

April 1989

Detailed Control Room Design Review

Supplementary Summary Report

Pilgrim Station

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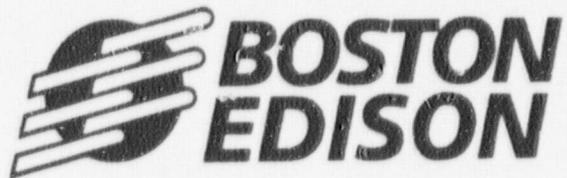


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PREFACE

Boston Edison submitted the Executive Summary Report of the Pilgrim Station Detailed Control Room Design Review Project (DCRDR) to NRC in September 1984, to comply with the requirements of NUREG-0737, Supplement 1.

In response, NRC issued a Safety Evaluation in May 1985, in which NRC requested that Boston Edison submit a supplementary summary report, with additional information.

This Supplemental Summary Report provides additional information requested by NRC's Safety Evaluation. This report describes progress since the previous report in 1984, identifies additional work required to complete the DCRDR, and provides schedule commitments for the next phase of work.

SECTION I

INTRODUCTION

A. Purpose

The purpose of this report is to update and expand upon the information in the September 1984 Summary Report for the Pilgrim Station Detailed Control Room Design Review (DCRDR), Reference 1.*

In summary, this report will:

- Describe the status of DCRDR at Boston Edison.
- Describe the process used for deciding upon corrective actions.
- Identify Human Engineering Discrepancies (HED's) for which corrective actions have been selected and their current status and schedule for implementation.
- Identify HED's for which corrective actions are completed.
- Identify HED's for which corrective actions are not yet decided and identify the steps underway to resolve them.
- Describe the work yet to be done, including new data collection (new task analysis and inventory) in order to complete the DCRDR.
- Respond to the NRC Safety Evaluation Report comments.

B. Background

Boston Edison originally prepared and submitted a Program Plan and a Summary Report (References 2 and 1) in 1984. The Program Plan described the project organization and methodology for performing a human factors review of the Pilgrim Station Control Room in accordance with the requirements of NUREG-0737 Supplement 1. The Summary Report described the work completed, listed the HED's identified during the review, and outlined a series of corrective actions.

NRC conducted a pre-implementation audit of the DCRDR program during the week of November 26-30, 1984, and issued a Safety Evaluation Report (SER) in May 1985. (Reference 3). The SER identified a number of deficiencies in the DCRDR program and concluded that the corrective actions were not described in sufficient detail in Reference 1. NRC required that a supplemental report be prepared and submitted to resolve their concerns.

* References listed in Appendix A

In August 1985, Boston Edison representatives met with NRC personnel at Bethesda, MD., to discuss the NRC's SER and Boston Edison's intended response. While the scope of the meeting included a number of topics, the central issue was NRC's concern with Boston Edison's approach to the System Function and Task Analysis (SFTA). The Technical Evaluation Report appended to the SER (Reference 3, pg. 11) concluded that substantial re-work would be required to produce an acceptable SFTA. In the August 1985 meeting, NRC concluded that Boston Edison need only perform the upgraded SFTA process for the two new Emergency Operating Procedures (EOP's) that had not been issued or reviewed during the DCRDR process.

In April 1986, Boston Edison met with the NRC Project Manager at our offices and we committed to submit this Supplemental Summary report by a date four months after the end of the next refueling outage of Pilgrim Station (RFO 7). This commitment was documented in Reference 4.

In March 1989, NRC conducted an in-process review of the Boston Edison DCRDR project. This report does not address NRC's comments provided during that review (see Reference 6).

C. DCRDR Evaluation Criteria

Boston Edison recognizes and is responsive to each of the nine NUREG-0737 criteria by which the NRC evaluates DCRDR Final Summary Reports. Table I-1 identifies each of these evaluation criteria and the specific section(s) of this report or the revised Program Plan (to be submitted separately) that describes compliance with each criterion for the BECo DCRDR.

D. Activities Since December 1984

1. Physical Improvements in the Control Room

Significant improvements have been made in the Pilgrim control room * since the NRC audit in November-December 1984. The key items are summarized below.

- a. Control Room Arrangement - Conceptual design, detailed design, procurement and installation have been completed for a major re-arrangement of the control room, including new operator "work stations." New consoles were provided for the reactor operator and shift supervisor, to replace conventional furniture previously used. Design of the consoles was integrated with design of the new plant computer system currently being installed. The new control room arrangement relocated the operating supervisor to the center of the room and placed his console on a raised floor. This provided him with a better view of the entire control room and better accessibility to safety-related panels. The console designs are based upon human engineering principles. The supervisor's console includes expansion capability for future annunciator improvements.

* See Appendix D for definition of the Pilgrim Control Room.

TABLE I-1
COMPLIANCE WITH DCRDR EVALUATION CRITERIA

| <u>Criteria</u> | <u>Reference*</u> |
|--|---|
| 1. Establishment of a qualified multidisciplinary review team. | Program Plan |
| 2. Function and task analyses to identify control room operator tasks and information and control requirements during emergency operations. | Program Plan |
| 3. Comparison of display and control requirements with a control room inventory. | Program Plan |
| 4. Control room survey to identify deviations from accepted human factors criteria. | Section I and Program Plan |
| 5. Assessment of HEDs to determine which HEDs are significant and should be corrected. | Section II and Program Plan |
| 6. Selection of design improvements. | Sections II and III and Program Plan |
| 7. Verification that selected design improvements will provide necessary correction. | Section I and Program Plan |
| 8. Verification that improvements will not introduce new HEDs. | Section I and Program Plan |
| 9. Coordination of control room improvements with changes from other programs such as SPDS, operator training, Reg. Guide 1.97 instrumentation, and upgraded EOPs. | Program Plan |

*Section numbers refer to this report; Program Plan refers to revised Program Plan to be submitted separately.

- b. Communications Panel - The communications panel, used by control room operators in both routine operations and emergencies, was redesigned and replaced. The new panel is integrated into the shift supervisor's console described above. The panel includes conventional telephones, radios, plant paging circuits, public address system, and automatic ring-down circuits (including the NRC Emergency Notification System), plus evacuation alarms.
- c. Panel Hardware Upgraded - Several plant design changes were made that resolved "Category A" HED's by replacing equipment. These included replacement of the reactor mode switch (SB-1 switch replaced by SB-9 switch), replacement of about 20 recorders with a preferred type, and partial replacement of reactor water level indication (which resolved an HED related to reactor water level common zero).
- d. Additional Instruments - Two instruments were added to the panels to provide information needed by the operators while implementing Emergency Operating Procedures (EOP's). The added devices are a torus pressure indicator and a primary containment water level indicator.
- e. Plant Computer - A General Electric "Emergency and Plant Information Computer" (EPIC) is installed and will shortly be operational. This computer provides an enhanced operational information source for the operator, including a Safety Parameter Display System (SPDS). The control room layout incorporates provisions for four EPIC terminals within the new operator consoles.

2. Other Improvements to Enhance Operator Performance

Besides the physical improvements to the control room environment, summarized above, other activities were completed that further enhance the operator's ability to prevent and mitigate an accident. While these activities are not part of DCRDR, they are summarized here to present a more complete picture of Boston Edison's efforts to enhance operator performance.

- a. Simulator - Boston Edison has constructed and is now operating a plant-specific simulator. This facility improves the quality and frequency of operator training. It provides increased opportunities for projects, such as DCRDR, to observe the control room environment, and to demonstrate and evaluate potential control room changes before committing to installation at the plant. The simulator has a transient capability to allow its use over wide range of critical events.
- b. Upgraded Emergency Operating Procedures - Boston Edison has upgraded the EOP's based upon Revision 4 of the BWR Owners' Group Emergency Procedure Guidelines. The upgraded EOP's were developed and validated on the Pilgrim simulator, and reflect plant-specific response characteristics to severe transients.

- c. Safety Enhancement Program - The Safety Enhancement Program (SEP) focused on understanding possible severe accidents and developing preventive and mitigative strategies. SEP was beneficial to DCRDR because severe transients are more realistically reflected in the EOP's, and because the control room was modified to include additional controls for added equipment (third emergency diesel-generator, direct torus vent). For more information on the Safety Enhancement Program, please refer to References 7 and 8.

E. Activities in Progress

In addition to completing the physical corrective actions just described, Boston Edison has progressed in several aspects of planning and analysis for the DCRDR project. (All corrective actions summarized here are described more fully in Section III.)

1. HED Assessment - Work has continued on the assessment of Human Engineering Discrepancies (HED's), including actions to resolve the NRC's SER comments. Highlights include:
 - a) A new process for "re-screening" HED's was conceived, developed, tested, and independently reviewed. The new process is intended to identify a logical, consistent, documented basis with which to establish the priorities for correcting HED's. The process takes into account both the technical benefits of correcting HED's (including considerations of safety and availability as well as human engineering principles) and the costs of corrective actions (monetary costs, training burden, risks of error due to change, etc.). This process is described in more detail in the Program Plan and summarized in Section II of this report.
 - b) The re-screening process was applied to the original 153 HED's, producing the evaluation used as a basis for the corrective actions described in this report. Results of the re-screening are discussed in Section II.
2. Panel Enhancements - Conceptual designs have been completed and approved for a "paint/label/tape" enhancement program for the main control panels in the control room (including back panels). The designs include all new labels in a hierarchical scheme, addition of a demarcation scheme throughout the panels (where appropriate), and improved mimics. An interim version of this enhancement program has been installed on two panels in the control room and three panels in the simulator. The interim installations have provided an opportunity for verifying concepts and for obtaining operator feedback. This project includes a replacement of meter scales that did not conform to NUREG-0700 guidelines.

3. Switch Improvements - Preliminary design documents have been approved for switch improvements. These improvements include corrections such as new escutcheons, handle replacements, and replacement or rewiring of selected switches. In addition, a switch standard will be developed.
4. Design Standards - Design standards have been prepared and approved for labels, mimics, demarcation, and meter scales. These were used for design of enhancements and will be established as guidance for future panel work.
5. Annunciator Conceptual Design - Work was begun to evaluate the numerous annunciator HED's and to determine the best corrective action. Work will resume in mid-1989 (see Section III).
6. Lighting Survey - A lighting survey was performed in late 1988, resulting in identification of several potential new HED's. Corrective actions are described in Section III.

F. Remaining Work

The remaining work on the DCRDR project is currently being planned. The specific activities are outlined below and the schedule for completion of these activities is included in Section IV. Details of the methodology for completion of these activities will be provided in the revised Program Plan (to be submitted separately).

1. System Function and Task Analysis - When the Boston Edison Detailed Control Room Design Review began in early 1984, the symptom-based EOP's were only in a draft state, and two EOP's had not been drafted. Boston Edison committed to the NRC to perform additional System Function and Task Analysis (SFTA) on the two new EOP's when they were issued. The initial set of EOP's was based upon Revision 2 of the BWR Owners Group emergency Procedure Guidelines.

In 1987-88, the entire set of Pilgrim EOP's was rewritten and re-issued, including the two new EOP's. The EOP's were upgraded to Revision 4 of the BWR Owners' Group Guidelines, which are substantially different from the Revision 2 guidelines. Changes in the entire set of EOP's are sufficiently extensive that Boston Edison will perform a new SFTA on the entire set (rather than on only the additional two).

Details of the new SFTA are being developed and will be described in a revision of the Program Plan, to be submitted separately.

2. Update of the Control Room Inventory - We will update the Control Room Inventory to reflect changes in the control panel configuration and any panels added to the defined scope. The inventory will be used in the verification of Task Performance Capabilities to compare the information and control requirements determined in the SFTA to the actual control room configuration.

3. Verification of task Performance Capabilities - Following the completion of the SFI4, we will conduct a Verification of Task Performance Capabilities. The objective of this activity is to ensure the availability and suitability of the required control room instrumentation and controls.
4. Validation of Control Room Functions - We will conduct a Validation of Control Room Functions to ensure that the functions allocated to the Control Room operating crew during emergencies can be accomplished effectively.
5. Control Room Survey - We will conduct the control room surveys that were not previously completed. These surveys include:
 - Noise Survey
 - Heating/ventilation/air conditioning (HVAC) survey
 - Computer survey (6.7)
 - Sections of surveys 6.8 and 6.9 not done previously

We will also review any plant equipment that has been installed in the control room since the surveys were conducted in 1984. In addition, we will survey any panels added to the scope of DCRDR since the previous survey. This survey will determine whether the new equipment conforms to the NUREG-0700 guidelines and will be conducted in accordance with our Program Plan.

6. Assessment of HED's and Selection of Corrective Actions - The work previously performed plus the new work described above (items 1 through 5) will result in a consolidated list of HED's. The HED's will be assessed for significance as described in the revised Program Plan (and summarized in Section II of this report). We will then select design improvements or other corrective actions to correct the safety-significant HED's, unless corrective actions are not justified. (Many HED's will already be addressed by the corrective actions described in this report.)
7. Implementation and Verification - Selected design improvements and other corrective actions will next be planned and implemented. As part of the implementation Boston Edison will verify the corrective actions will provide the necessary correction and will not introduce new human engineering discrepancies.

The results of the new data collection effort (items 1 through 5), selection of additional corrective actions, and schedules for implementation will be reported to the NRC in a final DCRCR summary report, by November 30, 1990.

SECTION II

ASSESSMENT OF HED's

A. Introduction

In its Safety Evaluation Report (Reference 3) the NRC noted that implementation of the BECo assessment process, to determine which HED's are significant and should be corrected, had not yet been completed. This section provides an overview of the revised assessment process which has been applied to the original set of HED's, and will be used for future HED assessment.

After receipt of the NRC SER in 1985, Boston Edison started a project to improve the HED assessment process and to use the improved process to re-screen the original HED's. The purpose of the improvements was to provide better documentation of the HED screening criteria and results, establish a more quantitative basis for setting priorities, and to incorporate cost-effectiveness considerations into the process. Boston Edison committed to perform the revised assessment by letter to the NRC (Reference 4).

The HED assessment procedure reflects the requirements of NUREG-0700, NUREG-0737 and NUREG-0800. In addition, it considers criteria for plant safety and availability.

B. Revised HED Assessment Process

1. Overview

The revised assessment methodology supplements the HED assessment process described in the previously issued DCRDR Program Plan (Reference 2). It provides a method to categorize HED's for implementation, and it evaluates the potential consequences of unresolved HED's.

The products generated by this assessment methodology are:

- a. A list of HEDs grouped in seven categories, according to probable methods for implementation of corrective action.
- b. A list of HEDs ranked by relative importance to transient or accident risk, considering the risk of contributing to the initiation of an event as well as the potential to affect operator performance during response to an accident or transient.
- c. A list of HEDs ranked by relative importance to potential costs (costs that could result if the HED is not corrected, or costs that are avoided by correcting it). The cost impact considers four contributions: the potential for inadvertent plant scrams, equipment damage, extended outage duration, and technical specification violations.

- d. Documentation that identifies the cost and risk impact from selected HEDs and the qualitative and quantitative bases for their relative importance rankings.

In summary, this procedure provides the estimate of the relative risk and the relative cost (lost productivity) but does not provide absolute measures for either quantity.

2. Revised Assessment Methodology

The revised HED assessment methodology supplements the initial classification and methodology described in the Program Plan. The overall process is as follows:

- The initial set of Human Engineering Observations (HEO's) had previously been assigned to Categories A, B, C and D on the basis of their importance to plant safety, availability, and reliability, as described in References 1 and 2. The starting point for the additional pre-screening process was the set of 153 Human Engineering Discrepancies, consisting of Categories A, B, and C.
 - The appropriate DCRDR team members conducted the pre-screening process which separated all the HEDs into seven implementation groups for development of the appropriate disposition.
 - The team then conducted the detailed screening process which provided a detailed analysis of specific HEDs to evaluate the potential risk and the averted cost impact of the HEDs.
- a. Pre-screening Process - Performance of the pre-screening process included the following tasks:
- Review of each HED in the control room and verification of the HED as originally stated against configuration of the plant. Any changes to the as-built configuration and design documentation affecting the HED as originally stated were noted as necessary.
 - Each HED was assigned to one of the seven implementation groups in Table II-1. If applicable, any references or justifications were noted in defining the appropriate group chosen for a particular HED.

