Enclosure 10

* DRAFT *

Interim Human Factors Review Criteria for the Design Process of an Advanced Nuclear Power Reactor

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1. INTRODUCTION

The staff of the Nuclear Regulatory Commissions (NRC) Human Factors Assessment Branch (LHFB) is reviewing the human factors elements of the General Electric (GE) Advanced Boiling Water Reactor (ABWR) Standard Safety Analysis Report (SSAR). Based upon the review of this material, the staff will prepare input for the NRC final safety evaluation report (FSER). Brookhaven National Laboratory (BNL) assisted the staff by producing a Technical Evaluation Report (TER) which was used in the preparation of the draft safety evaluation report (DSER) which was completed on July 2, 1991. Many outstanding issues were identified in the DSER. Each of these outstanding issues will be addressed prior to completion of the FSER.

One issue to emerge from the initial review is that detailed human-system interface (HSI) design information will not be available for staff review prior to design certification. To address this issue, the NRC is considering issuing a design certification based partially on the approval of a written design implementation process plan. GE has submitted a Design and Implementation Process Plan (D&IPP) describing the major design and implementation process activities for the ABWR human factors engineering (HFE) effort. The D&IPP is characterized in GE's Figure 18E.1-1 and Table 18E.1-1 of the SSAR submitted to the staff in October 1991. The first part of the plan presents the plant and system design definition stage which will be completed prior to design certification, and the second part outlines the minimum activities that must be conducted by a referencing applicant. The D&IPP will contain (1) descriptions of all required activities in the design, development and implementation of the ABWR human-system interfaces, (2) identification of predetermined NRC conformance review points, and (3) design acceptance criteria (DAC) and Inspection, Test, Analysis and Acceptance Criteria (ITAAC) for the conformance reviews.

To review the GE's ABWR D&IPP, it is necessary to (1) assess whether all the appropriate human factors engineering elements are included in the plan, (2) identify which HFE elements require NRC review, and (3) evaluate the proposed DAC/ITAAC to be utilized by the NRC to verify each of the review elements. Where GE's D&IPP is found by the staff to be lacking, appropriate elements and DAC/ITAAC must be developed.

The objective of the effort described in this report was to develop a technical basis for the review of the D&IPP. Since a design process review has not been conducted previously by the NRC as part of reactor licensing and is not addressed in the presently available guidance, i.e., NUREG-0800, a firm technical basis for such a review is lacking. Thus, it is important to identify what elements of such a plan are required to assure that safety goals are achieved and to identify the review criteria by which each element can be assessed. This element identification should be accomplished independently from that provided by GE in order to assure that GE's plan reflects currently acceptable human factors engineering practices and that it is a thorough, complete, and workable plan. While it is likely that such guidance will be developed under the proposed update to the Standard Review Plan, that the guidance will not be available in a time frame consistent with the GE review.

The specific objectives of this effort were:

1. To develop a model of the HFE design process which can serve as a technical basis for the review of the D&IPP proposed for certification by GE. The model should be: (1) based upon currently accepted practices, (2) well-defined, and (3) validated through experience with the development of complex, high-reliability systems.

2. To identify necessary HFE elements in a system development, design, and evaluation process that are requisites to successful integration of the human component in complex systems.

3. To identify which of the HFE elements are the key and require review to monitor the process.

4. To specify the design acceptance criteria by which key HFE elements can be evaluated.

2. METHODOLOGY

A technical review of current HFE guidance and practices was conducted to identify important human factors program plan elements relevant to a design process review. Sources reviewed included a wide range of nuclear industry and non-nuclear industry documents, including those currently under development as part of the DoD MANPRINT program. From this review a generic system development, design, and evaluation process was defined. Once specified, key HFE elements were identified and criteria by which they are assessed (based upon a review of current literature and accepted practices in the field of human factors engineering) were developed.

A Generic HFE Program Model was developed based largely on applied general systems theory and the Department of Defense (DoD) system development process which is rooted in systems theory. Applied general systems theory provides a broad approach to system design and development, based on a series of clearly defined developmental steps, each with clearly defined and attainable goals, and with specific management processes to attain them. Kockler et. al. define system engineering as ". . . the management function which controls the total system development effort for the purpose of achieving an optimum balance of all system elements. It is a process which transforms an operational need into a description of system parameters and integrates those parameters to optimize the overall system effectiveness. (Kockler, F., Withers, T., Podiack, J., & Gierman, M., 1990).

Utilization of the DoD system development as an input to the development of the Generic HFE Program Model was based on several factors. Department of Defense (DoD) policy identifies the human as an element of the total system (DoD, 1990a). A system approach implies that all system components (hardware, software, personnel, support, procedures, and training) are given adequate consideration in the developmental process. A basic assumption is that the personnel element receives serious consideration from the very beginning of the design process. In addition, the military has applied HFE for the longest period of time (as opposed to industrial, commercial or other users), thus the process is highly evolved and formalized and represents the most highly developed model available. Finally, since military system development and acquisition is tightly regulated by federal, DoD, and military branch laws, regulations, requirements, and standards, the model provides the most finely grained, specifically defined process available.

Within the DoD system, the development of a complex system begins with the mission or purpose of the system, and the capability requirements needed to satisfy mission objectives. Systems engineering is essential in the earliest planning period to develop the system concept and to define the system requirements. During the detailed design of the system, systems engineering assures:

- balanced influence of all required design specialties;
- resolution of interface problems;
- the effective conduct of trade-off analyses;
- the effective conduct of design reviews;
- the verification of system performance.

Systems engineering ensures the effective integration of HFE considerations into the design by providing a structured approach to system development and a management structure which details the nature of that inclusion into the overall process. The systems approach is iterative, integrative, interdisciplinary and requirements driven.

The systems engineering approach was expanded to develop a Generic HFE Program Model to be used for advanced through the inclusion of NRC regulatory requirements and acceptance criteria specific to the ABWR certification process.

3. RESULTS

3.1 HFE Program Requirements

A Generic HFE Program Model has been developed to serve as the basis for review of the GE ABWR HFE program. The generic model contains 10 elements which include:

- Element A - Human Factors Engineering Program Management
- Element B - Predecessor System Review
- Element C - HFE Issues Tracking
- Element D - Human Reliability Analysis
- Element E - System Functional Requirements Analysis
- Element F - Allocation of Function
- Element G - Task Analysis
- Element H - Human-System Interface Design
- Element I - Plant and Emergency Operating Procedure Development
- Element J - Human Factors Verification and Validation.

The elements and their interrelationships are illustrated in Figure 1. Also illustrated are the minimal set of items submitted to the NRC for review of the COL's HFE efforts. All NRC review items are identified as falling into one of the five review stages:

- HF Management Planning Review
- Implementation Plan Review
- Analysis Results Review
- HSI Results Review
- Human Factors Verification & Validation.

The materials reviewed at each stage are shown in Figure 2.

The specification for the NRC review materials and the acceptance criteria to be used for their evaluation are identified in the draft ITAAC/DAC which follow.

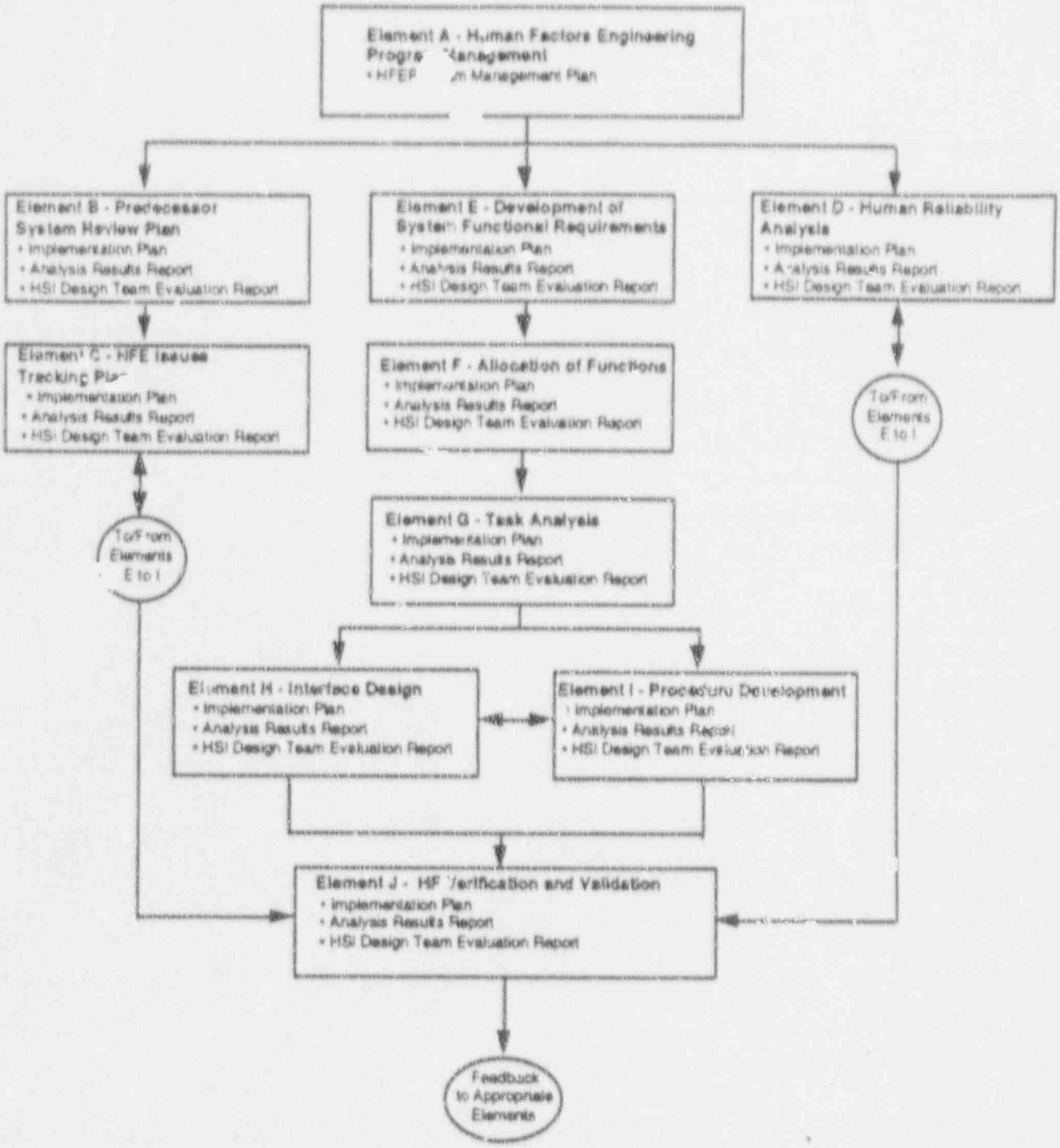

Figure 1. HFE Elements in NPP Design & Tier 1 DAC/ITAAC Structure

(Draft 3/12/92)

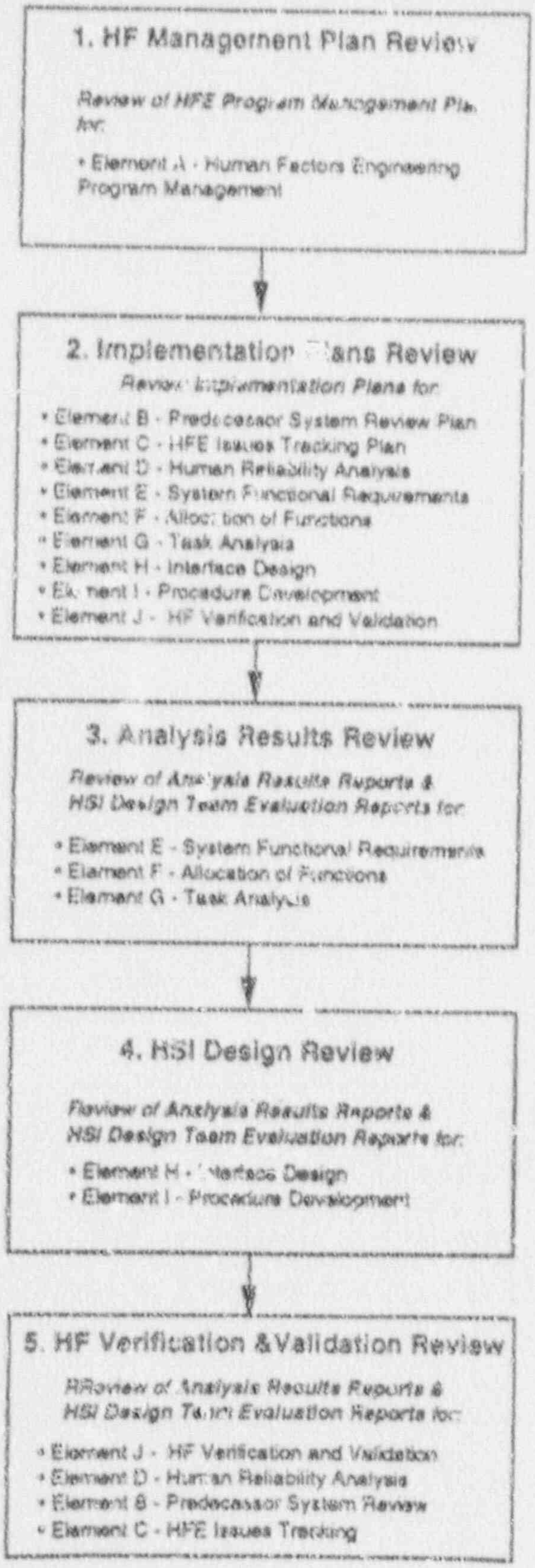

Figure 2. Human Factors Review Stages

(3/12/92)

3.2 Draft ITAAC/DAC Structure

A brief description of the generic structure of the draft ITAAC/DAC are briefly is provided in this section. The draft ITAAC/DAC are contained in Appendix A. For the present drafts, one ITAAC/DAC has been prepared for each element and no distinction has been made between Tiers 1 and 2. Each draft ITAAC/DAC is divided into three sections: Design Commitment, Inspection/Test/Analysis, and Design Acceptance Criteria.

Design Commitment
A concise and general statement as to the HFE objective of the Element is provided in this section.

Inspection/Test/Analysis
A specification of the inspections, tests, analysis, or other actions (i.e., some action that is required but which is not a specific inspection, test, or analysis, such as development of a program plan) taken by the COL to achieve the objective. Generally these are divided into three activities: planning, "analysis", and review. This section also defines those minimal set of materials to be provided to the NRC for review of the elment

Design Acceptance Criteria
This section is typically divided into four sections: General Criteria, Implementation Plan, Analysis Report, and HFE Design Team Review Report. The General Criteria represent the major statement of design acceptance criteria. These are the criteria the ITAAC are required to meet and which should govern the Implementation Plan, Analysis Report, and HFE Design Team Review Report development. The general criteria are derived from three sources:

1. *Regulatory Requirements* - these are the HFE related requirements stated in 10CFR. Since regulatory requirements generally apply to more than one HFE Program element, they are contained in a table (Table Y, at the end of the document) and are referenced as the first general criteria in each section. It must be emphasized that this represents a "coarse screening" of incorporation of regulatory requirements into ITAAC/DAC and further refinement is needed.

2. *Accepted HFE Practices* - these are the criteria derived from the HFE model development and HFE literature and current practices review. Important points are listed in the acceptance criteria and applicable documents are referenced in a table (Table X). This table is not contained in the attached package and is currently under development.

3. *ABWR Specific Criteria* - Up to this point, the model end criteria are generic and can be applied to any advanced reactor. In addition to the generic criteria, the certification process provides commitments that are specific to the design. In this case, these include the list of key HSI elements and the results of the inventory development. Where appropriate, these criteria are listed in the draft ITAAC/DAC and are put in italics for easy identification.

4. Bibliography

The following is a partial list of documents were used in the development of the Generic HFE model and the draft DAC contained in Appendix A. (The full list is being compiled)

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Appendix A

Draft ITAAC/DAC

DESIGN COMMITMENT:
Human-system interfaces (HSI) shall be provided for the operation, maintenance, test, and inspection of the ABWR that reflect "state-of-the-art human factors principles" (10 CFR 50.34(f)(2)(iii)) as required by 10 CFR 52.47(a)(1)(ii). All aspects of HSI shall be developed, designed, and evaluated based upon a structured top-down system analysis using accepted human factors engineering (HFE) principles based upon current HFE practices. HSI is used here in the very broad sense and shall include all operations, maintenance, test, and inspection interfaces, procedures, and training materials.

INSPECTION/TEST/ANALYSIS:
To assure the integration of HFE into system development, a HSI Design Team and a HFE Program Plan shall be established to assure the proper development, execution, oversight, and documentation of the human factors engineering program. The plan shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:
General Criteria
1. The primary goal of the HFE program shall be to developing an HSI which makes possible safe, efficient, and reliable operator performance and which satisfy all regulatory requirements as stated in 10 CFR as identified in Table Y. The general objectives of this program shall be stated in "operator-centered" terms which, as the HFE program develops, shall be objectively defined and shall serve as criteria for test and evaluation activities. Examples of such general "operator-centered" HFE design goals include:

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

- The system and allocation of functions will provide acceptable workload levels to assure vigilance and to assure no operator overload.

- The system will support a high degree of operating crew "situation awareness."

- 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.

- The system will minimize operator memory load.

- The operator interfaces will minimize operator error.

- The system will be error tolerant and will provide for error detection and recovery capability.

2. An HFE Design Team shall be established.

3. The HFE Design Team shall be governed by an HFE team and management plan which defines procedures to:

• Define the scope of the Team's authority within the broader scope of the organization responsible for plant construction. Included within this scope shall be the authority to suspend from delivery, installation, or operation any equipment which is determined by the Team to be deficient in regard to established human factors design practices and evaluation criteria.

• Define the process through which the Team will execute its responsibilities,

• Define the processes through which findings of the Team are resolved and how equipment design changes that may be necessary for resolution are incorporated into the actual equipment ultimately used in the plant.

• Establish the process through which the 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.

4. The HFE team and management plan shall be developed to be fully compliant to the Design Implementation Process as defined by the SSAR and FSER.

HFE Design Team

1. An HFE Design Team shall have the responsibility, authority and placement within the organization to ensure that the design commitment is achieved.

