V Implementation Plan

3. 2. (Tier 2 criteria only)
The human factors verification and validation (V&V) shall be performed using 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. (From BNL later)

b. (From BNL later)

...

x. (From BNL later)

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.

~~Implementation Plan~~

4. ~~3.~~ (Tier 2 criteria only) 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 ~~reference~~ and maintenance operations

(v) individual plant system and equipment ~~feeilities~~ 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.