If during the review process or at any time after the completion of the review it was found necessary to transfer the HED to another category, the documentation was revised to properly track HED implementation.

TABLE II-1
PRE-SCREENING CATEGORIES

1. Annunciator-related HEDs.
2. HED's for correction by surface enhancements (paint/label/tape/meter scale) or minor relocations of instruments, or switch handle change.
3. Control room habitability and environment-related HEDs.
4. Hardware-related HEDs associated with a less-than-desirable choice of equipment type or manufacturer based on human factors concerns. (Example: improper shape or size of component or method of changing component status.)
5. Hardware-related HEDs associated with a less-than-desirable location for the component relative to the operator's performance of normal or emergency procedure tasks using the component under review.
6. HED's that are potentially resolved, pending verification and validation.
7. HED's with administrative or operations disposition (Example: operations procedure changes).

Source: Reference 11.

- b. Detailed Screening Process - This process provided a detailed analysis of the HEDs in three of the seven categories identified in the pre-screening: Category 1 (annunciator-related), Category 4 (hardware type), and Category 5 (hardware location).

These three categories were chosen for the detailed analysis because of their potential cost, complexity, and disruption to the Control Room in the implementation of corrective actions. For the other categories detailed analysis and prioritization is either unnecessary because corrective actions for the items is justified without the detailed analysis, or the type of HED is not suited to this type of analysis. Forty-six (46) HEDs were subjected to the complete screening analysis.

The detailed screening process was conducted on June 6-10, 1987 at the Pilgrim control room mockup with the multi-disciplinary team present including operations and human factors representatives.

The detailed analysis was performed by a team using the approved procedure (Reference 11). To guide the team, the procedure includes forms and tables of HED rating criteria guidelines. Details of the process will be provided in the Program Plan revision to be submitted separately.

The impact of risk was determined through two types of contributions: (1) potential for the HED to affect operator performance during their response to a plant transient or accident, and (2) HEDs that can contribute to the initiation of an event by affecting routine operator performance during plant power operation, startup, shutdown, cold shutdown, or refueling. Qualitative evaluations of the relative significance of each HED are combined with quantitative information from representative probabilistic risk assessments (PRA) to evaluate the composite risk impact based on the frequency of possible operator errors and the consequences from those errors.

The impact of averted cost (i.e., potential cost if not corrected) was determined through four types of contributions: potential for the HED to: (1) cause an inadvertent plant scram, (2) cause damage to plant equipment, (3) cause unanticipated extensions to scheduled plant outages and (4) affect the operators' ability to maintain conditions within the limits set by the plant technical specifications. The averted cost impact evaluation follows the same format as the risk impact evaluation. Qualitative evaluations of the relative significance of each HED are combined with quantitative cost data to evaluate the composite cost impact based on the frequency of possible operator errors and the consequences from those errors.

Performance of the detailed screening included four basic tasks:

1. Identify and summarize all relevant information concerning the HED impact on the station operations procedures (normal and emergency) that use the equipment.
2. Develop quantitative risk impact indices for those HEDs that affect plant transient response or that may contribute to the initiation of an event.
3. Develop quantitative cost impact indices for those HEDs that affect any of the four cost elements identified earlier.
4. Rank the HEDs according to their risk and averted cost impact indices. These indices provide the relative benefits resulting from the correction of the HEDs. Thus, the risk indices and the averted cost indices together provide a basis for ranking the HED's according to the benefit of correcting them.

To complete the HED prioritization process the following activities are necessary:

1. Identify potential corrective actions and their potential implementation costs. Preliminary designs have been done for actions to correct the HED's subjected to detailed screening. The next step is to perform a cost estimate for implementation (engineering, construction, training).
2. Compare benefits and correction costs to set priorities. Corrective action costs can be compared to the HED risk and cost indices from Step 4 to rank the HED's for cost-effectiveness. This ranking will be a major factor in setting priorities for corrective actions.

During the detailed screening process, many of the HEDs (or portions of an HED) were reassigned to another implementation category for one of the following three reasons:

- Detailed investigation by the multi-disciplinary team identified that the corrective action had already been accomplished (pending human factors review).
- The analysis identified the recommended reassignment based on the present as-built configuration or the technical consensus of the multi-disciplinary team.
- Detailed analysis of the HED against the Pilgrim operating and emergency operations procedures identified no scenarios where utilization of the equipment identified in the HED would affect the risk or averted cost in accordance with the criteria in the screening procedure.

The reassessments of the HEDs to another implementation category were documented with justification provided in accordance with the relevant procedure.

3. Pre-Screening Results

All of the original HEDs were re-screened by members of the multi-disciplinary team. The pre-screening was conducted in the Pilgrim control room using support from the on-shift operations crew, as needed. The results of the pre-screening process are summarized in Table II-2. These results were used as input to the detailed screening process.

4. Detailed Screening Results

Detailed analysis of the forty-six (46) Category 1, 4 and 5 HEDs resulted in quantitative risk and averted cost impact evaluations of fifteen (15) HEDs as shown in Table II-3. Thirty one (31) HEDs were reassigned to other implementation groups, as shown in Table II-4. Appendix C tabulates the individual HEDs and lists their categories as determined to date.

Following the screening analysis, the design of corrective actions proceeded on a category basis as follows:

Category 1 (annunciator) HED's - Conceptual design will begin shortly.

Category 2 (enhancement) HED's - Enhancement designs have been developed and are being finalized and implemented.

Category 3 (environmental) HED's - Additional lighting is being designed. Noise and ventilation will be re-surveyed.

Category 4 and 5 (Panel Hardware) HED's - Conceptual designs have been developed, and corrective actions will be selected after the new task analysis verifies the nature and priority of major panel changes.

Category 6 (potentially resolved) - Field verification and documentation is underway.

Category 7 (non-engineered solutions) - All but two items have been completed by administrative actions; HED's will be reviewed and reassigned to Category 6 (completed items) or Category 2 (for two open items).

Details of the corrective actions planned for all categories are further discussed in Section III; schedules are in Section IV.

TABLE II-2
PRE-SCREENING RESULTS

| <u>Category #</u> | <u>Category Name</u> | <u># of HED's (1)</u> |
|-------------------|--|-----------------------|
| 1 | Annunciator | 25 |
| 2 | Paint/Label/Tape (+ minor relocations) | 55 |
| 3 | Habitability | 7 |
| 4 | Equipment type | 15 |
| 5 | Equipment location | 27 |
| 6 | Potentially resolved | 30 |
| 7 | Non-engineering resolutions | <u>13</u> 172 (2) |

- Notes:
1. Data as of June 1987, prior to the Detailed Screening.
 2. Some HED's are in two or more categories; actual total number of HED's is 153.

TABLE II-3
RESULTS FROM QUANTITATIVE
 IMPACT EVALUATIONS

| <u>HED #</u> | <u>Cat.</u> | <u>Brief Description</u> | <u>Relative Scores(1) (3)</u> | |
|--------------|-------------|---|-------------------------------|-----------------|
| | | | <u>Risk (2)</u> | <u>Cost (2)</u> |
| 4B131 | 4 | Non-standard switch positions | 110 | 20.5 |
| 8A008B | 5 | Panel C7 too crowded | 109 | 17.9 |
| 3B047 | 1 | Confusing auditory alarm | 32 | 7.5 |
| 3B026 | 1 | Lack of systematic priority scheme | 28 | 2.0 |
| 5B067 | 5 | Incomplete information display | 28 | 7.5 |
| 5B119 | 4 | Insufficient lettering height on scale | 27 | 1.5 |
| 3B028 | 1 | Separation of controls from alarms | 21 | 1.8 |
| 8A007B | 5 | Panel CP-600 not logically arranged | 8.7 | 1.7 |
| 1B005B | 5 | Displays too high above floor | 7.6 | -- |
| 1B015 | 5 | Displays inconvenient on backpanels | 0.6 | -- |
| 8B101 | 5 | Inconvenient location for sequential controls | 0.1 | 0.4 |
| 3C012 | 1 | No reflash capability | -- | 0.8 |
| 4B060B | 4 | Unused switch on CP-500 | -- | 0.1 |
| 4B051B | 4 | Controls violate population stereotype | 0 | 0 |
| 8B094B | 5 | Display exceeds length guideline | See results of #1B005B | |
| 4B115 | 4 | Pushbutton "cheater" capability | (4) | (4) |

- Notes:
- (1) All results are rounded off
 - (2) For definitions of "risk" and "cost", see Reference 11.
 - (3) Scores are on an arbitrary scale with no absolute meaning.
 - (4) HED #4B115: analysis is awaiting additional information
 - (5) Four of 26 HED's in Category 1 were considered representative of entire category.

TABLE II-4
DETAILED SCREENING RESULTS

| <u>Category #</u> | <u>Category Name</u> | <u># of HEDs (1)</u> |
|-------------------|-----------------------------|----------------------|
| 1 | Annunciator | 26 |
| 2 | Paint/Label/Tape (+minor) | 69 |
| 3 | Habitability | 5 |
| 4 | Equipment type | 5 |
| 5 | Equipment location | 7 |
| 6 | Potentially resolved | 45 |
| 7 | Non-engineering resolutions | <u>16</u> |
| | TOTAL | 173 (2) |

- NOTES: (1) Data as of May 9, 1988 after the completion of the detailed screening process per Reference 11.
- (2) Some HEDs are in 2 or more categories: the actual total number of whole HEDs is 153 (Reference 1).

SECTION III

CORRECTIVE ACTIONS

A. Introduction

This Section will describe the corrective actions for identified HED's. Corrective actions include physical improvements, programs or activities to obtain additional information so that more specific corrective actions can be identified, and non-engineered corrective actions such as procedure changes.

Corrective actions can be separated into three broad groupings: (1) those already completed; (2) those committed in this report for implementation by the end of the next refueling outage; and (3) those not yet committed, pending further data collection, analysis, and evaluation.

To a large extent, the HED's will be resolved in groups according to the screening categories described in Section II. Therefore, the following text is organized according to the screening categories, after a discussion of Category A HED's.

Table III-1 outlines the implementation status of the HED's, by category.

Section I of this report summarizes progress to date.

Section IV summarizes the schedules for the implementation programs.

Appendix C lists all HED's, including their implementation categories.

B. Category A HED's

Category A HED's are those that are known to have caused or contributed to an operating error, or which have the potential to cause an error of high safety consequence, under the HED categorization scheme used in the original (1984) survey. Because of their importance, Table III-2 provides a cross-reference to the current categories for all the original Category A HED's.

The status of each of the Category A HED's is as follows.

1. HED #4A003

This HED related to the reactor mode switch, which had worn and no longer had a positive detent. The mode switch was replaced with another of improved construction (SB-9 type vs. original SB-1) but with no change in appearance or function. This HED is ready for verification and closeout.

TABLE III-1. GENERAL IMPLEMENTATION PHASES FOR HED CATEGORIES

| HED Category | General Implementation Phases | | |
|--|-------------------------------|--|--|
| | Completed, to be verified | Concept Selected, Implementation by End of RFO 8 | Major Study Required |
| | | Decision after New SFTA | Special Data Collection Required before Design Selection |
| 1-Announcer | | X | |
| 2-Surface Enhancements & Minor Mods | | X(3) | |
| 3-Environmental HVAC Noise Lighting | | X | X X |
| 4-Equipment Type | | X(1) | X(1) |
| 5-Equipment Location | | | X |
| 6-Potentially Resolved; to be verified | X | | |
| 7-Operations (non-engineered solutions) | X(2) | | |

Notes to Table III-1

- (1) Three HED's in Category 4 are included in surface enhancements corrective action program; remainder (2 HED's) will be addressed after the new SFTA.
- (2) Two of HED's from Category 7 require action; both are to be done by the end of RFO 8.
- (3) Eleven HED's involving potential minor relocations require further review (see text).

TABLE III-2
CATEGORY A HED's

| <u>HED NO.</u> | <u>TITLE</u> | <u>SCREENING CATEGORY</u> |
|----------------|---|---------------------------|
| 4A003 | Mode switch - no detent | 6 |
| 5A004 | Recorders not satisfactory | 6 |
| 5A005 | Reactor water level - zero not consistent | 6 |
| 5A009 | Torus water level - zero not consistent | 2,6 |
| 5A010 | Drywell temperature - no indication by height | 5 |
| 8A006 | Panels need operator enhancement aids | 2 |
| 8A007 | Panel CP-600 not logically arranged. | 2,5 |
| 8A008 | Panel C-7 not logically arranged. | 2,5 |

Notes:

- (1) Source: Reference 1
- (2) See Appendix C or Reference 1 for more complete description of HED
- (3) Screening Categories 1-7 are defined in Section II.

2. HED #5A004

This HED concerned eleven (11) recorders with confusing scales and functional problems.

Of the total of eleven recorders on Panels C-170 and C-171* covered by the HED, seven were Westinghouse recorders of conventional type (pen and paper, with a separate scale) and four were Texas Instruments thermographic type (thermal printer, no conventional scale). Of the additional problems cited with "GE recorders...[which] are difficult to read and often fail", 25 recorders on five separate panels were involved (22 conventional, and three step-print types).

All Westinghouse and GE conventional recorders were replaced (total of 29 recorders) with Tracor Westronix "series E" recorders having a scale for each active channel and felt-tip pens which cannot rip the paper. Three GE step-print multi-channel types were replaced with Leeds & Northrup "Speedomax" type recorders. Of the four TI thermographic type, two were replaced with Westronix type recorders for non-human factors reasons, and two remain installed as satisfactory. This HED is ready for verification and closeout.

3. HED 5A005

This HED cites the differing zeros on the reactor water level indicators. As part of the reactor water level instrumentation modifications, all read-out instruments in the control room are now referenced to a common water level zero. In addition, red zones have been added to those indicator scales which show top of active fuel and below. This HED is ready for verification and closeout.

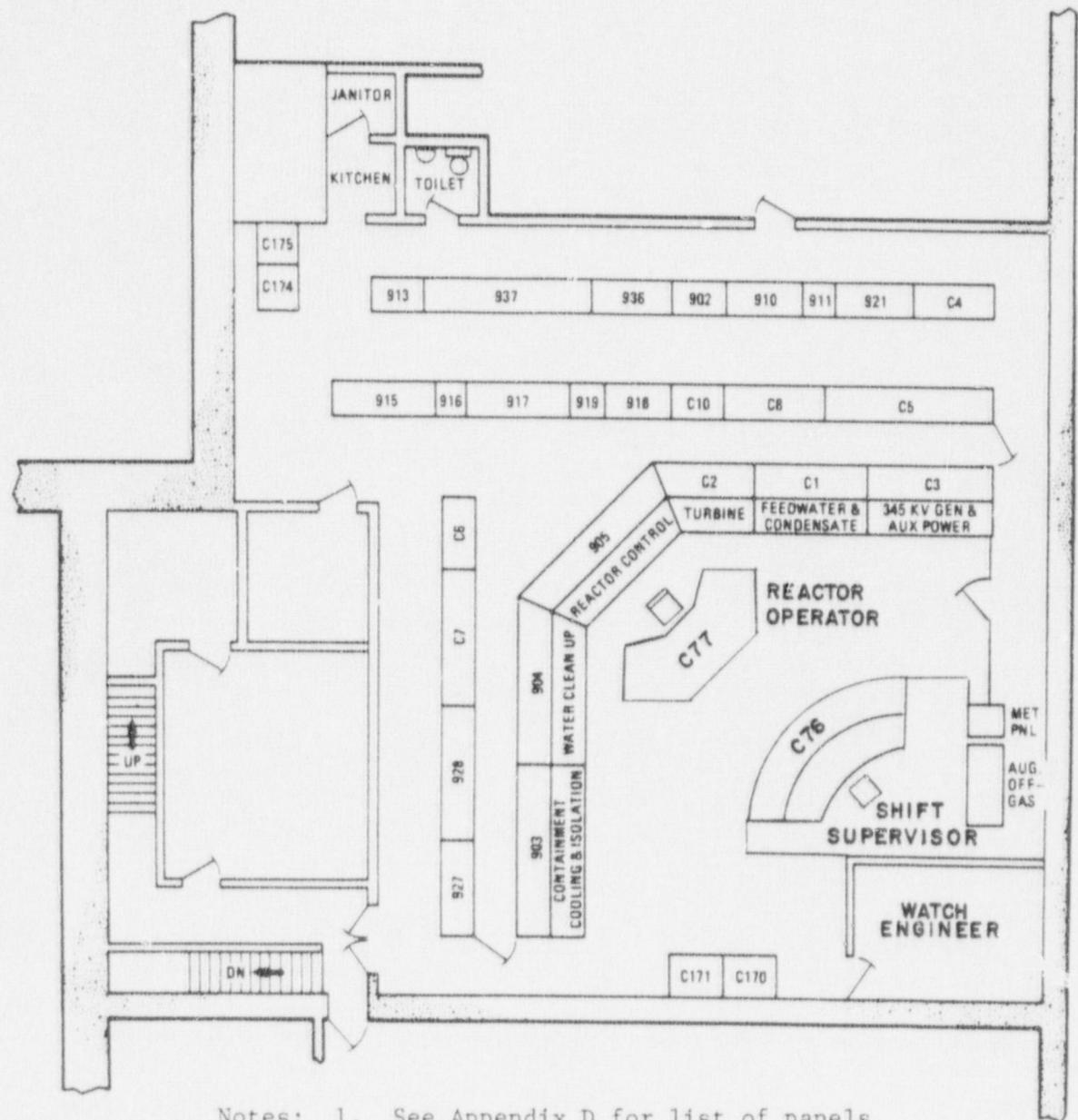
4. HED 5A009

This HED involves inconsistencies in torus water level instrument zeros. The discrepancy was found during the previous SFTA effort. Two different instrument ranges and six instruments are concerned. Two instruments are on each of panels C-170 and C-171, one instrument is on 903, and one instrument is on C-7.