2. The team shall be responsible for (1) the development of all HFE plans and procedures; (2) the oversight and review of all HFE design, development, test, and evaluation activities; (3) the initiation, recommendation, and provision of solutions through designated channels for problems identified in the implementation of the HFE activities; (4) verification of implementation of team recommendations, (5) assurance that all HFE activities comply to the HFE plans and procedures, and (7) scheduling of activities and milestones.

x. The scope of the Team's responsibility shall include:

- Control and instrumentation equipment
- all operations, maintenance, test, and inspection interfaces and facilities both within and outside the control room,
- procedures
- training development.

3. The Team shall have the authority and organizational freedom to ensure that all its areas of responsibility 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, access work areas, design documentation. The Team shall have the authority to assure that further processing, delivery, installation or use of HFE/HSI products is controlled until proper disposition of a non-conformance, deficiency or unsatisfactory condition has been achieved.

4. The HFE Team shall be placed at the level in the COL organization required to execute its responsibilities and authorities. The 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.

5. The HFE Team shall work on an interactive and timely basis with the NSSS and BOP designers and contractors engaged in HFE design-related activities.

6. The HFE design team shall include the following expertise:
(Insert specific GE's Table 18.E.2.1-Part II to elaborate on below)
- Technical Project Management
- Systems Engineering
- Nuclear Engineering
- Control and Instrumentation Engineering
- Architect Engineering
- Human Factors
- Plant Operations
- Computer Systems Engineering
- Plant Procedure Development
- Personnel Training
- Safety Engineering
- Reliability/Availability/Maintainability/Inspectability (RAMI) Engineering

HFE Program and Management Plan

1. The Plan shall be developed to describe how the human factors program shall be accomplished. The plan shall describe the HFE Team's organization and composition and which lays out the effort to be undertaken and provides a technical approach, schedule, and management control structure and technical interfaces to achieve the HFE program objectives. The plan is the single document which describes the designer's entire HFE program, identifies its elements, and explains how the elements will be managed. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element A in Table X.

2. The HFE Program Management Plan shall address the following:
1. Purpose and organization of the plan
2. Literature and current practices review
   - Describe the technical basis for the plan.
3. Overall HFE program goals and objectives
4. The relationship between the HFE program and the overall plant design program (organization and schedule).
5. HFE Team
   - Organization within the HFE program
     - Identify and describe the primary HFE organization or function within the organization of the total program, including charts to show organizational and functional relationships, reporting relationships, and lines of communication
   - Functions and internal structure of the HFE Organization
     - Describe the responsibility, authority and accountability of the HFE organization
     - Identify the organizational unit responsible for each HFE task
     - Describe the process through which management decisions will be made regarding HFE

- Describe the process through which design decisions will be made regarding HFE
- Describe all tools and techniques (e.g., review forms, documentation) to be utilized by the Team to ensure they fulfill their responsibilities

* Staffing
    - Describe the staffing of the HFE Team
    - Provide job descriptions of personnel of the HFE Team
    - Indicate the assignment of key personnel and provide their qualifications with regard to the areas of expertise indicated above

6. HFE requirements
    * Identify and describe the HFE requirements imposed on the design process
    * List the standards and specifications which are sources of HFE requirements
7. HFE program

    Identify and describe HFE participation in the development of implementation plans, analyses, and evaluation/verification of:
    * Predecessor System Review
    * HFE Issues Tracking
    * Human Reliability Analysis
    * System Functional Requirements Development
    * Allocation of Function
    * Task Analysis
    * Interface Design
    * Plant and Emergency Operating Procedure Development
    * HF Verification and Validation
8. HFE program milestones
    * Identify HFE milestones, so that evaluations of the effectiveness of the HFE effort can be made at critical check points and show the relationship to the plant design schedule
    * Provide a program schedule of HFE tasks showing:
        - compliance to the process implementation plan
        - start and completion dates
        - reports
        - reviews
    * Identify integrated design activities applicable to the HFE program but specified in other areas
9. HFE Documentation
    * Identify and briefly describe each required HFE documented item
    * Identify additional HFE data and describe procedures for accessibility and retention.
    * Identify and briefly describe all HFE reports and data to be submitted for NRC review.
    * Describe the supporting documentation and its audit trail maintained for NRC audits
10. HFE in subcontractor efforts
    * Provide a copy of the HFE requirements proposed for inclusion in each subcontract
    * Describe the manner in which the designer proposes to monitor the subcontractor's compliance with HFE requirements

DESIGN COMMITMENT:

Problems and issues encountered in similar systems of previous designs shall be identified and analyzed so that special attention may be given to those problems and issues in the development of the current system in order to avoid their repetition, or in the case of positive features to ensure their retention.

INSPECTION/TEST/ANALYSIS:

• A Predecessor System Review Implementation Plan shall be developed to assure that the analysis is conducted according to accepted HFE principles.

• An analysis of predecessor systems shall be conducted in accordance with the plan and the findings will be documented in an Analysis Results Report.

• The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

• The Predecessor System Review Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element B in Table Y.

2. Problems and issues encountered in similar systems of previous designs shall be identified and analyzed:
    - Human performance issues, problems and sources of human error shall be identified .
    - Design elements which support and enhance human performance shall be identified.

3. The review shall include both a review of literature pertaining the human factors issues related to similar systems and operator interviews.

4. The following sources both industry wide and plant or subsystem relevant should be investigated at a minimum:
    - Government and Industry Studies of Similar Systems
    - Licensee Event Reports
    - Outage Analysis Reports
    - Final Safety Analysis Reports and Safety Evaluation Reports
    - Human Engineering Deficiencies identified in DCRDRs
    - Modifications of the Technical Specifications for Operation
    - Internal Memoranda/Reports as Available

5. The following topics should be included in interviews as a minimum:

- Screen Design Issues
- Data Presentation Formats
- Data Entry Requirements
- Situational Awareness
- Communications
- Procedures
- Staffing and Job Design
- Training

Implementation Plan

1. The plan shall describe the designer's approach to Predecessor System Review. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element B in Table X.

2. At a minimum, the plan shall address the following:

- Literature and current practices review
- Describe the technical basis for the plan
- Documentation review and analysis
- User survey methodology (for conducting interviews) and analysis plans
- Method of documenting lessons learned
- Integration of lessons learned into the design process

Analysis Results Report

At a minimum, the report shall address the following:

- Objectives
- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

DESIGN COMMITMENT:

A method or procedure shall be developed to document and track HFE related problems and concerns. To assure that the system is conducted according to accepted HFE principles, a HFE Issues Tracking Plan shall be developed. The plan shall be based upon accepted HFE practices at the time of its development.

INSPECTION/TEST/ANALYSIS:

- An HFE Issues Tracking Implementation Plan shall be developed to assure that the tracking system is established according to accepted HFE principles.

- An HFE Issues Tracking system shall be maintained in accordance with the plan and the findings will be documented in an Analysis Results Report.

- The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

- The HFE Issues Tracking Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element C in Table Y.

2. The tracking system shall address human factors issues that are (1) generally known to the industry (such as TMI related HF issues and other NRC, industry and generic human factors issues), (2) identified in the Predecessor system review, and (3) those identified throughout the life cycle of the ABWR system design, development and evaluation.

3. The method shall document and track human factors engineering issues and concerns, from identification until elimination or reduction to a level acceptable to the review team.

4. Each issue/concern that meets or exceeds the threshold effects established by the review team shall be entered on the log when first identified, and each action taken to eliminate or reduce the issue/concern should be thoroughly documented. The final resolution of the issue/concern, as accepted by the review team, shall be documented in detail, along with information regarding review team acceptance (eg., person accepting, date, etc.)

5. The tracking procedures shall carefully spell out individual responsibilities when an issue/concern is identified, identify who should log it, who is responsible for tracking the resolution efforts, who is responsible for acceptance of a resolution, and who should enter closeout data.

Implementation Plan

1. The plan shall describe the designer's approach to HFE Issues Tracking. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element C in Table X.

2. The HFE Issues Tracking plan shall address:

- Literature and current practices review
- Responsibilities
  - Responsibilities on Issue Identification
  - Responsibilities for Issue Logging
  - Responsibilities for Issue Resolution
  - Responsibilities for Issue Closeout
- Procedures
  - ISSUE IDENTIFICATION
    - Description
    - Effects
    - Criticality and Likelihood
  - Issue resolution
    - Proposed Solutions
    - Implemented Solution
    - Residual Effects
    - Resultant Criticality and Likelihood
- Documentation
- Audit of the issue identification and tracking system

Analysis Results Report

At a minimum, the report shall address the following:

- Objectives
- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

DESIGN COMMITMENT:

Careful attention shall be given to the identification of those human interactions with the plant systems which are important to plant risk and reliability. A human reliability analysis shall be conducted in support of both HFE/HSI design activities and probabilistic risk assessment activities. The conduct of the analysis and the feedback of the results and findings shall be fully integrated between HFE and PRA teams.

INSPECTION/TEST/ANALYSIS:

• An HRA Implementation Plan shall be developed to assure that the analysis is conducted according to accepted HFE principles.

• An analysis of human reliability shall be conducted in accordance with the plan and the findings will be documented in an Analysis Results Report.

• The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

• The HRA Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element D in Table Y.

2. A thorough documentation system shall be established, including procedures to document the HRA including a description of the analyses, an audit trail for each analysis performed and each human error probability (HEP) derived, supporting rationale and source materials.

3. Specification shall be made of the materials (such as procedural guidance and control room panel design information) to be utilized by the HRA team in order to provide a reasonably accurate understanding of human involvement in the ABWR.

4. Specification shall be made of the human-system analyses utilized by the HRA team (such as screening analyses, detailed task analyses which would provide an understanding of the task requirements and demands on the operating staff, their interfaces with plant equipment, and the time constraints within which critical tasks must be accomplished).

5. The HRA shall address a broad diversity of human interactions with the plant systems and components.

6. Human action shall be adequately modelled within the event and fault trees.

7. Quantification methods and the human error data sources used to estimate human error probabilities (HEP) shall be selected based upon their appropriateness to the types of actions being quantified. Where data from earlier PRAs is to be used in the HRA, the rationale to justify

these generalizations, and if/why/how the values will be modified for use in the HRA shall be made.

8. Performance shaping factors shall be specifically identified and used in HEP quantification.

9. The influences of the advanced technology aspects of the human task allocation and HSI shall be accounted for in the analysis. In addition, specification shall be made of how the modelling will reflect changes in the operator's tasks and role in the system resulting from the increases in system automation.

10. Critical human actions shall be quantified by the HFE review team (or their designee) independently from the primary HFE team to serve as a verification of their values.

11. Sensitivity and uncertainty analyses shall be performed on the HEP values.

12. The HRA effort shall be thoroughly integrated with the development of the PRA. The insights gained from the analyses will be factored into system/operational design.

Implementation Plan

1. The plan shall describe the designer's approach to HRA. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element D in Table X.

2. The HRA Implementation Plan shall address:

- Literature and current practices review
- Documentation Procedures
- Material Available to Support the HRA Team
- Use of Human-System Analyses (completed as part of HFE design)
- Types of Human Task Actions Analyzed
- Adequacy of the Human Action Modelling
- Quantification Methods Used to Estimate HEPS
- Evaluation of Performance Shaping Factors
- Treatment of Advanced Technology
- Utilization of Human Error Data Sources
- Basis for Generalization from Earlier PRAs
- Approach to Sensitivity Modelling
- Utilization of Insights Gained from the Analyses and assurance of bidirectional feedback between the PRA and HFE organizations.

Analysis Results Report

At a minimum, the report shall address the following:

- Objectives
- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

DESIGN COMMITMENT:
Sy m requirements shall be analyzed to identify those functions which must be performed to s 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 plan and the findings will be documented in an Analysis Results Report.

• The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

• The System Functional Requirements Analysis Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:
General Criteria
1. The analysis shall meet all 10CFR regulatory requirements as specified under Element E in Table Y.

2. System requirements shall determine system functions, and the function itself shall determine what performance is necessary to carry out that function.

3 The system function requirements shall utilize the results of the precertification analyses as contained in the SSAR, GE design files, and in the system analyses utilized to derive the Inventory.

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

5. Those functions identified as safety functions shall be identified and their functional relationship with non-safety systems shall be identified.

6. 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.

7. Functions shall be described initially in graphic form, since graphic representation generally is more effective is presenting loosely defined material in an easily understood manner. Function diagramming is typically done at several levels, starting at a "top level"

where a very gross picture of major functions is described, and continuing to decompose major functions to several lower levels until a specific critical end-item requirement will emerge, e.g., a piece of equipment, software, or an operator.

8. 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), 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 areas. In addition, the alternatives available if correct functioning is lost shall be specified along with and how alternatives can be chosen.

9. Functional operations or activities shall minimally include:
- detecting signals
- measuring information
- comparing one measurement with another
- processing information
- acting upon decisions to produce a desired condition or result on the system or environment (e.g., system and component operation, actuation, and trips)

10. The function analysis shall continue over the life cycle of design development.

11. Verification
- All the functions necessary for the achievement of operational and safety goals are identified.
- All requirements of each function are identified.

__Implementation Plan__

1. The plan shall describe the designer's approach to System Functional Requirements Analysis. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element D in Table X.

2. The System Functional Requirements Analysis Implementation Plan shall address:
- Literature and current practices review
  - Describe the technical basis for the plan.
- List required system level functions
  - Based on System Performance Requirements
- Graphic function descriptions
  - e.g., Functional Flow Block Diagrams and Time Line Diagrams
- Detailed function narrative descriptions

  Describe:
  - Observable Parameters Which Will Indicate System Status
  - Control Process and Performance Measures Required to Achieve the Function
  - How to Determine Correct Discharge of Function
  - What Alternatives are Available if Correct Functioning is Lost and How Alternatives Can Be Chosen

• Analysis

- Define an integration of subfunctions that are closely related so that they can be treated as a unit
  - Divide identified subfunctions into two groups
    - Common achievement is an essential condition for the accomplishment of a higher level function
    - Alternative supporting functions to a higher level function or whose accomplishment is not necessarily a requisite for higher level function
  - Identify for each integrated subfunction:
    - Logical requirements for accomplishment (Why accomplishment is required)
    - Control actions necessary for accomplishment
    - Parameters necessary for control action
    - Criteria for evaluating the result of control actions
    - Parameters necessary for the evaluation
    - Evaluation criteria
    - Criteria for choosing alternatives
  - Identify characteristic measurement and define for each measurement important factors such as Load, Accuracy, Time factors, Complexity of action logic, Types and complexities of decision making, Impacts resulting from the loss of function and associated time factors

• Verification

- Describe the approach to system function verification

Analysis Results Report

At a minimum, the report shall address the following:

- Objectives
- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

DESIGN COMMITMENT:

The HFE organization shall insure that allocation takes advantage of human strengths and avoids allocating functions which would be impacted by human limitations. To assure that the allocation of function is conducted according to accepted HFE principles, a structured and well-documented methodology of allocating functions to personnel, system elements, and personnel-system combinations shall be developed and detailed in a HFE Issues Tracking Plan. The plan shall be based upon accepted HFE practices at the time of its development.

INSPECTION/TEST/ANALYSIS:

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

• An analysis of Allocation of Function shall be conducted in accordance with the plan and the findings will be documented in an Analysis Results Report.

• The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

• The Allocation of Function Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element F in Table Y.

2. All aspects of system and functions definition must be analyzed in terms of resulting human performance requirements based on the expected user population.

3. The allocation of functions to personnel, system elements, and personnel-system combinations shall be made reflect (1) sensitivity, precision, time, and safety requirements, (2) required reliability of system performance, and (3) the number and level of skills of personnel required to operate and maintain the system.

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

5. As alternative allocation concepts are developed, analyses and trade studies shall be conducted to determine optimum configurations of personnel- and system- performed functions. Analyses should confirm that the personnel elements can properly perform tasks allocated to them and assure appropriate operator situation awareness, workload, and vigilance. Proposed function assignment shall take the maximum advantage of the capabilities of human and machine without imposing unfavorable requirements on either.

6. Functions shall be re-allocated in an iterative manner, in response to developing design specifics and the outcomes of on-going analyses and trade studies.

7. Function assignment shall be evaluated.

Implementation Plan

1. The plan shall describe the designer's approach to Allocation of Function. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element F in Table X.

2. The Allocation of Function Implementation Plan shall address:

- Literature and current practices review
- Establishment of a structured basis for function allocation
- Alternative systems analyses
  - Specification of criteria for selection
- Trade studies
  - Define objectives and requirements
  - Identify alternatives
  - Formulate selection criteria
  - Weight criteria
  - Prepare utility functions
  - Evaluate alternatives
  - Perform Sensitivity Check
  - Select Preferred Alternatives
- Iterative allocation
  - The basis of iterative allocation shall be defined.
- Evaluation of function assignment
  - The plan shall describe the tests and analyses that will be performed to evaluate the function allocation

Analysis Results Report

At a minimum, the report shall address the following:

- Objectives
- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

DESIGN COMMITMENT:

Task analysis shall provide the systematic study of the behavioral requirements of the tasks the personnel subsystem is required to perform in order to achieve the functions allocated to them. The task analysis shall:

- provide one of the bases for making design decisions; e.g., determining before hardware fabrication, to the extent practicable, whether system performance requirements can be met by combinations of anticipated equipment, software, and personnel,
- assure that human performance requirements do not exceed human capabilities,
- be used as basic information for developing procedures,
- be used as basic information for developing manning, skill, training, and communication requirements of the system, and
- 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 plan and the findings will be documented in an Analysis Results Report.

- The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

- The Task Analysis Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element G in Table Y.

2. The scope of the task analysis shall include all operations, maintenance, test and inspection tasks. The analyses shall be directed to the full range of plant operating modes, including start-up, normal operations, abnormal operations, transient conditions, low power and shutdown conditions. The analyses shall include tasks performed in the control room as well as outside of the control room.

3. A task shall be a group of activities that have a common purpose, often occur in temporal proximity, and which utilize the same displays and controls.

4. . The analysis shall link the identified and described tasks in operational sequence diagrams. A review of the descriptions and operational sequence diagrams shall reveal which tasks can be considered "critical" in terms of importance for function achievement, potential for human

error, impact of task failure, etc. Where critical functions are automated, the analyses shall consider all human tasks including monitoring of an automated safety system and back-up actions if it fails.