An operator aid plaque was placed at Panels C-170/-171, explaining the different ranges of water level in relation to the torus low point and in relation to the torus downcomers.

The two distinct zero points are appropriate for the separate uses of the wide range and narrow range water level meters. The operations personnel are comfortable with the distinction and are not likely to become confused because the conditions and numerical values differ markedly between the two sets of scales. The new SFTA is expected to verify that the existing instrument scales are satisfactory.

* See Figure III-1 for panel locations and Appendix D for full panel names.



Notes:

1. See Appendix D for list of panels included in DCRDR scope
2. Some details omitted for clarity.

FIGURE III-1. Layout of Pilgrim Station Control Room

5. HED 5A010

This HED was identified during the previous task analysis. It cites the discrepancy that EOP entry conditions require knowing the temperature of the drywell air both above and below the 40-foot elevation, but no temperature monitor distinguishes the temperature relative to the 40-foot point.

We have not yet resolved HED 5A010. Revisions to the EOPs appear to have made this HED obsolete. No action will be taken until after the new SFTA, which will clarify HED 5A010's status.

6. HED 8A006

HED 8A006 involves the lack of operator enhancement aids on four panels: CP-600, C-7, C-170 and C-171. Panel CP-600 has since received its interim enhancements. Design of interim enhancements for the other panels is underway. All panels will be enhanced as described in Section III.D.

7. HED 8A007 & 8A008

These HEDs deal with the arrangement of displays and controls on panels CP-600 and C-7. The addition of interim enhancements, complete for CP-600 and in design for C-7, will reduce the significance of the human engineering discrepancies. Design of rearrangements of both panels has begun, and will be finalized after the new SFTA process is complete.

C. Category 1--Annunciator-Related HED'S

Twenty-seven annunciator-related HED's are included in Category 1. This is the numerically largest category of HED's not yet resolved.

The HED's in this category are:

| | | |
|--------|-------|--------------|
| 1B005A | 3B030 | 3B039 |
| 2C010 | 3B031 | 3B040 |
| 3B023 | 3B032 | 3B043 |
| 3B024 | 3B033 | 3B044 |
| 3B025 | 3B034 | 3B045 |
| 3B026 | 3B035 | 3B047 |
| 3B027 | 3B036 | 3C012 |
| 3B028 | 3B037 | 5B066A |
| 3B029 | 3B038 | HEO #6.3.020 |

HEO #6.3.020 is listed because it will be raised to HED status based on Pilgrim Station Licensing Event Report (LER) #88-023 which references the same problem previously noted in the HEO.

Early in the DCRDR project effort it was realized that the HEDs related to the annunciator system represented particularly complex issues, because all panels and many human factors issues are involved. Additionally, it was decided that maintenance/ reliability issues must be considered in any resolution.

An example of the complexity and trade-offs involved in the annunciator HEDs is that the HEDs indicate there are too many shared alarm windows and alarm windows are not grouped by system. This is significant because there are not enough "spare" windows to separate shared alarms and to rearrange the annunciator tiles, which implies a need for additional windows. The HEDs also indicate, however, that the individual alarm windows are too small to allow the proper size lettering for visibility, but the windows cannot be enlarged because the space available for window boxes on the panels is essentially filled. To address this conflict and the many other annunciator concerns, Boston Edison will conduct an annunciator conceptual design study, which will develop recommendations to resolve the Category 1 HEDs.

D. Category 2--Panel Enhancements and Minor Modifications

Category 2 represents the bulk of the HED's for which corrective actions have been defined. A panel enhancements program is underway, to be completed by the end of the next refueling outage, which will resolve 69 HED's (partially or completely).

The corrective actions for this category include the following items:

- Control room standards
- Enhancements--Improved labels, demarcations, meter scales, mimics
- Minor relocations
- Removal of abandoned equipment
- Switch enhancements--improved handles and escutcheons
- Switch modifications and replacements
- Electrical distribution panel enhancements

Each of these items is discussed below.

1. Control room standards development

Control room standards have been developed and used for the control panel enhancements program. These engineering standards will be used as guidelines for future related control panel design changes. Additional standards may be developed as new technical or human factors (HF) issues emerge later in the project.

Standards prepared to date are:

- a). Control Panel Labels and Nameplates
- b). Control Panel Demarcation
- c). Instrument Scales
- d). Abbreviations & Acronyms

One additional standard is in preparation, for control panel mimics. (A draft version of this standard was used for design of mimics in the enhancements program.)

We will prepare a standard for control panel switch applications, as part of the effort to resolve various switch-related HED's. We will consider issuance of additional standards as work proceeds. Potential topics for standards include:

- a). control panel painting
- b). control room lighting
- c). annunciator window engraving
- d). color usage

2. Enhancements

"Enhancements" include improvements generally thought of as "paint, label or tape" plus meter/recorder scale improvements, and resolution of certain HEDs that do not require major panel rework.

- a). The 29 HEDs assigned to labels, nameplates, mimics and demarcation are as follows.

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|---|
| 8A006 | Panel layout-enhancements |
| 8A007A | Panel CP-600 not logically arranged |
| 8A008A | Panel C-7 not logically arranged |
| 4B126 | Labels - Completeness of information |
| 5B066B | Displays - missing labels |
| 6B072 | Need for labels |
| 6B073 | Hierarchical label system |
| 6B074 | Label placement |
| 6B075 | Label placement |
| 6B076 | Label consistency |
| 6B077 | Label brevity |
| 6B078 | Label functional groups |
| 6B080 | Label readability - letter height |
| 6B081 | Label readability - contrast |
| 6B082 | Temporary labels |
| 6B084 | Demarcation - methods |
| 6B085 | Color coding - general |
| 6B087 | Color contrast - mimics |
| 6B088 | Use of mimics |
| 6B090 | Labels - consistency with procedures |
| 6B091 | Labels - clarity |
| 6B092 | Missing labels |
| 6B121 | Labels - system function |
| 6B125 | Labels - internal consistency |
| 8B094A | Labels - groups of similar components |
| 8B095 | Demarcation - groups of components (list continues on next page) |

Enhancements HED's, Cont'd

| | |
|-------|----------------------------------|
| 8B099 | Demarcation - spacing/separation |
| 8B100 | Demarcation - emergency controls |
| 1C005 | Labels - shadowing |

These HED's have been addressed by an integrated design of panel enhancements, incorporating new labels, area-type demarcations, improved or additional mimics. Designs were based upon the newly-developed control room standards for labels, demarcation, scales, abbreviations and acronyms and mimics (as described above). The enhancements design for each panel will be evaluated in part by interim installation of the design, either in the control room or in the simulator or both. The interim installation uses a combination of permanent and temporary materials to closely emulate the appearance of the final design, but without requiring alterations to operating procedures or plant drawings.

Once the interim enhancements are applied to a panel, plant operators (ROs and SROs) are asked to review and comment on the improvements. The interim enhancements are revised as needed and may be reviewed again. When the design is finalized, the enhancement will be applied to the corresponding panel in the PNPS control room. One panel in the main control room (CP-600) and three panels in the simulator had received interim enhancements by April 14, 1989.

As part of the surface enhancements project, we will appropriately identify instruments and indicators as required by Regulatory Guide 1.97.

Details of the label, demarcation and mimic enhancements are as follows.

1.) Labels

A label standard has been completed and a complete new set of labels has been designed for the defined control room. We are resolving operator comments on the entire set of labels. New labels are being installed at the PNPS simulator for review prior to their installation in the control room.

The new labels are based on a hierarchical scheme recommended by NUREG - 0700 guidelines and various human factors engineering texts. There will be three types of labelling in the control room: hierarchical system/component labels; operator information labels; operator warning labels. A fourth label type may be used to identify those instruments associated with Regulatory Guide 1.97. All labels have their character height

scaled so that they are visible from the proper viewing distance. The system/component labels are almond color with black characters; the information labels are light green with black characters; the warning labels are bright yellow with black characters. All characters are engraved and then filled to present the most visible appearance and to minimize the accumulation of dust or dirt. The type font chosen for all labels is "Helvetica".

ii.) Demarcation

Demarcation involves use of color shaded areas on the control panel faces to designate areas of importance and to identify relationships among devices. Five shades of color will be used. A sixth color is the "base", or panel, color.

By judiciously varying the extent and shading of the colored areas ("patches"), we can show which controls/instruments are related to others when panel arrangements do not readily identify the relationships. In addition, where groups of devices are related to a specific function, all devices are located on a single color. Particular areas can be made to stand out on the panel by using darker shades, and other areas recede into the background by using lighter shades.

At PNPS, demarcation by the color patch method is intended to accomplish the following:

- Functional grouping of components by task sequence.
- Functional grouping of components by system function.
- Functional grouping of components by importance and/or frequency of use.

iii.) Mimics

In selected areas where mimics would be both helpful and feasible, mimics will be applied to the panels. Mimics will consist of colored plastic strips affixed to the panels. Mimic beginning and end points will be identified with either component labels or mimic "end point" labels. Color of mimic labels will be the standard almond color, not the color of the mimic itself.

b.) HEDs involving instrument scales are as follows (10 HEDs):

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|---|
| 5B061 | Usability of displayed values - conversion |
| 5B062 | Visual displays - contrast |
| 5B063 | Visual displays - parameter scales |
| 5B064 | Visual displays - unit graduations (list continues on next page) |

Scales HED's Continued

| | |
|--------|--|
| 5B065 | Visual displays - direction of movement |
| 5B111 | Visual displays - zone markings |
| 5C016A | Visual displays - scale selection |
| 5C018A | Visual displays - quality of information displayed |
| 5C020 | Visual displays - unit scales |
| 5C022 | Visual displays - scale graduations |

A plant design change (PDC) has been issued to replace all instrument scales with human engineering discrepancies that can be resolved by replacement of the scale alone. Approximately 50 meter and recorder scales will be replaced with new scales that meet the PNPS instrument scale standard. Colored zones will be added in the future, if applicable.

Please note that several meter scales are too small for proper visibility due to the size or placement of the meter (e.g., HED #5B119) and are therefore addressed in Category 4.

3. Minor Relocations

Eleven HEDs have been assigned to a group called "minor relocations". These HEDs generally involve movement of components on a single panel. Many components are in clusters where the arrangement of the cluster does not meet human factors considerations, but resolution can be accomplished by re-arranging the cluster. Conceptual design of resolutions will begin shortly. If design work shows that any of the corrective actions are not appropriate under the enhancement program (i.e., if the panel needs significant rearrangement), the HED will be reconsidered for possible assignment to Category 5, or for resolution by other means. The HED's are as follows:

| HED No. | TITLE |
|---------|---|
| 4B051A | Controls - violation of population stereotype |
| 4B056 | Controls - legend push-buttons/displays |
| 4B057 | Controls - barriers |
| 8B097A | Mirror imaging |
| 8B098 | Functional grouping |
| 8B103 | Logical arrangement |
| 8B105 | Sequence of use |
| 8B122 | Layout consistency |
| 9B106A | Movement relationships |
| 9B107A | Control/display relationships |
| 9B109A | Control/display proximity |

4. Removal of Abandoned Equipment

Certain panel devices no longer needed will be removed, to eliminate visual clutter and to provide free space. HEDs in this group are as follows (3 HEDs):

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|---------------------------------|
| 4B060A | Equipment not connected or used |
| 5B071 | Unnecessary equipment |
| 5B124 | Unnecessary equipment |

Items cited in the HEDs, plus others known to be abandoned, will be removed from the panels during the enhancements program.

5. Switch Enhancements

HEDs related to switch applications not requiring replacement or rewiring of switches are as follows (7 HEDs):

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|----------------------------------|
| 4B048 | Controls - Human suitability |
| 4B049 | Controls - covers or guards |
| 4B052 | Controls - consistency |
| 4B054 | Controls - shape coding |
| 4B055 | Controls - color coding |
| 4B058 | Controls - position indication |
| 6B120 | Controls - illegible escutcheons |

These HEDs will be resolved by: (1) handle shape/color coding; (2) escutcheon engraving; (3) addition of position indicating index; (4) improved means to prevent inadvertent actuation. Approximately 300 switches will be affected. Included with this group of HEDs is preparation of a standard for application of switches and associated devices in the PNPS control room.

6. Switch Modifications

HEDs related to more complex issues which require replacement and/or re-wiring of switches are as follows (3 HEDs plus one previously undocumented HED):

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|----------------------------------|
| 4B051B | Controls - direction of movement |
| 4B115A | Controls - adequacy |
| 4B131 | Controls - direction of movement |
| HEO#6.4.024 | Controls - no detent |

Note that HED 4B131 was determined by re-screening effort to offer the highest "benefit of resolution" of all HEDs screened. (See Section II.)

Approximately 150 switches will be affected by resolving the HEDs in this group. Included in this group are HEDs related to switch rotation, switch position sequencing, multiple switches with identical positions but differing arrangements, and mis-application of switch types. Most switches in this group will be replaced or re-wired to resolve the HEDs. The switch applications standard to be created as part of item (5) above will be used as basis for engineering purchases of new switches.

The HEO listed above was recently discovered. There are approximately 50 "SBM" control switches on various panels having two maintained positions with a third unused position between the active positions. Such switches appear to be constructed with no detent between the active positions, an infraction of NUREG-0700, item 6.4.4.5 (2). The extent of this HEO is being investigated.

7. Electrical Systems Panel Enhancements

The Electrical Systems Panel (C-3) has six HED's to be resolved as a group, as follows:

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|--------------------------------------|
| 4B050 | Controls - Covers or guards |
| 4B053 | Controls - mirror imaging |
| 5B062 | Visual displays - contrast of scales |
| 5B069 | Visual displays - consistency |
| 6B086 | Mimics - color discrimination |
| 6B089 | Labels - internal consistency |

Resolving this group of HEDs will involve techniques to prevent inadvertent actuation, color coding of indicator lamps, re-arrangement of certain panel components, replacement of mimics, and replacement of several meters.

Criteria and techniques are consistent with other elements of the enhancements program, but tailored to this particular panel.

E. Category 3--Habitability-Related HED's

This category includes HED's related to lighting, noise, and heating/ventilating/air conditioning.

1. Lighting

HEDs and HEO's related to control room lighting are as follows (two HEDs and five HEO's):

| <u>HEO/HED No.</u> | <u>TITLE</u> |
|--------------------|---|
| 1B012 | Illumination - levels and uniformity |
| 1B013 | Illumination - glare and reflectance (list continues on next page) |

Lighting HEO/HED's Cont'd

| | |
|---------|-------------------------------------|
| 6.1.038 | Illumination--Levels and uniformity |
| 6.1.039 | Illumination--Uniformity |
| 6.1.040 | Illumination--Luminance Ratios |
| 6.1.041 | Illumination--Shadowing |
| 6.1.042 | Emergency lighting--Levels |

The five HEO's were determined by a lighting survey completed in the fall of 1988. In general, the cause of the HEO's is insufficient light, or light provided non-uniformly.

The control room lighting will be modified to address these observations. This modification will add ceiling light fixtures and dimming features to the PNPS Control Room to increase the intensity and uniformity of illumination.

The lighting modification will be designed to increase normal AC lighting levels to achieve a minimum of 20 foot-candles except for operator stations where a minimum of 50 foot-candles is designed to be maintained during normal operation. During emergency operations the emergency AC lighting levels will be designed to maintain a minimum of ten (10) foot-candles in operating areas. These minimum illumination values are maintained average foot-candles within the task areas of the panels.

Upon completion of this modification the lighting in the PNPS Control Room will be consistent with the guidance requirements of NUREG-0700 for all twelve (12) guidelines evaluated.

2. Control Room Noise

HED #1B014 is related to control room noise. One major noise source is the existing (old) computer system peripherals. No action has been taken on this HED because the existing computer devices are scheduled to be removed and replaced with different devices related to the new, EPIC computer system. Once the EPIC computer is installed and running, a new noise survey will be taken and any identified HEDs will be resolved.

(See Section IV for schedule.)

3. Heating/Ventilating/Air Conditioning

Existing HEDs related to heating, ventilating and air conditioning (HVAC) are as follows (2 HEDs):

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|---------------------------------|
| 1B011 | HVAC - air quantity |
| OB123 | HVAC - temperature and humidity |

A detailed survey of HVAC system operation will be performed, to clarify the HED's and to determine the methodology for their resolution. As an example, one HED documents insufficient fresh air flow into areas of the control room. We will investigate whether the problem is in the system design, maintenance, changing conditions, or system balance. Steps taken to resolve the HED will depend on the results of the investigation. Schedule for the corrective actions will be set after the survey is completed (see Section IV).

F. Category 4--HED's Related to Hardware Type

The following HED's involve incorrect equipment type:

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|----------------------------------|
| 4B051B | Controls - direction of movement |
| 4B060B | Controls - general principles |
| 4B115A | Controls - adequacy |
| 4B131 | Controls - direction of movement |
| 5B119 | Displays - readability |

As discussed in Section III.D above, HED #4B115A, 4B051B, and 4B131 will be resolved by switch changes under the panel enhancements program. HED's 4B060B and 5B119 require hardware replacements with potential rearrangement of the panels and will be addressed after the new SFTA.

G. Category 5--HED's Related to Equipment Location

HED's that involve the need to relocate panel hardware (or rearrange multiple devices) are as follows (8 HED's).

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|---|
| 5A010 | Drywell temperature--no indication by height |
| 1B005B | Console dimensions - display height |
| 1B015 | Control rm. layout - accessibility of equipment |
| 5B067 | Displays-completeness of information |
| 8A007B | Panel layout - CP-600 not logical |
| 8A008B | Panel layout - C-7 not logical |
| 8B094B | Panel layout - clusters of components |
| 8B101 | Panel layout - sequence of use |

These HED's will also be addressed after the new SFTA.

H. Category 6--Potentially Resolved HED's

The HEDs below are categorized as "potentially resolved". This indicates that either investigations or modifications are complete and no further action is required before the HED close-out process (i.e., verification) is initiated. Forty-seven HEDs are in this group. The close-out verification process will verify the extent of correction for each HED, will document justification for partial correction (or no correction), and will verify that no new HED has been created by the correction methodology.

Potentially Resolved HED's

| HED No. | TITLE |
|---------|---|
| 4A003 | Reactor Mode Switch - no detent |
| 5A004 | Recorders not satisfactory |
| 5A005 | Inconsistent reactor water level meters |
| 1B002 | Furniture and equipment layout |
| 1B003 | Supervisor access |
| 1B008A | Procedures/reference materials at consoles |
| 1B009 | Desk dimensions |
| 1B128 | Nitrogen flow to drywell indication |
| 2B016 | Conventional telephone system |
| 2B018 | Announcing system (volume) |
| 2B019 | Lack of priority paging |
| 2B020 | Point-to-point intercom system |
| 45059A | Prevention of accidental activation |
| 5B070 | Discrete recorders - channel select |
| 5B127 | Usability of displayed values - scale increments |
| 5B133 | Visual displays - information displayed |
| 6B083 | Tag-outs |
| 8B102 | Frequency of use |
| 8B129 | Sequence of use - functional considerations |
| 1C003 | Dimensions - control height |
| 1C006 | Personal storage |
| 5C015 | Recorder labels |
| 5C019 | Graphic recorders - visibility |
| 5C021 | Usability of displayed values - scales |
| 5A009B | Usability of displayed values - ranges |
| 1B001 | Accessibility of instrument/equipment |
| 4B051C | Direction of movement - controls |
| 4B060C | General principles - economy |
| 4B115B | General principles - control adequacy |
| 4B132 | General principles - suitability |
| 5B066C | Graphic recorders - placement |
| 5B068 | Light indicators - misinterpretation |
| 5B110 | Usability of displayed values - scales |
| 5B135 | Visual displays - completeness of information |
| 5B136 | Usability of displayed values - scales |
| 6B079 | Control position labelling - direction |
| 8B097B | Mirror imaging |
| 9B106B | Movement relationships |
| 9B107B | Control and display pairs - location |
| 9B108 | Control and display pairs - consistency |
| 9B109B | Control and display pairs - proximity |
| 1C025 | Equipment layout - coverage |
| 2C009 | Announcing system - general |
| 5C016B | Usability of displayed values - scales |
| 5C018B | General characteristics of graphic recorders |
| 5C026 | Usability of displayed values - operator conversion |
| 6C023 | Visibility of labels - cleaning |

If the close-out verification process shows that any portion of an HED requires further action, that portion of the HED will be assigned a new sub-number (e.g., an incomplete portion of #5A009B could be designated as 5A009C) and reassigned to the appropriate category for corrective action. The completed portion of the HED will remain in Category 6.

I. Category 7--Operations (Non-Engineered) HED's

Sixteen HED's were assigned to the Pilgrim Plant (operations) Dept. for resolution, as follows.

| <u>HED No.</u> | <u>TITLE</u> |
|----------------|--|
| 1B008B | Use of procedures at consoles |
| 2B017 | Communications - coverage in plant areas |
| 2B021 | Communications - use of face mask |
| 2B022 | Communications - posting of procedures |
| 4B059B | Controls - resistance to movement |
| 5B134 | Displays - operator conversions |
| OB113 | Training - maintaining proficiency |
| 1C001 | Document storage |
| 1C002 | Operating expendables and tools-storage |
| 1C004 | Protective equipment - availability |
| 1C026 | Protective equipment - replacement |
| 2C011 | Fire system - false alarms |
| 4C013 | Protective equipment - use |
| 5C014 | Matching recorder paper with proper recorder |
| 5C017 | Change of lamps - proper methods |
| OC024 | Communications - number of plug-ins |

These HED's deal with a variety of operational and training issues, such as furniture needs, communications problems, need for certain training, storage of procedures and spare parts, availability of safety equipment, and other items (see HED's in Appendix C).

Corrective actions have been completed for the following HED's:

- 1B008--New procedure racks installed
- 2B022--Signs posted re: VHF communications
- OB113--STA training completed (continuing)
- 1C001--Procedures have been clearly marked

The Plant Dept. has determined that the following HED's do not present operational problems and that no action is required:

- 2B021--Use of face masks is infrequent
- 4B059--Excessive switch spring loading is judgment of individual operators; decreased loading not advisable
- 5B134--Operator aid is adequate
- 1C002--Recorder supplies storage is adequate
- 1C004--Emergency equipment storage is adequate
- 1C026--Air pack storage and training are adequate
(list continues on next page)

(HED's not presenting operational problems Cont'd)

2C011--Fire alarms now very infrequent
5C014--Recorder scales and chart paper coordinated by procedure
0C024--Current communications jacks are sufficient.

Corrective action will be taken on two HED's, as follows:

2B017--Gaitronics communications problems will be reduced by implementation of a "priority paging" system to be implemented in 1989.
5C017--Panel indicator bulb changeout tools will be purchased by May 1, 1989.

SECTION IV

DCRDR SCHEDULE

This Section describes the overall plan for the completion of the DCRDR project. It summarizes the work plan described in greater detail in the Program Plan, previously submitted. In addition, this Section reflects recent changes to the project plan which will be described in more detail in a Program Plan revision, which will be submitted separately to NRC by June 30, 1989.

A. Resolution of Original HED's (1984 Set)

The 1984 Summary Report identified 153 human engineering discrepancies (HED's). In 1987 those HED's were re-screened and divided into seven categories according to type of corrective action:

| <u>Category #</u> | <u>Category Name</u> | <u># of HED's</u> |
|-------------------|-----------------------------|-------------------------|
| 1 | Annunciator | 26 |
| 2 | Panel Enhancements | 69 |
| 3 | Habitability | 5 |
| 4 | Equipment type | 5 |
| 5 | Equipment location | 7 |
| 6 | Potentially resolved | 45 |
| 7 | Non-engineering resolutions | <u>16</u> <u>173</u> |

(Please refer to Section II for more information on the screening process and on these results.)

The plan for resolution of these HED's can be summarized as follows:

- Category 1 - Annunciator - Because of the number and seriousness of annunciator-related HED's, Boston Edison will undertake a detailed review of the HED's and a full range of possible corrective actions. This study is scheduled to begin in mid-1989. It will result in a conceptual design decision by September 30, 1990, and will be reported in the Final DCRDR Summary Report by November 30, 1990.
- Category 2 - Enhancements - Work is currently underway to complete the design of the main control panel enhancements including demarcation, labels, meter scales, mimics, and minor switch improvements. Enhancement designs are currently being installed temporarily in the simulator to obtain operators' review and input before finalizing the design. Portions of the interim enhancements have been installed in the control room.

When the enhancements are reviewed and finalized, a Plant Design Change will be issued to implement the improvements. It is anticipated that improvements will be done partially while the plant is on-line (back panels and some other work) and partially in outages. Installation is scheduled for completion by the end of RF08.

Boston Edison has established two intermediate milestones for the control panel enhancements program. These milestones are:

- a.) A report on the panel enhancements program will be provided to NRC by June 30, 1989. The report will outline the interim enhancements done by the date of the report, summarize the operator response, and summarize the permanent enhancements planned (as described in Section III.D of this report). (This is part of Boston Edison response to NRC Inspection Report No. 88-21.)
- b.) Interim or permanent enhancements will be installed on selected control room panels by the end of the outage currently scheduled for October 1989. Boston Edison has not established the exact scope of the work to be committed for the October milestone. The scope will be defined in the report referred to in item (a) above, by June 30, 1989. Boston Edison will evaluate whether to continue installing interim versions of the enhancements, using temporary materials, or to begin installing the permanent versions.

Section III.D describes the enhancements program in more detail.

- * Category 3 - Habitability - HED's relating to control room habitability and environment (i.e., those relating to noise, lighting, and heating/ventilation/air conditioning (HVAC)) are being resolved in three tasks.

The two HED's relating to HVAC will be addressed by first performing a performance test and air balance of the control room HVAC system. These activities will be completed by May 31, 1990. Engineering recommendations for any deficiencies will be included in the Final Summary Report by November 1990.

Two of the original HED's relate to lighting. A detailed lighting survey was performed in the fall of 1988 and identified five additional discrepancies. We will install additional ceiling light fixtures to correct the discrepancies (see Section III.E for description), by the end of RF08.

One HED concerned noise. A detailed noise survey (per NUREG-0700) will be performed after removal of the old process computer, which is being replaced. (The computer is believed to be a major component of existing noise, so no useful conclusions can be drawn until the computer work is completed.) Following the survey, conceptual design

resolutions will be identified for any deficiencies. Corrective actions for excessive noise, if any, will be described in the Final Summary Report by November 1990.

- Category 4 and 5 - Equipment Type and Location - In general, these twelve (12) HED's involve replacement or relocation of panel hardware. Therefore, these have the most potential for high cost and for impacts on operations, training, and plant availability. Because of the substantial cost and risk considerations, Boston Edison decided, after consultation with the NRC, to defer decisions on the potential major panel changes until after a new task analysis is completed. The new SFTA will help to clarify the use of panel equipment in current procedures and thereby help identify what corrective actions are appropriate and their relative priority and will assure completeness and correctness. Therefore, the plan for these potential major panel changes is:
 - Perform new data collection (SFTA, Control Room inventory, and survey, including identification of instrumentation and control needs).
 - Develop composite list of HED's (old and new) and develop prospective corrective actions.
 - Assess and prioritize HED's (see Section II and Program Plan for description of the assessment process).
 - Implement corrective actions and perform the close-out verification.

The planned resolution of these potential major panel changes will be reported in the Final Summary Report by November 1990.

Three of the category 4 HED's will be partially or completely resolved in the near-term switch enhancements work. These three HED's involve various switch deficiencies that will be resolved by a switch actuation design change, new switch escutcheons, revised switches, or replacement of switches (see Section III for details).

- Category 6 - Potentially Resolved - These HED's were classified as having been partially or fully resolved, in many cases by construction of physical improvements. Field verification and documentation will be done by December 31, 1989. (Any found not to be completed will be reassigned to appropriate implementation categories.)
- Category 7 - Non-Engineering Solutions - Of the 16 HED's assigned to the Operations organization, 14 are completed or require no further action. Those identified as completed will be reassigned to Category 6 for closeout verification and documentation. Two HED's require corrective action. These include; a modification will be made to the Gaitronics system and a new bulb changeout tool will be purchased. Both are scheduled for completion in 1989.

B. Schedule for Remaining Work

The schedule for the six remaining activities is as follows:

1. System Function and Task Analysis - The details of the methodology for the updated SFTA are currently being developed and will be submitted in the revised Program Plan (to be submitted separately). Work is expected to be completed by April of 1990. The results of the SFTA will be reported in the Final Summary Report by November 30, 1990.
2. Update of the Control Room Inventory - The update of the Control Room Inventory is expected to begin in 1989, on a schedule to support completion of the SFTA.

A sample of the Control Room Inventory will be provided in the Final Summary Report, November 30, 1990.

3. Verification of Task Performance Capabilities - The Verification of Task Performance Capabilities will be conducted after the completion of the SFTA and Updated Control Room Inventory.

The results of the Verification activities as well as any newly identified HEDs will be reported in the Final Summary Report by November 30, 1990.

4. Validation of Control Room Functions - The Validation Walkthroughs will take place after completion of the SFTA.

The results of the Validation activities as well as any newly identified HEDs will be reported in the Final Summary Report by November 30, 1990.

5. Control Room Surveys - The surveys will be conducted concurrently with the activities described in items 1-4 above.

The results of the Surveys and newly identified HEDs will be reported in the Final Summary Report by November 30, 1990.

6. Assessment of HEDs and Selection of Corrective Actions - Any new HEDs identified in the activities described above will be assessed for significance (see Section II). We will then select design improvements to correct the safety-significant HEDs.