5. Task analysis shall begin on a gross level and involve the development of detailed narrative descriptions of what personnel must do. Task analyses shall be defined the nature of the input, process, and output required by and of personnel. Detailed task descriptions shall address (as appropriate):

- Information Requirements
  - -Information required, including cues for task initiation
  - -Information available
- Decision-Making Requirements
  - -Description of the decisions to be made (relative, absolute, probabilistic)
  - - Evaluations to be performed
  - -Decisions that are probable based on the evaluation (opportunities for cognitive errors, such as capture error, will be identified and carefully analyzed)
- Response Requirements
  - -Action to be taken
  - - Overlap of task requirements (serial vs. parallel task elements)
  - -Frequency
  - -Speed/Time line requirements
  - -Tolerance/accuracy
  - -Operational limits of personnel performance
  - -Operational limits of machine and software
  - -Body movements required by action taken
- Feedback Requirements
  - -Feedback required to indicate adequacy of actions taken
- Workload
  - - Cognitive
  - - Physical
  - - Estimation of difficulty level
- Task Support Requirements
  - - Special/protective clothing
  - - Job aids or reference materials required
  - -Tools and equipment required
  - - Computer processing support aids
- Workplace Factors
  - -Workspace envelope required by action taken
  - -Workspace conditions
  - -Location and condition of the work
  - -Environment/habitability
- Staffing and Communication Requirements
  - -number of personnel, their technical specialty, and specific skills
  - - Communications required, including type
  - -Personnel interaction when more than one person is involved
- Hazard Identification
  - -Identification of Hazards involved

6. The task analysis shall be iterative and become progressively more detailed over the design cycle. The task analysis shall be detailed enough to identify information and control

requirements to enable specification of detailed requirements for alarms, displays, data processing, and controls for human task accomplishment.

7. The task analysis shall be used to specify the procedures for operations (normal, abnormal, and emergency), test, maintenance and inspection.

8. The task analysis results shall provide input to the personnel training programs.

9. The task analysis shall utilize the results of the precertification analyses as contained in the SSAR, GE design files, and in the system analyses utilized to derive the Inventory.

<u>Implementation Plan</u>

1. The plan shall describe the designer's approach to task analysis. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element G in Table X.

2. The Task Analysis Implementation Plan shall address:

- Literature and current practices review
- General methods and data sources
- Gross task analysis
  - Convert Functions to Tasks
  - Develop Narrative Task Descriptions
    - General statement of task functions
    - Detailed task descriptions
    - Breakdown of tasks to individual activities
  - Develop Operational Sequence Diagrams
- Critical task analysis
  - Identification of Critical Tasks
  - Detailed Task Descriptions
- Information and control requirements
- Initial alarm, display, processing, and control requirements analysis
  - Develop a task-based I&C inventory
- Application of task analysis results to procedure development
- Application of task analysis results to training development
- Evaluation of task analysis
  - The plan shall describe the methods that will be used to evaluate the results of the task analysis.

<u>Analysis Results Report</u>

At a minimum, the report shall address the following:

- Objectives
- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

DESIGN COMMITMENT:
Human engineering principles and criteria shall be applied along with all other design requirements to identify, select, and design the particular equipment to be operated/maintained/controlled by plant personnel.

INSPECTION/TEST/ANALYSIS:

• A Human-System Interface Design Implementation Plan shall be developed to assure that the analysis is conducted according to accepted HFE principles.

• An analysis of Human-System Interface Design shall be conducted in accordance with the plan and the findings will be documented in a Analysis Results Report.

• The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

• The Human-System Interface Design Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element H in Table Y.

2. The design configuration shall satisfy the functional and technical design requirements and insure that the HSI will meet the appropriate HFE guidance and criteria.

3. The HFE effort shall be applied to HSI both inside and outside of the control room (local HSI).

4. HSI design shall utilize the results of the task analysis and the I&C inventory to assure the adequacy of the HSI.

5. The HSI and working environment shall be adequate for the human performance requirements it supports. The HSI shall be capable of supporting critical operations under the worst plausible environmental conditions.

6. The HSI shall be free of elements which are not required for the accomplishment of any task.

7. The selection and design of HSI hardware and software approaches shall be based upon demonstrated criteria that maximize human task performance and minimize errors. Criteria can be based upon test results, demonstrated experience, and trade studies of identified options.

8. HFE standards shall be employed in HSI selection and design. Human engineering guidance regarding the design particulars shall be developed to (1) insure that the human-system interfaces are designed to currently accepted HFE guidelines and (2) insure proper consideration of human capabilities and limitations in the developing system. This guidance

shall be derived from sources such as expert judgement, design guidelines and standards, and quantitative (e.g., anthropometric) and qualitative (e.g., relative effectiveness of differing types of displays for different conditions) data. Procedures shall be employed to ensure HSI adherence with standards.

9. HFE/HSI problems shall be resolved using studies, experiments, and laboratory tests, e.g.,
   - Mockups and models may be used to resolve access, workspace and related HFE problems and incorporating these solutions into system design
   - Dynamic simulation and HSI prototypes shall be evaluated for use to evaluate design details of equipment requiring critical human performance
   - The rationale for selection of design/evaluation tools shall be documented

10. Human factors engineering shall be applied to the design of equipment and software for maintainability, testing and inspection.

11. HSI design elements shall be evaluated to assure their acceptability for task performance and HFE, criteria, standards, and guidelines.

12. The HSI design shall incorporate the key HSI elements as defined in the SSAR and FSER.
   - *include list and description of key features*
   - *include valve position indication position*

13. The HSI design shall incorporate the I&C inventory as defined in the SSAR.
   - *include summary table of inventory items*

<u>Implementation Plan</u>

1. The plan shall describe the designer's approach to Human-System Interface Design. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element H in Table X.

2. The Human-System Interface Design Implementation Plan shall address:
   - literature and current practices review
   - I&C requirements analysis and design
     - Compare Task Requirements to I&C Availability
     - Modifications to I&C Inventory
   - General HSI approach selection
     - Trade Studies
     - Analyses
   - The criteria to be used to meet General Criterion # 7, described above
   - HFE design guidance development and documentation
   - HSI detailed design and evaluations
     - Use of design/evaluation tools such as prototypes shall be specifically identified and rationale for selection

<u>Analysis Results Report</u>

At a minimum, the report shall address the following:
   - Objectives

- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

** Under construction -Ignore this DAC for now - Proceed to Element J **

DESIGN COMMITMENT:

To assure that procedures reflect accepted HFE principles, a Plant and Emergency Operating Procedure Development Plan shall be developed. The plan shall be based upon accepted HFE practices at the time of its development.

INSPECTION/TEST/ANALYSIS:

• A ?? Implementation Plan shall be developed to assure that the analysis is conducted according to accepted HFE principles.

• An analysis of ?? shall be conducted in accordance with the plan and the findings will be documented in an Analysis Results Report.

• The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

• The ?? Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The task analysis shall be used to specify the procedures for operations (normal, abnormal, and emergency), test, maintenance and inspection.

Implementation Plan

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element I in Table \.

1. The plan shall describe the designer's approach to . The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element I in Table X.

2. The ?? Implementation Plan shall address:

Analysis Results Report

At a minimum, the report shall address the following:

- Objectives
- Description of the Methods
- Identification of any deviations from the implementation plan
- Results and Discussion
- Conclusions
- Recommendations/Implications for HSI Design

HFE Design Team Evaluation Report

At a minimum, the report shall address the following:

- The review methodology and procedures
- Compliance with Implementation Plan Procedures
- Review findings

DESIGN COMMITMENT:

The successful incorporation of human factors engineering into the final HSI design process and the acceptability of the resulting HSI shall be thoroughly 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 analysis is conducted according to accepted HFE principles.

• An analysis of Human Factors Verification and Validation shall be conducted in accordance with the plan and the findings will be documented in an Analysis Results Report.

• The analyses shall be reviewed by the HFE Design Team and shall be documented in an Evaluation Report.

• The Human Factors Verification and Validation Implementation Plan, Analysis Results Report, and HFE Design Team Evaluation Report shall be submitted to the NRC for review and approval.

DESIGN ACCEPTANCE CRITERIA:

General Criteria

1. The analysis shall meet all 10CFR regulatory requirements as specified under Element J in Table Y.

2. The evaluation shall verify that the performance of the HSI, when all elements are fully integrated into a system, meets (1) all HFE design goals as established in the program plan; and (2) all system functional requirements and properly support human operations, maintenance, test, and inspection task accomplishment.

3. The evaluation shall address at a minimum:
   - Human-Hardware interfaces
   - Human-software interfaces
   - Procedures
   - Workstation and console configurations
   - Control room design
   - Local control station design
   - Design of the overall work environment

4. Individual HSI elements shall be evaluated in a static and/or "part-task" mode to assure that all appropriate controls, displays, and data processing that are required are available and that they are designed according to generally accepted HFE guidelines, standards, and principles.

5. The integration of HSI elements with each other and with personnel shall be evaluated and validated through dynamic task performance evaluation using evaluation tools which are appropriate to the accomplishment of this objective. It is expected that a fully functional HSI prototype and plant simulator shall be used as part of these evaluations. If an alternative is

proposed its acceptability shall be documented in the implementation plan and approved by the staff in advance of testing. The evaluations shall have as their minimum objectives:

- Adequacy of entire HSI configuration for achievement of safety goals
- Confirm allocation of function and the structure of tasks assigned to personnel
- Adequacy of staffing and the HSI to support staff to accomplish their tasks.
- Adequacy of Procedures
- Confirm the adequacy of the dynamic aspects of all interfaces for task accomplishment
- Evaluation and demonstration of error tolerance to human and system failures

6. Dynamic evaluations shall evaluate HSI under a broad range of operational conditions and upsets, including at a minimum:

- Normal plant evolutions (e.g., start-up, full power, and shutdown operations)
- Instrument Failures (e.g., Safety System Logic & Control (SSLC)Unit, Fault Tolerant Controller (NSSS), Local "Field Unit" for MUX system, MUX Controller (BOP), Break in MUX line)
- HSI equipment and processing failure (e.g., loss of VDUs, loss of data processing, loss of large overview display)
- Transients (e.g., Turbine Trip, Loss of Offsite Power, Station Blackout, Loss of all FW, Loss of Service Water, Loss of power to selected buses/CR power supplies , and SRV transients)
- Accidents (e.g., Main steam line break, Positive Reactivity Addition, Control Rod Insertion at power, Control Rod Ejection, ATWS, and various-sized OCAs)

7. Performance measures for dynamic evaluations shall be adequate to test the achievement off all objectives, design goals, and performance requirements and shall include at a minimum:

- System performance measures relevant to safety
- Crew Primary Task Performance (e.g., task times, procedure violations)
- Crew Errors
- Situation Awareness
- Workload
- Crew communications and coordination
- Anthropometry evaluations
- Physical positioning and interactions

8. A verification shall be made that all issues documented in the Human Factors Issue Tracking System have be adequately addressed.

9. A verification shall be made that all critical human actions as defined by the HRA have be adequately supported in the design. The design of tests and evaluations to be performed as part of HFE V&V activities shall specifically examine these actions.

<u>Implementation Plan</u>

1. The plan shall describe the designer's approach to Human Factors Verification and Validation. The plan shall be based upon accepted HFE practices at the time of its development. The plan shall be based upon a review and identification of current practices and literature, including those documents under Element I in Table X.

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

- HSI element evaluation

- Control, Data Processing, Display audit
- Comparison of HSI element design to HFE guidelines, standards, and principles

• Dynamic performance evaluation of fully integrated HSI
  - General Objectives
  - Test methodology and procedures
  - Test participants (operators to participate in the test program)
  - Test Conditions
  - HSI description
  - Performance measures
  - Data analysis
  - Criteria for evaluation of results
  - Utilization of evaluations

• Documentation requirements
  - Test & Evaluation Plans and Procedures
  - Test Reports

<u>Analysis Results Report</u>

At a minimum, the report shall address the following:

• Objectives
• Description of the Methods
• Identification of any deviations from the implementation plan
• Results and Discussion
• Conclusions
• Recommendations/Implications for HSI Design

<u>HFE Design Team Evaluation Report</u>

At a minimum, the report shall address the following:

• The review methodology and procedures
• Compliance with Implementation Plan Procedures
• Review findings

Table Y
Human Factors Requirements in 10 CFR

(2 pages)

10 CFR REFERENCES	HFE ELEMENTS
Part 20: Standards for Protection Against Radiation	
20.203 - Caution signs, labels, signals, and controls.	H,I,B
20.207 - Storage and control of licensed materials in unrestricted areas.	B,E
Part 50: Domestic Licensing of Production and Utilization Facilities	
50.34 (f) - Additional TMI-related Requirements. Consider all sections but particularly:	
(1)(i) - Site specific PRA	D
(1)(v) - HPCI/RCIC initiation levels	B,E,F,G,I
(1)(vi) - Reduction of challenges to relief valves	B,E,G,H,I
(1)(vii) - Elimination of manual activation of ADS	B,E,F,G,H,I
(1)(viii) - Automation issues of ECCS restart	B,E,F,G,H,I
(1)(xi) - Depressurization methods	B,E,F,G,H,I
(1)(xii) - Hydrogen control systems	B,E,F,G,H,I
(2)(i) - Control room simulator	B,E,J
(2)(ii) - Improved plant procedures	I
(2)(iii) - Control room design that reflects state-of-the-art human factors principles	A
(2)(iv) - SPDS	B,E,F,G,H,I
(2)(v) - Indication of bypassed & inoperable systems	B,E,F,G,H,I
(2)(vi) - Vent systems in the control room	B,E,F,G,H,I
(2)(xi) - Indication of relief valves in control room	B,G,H
(2)(xvi) - ECCS & RPS actuation cycles	B,E,F,G,H,I
(2)(xvii) to (xix) - post accident instrumentation in control room	B,E,G,H,I
(2)(xxi) - Heat removal system controls	B,E,F,G,H,I
(2)(xxiv) - Reactor vessel level instrumentation	B,G,H,I
(2)(xxv) - TSC, OSC, and EOF	A,B,E,G,H,I
(2)(xxvii) - Radiation monitoring	B,E,F,G,H,I
(2)(xxviii) - Control room radiation protection	B,E,
(3)(i) - Incorporation of operating, design and construction experience	A,B
(3)(vii) - Management controls during design and construction	A,C,J
50.34a - Design objectives for equipment to control releases of radioactive material in effluents	B,E,F
50.44(iii) - High point vents in RCS, operable from control room	B,E,F,G,H,I
50.47 - Emergency planning, including procedures, facilities, etc.	B,E,G,H,I
50.48 - Fire Protection, references Appendix R and includes safe reactor shutdown requirements outside the main control room	B,E,F,G,H,I
50.54 - Conditions of licenses, contains control room staffing requirements	B,E,F,G
50.55a - Codes and standards - establishes inservice inspection and testing requirements, which should be considered when designing outside control room equipment and interfaces	B,E,G,H,I
50.62 - ATWS requirements, includes system specifications such as independence, reliability and automation	B,E,F,G,H,I
50.63 - Loss of all alternating current power, requires analyses, equipment and procedures	B,E,F,G,H,I

Appendix A - General Design Criteria for Nuclear Power Plants Throughout the GDC there are inspection and testing requirements specified for the various systems. These must be considered when designing the HSI throughout the plant. Some added specific criteria, as follows are also important.	A
12. Suppression of reactor power oscillations - They must be readily detected and suppressed	B,E,F,G,H,I
13. Instrumentation and control - Specifies I&C for variables and systems	B,E,G,H,I
19. Control Room - Specifies both a normal and remote control room	A,E
26. and 27. Reactivity control - Requires reliable control of reactivity changes	B,E,F,G,H,I
64. Monitoring radioactivity releases - Establishes monitoring requirements	B,E,G,H,I
Appendix B - Quality Assurance Criteria - Establishes design control and other pertinent QA requirements	All
Appendix E - Emergency Planning - Establishes many pertinent EP requirements for facilities, procedures, etc.	A,B,E
Appendix I - ALARA Guides - Provides guidance for radiation dose reduction, which is particularly pertinent to the design stage of a NPP.	A,B,F,G,H,I,J
Appendix J - Primary containment leakage rate testing - This section is also pertinent to the design stage outside the control room. Existing provisions for LRT in NPPs consider human factors only marginally.	B,E,G,H,I
Part 52 - Early site permits; standard design certifications; and combined licenses for nuclear power plants. This part establishes the requirements for advanced reactors and is particularly relevant.	A
Part 55 - Operators' licenses - Subpart E - Written examinations and tests - Discusses source of information for required operator knowledge, skills and abilities.	I
Part 73 - Physical protection of plants and materials - Details protection and security requirements, which in existing plants have caused significant operational conflicts. These must be carefully considered at the design stage from a human engineering standpoint to avoid repetition of these problems.	A,B,E,G,H,I

DEFENSE-IN-DEPTH AND DIVERSITY ASSESSMENT OF THE ABWR INSTRUMENTATION AND CONTROL SYSTEMS

- POTENTIAL COMMON MODE FAILURES/VULNERABILITIES
- REVIEW BASED UPON NUREG-0493 "A DEFENSE-IN-DEPTH AND DIVERSITY ASSESSMENT OF THE RESAR-414 INTEGRATED PROTECTION SYSTEM" (1979)
- LLNL STUDY OF THE ABWR SSAR AND ADDITIONAL INFORMATION PROVIDED BY GE
- LLNL STUDY EVALUATED ALL CHAPTER 15 EVENTS
- TWO EVENTS SELECTED AS PILOT CASES
- GENERATOR LOAD REJECTION WITH NORMAL BYPASS
- STEAM SYSTEM PIPING BREAK OUTSIDE CONTAINMENT
- SYSTEMS ASSUMPTIONS HAVE BEEN REVIEWED BY LLNL/SICB/RSB/PSB AND GE
- ASSUMPTIONS OF ANTICIPATED OPERATOR ACTIONS HAVE NOT YET BEEN REVIEWED BY OPERATIONS OR HUMAN FACTORS