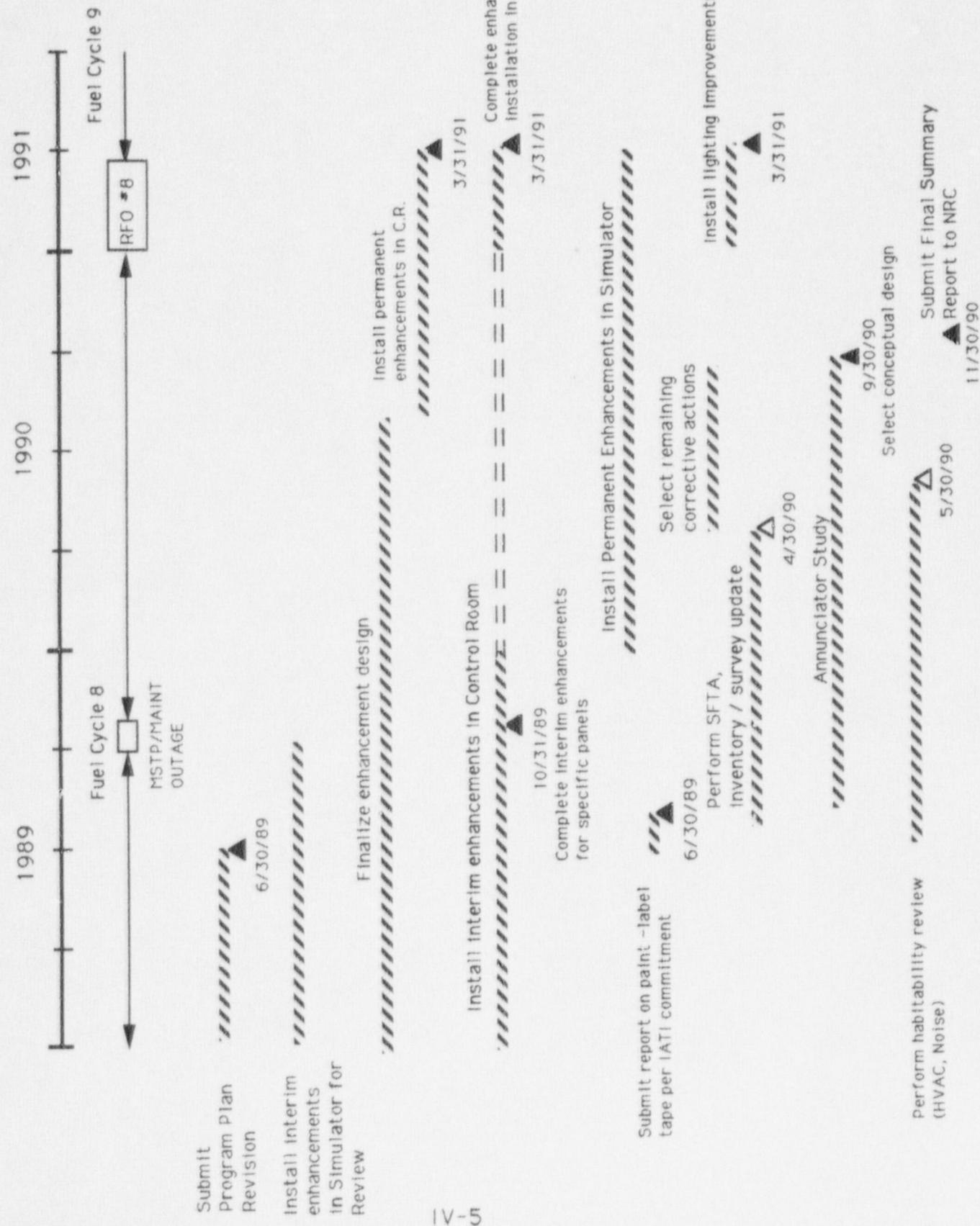
Several of the existing HED's are indicative of major control panel arrangement problems. (These are HED's in categories 4 and 5 under the new screening process described in Section II of this report.) The corrective actions for these HED's could involve major reconstruction of one or more panels. Decisions on currently known potential major panel changes will be provided in the November 30, 1990 report to NRC, as discussed above, as well as decisions on new HED's identified in the new SFTA and survey.

Figure IV-1 summarizes the schedule for the remaining tasks.

FIGURE IV-1

SUMMARY SCHEDULE - PILGRIM STATION CONTROL ROOM DESIGN REVIEW

▲ - Indicates committed end date
△ - Indicates target end date



SECTION V

RESPONSE TO SAFETY EVALUATION REPORT

A. Introduction

NRC issued a Safety Evaluation Report (SER) and accompanying Technical Evaluation Report (TER) in May 1985 (Reference 3), in response to Boston Edison's original Summary Report (Reference 1). The SER/TER was issued after the pre-implementation audit held in November 1984. The NRC and Boston Edison discussed the SER/TER in a meeting at NRC facilities on August 21, 1985.

This Section discusses and responds to the SER/TER.

Please note NRC conducted an in-process inspection of the Pilgrim Station DCRDR project during the week of March 20 through 24, 1989. The formal report (Reference 6) of the inspection was not issued before this report was prepared and is not addressed in this report.

Please refer to Section IV for the schedule of future activities referenced in this Section.

B. NRC Comments and Boston Edison Responses

This Section responds to NRC's SER/TER comments, following the criteria of NUREG-0737 in the same sequence as in the SER/TER.

1. Multidisciplinary Review Team

The SER concluded that Boston Edison satisfied the relevant requirements of NUREG-0737. The Program Plan (Reference 2) will be revised to update the description of the project team and to address additional comments in the SER/TER.

2. Systems Function and Task Analysis (SFTA)

The SER/TER identified a number of concerns relating to the System Function and Task Analysis (SFTA). NRC compared the Boston Edison SFTA to task analysis requirements established in conjunction with the BWR Owners' Group. The TER identified two basic problems with the SFTA as performed:

1. The NRC concluded that there was "no systematic 'front-end' task analysis" performed during preparation of the Emergency Operations Procedures (EOP's) or prior to the walk-throughs performed in the Control Room Design Review task analysis. As a result, NRC concluded that the operator's information and control needs for emergency operations had not been fully identified.
2. "... [T]he walk-through portion of the SFTA did not include a systematic interview technique to prompt the operators to describe the integrated plant operations needs".

Boston Edison and NRC discussed the SFTA issue at the August 21, 1985, meeting where we indicated that the Pilgrim Station SFTA was performed before the BWR Owner's Group agreed to the reference requirements cited by NRC. Further discussion resulted in the NRC withdrawing its requirement of Boston Edison to redo major portions of the SFTA because the discussion demonstrated the SFTA was more complete than indicated in the SER/TER. NRC instead stated the SFTA should be performed in accordance with the NRC-BWROG guidelines only for the two EOP's which, at that time, had not yet been drafted and for which no task analysis had been performed. Boston Edison agreed to use the NRC-BWROG guidelines for performing the task analysis for the two EOP's when they were issued.

Boston Edison has since revised the entire set of Emergency Operating Procedures (EOP's) to Revision 4 EPGs. The extensive EOP revisions, together with hardware changes since 1985, warrant a new SFTA. It will be performed according to the current NRC requirements for SFTA, and will address the specific concerns raised in the SER/TER. The SFTA will begin later in 1989 and results will be reported to NRC in 1990. (See Section IV). Any HED's resulting from the new SFTA, and those resulting from upgrading the control room survey, will be addressed in accordance with project procedures.

More detail on the revised SFTA procedures will be in the revised Program Plan to be submitted separately.

3. Comparison of Display and Control Requirements with a Control Room Inventory

These items are related to the System Function and Task Analysis (SFTA), discussed in Section B.2 above. NRC concluded that the Boston Edison control room inventory was sufficient, but that the inventory could not adequately be compared to the operator's information and control needs, because of SFTA deficiencies.

This report does not address all the detailed NRC comments because a new SFTA (with an upgraded inventory) will be performed, since the EOPs have been extensively revised, and because a number of Control Room alterations have occurred since the original inventory. Many of NRC's specific comments on possible HED's have been entered into our HEO database, however, and will be reviewed (see Appendix B).

The control room inventory is further described in the Program Plan.

4. Control Room Survey

The SER/TER identified certain specific shortcomings of the Control Room survey, as follows.

a) Comment Lighting levels require objective evaluation.

Response: A lighting survey was conducted in late 1988. The HEO's have been reviewed, and corrective actions are described in Section III.E.

b) Comment (There needs to be) an adequate, objective sound survey.

Response: Boston Edison has delayed the sound survey until the installation of the new Emergency and Plant Information Computer (EPIC). Computer peripherals are a major contributor to noise patterns, and we are installing new printers and other peripherals in new control room locations.

Also, the old and new computers will be operated in parallel until the new computer is fully operational. Therefore, data from a noise survey conducted with both computer systems running would be of little value. We will conduct the noise survey after the old computer is removed.

c) Comment NRC understands that Boston Edison will consider modifying the annunciator system to provide first-out annunciator indication.

Response: Boston Edison will conduct a conceptual design study that will examine the identified annunciator deficiencies, including the possibility of first-out capability. This study is scheduled to begin in mid-1989 and its results will be reported to NRC.

d) Comment NRC found five (5) specific instances of HED's that apparently had not been discovered during Boston Edison's control room survey. The five items are listed on page 14 of the TER; below is our response.

i) Item Problems with Leeds and Northrup data print recorders are mentioned in the SFTA section of the TER.

Response: The identified recorders have been replaced with newer models that perform satisfactorily.

ii) Item "Numerous annunciators have been broken or out of service for years...These were not specifically identified..."

Response: Boston Edison agrees that several annunciator windows are out of service or disabled. An HED was written on this discrepancy and is included in the original Summary Report (#3B044.4.1). The problem of disabled windows will be addressed during the annunciator conceptual design study.

iii) Item "Specific Yarway reactor vessel indicators as well as nearly all 480, 4160 and 13kV voltage, frequency and amperage meters have frosted faceplates. . ."

Response: No Yarway meters in the Pilgrim control room had frosted glass; this finding is a possible error in the TER. The Yarway meters were replaced as part of the reactor water level system modifications. Frosted glass faceplates on Sigma meters have been replaced with clear glass.

Operators have not complained about frosted glass meters on the electrical systems control panel (C-3), but Boston Edison will reconsider the frosted glass item during the survey update.

- iv) Item "The colored dot system used for new construction turnover still exists on some meters."

Response: The "colored dots" are not from initial construction, but are a system devised by several operators to clarify relationships between devices on panel C-3. Demarcation on this panel is evidently not satisfactory, and colored dots were added. Not all operators were aware of this informal system. We have incorporated the needs identified by the colored dot system into our labeling and demarcation improvement program, eliminating the operators' need. In addition, procedural controls will be modified to require approval of such operator aids.

- iv) Item "There is extensive use of plastic tape and handwritten labels in the control room".

Response: This item will be resolved as part of our labeling and demarcation program. An HED (#6B082.4.5) was written on the use of temporary labels.

5. Operating Experience Review

Our responses to the comments from page 15 of TER are as follows:

- a) Comment "The NRC audit team suggested that Pilgrim may want to consider revising procedures for writing LER's so more information can be recovered in the future."

Response: Boston Edison has improved its LER writing process. A work instruction (NEDWI 360) was issued in 1987 to govern the details of LER preparation. More emphasis is being placed on determining the reasons for human errors, such as human engineering issues. In addition, Boston Edison has initiated a Human Performance Evaluation System, as devised by INPO, that we expect will increase the awareness of and attention to the human engineering aspects of operating incidents.

- b) Comment "Although some human engineering observations were obtained from this source, a review of selected sections of the operator questionnaires by the NRC audit team indicates that the following additional HEOs should have been documented and assessed."

Response: All of the NRC's items under this comment have been listed as HEO's and will be reviewed. (HED's not listed in the original Summary Report are tabulated in Appendix B of this report.)

Each of the NRC comments is summarized below, together with our specific responses.

i) Item "Core spray discharge pressure meter is hard or impossible to read."

Response: The core spray discharge meters PI-1450-1A, 1B are Sigma meters and the scale printing is less bold than some other meters (e.g., GE meters). These meter scales are being replaced under the meter scale enhancement program (part of the panel enhancements described in Section III).

ii) Item "Main turbine steam seal header valves are confusing."

Response: Arrangement of the valve switches will be clarified by the panel C-2 enhancements program, which will provide both a partial mimic and demarcation to distinguish the valves.

iii) Item "Many benchboard switches have worn detents . . ."

Response: The only switch we found with this problem was the reactor mode switch. HED #4A003.4.4 was written against this discrepancy, and the reactor mode switch was replaced in 1986. We note, however, that additional worn switches may have been identified and replaced as maintenance activities. To help insure that any additional worn switches are addressed, we will survey the operators as part of our switch review in the panel enhancements program.

iv) Item "More of the feed system controls . . . should be moved to the front control panel . . ."

Response: HED #5B067.5, was written to address this discrepancy and was included in the 1984 Summary Report. Boston Edison agrees that it would be desirable to relocate some of the reference controls, and a preliminary design is being studied. Further consideration will be given to this Category 4 HED after the new SFTA is completed.

v) Item "Add reactor and turbine building closed cooling water system heat exchanger backwash capability to the control room."

Response: This is similar to item (d) above. These issues will be reviewed during the design selection process after the new SFTA.

vi) Item "The torus vacuum breaker and primary containment air supply valve controls are easily confused with each other."

Response: These controls are located on panel C-7 and HED #8A008.5 was written against panel C-7's entire arrangement. This HED is in category 4 and could result in major panel

changes. We are deferring a decision on this until after the new SFTA. In addition, these valve controls will be addressed in the panel enhancement program. Improved mimics, labels, and demarcation will reduce the confusion.

vii) Item "The source range nuclear instrument period meters are too far from the rod controls."

Response: This item will be reassessed during the control room survey update, and in the new SFTA.

6. Assessment of HED's to Determine Which are Significant and Should be Corrected

Comment "While the licensee has developed an acceptable assessment process, actual implementation of the process is not yet complete. BECo should describe the results of the assessment process in greater detail in the Supplemental Summary Report."

Response: Boston Edison has undertaken a re-evaluation of all the original 153 HED's, using a new methodology summarized in Section II.

7. Selection of Design Improvements that Will Correct Discrepancies

Comment "...BECo should describe in detail the additional efforts towards completing this requirement, such as the results and solutions from the special studies and how BECo has addressed cumulative and interactive effects of design solutions."

Response: The new assessment methodology described in Section II includes the process for selection of designs for corrective actions.

8. Verification that Improvements will Provide the Necessary Correction Without Introducing New HED's

Comment "The licensee should describe the actual process to be used to complete this activity along with the results."

Response: Verification has not been completed on most corrective actions. Verification will be performed as part of the implementation, as scheduled in Section IV. Procedures for verification are discussed in the Program Plan.

9. Coordination of Control Room Improvements with Changes Resulting from Other Improvement Programs

Comment "Coordination of the DCRDR with the SPDS and Reg. Guide 1.97 work is satisfactory. Coordination with the upgraded EOP effort should be improved as indicated in the TER..."

Response: In 1987-88, the entire set of Emergency Operating Procedures (EOP's) was rewritten, based upon Rev. 4E of the generic BWR emergency procedure guidelines. The EOP effort was managed by

the Nuclear Engineering Department; the EOP project manager was also on the Detailed Control Room Design Review (DCRDR) team both before and after the EOP revision effort, which helped to insure coordination with DCRDR activities. There was frequent informal contact between DCRDR and EOP teams, but no formal joint activity.

The two projects will also be coordinated when the new task analysis is performed. The task analysis will reflect the new EOP's and will serve both the DCRDR and EOP projects' needs. SFTA and evaluation of information and control needs will rely heavily on the EOP technical data base.

In addition, a procedure change will be initiated to require human engineering items found during EOP verification and validation to be formally transmitted to the engineering department for resolution (if appropriate) by DCRDR project.

In short, coordination of EOP's and DCRDR has been fundamentally improved because both projects are now managed by a single department. Coordination will be continued in the future, particularly through the task analysis to be done on behalf of both projects.

APPENDIX A

REFERENCES

APPENDIX A
REFERENCES

- (1) Detailed Control Room Design Review; Executive Summary Report; Doc. No. BECO/ESR-1, September 1984, Rev. 1; Boston Edison Co.
- (2) Detailed Control Room Design Review; Program Plan; June 1984, Rev. 1; Boston Edison Co.
- (3) Safety Evaluation by the Office of Nuclear Reactor Regulation of the Detailed Control Room Design Review for Pilgrim Nuclear Power Station, Docket No. 50-293; forwarded by NRC letter dated May 16, 1985 (D. B. Vassallo to W. D. Harrington)
- (4) Boston Edison letter to NRC BECo 87-008 dated January 20, 1987
- (5) Supplement 1 to NUREG - 0737; Requirements for Emergency Response Capability (Generic Letter No. 82-33); December 17, 1982
- (6) In-Progress Audit Report of the Detailed Control Room Design Review at Boston Edison Company's Pilgrim Nuclear Power Station, dated April 12, 1989; forwarded by NRC letter to Boston Edison dated April 26, 1989.
- (7) BECo Letter 87-111 dated July 8, 1987 (R. G. Bird to S. Varga, Information Regarding Pilgrim Station Safety Enhancement Program)
- (8) BECo Letter 88-131 dated September 7, 1988 (R. G. Bird to U. S. NRC, Pilgrim Station Safety Enhancement Program: Response to a Request for Additional Information)
- (9) U.S. Nuclear Regulatory Commission, Standard Review Plan, NUREG 0800, Revision 1, Section 18.0 and 18.1 (with Appendix A), September 1984.
- (10) BECo Probabilistic Safety Assessment, dated March, 1988 (PLG-0616, Volume 1-4)
- (11) Boston Edison Company Nuclear Engineering Department Work Instruction No. 344, Revision 1, dated May 18, 1987. "Assessment of Human Engineering Discrepancies."

APPENDIX B
HUMAN ENGINEERING OBSERVATIONS

HEO LISTING

This tabulation includes Human Engineering observations (HEO's) that have not yet been screened and categorized as Human Engineering Discrepancies (HED's) using the screening process summarized in Section II of this report. Screening may determine that an HEO is a valid HED that requires corrective action; that it is an HED but that no corrective action is warranted; that it is not a valid HED; or that the HEO is duplicative of an existing HEO or HED. Resolution of these HEO's will be reported in the Final Summary Report.

| ITEM # | HEO # | C/L ITEM* | PNL | DESCRIPTION |
|--------|--------------------|--------------------------|--|--|
| 1 | 6.5.049 | 6.6.1.1 | C-1 | CRU-3361 Recorder has missing label (note: this was checked & found label installed.) |
| 2 | 6.5.050 | 6.6.1.1 | C-2 | PR-3392 has erroneous label |
| 3 | 6.4.024 | 6.4.4.5(b) 904 | C-7 | Two-position maintained SBM switches with "dead" intermediate position. Such switches have no detent. Example: SV-5065-31B on 904 |
| 4 | 6.8.020 6.5.058 | 6.8.1.1(c) 6.5.3.1(d) | C-1 | "Compartment door open" light on bench section should be on vertical section. Label should have more information. |
| 5 | 6.5.049 | 6.5.1.1(c) | C-1 | Recorder CRU-3361 is multi-channel device, but only 1 channel used. Should be changed to single-channel recorder. |
| 6 | 6.6.031 | 6.6.3.1(b) | C-1 | "Loop select" sw. - not clear what switch does. Need more info on label. |
| 7 | 6.4.025 | 6.4.1.1(b) | C-1 | "Air dryer bypass" has "do not use" tag. Is this permanent? Remove switch? |
| 8 | 6.6.032 | 6.6.3.1(b) | C-1 | "Coarse/fine make-up & reject" controls not clear. Need more info on labels. |
| 9 | 6.5.050 | 6.5.1.1(e) 903 | R&G lites for CF-9068A/B show command not actual position. Need special label. | |
| 10 | 6.4.026 | 6.4.1.1(b) 905 | | Stabilizing valves are mechanically blocked from functioning. Should controls be removed? |

* "C/L" = NUREG-0700 Checklist Item Number.

HEO LISTING

| ITEM # | HEO # | C/L ITEM | PNL | DESCRIPTION |
|--------|---------|------------|-------------|---|
| 11 | 6.4.027 | 6.4.1.1(b) | 904 | 2 P.B. switches in Recirc. Sys. (Inv. nos. 992 & 1008) are labelled "spare". Should be removed. |
| 12 | 6.6.033 | 6.6.1.1 | C-2 | 3 step-print recorders have no labels. |
| 13 | 6.6.034 | 6.6.1.1 | C-7 | Switches on C-7 with erroneous escutcheons. (Ref: PCAQ #NOD 87-20). |
| 14 | 6.6.035 | 6.6.6.1 | C-7 | Need for location aids. Controls for torus vacuum breakers and primary containment air supply are easily confused. |
| 15 | 6.4.028 | 6.4.1.2 | 903, 904 | HPCI and RCIC trip p.b. switches should have guards. |
| 16 | 6.8.031 | 6.8.1.2 | 905 | Source range N.I. readouts located too far from operator seated at rod controls. |
| 17 | 6.8.022 | 6.8.1.2 | 905 | Rod worth minimizer too far from operator seated at rod controls. (Note: EPIC project will add new RWM; should evaluate based on new equipment.) |
| 18 | 6.8.023 | 6.8.1 | C-1 | The off-gas hold-up line drain valve position indication does not belong on C-1. It should be on CP-600 (?) |
| 19 | 6.8.024 | 6.8.1 | C-1 | The off-gas after condenser drain line valve position indication does not belong on C-1. It should be on CP-600(?) |
| 20 | 6.1.035 | 6.1.2.5(a) | CP-600 | Many controls below min. height of 34 in. above floor. |
| 21 | 6.5.051 | 6.5.1.1 | CP-600 | Off-gas radiation not displayed in control room area. |
| 22 | 6.5.052 | 6.5.1.1 | C-7 | Standby Gas Treatment System operation cannot be observed from control room operating area. |
| 23 | 6.1.036 | 6.1.2.5(a) | C-7 | Many controls too low on panel |
| 24 | 6.8.025 | 6.8.1 | 903 | Main Steam Isolation Valve controls should be located on C-2 with rest of turbine controls. |

HEO LISTING

| ITEM # | HEO # | C/L ITEM | PNL | DESCRIPTION |
|--------|---------|------------|-------------|---|
| 25 | 6.8.026 | 6.8.1 | 904 | Main Steam Drain Valve controls should be on Panel C-2. |
| 26 | 6.8.027 | 6.8.1.2 | 903 | Panel not effectively arranged. |
| 27 | 6.8.028 | 6.8.1.2 | 904 | Panel not effectively arranged. |
| 28 | 6.4.029 | 6.4.1.1 | 904 | N ₂ Pressure, N ₂ flow and D.W. Cooler temps are not in control room. |
| 29 | 6.6.036 | 6.6.6.4 | 903, 904 | Several systems need mimics, among RHR, CS, HPCI, RCIC. |
| 30 | 6.9.006 | 6.9.2.1(a) | 903, | Recorder CRU-E1 should be relocated to C-1; also recorder CRU-E2. |
| 31 | 6.3.028 | 6.3.1 | 904 | Alarms for demineralizer system status go to home-built panel insert to turn off lights. Should go to annunciator system. |
| 32 | 6.4.030 | 6.4.1.1 | C-1 | TBCCW Hx. backwash controls not in control room. Also RBCCW. |
| 33 | 6.4.031 | 6.4.1.1 | C-1 | Many feedwater controls on back panels. Evaluate which should be brought to Panel C-1 to get more efficient operation. |
| 34 | 6.8.029 | 6.8.1 | C-1 | Condensate pumps min. flow valve control is with circ. water controls. |
| 35 | 6.8.030 | 6.8.1 | 905 | Four "half-scram" lights are on back panels 915/917. These should be duplicated on 905. |
| 36 | 6.4.032 | 6.4.1.1(c) | C-7 | Control switch for Torus Vent Has "t-handle" grip. No other switch like this. |
| 37 | 6.8.031 | 6.8.2.3(b) | 904 | Mirror-imaging of recirc. and jet pump instruments. |
| 38 | | | 904 | Switches for SV-5065-31B -35B -37A -33A -13B -20B -24A -26A -25B -27B -21A -14A -15B -22B -18A -11A |

HEO LISTING

| ITEM # | HEO # | C/L ITEM | PNL | DESCRIPTION |
|--------|---------|------------|-----|--|
| | 6.4.033 | 6.4.1.1(c) | | (a) are for isolation valves, but have maintained contacts, so switch could be in "open" and valve closed. |
| | 6.5.053 | 6.5.1.1(e) | | (b) G&R lites may not show valve position. |
| | 6.8.032 | 6.8.2.2 | | (c) do not seem to be arranged in any logical order. |
| 39 | 6.4.034 | 6.4.1.1(c) | 904 | Switches for SV-5065-91 & - 92 are for isolation valves, but have maintained contacts (see #38). |
| 40 | 6.5.054 | 6.5.3.1(c) | 904 | G&R lites for RCIC turbine control valve are <u>off</u> in mid-stroke. Should be <u>on</u> in mid-stroke. |
| 41 | 6.5.055 | 6.5.3.1(c) | 903 | G&R lites for HPCI turbine control valve - same as #40. |
| 42 | 6.5.056 | 6.5.1.5 | 903 | LI-5008, PI-1001-69 have scales which do not meet standards. |
| 43 | 6.5.057 | 6.5.1.1(e) | 903 | HPCI system - components CV-9068A/B, G&R lites do not show valve position. |
| 44 | 6.1.037 | 6.1.2.7(a) | N/A | Shift supervisor's workstation has inadequate space. |
| 45 | 6.8.033 | 6.8.2.1(c) | 904 | RWCU System split-up by addition of unrelated switches in its area. |
| 46 | 6.1.038 | 6.1.5.3 | ** | Lighting levels do not meet minimum requirements on vertical panel surfaces. |
| 47 | 6.1.039 | 6.1.5.3 | ** | Lighting does not meet requirement for uniformity within task areas on certain panels. |
| 48 | 6.1.040 | 6.1.5.3 | ** | Lighting does not meet requirement for uniformity between certain adjacent task areas. |
| 49 | 6.1.041 | 6.1.5.3 | ** | Lighting does not conform to shadowing criteria in certain areas. |
| 50 | 6.1.042 | 6.1.5.4 | ** | Emergency lighting levels do not conform to minimum requirements in certain areas. |

** Several panels and other areas of control room are affected by lighting HEO's.

APPENDIX C
HUMAN ENGINEERING DISCREPANCIES

APPENDIX C
HUMAN ENGINEERING DISCREPANCIES

This listing includes the 153 Human Engineering Discrepancies (HED's) referred to throughout this report.

Data included in this listing is as follows:

HED Number: The first 5 digits (e.g., 1B005) are the original HED numbers as used in the first DCRDR Summary Report (Reference 1). The suffixes used in some places in Reference 1 have been dropped, because they referred to the original program of corrective actions. E.g., HED #4B048.4.4 is referred to here simply as 4B048.

During the HED re-screening described in Section II, it was recognized that some HED's belonged in more than one implementation category. In those cases, the HED number has been suffixed with a letter. For example, HED 1B005 has been defined as HED 1B005A in Category 1 and as HED 1B005B in category 5. In effect, each such HED part is being tracked as a distinct HED.

In addition, a few HED's required investigation before the next step. Such HED's are identified with the suffix I.

The system for numbering HED's is further defined in the Program Plan (Reference 2, Section 4.4.2).

Implementation Category: This refers to the pre-screening categories defined in Table II-3.

HED Description: This description is reproduced from the computer database. Note that the same description is repeated for HED's that have been divided into two or three categories; the distinct scope for each part of the HED is not described here.

Next Action: This is an abbreviated reference to the next activity for the HED. In general, the HED's are tagged for corrective action programs as described in Section III. The designations should be self-explanatory except perhaps for the following terms:

SFTA refers to the System Function and Task Analysis discussed in this report, results of which are needed before deciding on certain HED's.

PDC means that a Pilgrim Station Plant Design Change has been issued to implement the modification.

Some additional information about each HED was provided in the Appendices to Reference 1. Note, however, that the statements about corrective actions in Reference 1 have been supplanted by the information in Section III of this report.

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

OB113 7 HOW DO YOU MAINTAIN YOUR TECHNICAL PROFICIENCY? VERIFY COMPLETE
CIENCY? Lack of STA simulator
training for retaining and updating tec
hnical proficiency.

OB123 3 TEMPERATURE & HUMIDITY (Comfort Zone): T AIR BALANCE/SURVEY
ouching the instrument face co
ver can influence the instrument reading
due to a static charge due t
o friction of the operators feet on the
floor

OC024 7 DO ANY COMMUNICATIONS SYSTEMS INTERFERE NONE--VERIFY OK
WITH CONTROL ROOM OPERATIONS?
General Requirements (Plug-in Jacks): T
here is an insufficient number
of plug-in phone jack positions at the
console panels (one at either
end of the control room panels).

1B001 6 ACCESSIBILITY OF INSTRUMENT/EQUIPMENT In VERIFY COMPLETE
strumentation requiring contin
uous monitoring by operators during emer
gency operations: Panel C7:
Drywell temperatures, #1358, 1361 Conta
inment purge and vent control
, #1412,1413, 1447,1448,1449,1450,1451,1
452,1453,1454,1455,1456, 1472
,1473 Torus temperature, #1427,1428

1B002 6 FURNITURE AND EQUIPMENT LAYOUT: There is VERIFY COMPLETE
a limited amount of work spac
e for the operator. The space available
is used to hold two printers
and a computer terminal. This observatio
n is supported by OER-001.

1B003 6 SUPERVISOR ACCESS: Shift Supervisors' Of VERIFY COMPLETE
fice (Watch Engineer) does not
permit prompt physical access to the co
ntrol room. In addition, ther
e is no dedicated communications link be
tween these two spaces. This H
EO is supported by observations OER-005
AND OER-010.

1B005
1B005A 1 STAND-UP CONSOLE DIMENSIONS (Display Height ANNUNC STUDY
ght and Orientation): Displays
that exceed 80 in. in height include al
l the annunciator panels, con
tainment isolation mimic and the upper p
ortion of the rod indicator li
ghts. These are: Panel 903: #538,539,540
and upper portion of the cont
ainment isolation mimic. Panel 904: #780
,781,782 Panel 905: #1033,1034
and upper portion of the rod indicator
lights. Panel C2: #128,149 Pan
el C1: #1,38 Panel C3: #234,235,236,237,
238,239,240,241,242,243,244,24

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 1B005B 5 5, 246,247,248
STAND-UP CONSOLE DIMENSIONS (Display Height and Orientation): Displays that exceed 80 in. in height include all the annunicator panels, containment isolation mimic and the upper portion of the rod indicator lights. These are: Panel 903: #538,539,540 and upper portion of the containment isolation mimic. Panel 904: #780,781,782 Panel 905: #1033,1034 and upper portion of the rod indicator lights. Panel C2: #128,149 Panel C1: #1,38 Panel C3: #234,235,236,237,238,239,240,241,242,243,244,245, 246,247,248
- 1B008
1B008A 6 USE OF PROCEDURES AND OTHER REFERENCE MATERIALS AT CONSOLES: No provision for use of procedures and other reference material at the consoles (benchboards).
- 1B008B 7 USE OF PROCEDURES AND OTHER REFERENCE MATERIALS AT CONSOLES: No provision for use of procedures and other reference material at the consoles (benchboards).
- 1B009 6 DESK DIMENSIONS: There is inadequate work station (space) to perform administrative tasks. This observation is supported by OER-001.
- 1B011 3 VENTILATION (Air Quantity): Fresh air introduced into the control room is not adequate. This observation is supported by OER-006.
- 1B012 3 ILLUMINATION (Levels and Uniformity): The lighting levels do not conform to the guidelines criteria. See lighting survey - luminance record.
- 1B013 3 ILLUMINATION (Glare and Reflectance): Glare and reflectance on instrument faces is produced by the overhead light placement. This observation is supported by OER-003.
- 1B014 3 AUDITORY ENVIRONMENT (Limit and Noise Distractions): The continuous background noise created by the pager system and printers is annoying and produces distractions to the operators. See sound survey record. This observation is supported by OER-007.
- 1B015 5 ACCESSIBILITY OF INSTRUMENT/EQUIPMENT (Arranged to facilitate coverage): Instrumentation requiring continuous

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

monitoring by operators during emergency operations located on back panels 915 and 917 are the same solenoid lights and MSIV isolation lights(2). This observation is supported by OER-001.