A DEFENSE-IN-DEPTH AND DIVERSITY ASSESSMENT OF THE RESAR-414 INTEGRATED PROTECTION SYSTEM

Date Published: MARCH 1979

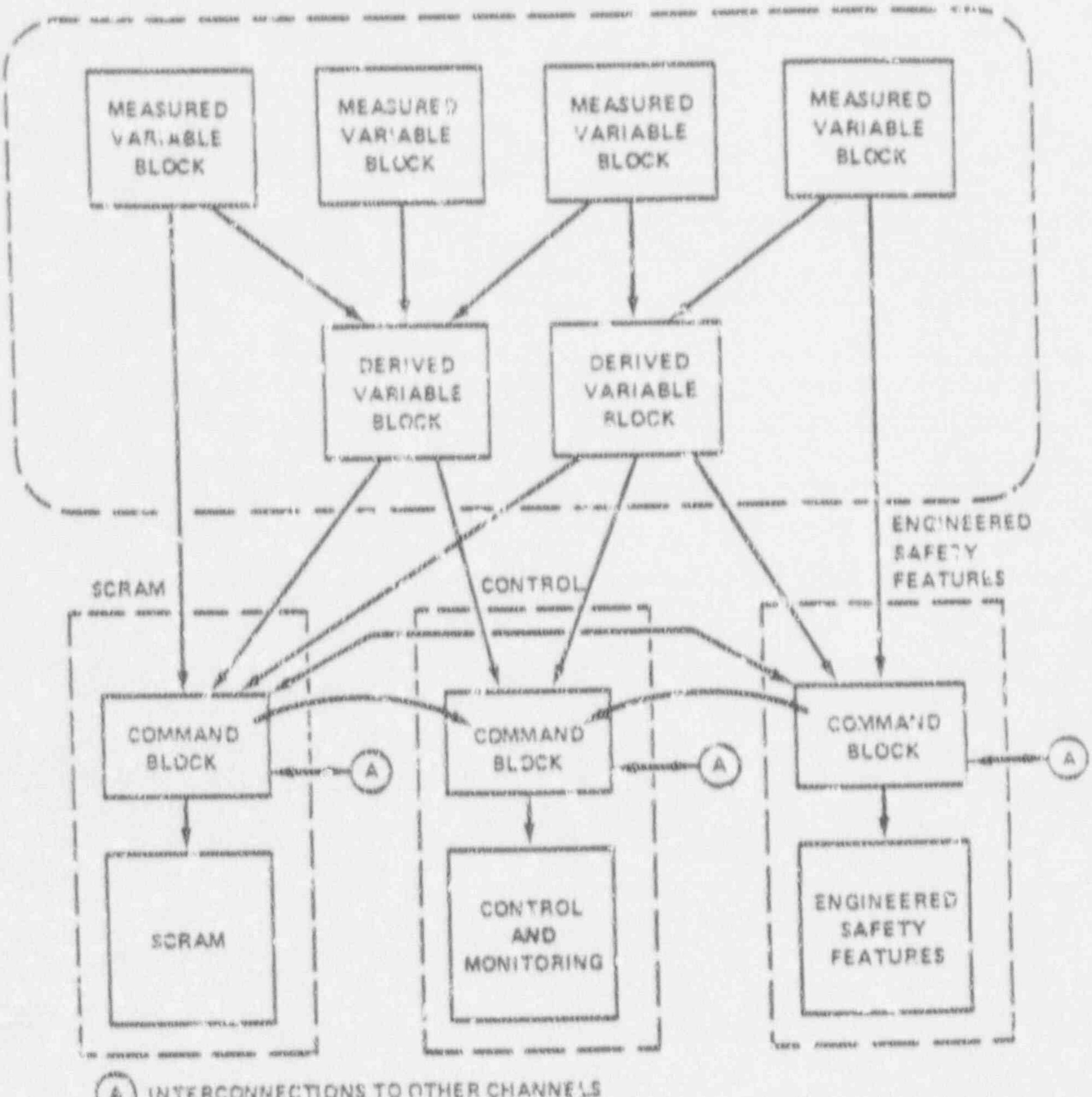

Figure 2. Basic System Architecture for Evaluation of Defense-in-Depth Principle.

Event 15.6.4

Plant Parameter \ CMF Groups	351A-D Narrow level	353A-D Wide level	353E-H Wide level	Drywell Pressure	RPV Pressure	PRRM (MSL rad.)	APRM (n/n rad.)	MSIV Position	Steam Tunnel Temperature	Turbine Room Temperature	Steam Line Flow	MPX	DTM	TLU	Turbine Sto Valve Switc	Turbine Co Valve Switc	Turbine Oil Pressure			Legend: blank - not involved or not affected; 0 - not available due to postulated CMF; 1 to 11 - actual initiating parameter
1 Low Water Level	0/	O	O									O	O	O						ECCS initiator
2 RPV High Pressure					O							O	O	O						Secondary scram initiator
3 High Water Level	/0																			
4 High Reactivity							O							O						Secondary scram initiator
5 High MSL Radiation																				
6 MSLIV								O					O	O						Primary scram initiator
7 Steam Tunnel Temperature									O			O	O	O						Secondary MSIV initiator
8 Turbine Room Temperature										O		O	O	O						Secondary MSIV initiator
9 Steam Line Flow											O	O	O	O						Primary MSIV initiator
10 Turbine Valves Closing																				
11 Low Turbine Inlet Pressure												O	O	O						Tertiary MSIV initiator
Mitigation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
Scram	6	6	6		6		6	2/4	6	6	6	O	O	O						
ARI												O	O	O						
HPCF	9/1	O	1		1		1	1	1	1	1	O	O	O						Secondary core cooler
RCIC	9/1	1	O		1		1	1	1	1	1	O	O	O						Primary core cooler
LPFL	O	O	O									O	O	O						Unavailable because ADS will not initiate
SLCS																				
MSLIV	9	9	9		9		9	9	9	9	7/8	O	O	O						
ADS	O	O	O									O	O	O						ADS is required for LPFL
SRV																				
Information												O	O	O						

ABWR DESIGN CERTIFICATION

ITAAC - GE VIEW OF STATUS

- o SYSTEM ITAAC SCOPE, FORM AND CONTENT ESTABLISHED VIA PILOTS
  - GE IN PRODUCTION MODE

- o GENERIC ITAAC
  - GE POSITION ON THE TABLE
  - GE PROPOSALS ON EQ, SETPOINTS, SOFTWARE BEFORE NRC (SSLC LATER)
  - NO GE/NRC AGREEMENT ON TOTAL LIST

- o DAC ACTIVITIES
  - PIPING, RADIATION PROTECTION MOVING TOWARD RESOLUTION (NO MAJOR DIFFERENCES)
  - HFE STALLED

- o ON CURRENT SCHEDULE, ALL GE TIER 1 PROPOSALS TO BE SUBMITTED BY 5/31/92

AJJ
3/25/92

INTERFACES - PLANS FOR CONCEPTUAL DESIGN

- Initiate descriptive information following final agreement on what items are Part 52 interfaces

- Prepare similar to ultimate heat sink (SSAR Section 9.2.5) as appropriate

  - Safety design bases (interfaces requirements)
  - Power generation design bases (interface requirements)
  - System description (conceptual design)
  - System operation/performance (conceptual design)
  - Performance evaluation (interface requirements)
  - Safety evaluation (interface requirements)
  - Other (interface requirements)

- Submittal by May 15, 1992

ABWR DESIGN CERTIFICATION

ITAAC'S - OTHER ISSUES NEEDING DISCUSSION

DOCUMENTATION STRUCTURE

- o PROCEEDING PER STAGE 2 OUTLINE
  - 5 SECTION REPORT COVERING ALL ITAAC-RELATED ISSUES
  - FULL SET OF TIER 1 MATERIAL (GE PROPOSAL)
  - HEAVY INVESTMENT IN THIS FORMAT; STRUCTURAL CHANGES WILL BECOME INCREASINGLY BURDENSOME

- o NRC REVIEW/CONCURRENCE REQUESTED

ROADMAPS

- o SAMPLE IN STAGE 2 SUBMITTAL (CHAPTER 6/CHAPTER 15 ANALYSIS VERIFICATION)

- o GE HOLDING ON OTHERS PENDING NRC COMMENTS ON SAMPLE

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ABWR DESIGN CERTIFICATION

ITAAC'S - OTHER ISSUES NEEDING DISCUSSION

INTERFACE ITAAC (PER PART 52)

- ULTIMATE HEAT SINK
- GRID CHARACTERISTICS

DISPOSITION OF SAR INTERFACE ITEMS

- CASE-BY-CASE DISPOSITION; SOME ITEMS MAY INVOLVE ITAAC
- HANDLE BY EXISTING SYSTEM, GENERIC STRUCTURE
- NO SPECIAL ITAAC CATEGORY

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ABWR DESIGN CERTIFICATION

ITAAC'S - OTHER ISSUES NEEDING DISCUSSION

GENERIC ITAAC/DAC LIST

CANDIDATE	GE VIEW
SEISMIC CATEGORY 1 STRUCTURES	PER BUILDING ITAAC
EQUIPMENT QUALIFICATION	GENERIC ITAAC
INSTRUMENT SETPOINTS	GENERIC ITAAC
SOFTWARE	GENERIC ITAAC
SSLC	GENERIC ITAAC
MUX (EMS AND NEMS)	SYSTEM ITAAC
HFE	DAC
RADIATION PROTECTION	DAC
PIPING	DAC
FLOODING MISSILES FIRE PROTECTION PIPE BREAKS	COVER AS REQUIRED IN SYSTEMS
WELDING, REBAR, CABLE TRAYS, ETC.	NO TIER 1 TREATMENT

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ABWR DESIGN CERTIFICATION

STATUS OF STAGE 2

o DRAFT SENT INFORMALLY TO NRC 3/20/92. MISSING ONLY:

- REACTOR BUILDING
- SOME FIGURES

o CURRENT PLAN IS TO SUBMIT COMPLETE ON SCHEDULE 3/31/92

- FORMAL DOCKET SUBMITTAL

o GE ANTICIPATED FORMAL NRC COMMENTS (DATE?)

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3/25/92

ABWR DESIGN CERTIFICATION

PROPOSED ITAAC SUBMITTAL SCHEDULE

STAGE	SUMMARY OF CONTENTS	SUBMIT DATE
1	9 PILOTS SAMPLE GENERIC SAMPLE DAC	COMPLETED 1/17/92
2	GENERAL DESCRIPTION 38 SYSTEMS (TOTAL) 3 GENERIC ITAAC 3 DAC 1 INTERFACE ITAAC 1 ROADMAP	3/31/92
3	COMPLETE TIER 1 SET	5/31/92

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		DD	ITAAC	STAGE	COVE ELSE
3.0	Generic ITAAC				
3.1	Equipment Qualification (EQ)	✓	✓	2	
3.2	Instrument Setpoint Methodology	✓	✓	2	
3.3	Piping Design	✓	✓	2	
3.4	SSLC	✓	✓	3	
4.0	Design Acceptance Criteria				
4.1	Software Development	✓	✓	2	
4.2	Man-Machine Interface Systems (MMIS) Design Team DAC ITAAC		(*)		
4.3	Radiation Protection DAC ITAAC	✓	✓	2	
5.0	Interface ITAAC				
5.1	Ultimate Heat Sink	✓	✓	2	

(*) STALLED.

ABWR DESIGN CERTIFICATION

SYSTEM TIER 1 MATERIAL

	DD ENTRIES	ITAAC ENTRIES
STAGE 2	40	39
STAGE 3 (ADDITIONAL ITEMS)	65	46
TOTAL TO BE SUBMITTED AS SEPARATE ENTRIES	105	85
COVERED ELSEWHERE	17	17
TOTAL SYSTEM LIST	139	
NOT ADDRESSED AT ALL	17	37

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			DD	ITAAC	STAGE	COVER ELSEW
2.14	Containment and Environmental Control					
	2.14.1	Primary Containment System	✓	✓	3	–
	2.14.2	Containment Internal Structures	✓	✓	2	–
	2.14.3	Reactor Pressure Vessel Pedestal	✓	✓	3	–
	2.14.4	Standby Gas Treatment System	✓	✓	3	–
	2.14.5	PCV Pressure and Leak Testing Facility	✓	–	3	–
	2.14.6	Atmospheric Control System	✓	✓	2	–
	2.14.7	Drywell Cooling System	✓	✓	2	–
	2.14.8	Flammability Control System	✓	✓	2	–
	2.14.9	Suppression Pool Temperature Monitoring System	✓	✓	2	–
2.15	Structures and Servicing					
	2.15.1	Foundation Work	–	–	–	2.15.1
	2.15.2	Turbine Pedestal	–	–	–	–
	2.15.3	Crane and Hoist	✓	✓	2	–
	2.15.4	Elevator	✓	–	3	–
	2.15.5	Heating, Ventilating and Air Conditioning	✓	✓	2	–
	2.15.6	Fire Protection System	✓	✓	3	–
	2.15.7	Floor Leakage Detection System	✓	✓	3	–
	2.15.8	Vacuum Sweep System	✓	–	3	–
	2.15.9	Decontamination System	✓	✓	2	–
	2.15.10	Reactor Building	✓	✓	2	–
	2.15.11	Turbine Building	✓	✓	2	–
	2.15.12	Control Building	✓	✓	2	–
	2.15.13	Radwaste Building	✓	✓	3	–
	2.15.14	Service Building	✓	✓	3	–
2.16	Yard Structures and Equipment					
	2.16.1	Stack	✓	✓	3	–
	2.16.2	Oil Storage and Transfer Systems	✓	✓	3	–
	2.16.3	Site Security	✓	✓	3	–

		DD	ITAAC	STAGE	COVERED ELSEWH
2.11	Station Auxiliary				
2.11.1	Makeup Water System (Purified)	✓	✓	3	—
2.11.2	Makeup Water System (Condensate)	✓	✓	3	—
2.11.3	Reactor Building Cooling Water System	✓	✓	2	—
2.11.4	Turbine Building Cooling Water System	✓	✓	3	—
2.11.5	HVAC Normal Cooling Water System	✓	✓	3	—
2.11.6	HVAC Emergency Cooling Water System	✓	✓	2	—
2.11.7	Oxygen Injection System	—	—	—	—
2.11.8	Ultimate Heat Sink	—	—	—	5.1
2.11.9	Reactor Service Water System	✓	✓	2	—
2.11.10	Turbine Service Water System	✓	✓	3	—
2.11.11	Station Service Air System	✓	✓	3	—
2.11.12	Instrument Air System	✓	✓	3	—
2.11.13	High Pressure Nitorgen Gas Supply System	✓	✓	3	—
2.11.14	Heating Steam and Condensate Water Return System	✓	—	3	—
2.11.15	House Boiler	✓	—	3	—
2.11.16	Hot Water Heating System	✓	—	3	—
2.11.17	Hydrogen Water Chemistry System	✓	✓	2	—
2.11.18	Zinc Injection System	—	—	—	—
2.11.19	Breathing Air System	✓	✓	3	—
2.11.20	(This section not used)	—	—	—	—
2.11.21	Process Sampling System	✓	✓	2	—
2.11.22	Freeze Protection System	✓	—	3	—
2.11.23	Iron Ion Injection System	—	—	—	—
2.12	Station Electrical				
2.12.1	Electrical Power Distribution System	✓	✓	2	—
2.12.2	Unit Auxiliary Transformer	—	—	—	2.12.1
2.12.3	Isolated Phase Bus	—	—	—	2.12.1
2.12.4	Nonsegregated Phase Bus	—	—	—	2.12.1
2.12.5	Metal Clad Switchgear	—	—	—	2.12.1
2.12.6	Power Center	—	—	—	2.12.1
2.12.7	Motor Control Center	—	—	—	2.12.1
2.12.8	Raceway System	—	—	—	2.12.1
2.12.9	Grounding Wire	—	—	—	2.12.1
2.12.10	Electrical Wiring Penetration	✓	✓	3	—
2.12.11	Combustion Turbine Generator	✓	✓	2	—
2.12.12	Direct Current Power Supply	✓	✓	3	—
2.12.13	Emergency Diesel Generator System	✓	✓	2	—
2.12.14	NOT USED				
2.12.15	Vital A.C. Power Supply	✓	✓	2	—
2.12.16	Instrument and Control Power Supply	✓	✓	3	—
2.12.17	Communication System	✓	✓	3	—
2.12.18	Lighting and Service Power Supply	✓	✓	2	—
2.13	Power Transmission				
2.13.1	Reserve Auxiliary Transformer	—	—	—	2.12.1

		DD	ITAAC	STAGE	COVER ELSEW
2.5.11	Plant Startup Test Equipment	—	—	—	—
2.5.12	Inservice Inspection Equipment	✓	—	3	—
2.6	Reactor Auxiliary				
2.6.1	Reactor Water Cleanup System	✓	✓	2	—
2.6.2	Fuel Pool Cooling and Cleanup System	✓	✓	2	—
2.6.3	Suppression Pool Cleanup System	✓	✓	3	—
2.7	Control Panels				
2.7.1	Main Control Room Panel	✓	✓	2	—
2.7.2	Radioactive Waste Control Panel	—	—	—	2.9.1
2.7.3	Local Control Panels	✓	—	3	—
2.7.4	Instrument Racks	✓	—	3	—
2.7.5	Multiplexing System	✓	✓	3	
2.7.6	Local Control Box	✓	—	3	—
2.8	Nuclear Fuel				
2.8.1	Nuclear Fuel	✓	✓	2	—
2.8.2	Fuel Channel	✓	✓	3	—
2.8.3	Control Rod	✓	✓	2	—
2.9	Radioactive Waste				
2.9.1	Radwaste System				
2.10	Power Cycle				
2.10.1	Turbine Main Steam System	✓	✓	2	—
2.10.2	Condensate Feedwater and Condensate	✓	✓	2	—
2.10.3	Heater Drain and Vent System	—	—	—	—
2.10.4	Condensate Purification System	✓	✓	2	—
2.10.5	Condensate Filiter Facility	—	—	—	2.10.
2.10.6	Condensate Demineralizer	—	—	—	2.10.
2.10.7	Main Turbine	✓	✓	2	—
2.10.8	Turbine Control System	—	—	—	2.10.
2.10.9	Turbine Gland Steam System	✓	✓	2	—
2.10.10	Turbine Lubricating Oil System	—	—	—	—
2.10.11	Moisture Separator Heater	—	—	—	—
2.10.12	Extraction System	—	—	—	—
2.10.13	Turbine Bypass System	✓	✓	2	—
2.10.14	Reactor Feedwater Pump Driver	—	—	—	2.10.7
2.10.15	Turbine Auxiliary Steam System	—	—	—	—
2.10.16	Generator	—	—	—	2.10.
2.10.17	Hydrogen Gas Cooling System	—	—	—	—
2.10.18	Generator Cooling System	—	—	—	—
2.10.19	Generator Sealing Oil System	—	—	—	—
2.10.20	Exciter	—	—	—	—
2.10.21	Main Condenser	✓	✓	2	—
2.10.22	Off-Gas System	✓	✓	3	—
2.10.23	Circulating Water System	✓	✓	2	—
2.10.24	Condenser Cleanup Facility	—	—	—	—