1B015I SEE 1B015 INVESTIGATION
1B128 6 ACCESSIBILITY OF INSTRUMENTATION/EQUIPMENT VERIFY COMPLETE
NT (Present in the Control Room): In executing the task "Start N2 Flow to DW for Additional Cooling" (4T:39.00), verification of N2 system pressure can only be done outside the control room.

1B128I SEE 1B128 INVESTIGATION
1C001 7 DOCUMENT ORGANIZATION AND STORAGE: Location aids to access appropriate procedures do not conform to guideline criteria to identify, distinguish and access documents. In addition, the documents are not protected against wear.

1C002 7 SPARE PARTS, OPERATING EXPENDABLES AND TOOLS: Spare parts are readily accessible. The storage space is limited and there is no inventory accounting to ensure that an adequate supply of spares and expendables is readily available.

1C003 6 STAND-UP CONSOLE DIMENSIONS (Control Height): Controls that exceed 63 in. on the benchboard panels are: Panel 903: vibration meter subpanel #587,591,592,594,599. Controls that are located below 34 in. in height are: Panel 903: HPCI inverter (toggle switch) Panel 904: RCIC inverter (toggle switch)

1C004 7 OPERATOR PROTECTIVE EQUIPMENT (Types of Equipment): No protective equipment other than the Scott Air Paks are available in the control room

1C005 2 ILLUMINATION (Shadowing): Labels below instrumentation on vertical panels are shadowed. This is especially true for recorders which project beyond the panel surface.

1C006 6 No space is provided for personal storage.

1C025 6 CONSISTENCY OF MANNING WITH EQUIPMENT LOAD (COVERAGE): The overhead TV monitor used to display computer generated data at the 905 panel is not located in a convenient position for operator viewing. This obse

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 1C026 7 rvation is supported by OER-002.
OPERATOR PROTECTIVE EQUIPMENT (Expendabl VERIFY COMPLETE
es): There are no replacement
air tanks that are readily available.
- 2B016 6 CONVENTIONAL POWERED TELEPHONE SYSTEM (H VERIFY COMPLETE
andsets): The phones at the sh
ift supervisor's workstation are not ide
ntified or coded by circuit o
r function. It should be noted that the
communications equipment at th
is workstation is "jury rigged" and not
functionally arranged. Some ph
ones are inoperative and others broken o
r not connected to a live circ
uit. This observation is supported by OE
R-005.
- 2B017 7 ANNOUNCING SYSTEM (Intelligibility and C GAITRONICS MAINT
verage): Loud speaker voice m
essages cannot be heard in some rotating
machinery areas, e.g., diesel
generator space. Speaking from noisy a
reas masks the voice message.
This observation is supported by OER-011
- 2B018 6 ANNOUNCING SYSTEMS (Loudspeaker Volume): VERIFY COMPLETE
Speaker gain control can redu
ce volume below audible level. This obse
rvation is supported by OER-0
07.
- 2B019 6 ANNOUNCING SYSTEMS (Priority): Channel 3 VERIFY COMPLETE
is reserved for emergency or
control room voice traffic but there is
no priority procedure or capa
bility for interrupting an announcement
in progress.
- 2B020 6 POINT-TO-POINT INTERCOM SYSTEMS: There i VERIFY COMPLETE
s no point-to-point intercom b
etween the control room and the watch en
gineer's office. This observa
tion is supported by OER-010.
- 2B021 7 EMERGENCY COMMUNICATIONS (Equipment Usab NONE-VERIFY OK
ility and Voice Communications
) Voice communications while wearing a f
ace mask is unsatisfactory. T
his observation is supported by OER-008.
- 2B022 7 FIXED BASE VHF TRANSCEIVERS (Procedures) VERIFY COMPLETE
: Procedures are written for t
his system but not posted.
- 2C009 6 ANNOUNCING SYSTEM (General): The 5 voice VERIFY COMPLETE
channels are continuously in
use. During plant shutdown, when contra
ctors are at the plant, they g
enerate nuisance sounds that interferes
with control room communicatio
ns. This observation is in support of OE

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- R-007.
- 2C010 1 SIGNAL INTENSITY (Comfort): The PAM alarm ANNUNC STUDY m and fire alarm produce sounds that are a discomfort to the operator.
- 2C011 7 READABILITY (False Alarms): Fire alarm is NONE--VERIFY OK s activated by cigarette smoke in areas of the Administration Building, Control Room Annex and Security Alarm Station (SAS).
- 3B023 1 ALARM PARAMETER SELECTION (General Alarm ANNUNC STUDY s): There are several alarms that require control room operators to direct auxiliary or equipment operators to various parts of the plant to identify trouble, e.g., C60 ventilation problem. This observation is supported by OER-047.
- 3B024 1 ALARM PARAMETER SELECTION (Multi-channel ANNUNC STUDY or Shared Alarms): There are at least 5 alarms that are shared: Panel 1 904: TORUS THOUGH ALARM HI/L O #782. Panel 904: RECIRC PUMP OIL LEVEL HI/LO #781. Panel 904: DRYWEL L PRESSURE HI/LO #780. Panel 904: REACTO R WATER HI/LO LEVEL #1033. Panel C1: A/B/C SERVICE WATER PUMPS LOW DIS CHARGE PRESSURE #38. This observation is supported by OER-014.
- 3B025 1 FIRST-OUT ANNUNCIATORS (Reactor System and Turbine Generator System): There is no first-out annunciator for either the reactor system or the turbine generator system. This observation is supported by OER-013.
- 3B026 1 PRIORITIZATION (Levels of Priority): There is a lack of a systematic ann. prioritization scheme. The tiles that should be prioritized are: Panel 903: HPCI ISOLATED, OFF GAS TIME INITIATED. Panel 904: PCIC ISOLATED, CLEAN-UP HI TEMP, NONREGEN HX, DRY WELL PRESS. HI/LO - RECIRC M/G SET A GEN LOCKOUT, - RECIRC M/G SET B GEN LOCKOUT. Panel 905: Rx WATER HI/LO LEVEL, - Rx HI PRESS. Panel C1: RFP TRIP - A/B/C TRIP COND PUMP TRIP, - OFF-GAS LINE GAS FULLY OPEN, A OR B SEAWATER PUMP TRIP, - TB CCW PUMP TRIP Panel C2: TURBINE STM SEAL HDR LO PRESS, - INSTR. AIR OR N2 LVL TO DRYWELL Panel C3: INST POWER TRANSFER, - RFS M/G SET A BKR TRIP, - RPS M/G SET B BKR TRIP, - STATOR COOLING WATER. THIS OBSERVATION SUPPORTED BY OER-015.

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 3B027 1 CLEARED ALARMS (Auditory Signal): There ANNUNC STUDY
is no distinct audible signal
to distinguish cleared alarms from aler
ting alarms.
- 3B028 1 VISUAL ANNUNCIATOR PANELS (Location): So ANNUNC STUDY
me annunciator tiles are on di
fferent panels than their controls (e.g.
, the OFFGAS TIMER tile is on
Panel 903 with associated control on Pa
nel C1). This observation is s
upported by OER-017.
- 3B029 1 VISUAL ANNUNCIATOR PANELS (Labeling): In ANNUNC STUDY
dividual annunciator panels ar
e not all labeled.
- 3B030 1 VISUAL ANNUNCIATOR PANELS (Lamp Replacem ANNUNC STUDY
ent): Operators have reported
being shocked while replacing bulbs as
well as shorting out the entir
e annunciator panel. This observation is
supported by OER-020.
- 3B031 1 VISUAL ALARM RECOGNITION AND IDENTIFICAT ANNUNC STUDY
ION (Contrast Detectability):
The opaque yellow annunciators on panel
905 (#1033) are difficult to
distinguish between 'ON' and 'OFF' state
s. This observation is support
ed by the annunciator OER-049.
- 3B032 1 VISUAL ALARM RECOGNITION AND IDENTIFICAT ANNUNC STUDY
ION ("Dark" Annunciator Annunc
iators are lit to indicate equipment is
out of service (continuous).
This observation is in support of OER-01
9.
- 3B033 1 ARRANGEMENT OF VISUAL ALARM TILES (Label ANNUNC STUDY
ing of Axes): Annunciator pane
ls are not labeled to conform with this
criteria.
- 3B034 1 ARRANGEMENT OF VISUAL ALARM TILES (Patt ANNUNC STUDY
ern Recognition): There are 63
tiles on each annunciator panel of 905.
This exceeds the maximum mat
rix density of 50 tiles suggested in the
guideline criteria.
- 3B035 1 ARRANGEMENT OF VISUAL ALARM TILES (Patte ANNUNC STUDY
rn Recognition): Tiles are not
grouped by logical organization because
of changes subsequent to the
original design. This Observation is su
pported by OER-049.
- 3B036 1 VISUAL TILE LEGENDS (Unambiguous and Abb ANNUNC STUDY
reviations) Some contain exces
sive information and others contain insu
fficient information. In addi
tion, abbreviations and acronyms are not
used consistently on all time

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 3B037 1 s e.g., Delta-;/Diff Press, REAC/Reactor /Rx. This observation is suppo rted by annunciator OER summary.
- 3B037 1 VISUAL TILE LEGENDS (Singularity and Spe ANNUNC STUDY cificity): Some tiles refer the operator to annunciator panels outside the main control area. In add ition, there are tiles that alarm for tw o conditions, e.g., DRYWELL HI /LO. Also K COMPUTER alarm on panel 905 refers operator to computer on panel C7. This observation is supported by OER-014 and OER-17.
- 3B038 1 VISUAL TILE READABILITY (Distance and Le ANNUNC STUDY tter Dimensions and Spacing): The lettering size on the annunciator t iles do not conform to the gui deline criteria. This observation is sup ported by OER-016.
- 3B039 1 VISUAL TILE READABILITY (Type Style): Th ANNUNC STUDY e letter type style and size d iffer on the annunciator lettering. This obser vation is supported by OER-016.
- 3B040 1 VISUAL TILE READABILITY (Legend Contrast ANNUNC STUDY): There are several annunciat or tiles that have light letters on dark background (panel 905 #1034) . Other annunciators are labeled using d ynotape (panel C3 #248 and pan el 905 #1033).
- 3B043 1 CONTROL SET DESIGN (Positioning of Repet ANNUNC STUDY itive Groups etc.): All contro l set designs are not alike, e.g., Panel C7 has two sets, one horizon tal and one vertical. Panel C6 only has two pushbuttons and C170 has t hree pushbuttons arranged in a triangula r formation.
- 3B044 1 ARRANGEMENT OF VISUAL ALARM TILES (Out o ANNUNC STUDY f Service Alarms etc): Tiles l abeled for equipment that has not been u sed and will not be used are still included on the annunciator panels , e.g., PLANT HEAT EXCHANGERS A AND B. This observation is supported b y OER-018.
- 3B045 1 SIGNAL DETECTION (Intensity): There is a ANNUNC STUDY large discrepancy in the audi ble alarm intensities. The PAM alarm is too high and the alarm intens ity on panels C1, C2 and C3 are too low. This observation is supported by OER-021.
- 3B047 1 SIGNAL DETECTION (Identification): The a ANNUNC STUDY

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- uditory alarm does not provide
for workstation or system identificatio
n. This observation is suppor
ted by OER-019.
- 3C012 1 ALARM PARAMETER SELECTION (Multi-channel ANNUNC STUDY
or Shared Alarms): The annunc
iator system does not have a reflash cap
ability.
- 4A003 6 ROTARY SELECTOR CONTROLS (Positioning): VERIFY COMPLETE
No positive detent feedback fo
r reactor mode switch on Panel 905 (#126
4).
- 4B048 2 GENERAL PRINCIPALS (Human Suitability): SWITCH MODS
All "J" handles are the same f
or pumps, valves and switches - some of
two position, others are "jog
" - poor discrimination by function or m
ode of operation. This observa
tion is supported by OER-023.
- 4B049 2 PREVENTION OF ACCIDENTAL ACTIVATION (Mov SWITCH MODS
able Covers or Guards): Panel
C3: Switch #410 should be guarded. Back
Panels: Instrument air nitrog
en to drywell and FW heater block valves
were identified during the OE
R as controls that should be guarded. Th
is observation is supported by
OER-026.
- 4B050 2 PREVENTION OF ACCIDENTAL ACTIVATION (Mov PANEL C3 MODS
able Covers or Guards): Protec
tive covers on controls that interfere w
ith adjacent controls: Panel
C1: Control #122 interferes with control
#107, 119 and 120. Panel C3:
Control #425 interferes with control #40
3. Panel 904: Control #955 int
erferes with control #960.
- 4B051
- 4B051A 2 DIRECTION OF MOVEMENT: Controls that vio CONCEPT DESIGN
late population stereotype are
: Panel 904: Rotary finger switches #945
, 951, 952, 956 counterclockw
ise move- ment to open. Panel C3: Rotary
handswitch #356, 372, 377, 38
0, 404, 406 counterclockwise to increase
(raise). Panel C7: Rotary fin
ger controls #1357, 1359, 1360, 1362, 13
77, 1379, 1380, 1382, 1385, 13
87, 1388, 1390, 1391, 1392, 1394, 1395,
1397, 1398, 1399 increase coun
terclockwise.DIRECTION OF MOVEMENT (Cont
.) Panel C7: Photos show that
"J" handles #1413, 1448, 1454, 1455, 147
7 have operator notation that
indicates control movement violates popu

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

lation stereotype permanent lab
els on the controls. Panel C2: #192, 206
, 207, 208, 215, 216 turn coun
terclockwise to raise and clockwise to l
ower. This observation is supp
orted by OER-024.

4B051B 4 DIRECTION OF MOVEMENT: Controls that vio SWITCH MODS
late population stereotype are
: Panel 904: Rotary finger switches #945
, 951, 952, 956 counterclockw
ise move- ment to open. Panel C3: Rotary
handswitch #356, 372, 377, 38
0, 404, 406 counterclockwise to increase
(raise). Panel C7: Rotary fin
ger controls #1357, 1359, 1360, 1362, 13
77, 1379, 1380, 1382, 1385, 13
87, 1388, 1390, 1391, 1392, 1394, 1395,
1397, 1398, 1399 increase coun
terclockwise.DIRECTION OF MOVEMENT (Cont
"J" handles #1413, 1448, 1454, 1455, 147
7 have operator notation th
indicates control movement violates popu
lation stereotype permanent lab
els on the controls. Panel C2: #192, 206
, 207, 208, 215, 216 turn coun
terclockwise to raise and clockwise to l
ower. This observation is supp
orted by OER-024.

4B051C 6 DIRECTION OF MOVEMENT: Controls that vio VERIFY COMPLETE
late population stereotype are
: Panel 904: Rotary finger switches #945
, 951, 952, 956 counterclockw
ise move- ment to open. Panel C3: Rotary
handswitch #356, 372, 377, 38
0, 404, 406 counterclockwise to increase
(raise). Panel C7: Rotary fin
ger controls #1357, 1359, 1360, 1362, 13
77, 1379, 1380, 1382, 1385, 13
87, 1388, 1390, 1391, 1392, 1394, 1395,
1397, 1398, 1399 increase coun
terclockwise.DIRECTION OF MOVEMENT (Cont
"J" handles #1413, 1448, 1454, 1455, 147
7 have operator notation that
indicates control movement violates popu
lation stereotype permanent lab
els on the controls. Panel C2: #192, 206
, 207, 208, 215, 216 turn coun
terclockwise to raise and clockwise to l
ower. This observation is supp
orted by OER-024.