Table of Contents

ABWR DESIGN CERTIFICATION

ITAAC/DAC STATUS

- OVERVIEW OF TOTAL TIER 1 SCOPE

- PROPOSED SUBMITTAL SCHEDULE

  STAGE 2
  STAGE 3

- STATUS OF STAGE 2

- OTHER ISSUES NEEDING DISCUSSION

AJJ
3/25/92

RECLASSIFICATION OF DSER INTERFACE ITEMS

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SSAR SECTION	DSER SECTION
	Advanced Technology Aspects of the ABWR	HF/DAC		19.3.7.2.8
	GESSAR II PRA in the Plant-Specific ABWR PRA	HF/DAC		19.3.7.2.10
	Site-Specific Design Verification for "External" Events	COL		19.4.1
	Internal Floods	Unresolved		19.4.1
	Seismic Capacities for Components and Structures	COL/ITAAC		19.4.3.3.1 19.4.3.3.3
	Potential for Seismic-Induced Soil Failures	COL		19.4.3.3.2
	Walkdown of the Final Constructed Plant	Piping/DAC/ITAAC		19.4.3.3.2
	Deterministic and Probabilistic Site-Specific Response Spectra	COL		19.4.3.3.2
	Seismic Capacities Assigned to Active Electrical Equipment	COL/ITAAC		19.4.3.3.2
	System Reliability Requirements and Risk Significant Assumptions	Interface Issue		19.3.5

RECLASSIFICATION OF DSER INTERFACE ITEMS

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SSAR SECTION	DSER SECTION
	Provide Administrative Controls to Limit Liquid Wastes	COL		11.2.1
	Ensure Gaseous Waste System Design Complies with Appendix I	COL		11.3.2
	Provide Process for Solidifying Evaporator Concentrates	COL		11.4.1
	Access Control	COL		13.6.3.5
	Control Room Evacuation Analysis	HF DAC		13.6.3.5
	Inspection and Surveillance Requirements for Suppression Pool Bypass	COL/ITAAC		15.3(1)
	Primary Containment Leakage Rates	COL/ITAAC		15.3(2)
	Main Steam Isolation Valve Leak Rate	COL (TECH SPECS)		15.3(3)
	Primary Coolant Activity Limits	COL (TECH SPECS)		15.3(4)
	Confirmation of Initiating Event Freque Estimate of the Loss of AC Power Event	COL		19.3.2
	Plant-Specific HRA	HF/DAC		19.3.7.2.2
	Role of Human Actions in the PRA Event and Fault Trees	HF/DAC		19.3.7.2.3
	Modeling of Human Actions Related to the Advanced Technology of the ABWR Control and Instrumentation	HF/DAC		19.3.7.2.5
	Performance Shaping Factors	HF/DAC		19.3.7.2.7

RECLASSIFICATION OF DSER INTERFACE ITEMS

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SSAR SECTION	DSER SECTION
	Engineered Safety Feature Ventilation System Design	ITAAC		9.4.5
	Essential Electrical Equipment HVAC Monitoring and Electrical Controls	Deleted		9.4.5.4
	Assurance of Proper Function of Standby Gas Treatment System	Deleted		9.4.5.5
	Ensure No Health Hazards from Noncombustible Liquid Insulator Transformers	COL		9.5.1.4.6
	Provide Fire-Related Administrative Controls	COL		9.5.1.5
	Diesel Generator Maintenance and Training	COL		9.5.4.1
	Plant-Specific Leak-Before-Break Analysis	COL		10.3
	Procedures to Avoid Steam Hammer and Relief Valve Discharge Loads	COL		10.3
	Main Steam Isolation Valve Protection from Postulated Pipe Failures	ITAAC	3.6.4.1	10.3
	Procedure to Swith Over to Auxiliary Steam	COL		10.4.3
	Provide Liquid Effluent Source Terms (Admin Controls)	COL		11.1
	Provide for QA of Liquid Radwaste Sys.	COL		11.2.2

RECLASSIFICATION OF DSER INTERFACE ITEMS

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SSAR SECTION	DSER SECTION
	Submit Plans for Preservice Examination of Reactor Pressure Vessel Welds	UNRES		5.2.4.3
	Submit Complete Site-Specific ISI Program	COL		5.2.4.3
	Docket Complete and Acceptable PSI Program	COL		5.2.4.3
	Plant-Specific ISI, PSI	COL		5.2.4.4
	Drywell Leak Rate Calculational Procedures	COL		5.2.5
	Plant-Specific Pressure-Temperature Information	COL		5.3.2
	Steam Isolation Valve Testing	RCIC ITAAC		5.4.6
	Identification from Inservice Inspection of Class 2 and 3	UNRES (Tied to Item 3.15)		6.6.1
	Plant-Specific PSI/ISI Program Information	COL		6.6.2
	Interface Requirements for Heavy Load Handling Equipment	COL		9.1.5
	Makeup Water (Purified)	Interface		9.2.10
	Reactor Building Cooling Water System Design Parameters	Interface (include in RSW Interface)		9.2.11
	Reactor Service Water System Design to Prevent Organic Fouling	Interface		9.2.15

RECLASSIFICATION OF DSER INTERFACE ITEMS

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SSAR SECTION	DSER SECTION
	Excavation and Backfilling for Foundation Construction	COL	2.3.2	2.5.4.6
	Ground Water Level	BSP	2.3.1	2.5.4.7
	Liquefaction Potentials	BSP	2.3.1	2.5.4.8
	Response of Soil and Rock to Dynamic Loadings	BSP	2.3.2	2.5.4.9
	Maximum Soil Bearing Pressures	COL	2.3.1	2.5.4.10
	Earth Pressures	COL	2.3.2	2.5.4.11
	Soil Properties for Seismic Analysis of Buried Pipes	COL/Seismic Cat I ITAAC	2.3.2	2.5.4.12
	Static and Dynamic Stability of Facilities	COL/Seismic Cat I ITAAC	2.3.2	2.5.4.13
	Subsurface Instrumentations	COL/Seismic Cat I ITAAC	2.3.2	2.5.4.14
	Stability of Slopes	COL	2.3.2	2.5.5
	Embankments and Dams	COL	2.3.2	2.5.6
	Turbine Missile Maintenance Inspection	COL	3.5.4.6	3.5.1.3
	Seismic Instrumentation	COL/Seismic Cat I ITAAC		3.7.4
	Structural Integrity Test Program	COL/Containment ITAAC		3.8.1
	Containment Structural Details and Other Seismic Category I Structures	UNRES/Building Structure Design Details		3.8.4

RECLASSIFICATION OF DSER INTERFACE ITEMS

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SSAR SECTION	DSER SECTION
	Hydrologic Features Description	BSP	2.3.2	2.4.1
	Potential Dam Failures	BSP	2.3.2	2.4.4
	Ice Flooding or Blockage	Interface	2.3.2	2.4.7
	Hydraulic Design of Canals and Reservoirs	Interface	2.3.2	2.4.8
	Cooling Water Supply	Interface	2.3.2	2.4.11
	Surface Water Dispersion of Emergency Operation and Shutdown Water Supply	COL	2.3.2	2.4.13
	Tech. Spec. and Emergency Operation and Shutdown Water Supply	COL	2.3.2	2.4.14
	Geology and Seismology	BSP	2.3.2	2.5.1
	Vibratory Ground Motion	BSP	2.3.1	2.5.2
	Surface Faulting*	COL	2.3.2	2.5.3
	Stability and Subsurface Material and Foundation	BSP	2.3.2	2.5.4.1
	Site and Facilities	BSP	2.3.2	2.5.4.2
	Field Investigations	COL	2.3.2	2.5.4.3
	Laboratory Investigations	COL	2.3.2	2.5.4.4
	Subsurface Conditions	BSP	2.3.2	2.5.4.5

----

* CONSIDER ADDING TO TABLE 2.01-1, SITE PARAMETERS

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
19.6	Feedback of Operating, Design and Construction Experience	COL	19A.3.6
19.7	Organization and staffing to oversee design and Construction	COL	19A.3.7
19.8	Quality Assurance Program	COL/DAC	19B.3.1
19.9	Prevention of Core Damage	COL	19B.3.2
19.10	Protection from External Threats	COL	19B.3.3
19.11	Ultimate Heat Sink Models	Interface	19B.3.4
19.12	Ultimate Heat Sink Reliability	Interface	19B.3.5
19.12a	Main Transformer Design	Interface	19B.3.6
19.13	Plant Siting	BSP	19B.3.7
19.14	Interdesciplinary Design Reviews	COL	19B.3.8
19.15	Sabotage Vulnerability During Plant Shutdown	COL	19B.3.9
19.15	Impact of Security System on Plant Operation, Testing, and Maintenance	COL	19B.3.10
19.16	Security Plan Compatibility with ALWR Requirements	COL	19B.3.11
19.17	Plant Security Systems Electrical Requirements	COL	19B.3.12
19.18	Bolting Degradation or Failure	COL	19B.3.13

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
11.1	Cement Glass Solidification System	COL	11.4.3.1
12.1	Regulatory Guide 8.10	COL	12.1.4.1
12.2	Regulatory Guide 1.8	COL	12.1.4.2
12.3	Occupational Radiation Exposure	COL	12.1.4.3
12.4	10 CFR 20 and GDC61 Compliance	COL	12.2.3.1
12.5	Turbine Building Compliance	DAC	12.2.3.2
12.6	RWCU Installation	Deleted	12.3.7
13.1	Security Plan	COL	13.6.2
13.1a	Physical Security Interfaces	COL	13.6.3
14.1	Other Testing	COL	14.2.13
18.1	Main Control Room	ITAAC/DAC	18.5
19.1	Long-term Training Upgrade	COL	19A.3.1
19.2	Long-term Program of Upgrading of Procedures	COL	19A.3.2
19.3	Purge System Reliability	COL	19A.3.3
19.4	Licensing Emergency Support Facility (TSC, OSC, EOF)	UNRES	19A.3.4
19.5	In-plant Radiation Monitoring	UNRES	19A.3.5

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
9.9	Contamination of DG Combustion Air Intake	ITAAC	9.5.13.1
9.10	Use of Communication System in Emergencies	COL	9.5.13.2
9.11	Maintenance and Testing Procedures for Communication Equipment	COL	9.5.13.3
9.11a	Use of Portable Hand Light in Emergency	COL	9.5.13.4
9.11b	Vendor-Specific Design of Diesel Generator Auxilliaries	ITAAC	9.5.13.5
9.11c	Diesel Generator Cooling Water System Design Flow and	ITAAC	9.5.13.6
9.11d	Fire Rating for Penetration Seals	ITAAC	9.5.13.7
9.11e	Diesel Generator Requirements	ITAAC	9.5.13.8
9.11f	Applicant Fire Protection Program	COL	9.5.13.9
9.11g	HVAC Pressure Calculations	COL	9.5.13.10
9.11h	Plant Security Systems Criteria	COL	9.5.13.11
9.11i	Fire Hazards Analysis	COL/ITAAC	9.5.13.12
9.12	Fire Hazard Analysis Database	(9.11.i) ITAAC	9A.6.3
10.1	Low Pressure Turbine Disk Fracture Toughness	ITAAC	10.2.5.1
10.2	Turbine Design Overspeed	ITAAC	10.2.5.2
10.3	Radiological Analysis of TGSS Effluents	COL	10.4.10.1

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
8.17	Minimum Starting Voltages for Class 1E Motors	P.Dist/ITAAC	8.3.4.12
8.18	Identification and Justification of Associated Circuits	SSAR/ITAAC	8.3.4.13
8.19	Admin. Controls for Bus Grounding Circuit Breakers	SSAR/COL	8.3.4.14
8.20	Testing of Thermal Bypass Contacts for MOV's	ITAAC	8.3.4.15
8.21	Emergency Operating Procedures for SBO	COL	8.3.4.16
8.22	Common Industrial Standards Referenced in Purchase Specifications	UNRES	8.3.4.17
9.1	New Fuel Storage Racks Criticality Analysis	ITAAC	9.1.6.1
9.2	New Fuel Storage Racks Dynamic and Impact Analysis	ITAAC	9.1.6.2
9.3	Spent Fuel Storage Racks Criticality Analysis	ITAAC	9.1.6.3
9.4	Spent Fuel Storage Rack Load Drop Analysis	ITAAC	9.1.6.4
9.5	Ultimate Heat Sink Capability	Interface	9.2.17.1
9.6	Makeup Water System Capability	Interface	9.2.17.2
9.7	Potable and Sanitary Water System	Interface	9.2.17.3
9.7a	Reactor Service Water System	Interface	9.2.17.4
9.7b	Turbine Service Water System	Interface	9.2.17.5
9.8	Radioactive Drain Transfer System Collection Piping	ITAAC	9.3.12.1

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
8.2	Diesel Generator Reliability - (Training Requirements)	COL	8.1.4.2
8.3	Separated Power Feeds for 6.9 kv Switchgear	SSAR/ITAAC	8.1.4.3
8.3a	Class IE Feeder Circuits	Deleted	8.2.3.1
8.4	Non-class IE Feeders	Deleted	8.2.3.2
8.5	Offsite Power System	Interface	8.2.3
8.6	Interrupting Capability of Electrical Distribution Equipment	ITAAC	8.3.4.1
8.7	Diesel Generator Design Details	ITAAC	8.3.4.2
8.8	Certified Proof Tests on Cable Samples	EQ ITAAC	8.3.4.3
8.9	Electrical Penetration Assemblies	R.BLDG ITAAC	8.3.4.4
8.10	Analysis Testing for Spatial Separation per IEEE 384	Delete	8.3.4.5
8.11	DC Voltage Analysis	ITAAC	8.3.4.6
8.12	Seismic Qualification of Eyewash Equipment	Delete/SSAR	8.3.4.7
8.13	Diesel Generator Load Table Changes	Delete/SSAR	8.3.4.8
8.14	Offsite Power Supply Arrangements	COL	8.3.4.9
8.15	Diesel Generator Qualification Tests	ITAAC	8.3.4.10
8.16	Defective Refurbished Circuit Breakers	Delete/SSAR	8.3.4.11

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
4.6	Thermal Limits	ITAAC	4.4.4.2
4.7	Loose-parts Monitoring Systems	UNRES-DESIGN	4.4.4.3
4.8	CRD Inspection Program	COL	4.5.3.1
5.1	Water Chemistry	Deleted	5.7.6.1
5.2	Conversion of Indicators (Drywell Leakage Rate - Procedure)	COL	5.2.5.2
5.3	Fracture Toughness Data	COL	5.3.4.1
5.4	Materials and Surveillance Capsule	COL	5.3.4.2
6.1	Protection Coatings and Organic Materials	COL	6.1.3.1
6.1a	ECCS Performance Results	COL	6.3.6.1
6.2	External Temperature	BSP	6.4.7.1
6.3	Meterology (X/Qs)	BSP	6.4.7.2
6.4	Toxic Gases	COL	6.4.7.3
7.1	Effects of Satien Blackout on HVAC	COL	7.8.1
7.2	Electrostatic Discharge on Exposed Equipment Components	ITAAC/DAC	7.8.2
7.3	Localized High Heat Spots in Semiconductor Material for Computing Devices	ITAAC/DAC	7.8.3
8.1	Stability of Offsite Power System	Interface	8.1.4.1

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
3.13	Site Specific Physical Properties and Foundation Settlement	COL/NEW ITAAC	3.8.6.2
3.14	Reactor Internals Vibration Analysis Measurement and Inspection Programs	ITAAC	3.9.7.1
.5	ASME Class 2 or 3 Quality Group Components with 60-Year Design Life	COL/ITAAC	3.9.7.2
3.15a	Pump and Valve Inservice Testing Program	COL GL 89-10-ITAAC	3.9.7.3
3.15b	Audits of Design Specifications and Design Reports	COL/UNRES*	3.9.7.4
3.16	Equipment Qualification Report	ITAAC	3.10.5.1
3.17	Dynamic Qualification Report	ITAAC	3.10.5.2
3.18	Environmental Qualification Document	ITAAC	3.11.6.1
3.19	Enviromental Qualification Records	ITAAC	3.11.6.2
4.1	Fuel Design	ITAAC	4.2.2.1
4.2	Control Blade Design	ITAAC	4.2.2.2
4.3	Core Loading Pattern	COL	4.3.2.1
4.4	Core Effective Multiplication Values	COL	4.3.2.2
4.5	Power Flow Operating Map	ITAAC	4.4.4.1

* STAFF AUDIT WILL CLARIFY

Table 1.9-1 (Continued)

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
3.2	Site-Specific Design Basis Tornado	BSP	3.3.3.2
3.3	Effect of remainder of plant structures, systems, and components on systems not designed to tornado loads	COL	3.3.3.3
3.4	Flood Elevation	BSP	3.4.3.1
3.5	Ground Water Elevation	BSP	3.4.3.2
3.5a	Leak-Before-Break Analysis	COL	3.4.3.3
3.5b	Flood Protection Requirements for Other Structures	COL	3.4.3.4
3.6	Protection of ultimate heat sink	Interface	3.5.4.1
3.7	Missiles generated by natural phenomena from remainder of plant	COL	3.5.4.2
3.8	Site proximity missiles and aircraft hazards	COL	3.5.4.3
3.9	Protection against secondary missiles inside containment	ITAAC	3.5.4.4
3.9a	Impact of Non Safety-Related Item Failure - Design Basis Tornado	COL	3.5.4.5
3.9b	Turbine System Maintenance Program	COL	3.5.4.6
3.10	Details of pipe break analysis results and protection methods	ITAAC/DAC	3.6.4.1
3.11	Leak-before-break analysis results	COL	3.6.4.2
3.11a	Seismic Parameters	BSP	3.7.5.1
3.12	Foundation Waterproofing	COL	3.8.6.1

Table 1.9-1

SUMMARY OF ABWR STANDARD PLANT INTERFACES
WITH REMAINDER OF PLANT

ITEM NO.	SUBJECT	INTERFACE RECLASSIFICATION	SUB-SECTION
1.1	Standard review plan sections for remainder plant identified in "Interface" in Table 1.8-19	COL	1.8.4
1.2	Applicability of regulatory guides for remainder of plant identified as "Interface" in Table 1.8-20	COL	1.8.4
1.3	Applicability of Experience Information for remainder of plant identified as "Interface" in Table 1.8-22	COL	1.8.4
1.4	Emergency procedures and emergency procedures training program	COL	1A.3.1
1.5	Procedures for removing safety-related systems from service	COL	1A.3.2
1.6	Inplant radiation monitoring	COL	1A.3.3
1.7	Reporting of Failures of Reactor System Relief Valves	COL	1A.3.4
1.8	Report on ECCS Outage	COL	1A.3.5
2.1	Envelope of ABWR Standard Plant Site Design Parameters	BSP	2.3.1
2.2	Standard Review Plan Site Characteristics	BSP	2.3.2
2.3	CRAC 2 Computer Code Calculations	BSP	2.3.3
3.1	Site-Specific Design Basis Wind	BSP	3.3.3.1

ACTION ITEMS

- GE DOCUMENTATION
  - CHAPTER 1 LISTING OF RECLASSIFIED ITEMS
  - CROSS REFERENCING TO ITAAC
  - DEVELOPMENT OF NEW AND MODIFIED ITAAC/DAC
  - DEVELOPMENT OF INTERFACE CONCEPTUAL DESIGNS AND VERIFICATION METHODS
  - CLOSEOUT OF UNRESOLVED ITEMS
- STAFF FSER DOCUMENTATION
  - DISPOSITION OF DSER INTERFACE ITEMS
  - EVALUATION OF PART 52 INTERFACE ITEMS
  - EVALUATION OF "RECLASSIFIED" INTERFACES
- AGREEMENT ON SUBMITTAL DATES

DESIGN INFORMATION

- LOOSE PARTS MONITORING SYSTEM

UNRESOLVED

- AUDITS OF DESIGN SPECIFICATIONS AND DESIGN REPORTS
- COMMON INDUSTRIAL STANDARDS REFERENCED IN PURCHASE SPECIFICATIONS
- LICENSING EMERGENCY SUPPORT FACILITY (TSC, OSC, EOF)
- IN-PLANT RADIATION MONITORING
- CONTAINMENT STRUCTURAL DETAILS AND OTHER SEISMIC CATEGORY I STRUCTURES
- PLANS FOR PRESERVICE EXAMINATION OF REACTOR PRESSURE VESSEL WELDS
- ISI OF CLASS 2 AND 3 COMPONENTS
- PRA FOR INTERNAL FLOODS

SIGNIFICANT ITAAC/DAC

(CONTINUED)

- DC VOLTAGE ANALYSIS
- FIRE HAZARDS ANALYSIS
- TURBINE MATERIALS, DESIGN
- DESIGN QUALITY ASSURANCE
- HUMAN RELIABILITY ANALYSIS ITEMS (PRA)

SIGNIFICANT ITAAC/DAC

- SECONDARY MISSILES INSIDE CONTAINMENT
- STEAM ISOLATION VALVE TESTING
- PIPE BREAK ANALYSES, PROTECTION METHODS
- MSIV PROTECTION FROM PIPE FAILURES
- REACTOR INTERNALS VIBRATION MEASUREMENT/INSPECTION
- RADIOACTIVE DRAIN TRANSFER SYSTEM COLLECTION PIPING
- ASSOCIATED CIRCUITS
- NEW AND SPENT FUEL STORAGE RACKS
- DIESEL GENERATOR DESIGN DETAILS/QUALIFICATION TESTS
- DIESEL AUXILIARY SYSTEMS
- ELECTRICAL PENETRATION ASSEMBLIES

INTERFACES

- ULTIMATE HEAT SINK
- OFFSITE POWER SYSTEM
- MAKEUP WATER SYSTEM
- POTABLE AND SANITARY WATER SYSTEM
- SERVICE WATER SYSTEM
- TURBINE SERVICE WATER SYSTEM

RESULTS OF REVIEW

- 137 SSAR INTERFACE ITEMS
- 69 DSER INTERFACE ITEMS
- RECLASSIFICATION RESULTS:
  - 18 INTERFACE
  - 63 ITAAC/DAC
  - 110 COL ACTION ITEMS
  - 1 DESIGN ITEM
  - 10 DELETIONS
  - 21 SITE PARAMETERS
  - 8 UNRESOLVED

INTERFACE REVIEW

- SSAR AND GE EVALUATION OF SSAR AND DSER INTERFACES
- RECLASSIFICATION
  - VERIFIED INTERFACES (PT 52)
  - ITAAC/DAC ITEMS
  - COL ACTION ITEMS
  - DESIGN ITEM
  - DELETION
  - SITE PARAMETERS
  - UNRESOLVED
- FEBRUARY 27, 1992 MEETING FOLLOWED BY CONFERENCE CALLS

2) FOR THE ABOVE FIVE PLANTS:

A) OBTAIN INFORMATION FROM DLPQ/LPEB, AND THE PM TO OBTAIN NRR PERSPECTIVE ON LICENSEE PRE-OP AND START-UP PROGRAMS

B) PREPARE A MATRIX OF THE PRE-OP TESTS PEFORMED AT EACH SITE BASED ON THE FSAR AND THE IP 94300 LETTER

C) REVIEW TESTS PERFORMED AS PART OF THE MC 2512 (CONSTRUCTION) AND MC 2514 (STARTUP) PROGRAMS FOR INCLUSION IN ITAAC AND INCORPORATION IN THE ABOVE MATRIX

D) OBTAIN REGIONAL INSIGHTS REGARDING THE IMPLEMENTATION OF MC 2513 AND 2514 PROGRAMS AND INPUTS REQUIRED FOR THE IP 94300 LETTER

E) CONDUCT A BRIEF ONSITE REVIEW OF LICENSEE PRE-OP AND STARTUP PROGRAMS. AS TIME PERMITS, IDENTIFY THE KEY PROCESS VARIABLES OR TEST PARAMETERS MEASURED THAT FORMED THE BASES FOR THE DETERMINATION OF SUCCESS.

3) USING THE INFORMATION AND INSIGHTS GAINED FROM THE FIVE RECENTLY LICENSED BWRs DEVELOP THE INFORMATION SPECIFIED IN THE TASK IMPLEMENTATION STATEMENT

COMPLETION DATE

APRIL 30, 1992

3-24-92

Enclosure 14.1

PRE-OPERATIONAL (STARTUP) TESTS FOR ABWR CERTIFICATION

TASK

1) DEVELOP COMPREHENSIVE LIST OF PRE-OPERATIONAL (STARTUP) TESTS TO BE PERFORMED FOR THE ABWR PRIOR TO FUEL LOAD

2) PARSE LIST DEVELOPED IN ITEM 1 INTO:

   A) TESTS THAT SHOULD BE INCLUDED AS PART OF THE TIER 1 DESIGN CERTIFICATION RULE (ITAAC),

   B) TESTS THAT SHOULD BE INCLUDED IN THE ITAAC FOR THE SITE-SPECIFIC PORTION OF THE DESIGN TO BE APPROVED AT COL, AND

   C) TESTS THAT SHOULD BE PERFORMED BUT DO NOT NEED TO BE INCLUDED IN THE DESIGN CERTIFICATION RULE (ITAAC)

3) FOR THE TESTS RECOMMENDED AS ITAAC, PROVIDE INSIGHTS REGARDING LICENSEE AND REGION ACCEPTANCE CRITERIA

4) PROVIDE THE ABOVE INFORMATION TO DLPQ/LPEB FOR USE AS APPROPRIATE IN REVIEW OF ABWR CHAPTER 14 AND DEVELOPMENT OF PRE-OP AND START-UP TESTS (ITAAC) TO BE INCLUDED IN THE ABWR DESIGN CERTIFICATION RULE

STAFF INTERFACES

1) COORDINATE CLOSELY WITH DLPQ/LPEB (Gary Zech, Ray Ramirez) DURING TASK PERFORMANCE TO ENSURE A USEFUL PRODUCT AND AVOID POSSIBLE DUPLICATION OF EFFORT

2) OBTAIN INSIGHTS FROM THE REGIONS REGARDING IMPLEMENTATION OF MC 2512, 2513 AND 2514 PROGRAMS AND IP 94300

RESOURCES

ONE RSIB STAFF PERSON (Sam Malur) AND ONE CONTRACTOR FOR EIGHT WEEKS

APPROACH

1) SELECT FIVE RECENTLY LICENSED BWRS:

   CLINTON
   NINE MILE POINT 2
   PERRY
   LIMERICK
   HOPE CREEK

   TO OBTAIN A HISTORICAL PERSPECTIVE ON THEIR PRE-OP AND START-UP TEST PROGRAMS

SUMMARY OF ITAAC STATUS

- INTERFACES (PRESENTED SEPARATELY)
- STAFF EXAMINING OVERLAP OF ITP WITH ITAAC

ROADMAP ISSUES/KEY ANALYSES

- SEVERE ACCIDENT DESIGN FEATURES
- DESIGN BASIS ACCIDENT ANALYSES (CONTAINMENT PERFORMANCE, ETC.)
- PRA INPUTS/ASSUMPTIONS
- "COMMON COMPONENT" SYSTEMS INTERACTIONS
- FLOODING (INTERNAL/EXTERNAL)
- FIRE PROTECTION FEATURES/ANALYSES
- EXTERNAL PHENOMENA
- PIPE BREAKS
- MISSILES
- MOV'S
- TRIP OF ALL RIP'S WITH PRESSURE REGULATOR FAILURE
- ATWS

GENERIC ITAAC DISCUSSION POINTS

- SEISMIC/NON-SEISMIC INTERACTION (2 OVER 1 ANALYSIS/WALKDOWN)
  - INTERNAL STRUCTURES EFFECTS ON CONDENSOR, MSL BYPASS PIPING
  - DYNAMIC ANALYSIS OF MSL vs. STATIC ANALYSIS OF TURBINE BUILDING
- NON-SAFETY RELATED I&C (ALTERNATE ROD INSERTION, NON-ESSENTIAL MULTIPLEX DIVERSITY)
- PIPING DAC
  - PIPING LAYOUT
  - STRESS ANALYSIS (SEISMIC CAT I?)
  - HIGH-ENERGY LINE BREAK (SEISMIC CAT I?)
  - LEAK-BEFORE-BREAK (DROP?)
  - CONFIRMATION THAT AS-BUILT MEETS DESIGN PER BULLETIN 79-14
- HVAC SUPPORTS STRUCTURAL DESIGN
- CABLE TRAY AND CONDUIT SUPPORTS STRUCTURAL DESIGN
- WELDING

GENERIC ITAAC

"AGREED TC": (* => DAC AREA) SUBMITTAL:

• SEISMIC CATEGORY I STRUCTURES (GENERIC CONCERN--MAY BE PUT IN BUILDING SYSTEM ITAAC)	MAY
• EQUIPMENT QUALIFICATION (MAY BE SEPARATED)	MARCH
- ENVIRONMENTAL QUALIFICATION	
- SEISMIC QUALIFICATION	
- EMI/SWC*	
• INSTRUMENT SETPOINT METHODOLOGY*	MARCH
• SOFTWARE*	MARCH
• SAFETY SYSTEM LOGIC AND CONTROL*	MAY
• ESSENTIAL MULTIPLEXING* (GENERIC CONCERN--MAY BE A SYSTEM ITAAC)	MAY
• HUMAN FACTORS*	MAY
• RADIATION PROTECTION*	MARCH
• PIPING*	MARCH

SUMMARY OF ITAAC STATUS

- GENERIC ITAAC STATUS

  - "AGREED" LIST OF GENERIC ITAAC (9)

  - CANDIDATE LIST OF GENERIC ITAAC (6)

  - ADDITIONAL ITAAC MAY RESULT FROM INTERFACE RECLASSIFICATIONS

  - SEVERAL KEY SSAR ANALYSES AND ISSUES TO BE CROSS-REFERENCED TO ITAAC IN A "ROADMAP"

  - SUBMITTAL SCHEDULE TO BE DETERMINED

Enclosure 14

SUMMARY OF ITAAC STATUS

- MEETING ON FEBRUARY 27, 1992, AT NRC, ROCKVILLE, MD., ON ITAAC AND INTERFACES

- SYSTEM ITAAC STATUS

  - GE WILL PROVIDE TIER 1 DESIGN DESCRIPTIONS FOR ALL SSAR SYSTEMS (139 SYSTEMS)

  - STAFF REQUESTED SELECTED ELECTRICAL (6), PLANT (2), AND REACTOR (4) SYSTEMS BE INCLUDED IN THE END OF MARCH SUBMITTAL

  - PHASE I SYSTEMS (9 PILOT) AND PHASE II SYSTEMS (30) SUBMITTED BY MARCH 31

  - PHASE III (51) SYSTEMS SUBMITTED BY MAY 31

REFERENCING OF CODES AND STANDARDS

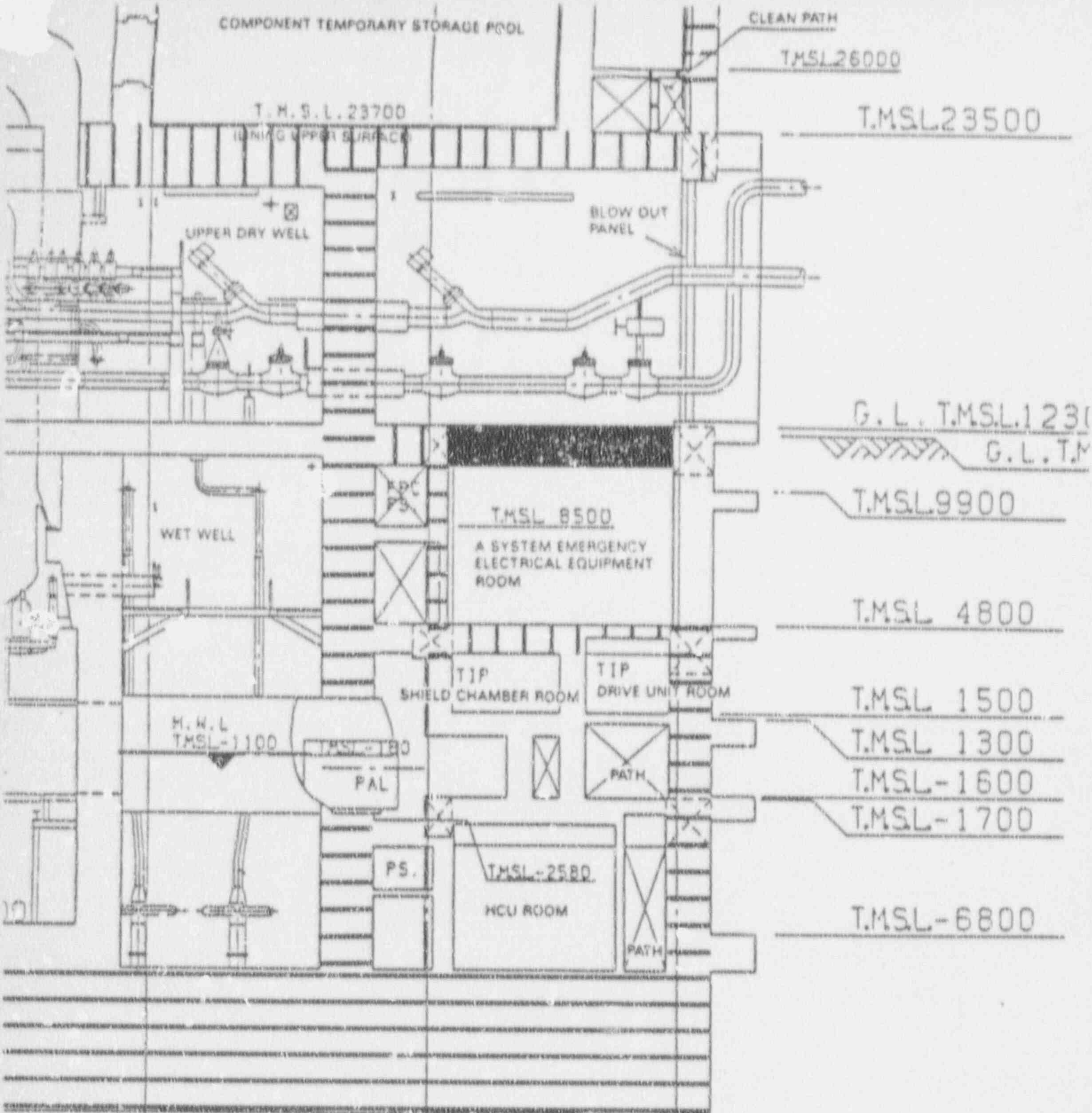
- Licensing review bases cutoff
  - March 30, 1987
- Most branches silent on code/standard effectiveness
- Some mutually agreed upon updates beyond March 30, 1987
- Six IEEE standards, effective March 30, 1987, not yet approved by NRC
- NRC requests specific code editions for PSI and ISI not be referenced
  - Per 10CFR50.55a
- Piping codes utilization to recognize developing technology
  - Not adopting current version of ASME Section III
- NRC requests common industrial standards be referenced in purchase specifications

Enclosure 13

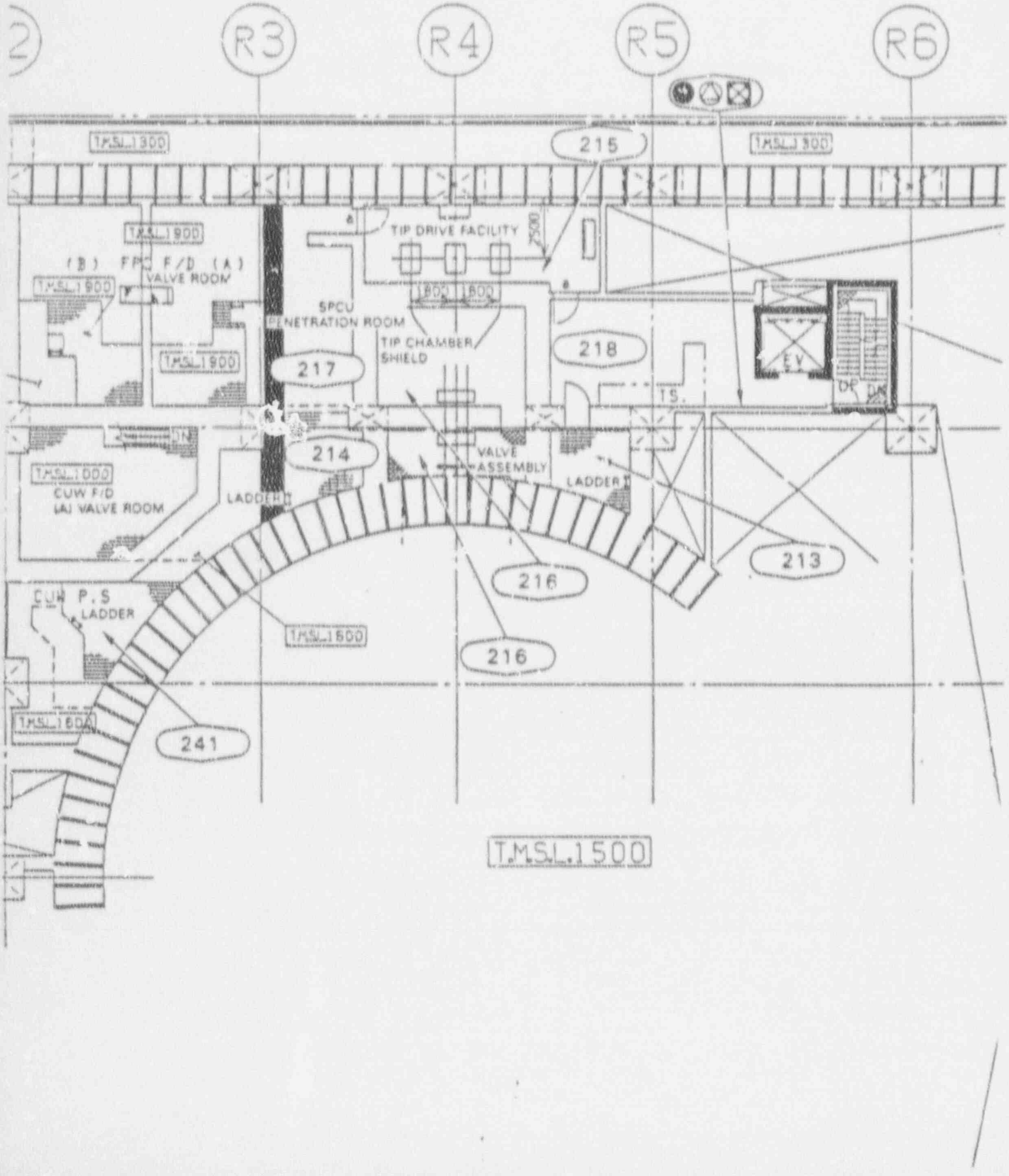
Table 12.2-24

ACTIVITY LEVELS OF THE TRANSVERSING IN-CORE PROBE SYSTEM

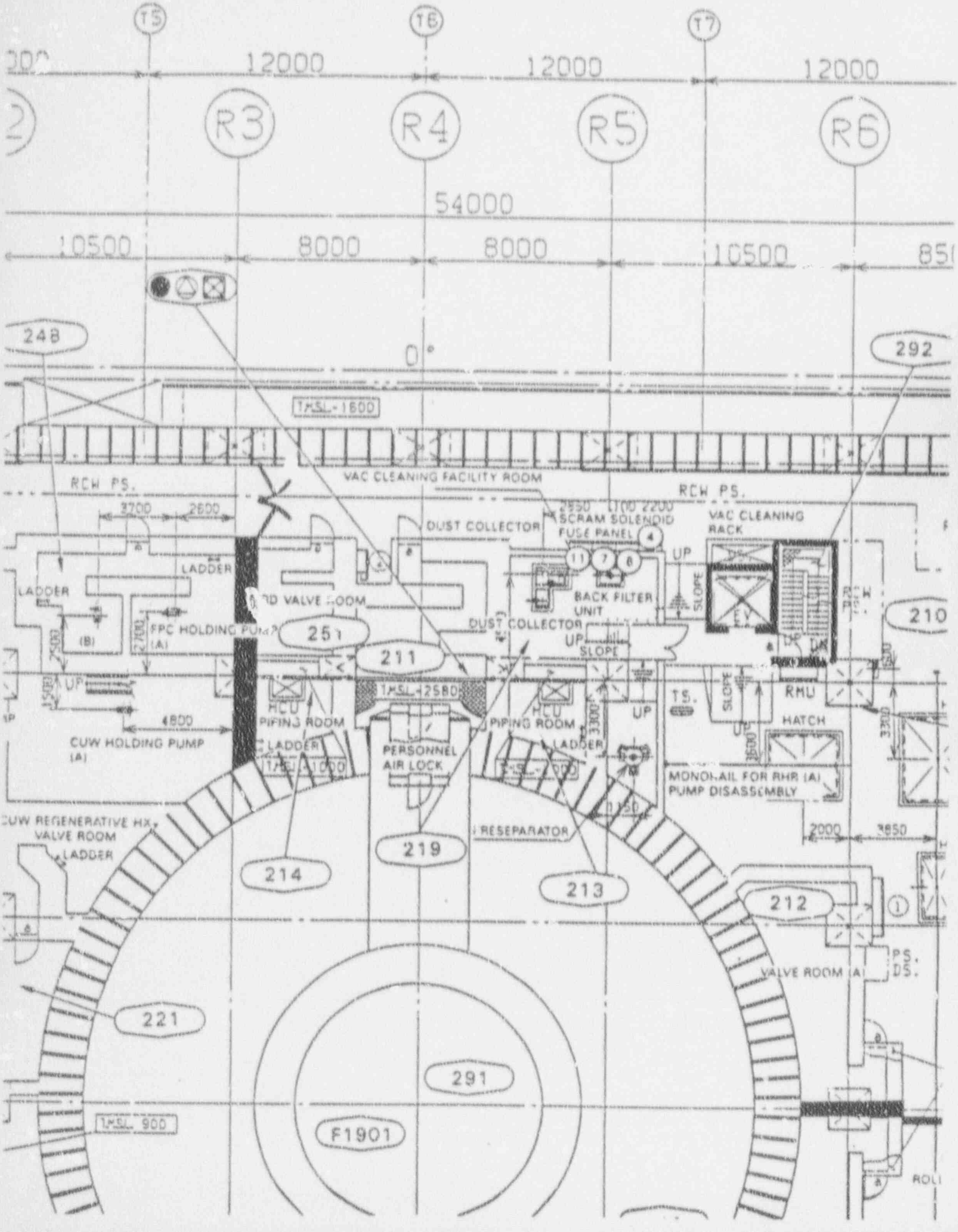
	Decay Time (day)	Rad/hr @ 1 meter	Major Isotopes
[illegible] [redacted]			
Sensor	0.00139	5.61	Mn-56, Al-28, Ti-5.
	0.0417	3.20	Mn-56, Na-24, Ni-65
	1.0	0.0133	Mn-56,Na-24, Cu-64
	2.0	0.00384	Na-24, Co-60, Cr-51
Cable	0.00139	53.5	Mn-56, Mg-27, Ni-65
	0.0417	4[illegible]2	Mn-56, Ni-65, Fe-59
	1.0	0.104	Mn-56, Fe-59, Mn-54
	2.0	0.018	Fe-59, Mn-54, Cr-51
[illegible] [redacted]			
Sensor	0.00139	3.382	Mn-56, Al-28, Ti-51
	0.0417	2.142	Mn-56, Na-24, Ni-65
	2.0	0.00378	Co-60, Na-24, C0-58
Cable	0.00139	45.[illegible]	Mn-56, Mg-27, Ni-65
	0.0417	34.8	Mn-56, Ni-65, Fe-59
	1.0	0.091	Mn-56, Fe-59, Mn-54
	2.0	0.0189	Fe-59, Mn-54, Co-60


COMPONENT TEMPORARY STORAGE POOL
CLEAN PATH
T.M.S.L.26000
T.M.S.L.23700
(LINING UPPER SURFACE)
T.M.S.L.23500
UPPER DRY WELL
BLOW OUT PANEL
G.L. T.M.S.L.123
G.L.T.M
T.M.S.L.9900
T.M.S.L. 8500
A SYSTEM EMERGENCY ELECTRICAL EQUIPMENT ROOM
WET WELL
T.M.S.L. 4800
TIP SHIELD CHAMBER ROOM
TIP DRIVE UNIT ROOM
T.M.S.L. 1500
T.M.S.L. 1300
H.W.L
T.M.S.L.-1100
T.M.S.L.-180
PAL
PATH
T.M.S.L.-1600
T.M.S.L.-1700
PS.
T.M.S.L.-2580
HCU ROOM
PATH
T.M.S.L.-6800

ON



R3
R4
R5
R6
T.M.S.L.1300
215
T.M.S.L.1300
T.M.S.L.1900
(B) FPC F/D (A)
VALVE ROOM
T.M.S.L.1900
TIP DRIVE FACILITY
2500
1800
1800
SPCU
PENETRATION ROOM
TIP CHAMBER
SHIELD
218
T.M.S.L.1900
217
EV
TS.
UP
DN
DN
214
T.M.S.L.1000
CUW F/D
(A) VALVE ROOM
VALVE
ASSEMBLY
LADDER
LADDER
213
216
CUW P.S
LADDER
T.M.S.L.1600
216
T.M.S.L.1600
241
T.M.S.L.1500



T5
T6
T7
12000
12000
12000
R3
R4
R5
R6
54000
10500
8000
8000
10500
248
292
0°
TMSL-1600
VAC CLEANING FACILITY ROOM
RCW PS.
RCW PS.
3700
2600
DUST COLLECTOR
SCRAM SOLENOID
FUSE PANEL
VAC CLEANING
RACK
LADDER
LADDER
UP
SLOPE
BACK FILTER
UNIT
FPC HOLDING PUMP
(A)
(B)
DUST COLLECTOR
UP
SLOPE
210
251
211
UP
HCU
PIPING ROOM
HCU
PIPING ROOM
PERSONNEL
AIR LOCK
4800
CUW HOLDING PUMP
(A)
LADDER
LADDER
T.S.
SLOPE
RMU
HATCH
UP
MONORAIL FOR RHR (A)
PUMP DISASSEMBLY
2000
3850
CUW REGENERATIVE HX
VALVE ROOM
LADDER
219
214
213
212
VALVE ROOM (A)
PS.
DS.
221
291
TMSL 900
F1901

DIVERSITY DISCUSSION

- SOFTWARE DRIVEN SYSTEMS ARE OF SPECIAL CONCERN FOR SEVERAL REASONS

  1. THE COMMONALITY OF TIMING SUCH THAT AN ERROR IN ONE CHANNEL IS EXPECTED TO OCCUR IN ALL IDENTICAL CHANNELS AT THE SAME TIME

  2. THE POSSIBILITY THAT THE INITIATING EVENT CREATES A SET OF CIRCUMSTANCES THAT REVEAL THE SOFTWARE ERROR

  3. THE INABILITY TO DEMONSTRATE SPECIFIC RELIABILITY OR PROOF OF CORRECTNESS

  4. REDUNDANCY IN SOFTWARE DOES NOT INCREASE RELIABILITY/AVAILABILITY OF THE OVERALL SYSTEMS AS IT DOES WITH ANALOG SYSTEMS

  5. SELF DIAGNOSTICS AND NORMAL SURVEILLANCE SIGNIFICANTLY REDUCE THE POSSIBILITY OF UNDETECTED FAILURES BUT DO NOT PREVENT THE FAILURES

DISCUSSION OF THE ABWR DESIGN FEATURES FOR DIVERSITY

- THE TURBINE INPUTS TO THE RPS ARE HARDWIRED (DO NOT USE THE EMS)
- THE NEUTRON MONITORING SYSTEM IS INDEPENDENT OF THE EMS
- MANUAL SCRAM AND MSIV ACTUATION IS HARDWIRED
- ARI (ATWS) IS INDEPENDENT OF THE EMS
- THE NON-ESSENTIAL MULTIPLEXOR IS DIVERSE (HARDWARE AND SOFTWARE) FROM THE EMS
- THE REMOTE SHUTDOWN STATION IS HARDWIRED
- FINAL DISPLAY TO THE OPERATOR HAS MIMIC AND VDU DIVERSITY
- NEUTRON MONITORING BYPASSES THE DTM
- ARI BYPASSES THE DTM
- ARI IS DIVERSE FORM THE RPS
- DTM FUNCTIONAL DIVERSITY
- TLU FUNCTIONAL DIVERSITY

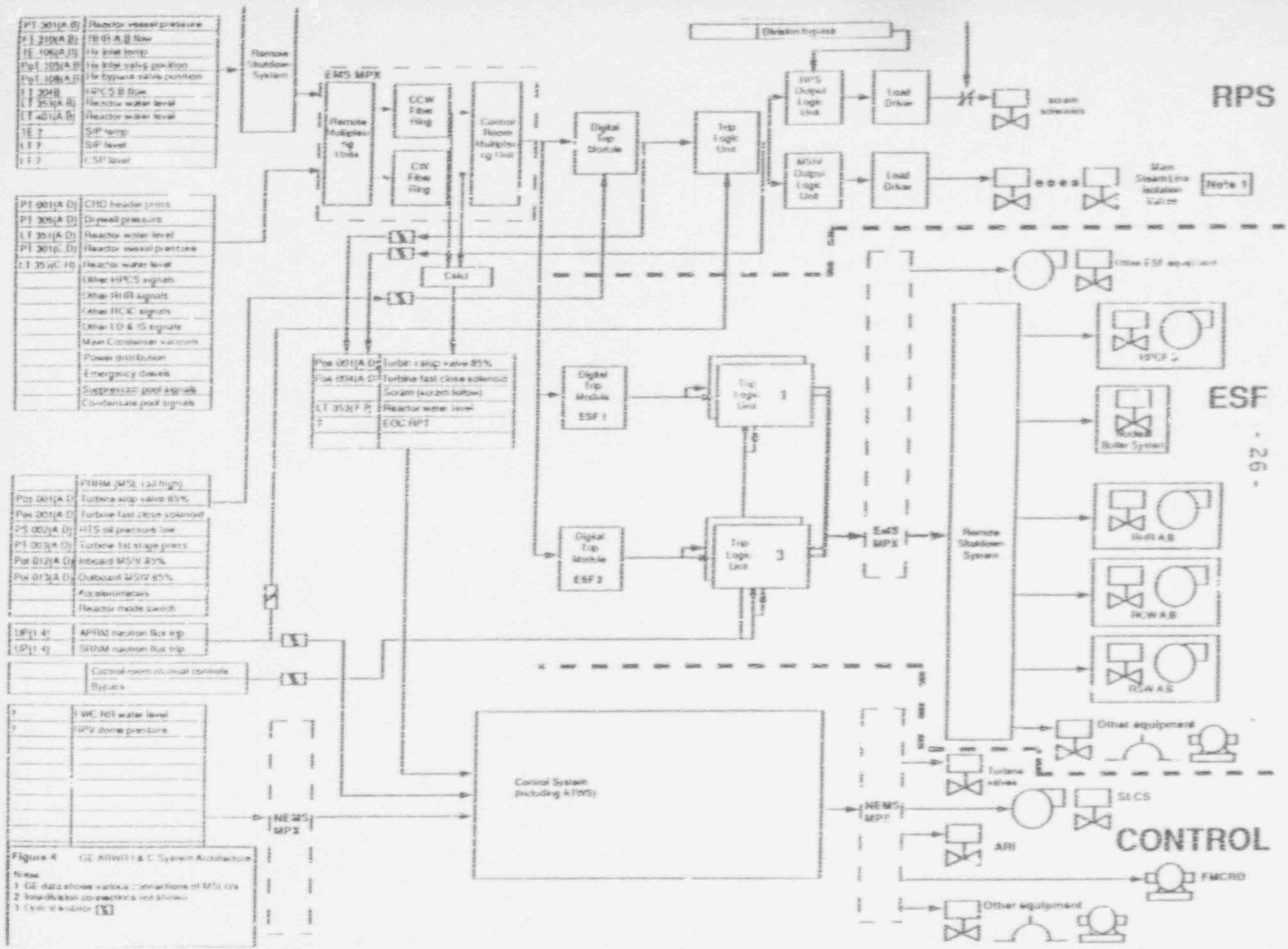
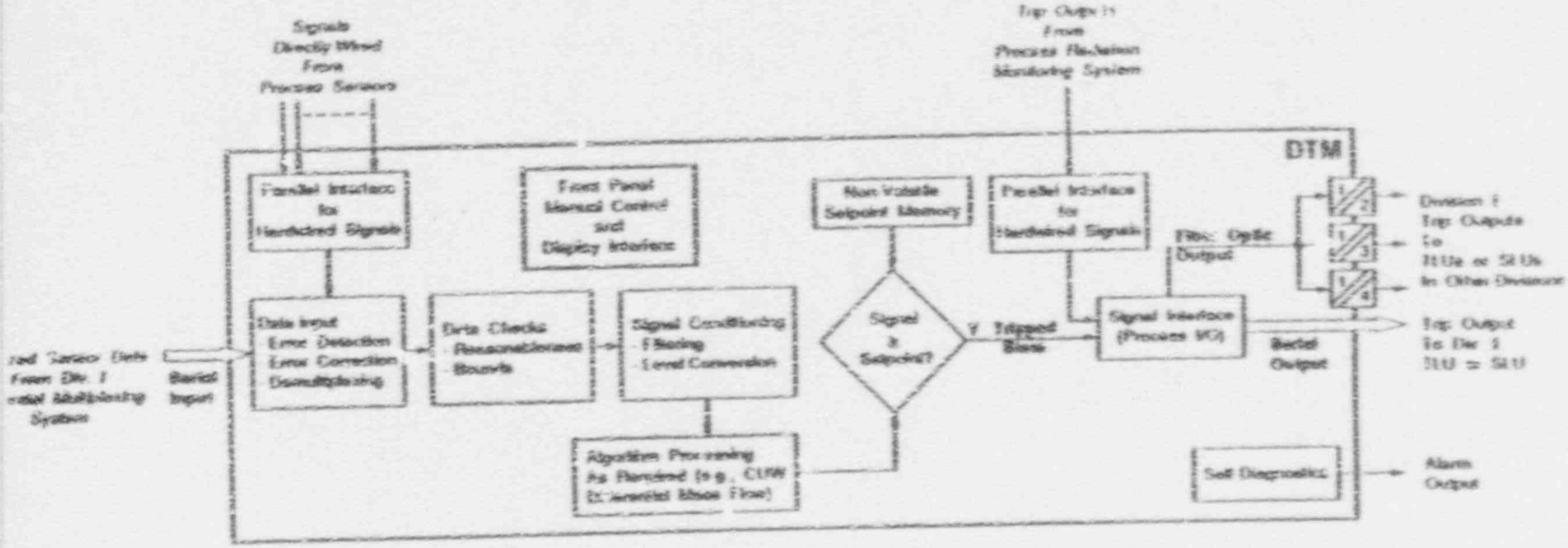


Figure 4 GE ABWR I & C System Architecture

Notes:
1 GE data shows various connections of MSIVs
2 Interdivision connections not shown
3 Optical isolator [X]



NOTES

1. Div. I DTM Shown. Typical for Other Divisions
2. This DTM can be used in either RPS/MSIV or ECCS applications
3. For de-energize-to-operate applications, this instrument provides a tripped output state on loss of instrument power or signal
4. For energize-to-operate applications, this instrument provides an untripped output state on loss of instrument power or signal

Digital Trip Module
Basic Signal Flow
Figure 7

GENERATOR LOAD REJECTION WITH NORMAL BYPASS

- POSTULATED COMMON MODE FAILURE - ESSENTIAL MULTIPLEXING SYSTEM (EMS)

FAILURE ANALYSIS

- THIS FAILURE WILL (WORST CASE) PREVENT A REACTOR TRIP ON REACTOR PRESSURE RPS INPUT, THIS IS THE THIRD OF THE EXPECTED REACTOR TRIP SIGNALS FOR THIS EVENT

- THIS FAILURE WILL ALSO SIGNIFICANTLY REDUCE THE INFORMATION AVAILABLE TO THE OPERATOR, SPECIFIC TO THIS EVENT, THE 1E RPV NARROW AND WIDE RANGE WATER LEVEL AND THE 1E DOME PRESSURE ARE DISABLED

- THIS FAILURE WILL DISABLE CONTROL AND INDICATION OF THE ECCS SYSTEMS FROM THE MAIN CONTROL ROOM

DEFENSE-IN-DEPTH AND DIVERSITY GENERATOR LOAD REJECT WITH NORMAL BYPASS

- REACTOR TRIP WILL OCCUR ON TURBINE FAST CLOSURE SOLENOID VALVE RPS INPUT WHICH IS HARDWIRED AND DOES NOT USE THE EMS, THIS IS THE PRIMARY EXPECTED TRIP INPUT FOR THIS EVENT

- THIS POSTULATED FAILURE DOES NOT DEGRADE FEEDWATER, THE FEEDWATER NEMS IS DIVERSE IN HARDWARE AND SOFTWARE FROM THE EMS, ECCS IS NOT RELIED UPON FOR THIS EVENT/FAILURE

- THE INFORMATION AVAILABLE TO THE OPERATOR WILL INCLUDE CLASS 1E RPV FUEL ZONE WATER LEVEL(RG 1.97), NON-1E SHUTDOWN LEVEL, NON-1E FEEDWATER LEVEL CONTROL, AND NON-1E WIDE RANGE PRESSURE

- CLASS 1E NEUTRON FLUX INFORMATION IS AVAILABLE SINCE IT DOES NOT USE THE EMS

- INFORMATION AND AUTOMATIC ACTUATION ARE AVAILABLE TO MITIGATE THE EVENT/FAILURE

- POTENTIAL PROBLEMS
  - INDICATION AND CONTROL OF THE ECCS IS DISABLED IN THE MAIN CONTROL ROOM
  - THE REMAINING DISPLAYED VARIABLES ARE FEW AND DIGITAL

ADDITIONAL CONSIDERATIONS
GENERATOR LOAD REJECT WITH NORMAL BYPASS

- ADDITIONAL REACTOR SCRAM INPUTS ARE AVAILABLE
  - IF THE TURBINE TRIP INPUT IS ALSO FAILED, THE REACTOR TRIP SIGNAL WILL BE PROVIDED BY THE CLASS 1E NEUTRON FLUX INPUT TO THE RPS
  - THE ALTERNATE ROD INSERTION (ARI) FEATURE OF THE ATWS MITIGATION DESIGN USES THE WIDE RANGE DOME PRESSURE SENSORS OF THE STEAM BYPASS AND PRESSURE CONTROL SYSTEM (SB&PC) TO INITIATE ARI THIS IS A NON-1E SYSTEM WHICH DOES NOT USE THE EMS
  - MANUAL (HARDWIRED) SCRAM IS AVAILABLE FROM:
    A. TWO BUTTON SCRAM (DISCONNECTS SOLENOID POWER SOURCES) (1E IN THE CONTROL ROOM)
    B. OPERATION OF TWO OUT OF FOUR DIVISIONAL REACTOR TRIP SWITCHES (1E IN THE MCR)
    C. MANUAL DISCONNECT OF SOLENOID POWER SOURCES AT THE REMOTE ELECTRICAL DISTRIBUTION PANEL (1E)
    D. TWO BUTTON MANUAL ARI INITIATION (NON-1E) IN THE CONTROL ROOM
    E. OPERATION OF PAIRED-ROD SCRAM TEST PANEL (NON-1E) IN THE CONTROL ROOM
    F. MODE SWITCH - SHUTDOWN (1E)
- ECCS SYSTEMS ARE AVAILABLE ON THE HARDWIRED REMOTE SHUTDOWN STATION

STEAM SYSTEM PIPING BREAK OUTSIDE CONTAINMENT

- POSTULATED COMMON MODE FAILURE - ESSENTIAL MULTIPLEXING SYSTEM (EMS)

FAILURE ANALYSIS

- THIS FAILURE WILL (WORST CASE) PREVENT AUTOMATIC AND MANUAL INITIATION OF RCIC/HPCF AND RHR FROM THE MAIN CONTROL ROOM
- MAIN STEAM LINE FLOW SENSOR INPUT IS DISABLED, THIS IS THE PRIMARY MSIV INITIATOR
- THE 1E INDICATION, WITH THE EXCEPTION OF THE HARDWIRED INPUTS AND THE NEUTRON MONITORING WILL BE DISABLED, THE NON-1E INDICATIONS WILL BE AVAILABLE

DEFENSE-IN-DEPTH AND DIVERSITY
STEAM SYSTEM PIPING BREAK OUTSIDE CONTAINMENT

- MAIN STEAM LINE LOW TURBINE INLET PRESSURE WILL INITIATE CLOSURE OF THE MSIVS
- MSIV CLOSURE WILL INITIATE REACTOR SCRAM
- THE POSTULATED FAILURE DOES NOT DISABLE THE FEEDWATER SYSTEM WHICH USES THE DIVERSE NEMS
- THE INFORMATION AVAILABLE TO THE OPERATOR INCLUDES: CLASS 1E RPV FUEL ZONE WATER LEVEL(RG 1.97), NON-1E SHUTDOWN, FEEDWATER CONTROL, AND REACTOR WELL(ISI) WATER LEVELS, NEUTRON FLUX IS AVAILABLE, NON-IE NARROW RANGE RPV PRESSURE INSTRUMENTATION AND CONTROL IS AVAILABLE
- INFORMATION AND AUTOMATIC ACTUATION ARE AVAILABLE TO MITIGATE THE EVENT/FAILURE
- POTENTIAL PROBLEMS
  - INDICATION AND CONTROL OF THE ECCS IS DISABLED IN THE MAIN CONTROL ROOM
  - THE REMAINING DISPLAYED VARIABLES ARE FEW AND DIGITAL

ADDITIONAL CONSIDERATIONS
STEAM SYSTEM PIPING BREAK OUTSIDE CONTAINMENT

- ADDITIONAL REACTOR SCRAM INPUTS ARE AVAILABLE
  - THE ALTERNATE ROD INSERTION (ARI) FEATURE OF THE ATWS MITIGATION DESIGN USES THE WIDE RANGE DOME PRESSURE SENSORS OF THE STEAM BYPASS AND PRESSURE CONTROL SYSTEM (SB&PC) TO INITIATE ARI THIS IS A NON-1E SYSTEM WHICH DOES NOT USE THE EMS
  - MANUAL (HARDWIRED) SCRAM IS AVAILABLE FROM:
    A. TWO BUTTON SCRAM (DISCONNECTS SOLENOID POWER SOURCES) (1E IN THE CONTROL ROOM)
    B. OPERATION OF TWO OUT OF FOUR DIVISIONAL REACTOR TRIP SWITCHES (1E IN THE MCR)
    C. MANUAL DISCONNECT OF SOLENOID POWER SOURCES AT THE REMOTE ELECTRICAL DISTRIBUTION PANEL (1E)
    D. TWO BUTTON MANUAL ARI INITIATION (NON-1E) IN THE CONTROL ROOM
    E. OPERATION OF PAIRED-ROD SCRAM TEST PANEL (NON-1E) IN THE CONTROL ROOM
    F. MODE SWITCH - SHUTDOWN (1E)
- MSIV CLOSURE WILL CAUSE TURBINE TRIP WHICH WILL CAUSE REACTOR TRIP
- ECCS SYSTEMS ARE AVAILABLE ON THE HARDWIRED REMOTE SHUTDOWN STATION

STEAM SYSTEM PIPING BREAK OUTSIDE CONTAINMENT

- POSTULATED COMMON MODE FAILURE - TRIP LOGIC UNIT (TLU)

FAILURE ANALYSIS

- THIS FAILURE WILL(WORST CASE) DISABLE THE RPS AND ECCS AUTOMATIC ACTUATION
- THIS FAILURE WOULD DISABLE THE MANUAL ECCS SYSTEM ACTUATION
- ALL 1E AND NON-1E INFORMATION TO THE OPERATOR IS AVAILABLE
- ALL NON-1E SYSTEMS REMAIN AVAILABLE

ADDITIONAL CONSIDERATIONS
STEAM SYSTEM PIPING BREAK OUTSIDE CONTAINMENT

- ADDITIONAL REACTOR SCRAM INPUTS ARE AVAILABLE:
  - MANUAL (HARDWIRED) SCRAM IS AVAILABLE FROM:
    A. TWO BUTTON SCRAM (DISCONNECTS SOLENOID POWER SOURCES) (1E IN THE CONTROL ROOM)
    B. OPERATION OF TWO OUT OF FOUR DIVISIONAL REACTOR TRIP SWITCHES (1E IN THE MCR)
    C. MANUAL DISCONNECT OF SOLENOID POWER SOURCES AT THE REMOTE ELECTRICAL DISTRIBUTION PANEL (1E)
    D. TWO BUTTON MANUAL ARI INITIATION (NON-1E) IN THE CONTROL ROOM
    E. OPERATION OF PAIRED-ROD SCRAM TEST PANEL (NON-1E) IN THE CONTROL ROOM
    F. MODE SWITCH - SHUTDOWN (1E)
- STANDBY LIQUID CONTROL AUTOMATIC AND MANUAL INITIATION IS AVAILABLE (NON-1E)
- ECCS MANUAL INITIATION IS AVAILABLE AT THE REMOTE SHUTDOWN STATION

DEFENSE-IN-DEPTH AND DIVERSITY
STEAM SYSTEM PIPING BREAK OUTSIDE CONTAINMENT

- REACTOR SCRAM IS PROVIDED BY THE ARI FEATURE OF THE ATWS MITIGATION SYSTEM, ARI IS DIVERSE FROM THE RPS

- MANUAL (HARDWIRED) MSIV CLOSURE IS AVAILABLE IN THE MAIN CONTROL ROOM BY TRIPPING TWO OUT OF FOUR DIVISIONAL ISOLATION SWITCHES OR BY OPERATING THE EIGHT INDIVIDUAL MSIV CLOSURE SWITCHES

- THE FEEDWATER SYSTEM REMAINS AVAILABLE

- INFORMATION AND ACTUATION (MANUAL MSIV) ARE AVAILABLE TO MITIGATE THE EVENT/FAILURE

- POTENTIAL PROBLEMS
  - CONTROL OF THE ECCS IS DISABLED IN THE MAIN CONTROL ROOM
  - AN ANALYSIS HAS NOT YET BEEN DONE WHICH DEMONSTRATES THAT THE OPERATOR HAS TIME TO INITIATE MSIV CLOSURE

DEFENSE-IN-DEPTH/DIVERSITY
GENERAL CONCLUSIONS

- DEFENSE IS PROVIDED IN REVIEW OF TWO EXAMPLES

    - REACTOR SCRAM

    - LEVEL AND PRESSURE CONTROL

    - INDICATION TO THE OPERATOR

    - AUTOMATIC AND MANUAL ACTIONS

CONCERNS

1. RESPONSE NEEDS TO BE CONFINED TO THE MAIN CONTROL ROOM
2. INCOMPLETE ANALYSIS ON TIME AVAILABLE FOR OPERATOR ACTIONS FOR EACH EVENT
3. LACK OF NECESSARY SYSTEM LEVEL ACTUATION FROM THE CONTROL ROOM - ECCS
4. LACK OF NECESSARY CLASS 1E VARIABLES DISPLAYED IN THE MAIN CONTROL ROOM

NRC ACTION

- EVALUATE THE CONCERNS AND GE RESPONSE AND PRESENT RECOMMENDATIONS TO THE COMMISSION - SECY PAPER

REQUEST FOR GE ACTION

- COMPLETE ANALYSIS
  - EVALUATION OF THE REMAINING EVENTS AND ASSUMPTIONS IN THE LLNL STUDY
  - RESPOND TO THE ABOVE NRC CONCERNS

Enclosure 20

DRAFT
3/26

Defense Against Common Failure in Digital I&C Systems

NRC Position

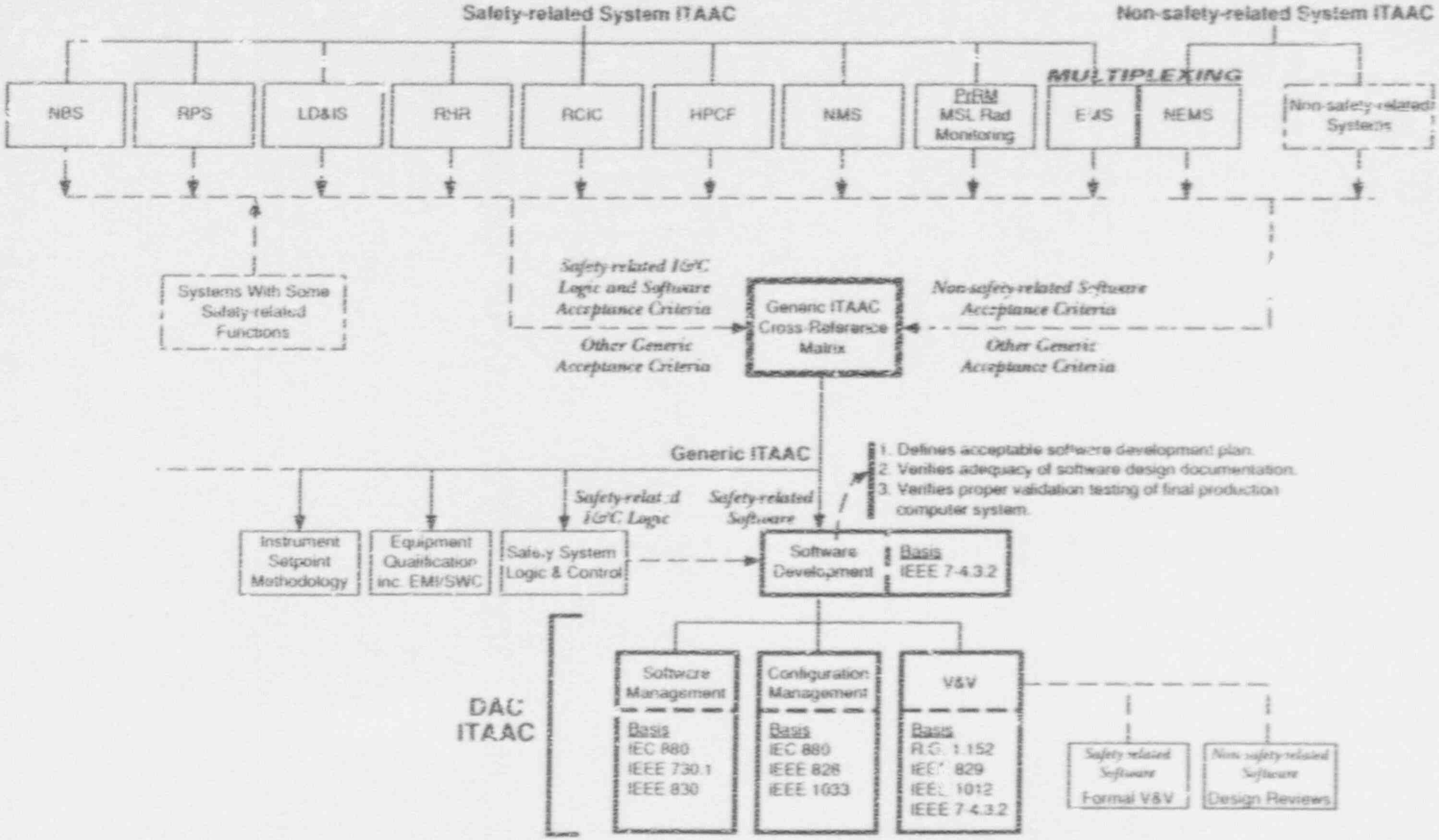
1. Diversity is to be provided for all common mode vulnerabilities.

2. For software common mode vulnerabilities, diversity shall be provided by a diverse software and hardware system or a non-software based system. Manual action from inside MCR may constitute acceptable diversity if time and information available.

3. The capability for manual system-level actuation and control from the main control room shall be provided. Necessary displays and controls (class 1E) shall be independent, the necessary display shall be analog and the necessary control shall be conventionally hard-wired to as low a level in the I&C architecture as practical.

4. Applicants must show that 1-3 above have been satisfied by performing a "Defense in Depth" and "Diversity Assessment" of the proposed digital Instrumentation and Control System. An acceptable method for performing this analysis is described in NUREG 049?. Other methods will require a case-by-case NRC approval.

GENERIC ITAAC and DAC for SOFTWARE DEVELOPMENT INTERFACE DIAGRAM



IEC 880	1986	Software for safety system computers
RG 1.152	1985	Application criteria for safety software
ANSI/IEEE ANS-7-4.3.2	1982	Criteria for safety software
IEEE Std. 730.1	1989	Software Quality Assurance Plans
IEEE Std. 828	1983	Software configuration management
IEEE Std. 829	1983	Software test documentation
IEEE Std. 830	1983	Software requirements specifications
IEEE Std. 1012	1986	Software V&V plans
IEEE Std. 1033	1985	Application practice for IEEE Std 828

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