4B051I SEE 4B051C INVESTIGATION
4B052 2 CODING OF CONTROLS (Consistency): There SWITCH MODS
is a limited amount of color c

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- oding on the "J" jog controls. On panel C1 and C3 some controls are color coded but there is no consistent pattern throughout the control room. This observation is supported by OER-023.
- 4B053 2 CODING OF CONTROLS (Location Coding): Mirrror imaging of controls. Panel C3: Mirror image controls #348/351; 349/350; 356/372; 357/371; 358/370; 377/380; 378/379; 388/402. Panel C1: Mirror image controls #97/98; 99/100. This observation is supported by OER-045.
- 4B054 2 CODING OF CONTROLS (Shape Coding): Shape SWITCH MODS coding of controls is not used. The OER identified that the vacuum breakers and containment air valve controls were too close to each other and identical in shape making accidental activation possible on Panel C7. This observation is supported by OER-023.
- 4B055 2 CODING OF CONTROLS (Color Coding): Except SWITCH MODS for Panel C3 there is no color coding association between controls and displays. The color coded jog 'J' handles (green) do not adequately contrast with panel background.
- 4B056 2 LEGEND PUSHBUTTONS (Discriminability): CONCEPT DESIGN he rod selector pushbuttons on the bench board are the same in size and appearance as the legend displays on the vertical portion of this panel. In addition, there are other legend pushbuttons and legend labels on the vertical portion of panel 905 which are identical in size and shape.
- 4B057 2 LEGEND PUSHBUTTONS (Barriers): No barriers provided for contiguous pushbuttons. Panel 905.
- 4B058 2 ROTARY SELECTOR CONTROLS (Position Indication): Controls on panel C1, #56 and 57 do not have position indicating line down the side of the rotary control knob. This condition may appear on other controls but could not be identified from the mockup photographs.
- 4B059 4B059A 6 PREVENTION OF ACCIDENTAL ACTIVATION (Response to Movement): During the OER, operators reported that rod cont

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

rol switch #1268 and notch ov
erride switch #1261 have excessive sprin
g loading. This observation is
supported by OER-025.

4B059B 7 PREVENTION OF ACCIDENTAL ACTIVATION (Res NONE-VERIFY OK
istance to Movement): During t
he OER, operators reported that rod cont
rol switch #1268 and notch ov
erride switch #1261 have excessive sprin
g loading. This observation is
supported by OER-025.

4B060 4B060A 2 GENERAL PRINCIPLES (Economy): Controls n PREPARE PDC
ot used or not connected are:
Panel 903: #638, 663, 677, 645, 690, 58
9 Panel 904: #927,1023,997,100
1,1013,1017 Panel 905: #1257 Panel C2: #
221 Panel CP600: #512. GENERAL
PRINCIPLES (Economy): The key switch on
control #512 violates tech sp
ecs and shculd be removed and circuit fr
ozen in position 2.

4B060B 4 GENERAL PRINCIPLES (Economy): Controls n SFTA
ot used or not connected are:
Panel 903: #638, 663, 677, 645, 690, 58
9 Panel 904: #927,1023,997,100
1,1013,1017 Panel 905: #1257 Panel C2: #
221 Panel CP600: #512. GENERAL
PRINCIPLES (Economy): The key switch on
control #512 violates tech sp
ecs and should be removed and circuit fr
ozen in position 2.

4B060C 6 GENERAL PRINCIPLES (Economy): Controls n VERIFY COMPLETE
ot used or not connected are:
Panel 903: #638, 663, 677, 645, 690, 58
9 Panel 904: #927,1023,997,100
1,1013,1017 Panel 905: #1257 Panel C2: #
221 Panel CP600: #512. GENERAL
PRINCIPLES (Economy): The key switch on
control #512 violates tech sp
ecs and should be removed and circuit fr
ozen in position 2.

4B060I SEE 4B060A INVESTIGATION

4B115 4B115A 4 GENERAL PRINCIPLES (ADEQUACY): The pushb SWITCH MODS
uttons #666 and 645 on panel 9
03 have a "cheater capability" to keep t
he pushbutton activated

4B115B 6 GENERAL PRINCIPLES (ADEQUACY): The pushb VERIFY COMPLETE
uttons #666 and 645 on panel 9
03 have a "cheater capability" to keep t
he pushbutton activated

4B115I SEE 4B115A INVESTIGATION

4B126 2 CODING OF CONTROLS (Location Coding): Co PDC
ntrol 1301 is located on panel

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 905 with its associated system located
on panel C1.
- 4B131 4 DIRECTION OF MOVEMENT: Switches 1434, 14 SWITCH MODS
35, 1436, 1443, and 1445 have
"open" at the left position and "auto"
at the right position. Switches
1400, 1401, 1402, 1403, 1404, 1405, 14
06 and 1407 have "close" at the
left position and "auto" at the right
position. Other switches 1410
and 1411 have three labels and two function
positions, i.e., "close-automatic"
and "open". The functional positions
of the controls do not conform
with convention.
- 4B131I SEE 4B131 INVESTIGATION
- 4B132 6 GENERAL PRINCIPLES (Human Suitability): VERIFY COMPLETE
In executing the task "Inhibit
Auto ADS" (1T: 31.00), the operator must
remember to reset ADS timer
A, 653, and B, 698 (panel 903) within every 120 seconds. Failure to reset
the timers could alter the plant response such as to erroneously
indicate to the operator that additional
failures have occurred and unnecessarily
aggravate operator tasks.
- 4C013 7 GENERAL PRINCIPLES (Compatibility with Emergency Gear): Operators have
no experience using controls while dressed in protective clothing.
- 5A004 6 SCALE MARKINGS (Multi-scale Indicators); VERIFY COMPLETE
Recorders on these panels (43
4,439,441,444,448,449,1327,1332,1334,133
7,1339) have only one scale with three different colored pens. Further the metal pens tear the paper. This observation is supported by OER-029. DO THE CHART RECORDERS PROVIDE INFORMATION THAT IS EASY TO READ & USE? The GE Recorders are difficult to read and often fail. Recorder failure results in activating false annunciation alarms.
- 5A005 6 SCALE MARKINGS (Compatibility): The core water level display indicator is on panels 903, 904, 905, 170 and 171 and differ. Panel 903: #620, 634 Panel 904: #882 Panel 905: #1173, 1174, 1183, 1186 Panel 170: #439 Panel 171: #1332 Board Title: Rx CLG, Rx Clnup, Rx Cont, PAM-A, PAM-B
- 5A005I SEE 5A005 INVESTIGATION
- 5A009
- 5A009A 2 USABILITY OF DISPLAY VALUES (Elimination SFTA)

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- of Operator Conversion): Reco
rders 439,1429 and 615 display the same
parameter but use different s
cales requiring conversion to compare. T
his observation is supported b
y OER-046.
- 5A009B 6 USABILITY OF DISPLAY VALUES (Elimination SFTA
of Operator Conversion): Reco
rders 439,1429 and 615 display the same
parameter but use different s
cales requiring conversion to compare. T
his observation is supported b
y OER-046.
- 5A010 5 COMPLETENESS OF INFORMATION: Monitoring SFTA
the drywell (DW) temperature f
or EOP entry conditions and for decision
points therein, requires the
temperatures above & below the 40 ft. p
oint in the DW. The DW tempera
ture indicators/recorder 582,637 (panel
903) and "Plant Air Temperatur
e Monitor," KAYE Assembly: 1376, 1418, 1
419, 1420, 1421, 1422, 1423, 1
424, 1425, 1426 (panel C7), with multipl
e readout points, do not disti
nguish the temperatures relative to the
40 ft. point.
- 5B061 2 USABILITY OF DISPLAYED VALUES (Eliminati PDC
on of Operator Conversion): In
struments on panels requiring conversion
are: Panel 903: #603,606,613
require multiplying by 5. Panel C2: #14
6 subtract value from 30. #147
multiply by 50 Panel CP600: #479 multip
ly value by 5 This observation
is supported by OER-30 and OER-033.
- 5B062 2 CONTRAST: Indicators with white letters PDC
on black background are: Panel
C3: #332, 342, 329, 318. Panel C7: 1459
- 5B063 2 PRINTING ON THE DISPLAY FACE (Provision PDC
of Needed Message): Parameter
scales missing: Panel 903: #601,604,608
,610. Panel 904: #836,880,814,
912. Panel 905: #1302, 1303, 1305. Panel
C2: #145, 146. Panel C1: #24,
25,42,47,26,27,48,46,45. Panel C4: Foxbo
ro indicators. Panel C170: #44
2, 443. Panel CP600: #466.
- 5B064 2 SCALE MARKINGS: (Values Indicated by Uni PDC
t Graduations): Scale graduati
on values that do not agree with guideli
ne criteria for progression:
Panel 903: #602,631,632,633,635,583,584,
586,618,619,621. Panel 904: #8

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

29, 830, 831, 875, 876, 877, 878, 889, 8
90, 907, 908, 1025, 813. Panel
905: #1099, 1100, 1101, 1102, 1175, 117
6, 1177, 1178, 1188, 1192, 119
3, 1171, 1107, 1108, 1162. Panel C2: #13
0, 133, 136. Panel C1: #14, 15
, 18, 19, 20, 25. Panel C3: #283, 287, 2
97, 301, 345. Panel CP600: #46
8, 469. Panel C7: #1367, 1368, 1369, 1374, 1
375, 1358, 1378, 1386, 1393, 1384, 1
430, 1361, 1381, 1389, 1396, 1383.

5B065 2 DIRECTIONALITY OF MOVEMENT AND NUMBERING PDC
WITH MOVING-POINTER METERS (V
ertical Straight Scales): Values increas
e in downward movement. Panel
903: #629. Panel 904: #833.

5B066

5B066A 1 GENERAL CHARACTERISTICS OF GRAPHIC RECOR ANNUNC STUDY
DERS (Placement of Recorders):
Recorders that must be verified and att
ended should be located in th
e primary operating area. Panels C7 and
902 both contain recorders. Re
corder on panel C2 #165 should be on Pan
el 903. Board Title: Cntmt Ven
t, Turbine, Process Rad, Rx Clg.

5B066B 2 GENERAL CHARACTERISTICS OF GRAPHIC RECOR PLT MODS
DERS (Placement of Recorders):
Recorders that must be verified and att
ended should be located in th
e primary operating area. Panels C7 and
902 both contain recorders. Re
corder on panel C2 #165 should be on Pan
el 903. Board Title: Cntmt Ven
t, Turbine, Process Rad, Rx Clg.

5B066C 6 GENERAL CHARACTERISTICS OF GRAPHIC RECOR VERIFY COMPLETE
DERS (Placement of Recorders):
Recorders that must be verified and att
ended should be located in th
e primary operating area. Panels C7 and
902 both contain recorders. Re
corder on panel C2 #165 should be on Pan
el 903. Board Title: Cntmt Ven
t, Turbine, Process Rad, Rx Clg.

5B066I SEE 5B066C INVESTIGATION

5B067 5 INFORMATION TO BE DISPLAYED (Completeness SFTA
s of Information): FW heater b
lock (dump)(10) valve position is needed
on panel C1 as well as back
panel C4. This observation is supported
by OER-034.

5B068 6 CHARACTERISTICS AND PROBLEMS OF LIGHT IN VERIFY COMPLETE
DICATORS (Precautions to Avoid
Misinterpretation): The indicator light
s above controls #206, 404, 4

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 06 have red lens on left and green lens
on right (reversal from conven
tion).
- 5B068I SEE 5B068 INVESTIGATION
- 5B069 2 COLOR CODING (Consistency of Meaning): B PANEL C3 MODS
US trouble lights on Panel C3
use amber and white covers with the sam
e meaning.
- 5B070 6 DISCRETE RECORDERS (Channel Selection Ca VERIFY COMPLETE
pability): Recorder #460 does
not have the capability of selecting a
single channel display.
- 5B071 2 INFORMATION TO BE DISPLAYED (Unnecessary PREPARE PDC
Information): Indicator Light
s #870 and 871 not needed or used.
- 5B110 6 USABILITY OF DISPLAYED VALUES (Scale Ran VERIFY COMPLETE
ge): Recorder #145 uses dual p
ens and a dual scale for coarse and fine
readings. The pointers are n
ot identified or associated with either
colored pen and reading accura
cy is made difficult by the scale markin
gs.
- 5B111 2 ZONE MARKINGS: The majority of instrumen PDC
ts have no zone markings on th
e instrument faces to identify opreating
ranges, upper or lower limit
s and danger zones used throughout the c
ontrol room. Existing markings
were applied without use of a standard
or criteria.
- 5B119 4 READABILITY (CHARACTER HEIGHT): The char SFTA
acter heights on meter #601 an
d 610 do not subtend a visual angle of 1
5 minutes of arc
- 5B124 2 INFORMATION TO BE DISPLAYED (Unnecessary PREPARE PDC
Information): The amber light
s on instruments 720,721,750,751 are dis
connected and their function
removed.
- 5B127 6 USABILITY OF DISPLAYED VALUES (Scale Sel VERIFY COMPLETE
ection): RHR flow indicators 6
17, Loop A and 631, Loop B, and flow rec
order 602, Loop A/B, all on p
anel 903, indicate the same flow within
the same range but have differ
ent scale increments: o 617 & 631: 500 g
pm increments o 602 : 200 gpm
increments
- 5B133 2 INFORMATION TO BE DISPLAYED (Completeness VERIFY COMPLETE
s of Information): Monitoring
SP pressure for EOP entry and decision
points therein requires a rang
e of 0-60 psig. SP pressure is available
on 862 (panel 904), having a

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- range of -1.0 to +2.0 PSID, or by combin
ing DW/SP Delta-P, 863 (panel
904), with DW pressure, 1329 or 1330 (pa
nel C171).
- 5B134 7 USABILITY OF DISPLAYED VALUES (Eliminati NONE--VERIFY OK
on of Operator Conversion): Th
e plaque, 2004, defining reactor power l
evel vs. IRM channel range po
sition specifies reactor power in KWT or
MWT whereas operator decision
points in the FOPs require % power. Thu
s the operator must work with
2 different sets of power units during e
mergency events.
- 5B134I SEE 5B134 INVESTIGATION
5B135 6 INFORMATION TO BE DISPLAYED (Completeness VERIFY COMPLETE
of Information): During the
OER operators reported that they do not
have feedback as to whether t
he torus or the drywell O-2 concentratio
n sample points are being moni
tored. This observation is supported by
OER-027.
- 5B135I SEE 5B135 INVESTIGATION
5B136 6 USABILITY OF DISPLAYED VALUES (Scale Ran VERIFY COMPLETE
ge): The cooling water flow in
the CRD hydraulic system is ~65 gpm but
the flow indicator range, 11
91, is 0-50 gpm.
- 5C014 7 GENERAL CHARACTERISTICS OF GRAPHIC RECOR VERIFY COMPLETE
DERS (Scale Compatibility): Re
corder scales and recorder paper that ar
e not compatible are: Panel C
170: #434, 439, 449. Panel C171: #1327,
1332, 1339. Panel 903: #615. P
anel C1: #24, 25, 23. Panel C7: #1430. P
anel CP902: Area Rad FR 705-4,
AR 5075-A.
- 5C015 6 SPECIFIC RECORDER TYPES (Continuous Reco VERIFY COMPLETE
rders-Labeling): There is no r
ecorder labeling on Panel CP600 - #466.
- 5C016 5C016A 2 USABILITY OF DISPLAYED VALUES (Scale Sel PDC
ection): The scales on APRM me
ters #1162,1163,1107,1108 on Panel 905
and #168 on Panel C2 do not pr
ovide the required precision. This obser
vation is supported by OER-031
- 5C016Z 6 USABILITY OF DISPLAYED VALUES (Scale Sel VERIFY COMPLETE
ection): The scales on APRM me
ters #1162,1163,1107,1108 on Panel 905 a
nd #168 on Panel C2 do not pr
ovide the required precision. This obser
vation is supported by OER-031
- 5C017 7 PRECAUTIONS TO ASSURE AVAILABILITY (Bulb PURCHASE BULB TOOL

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

Changing Hazard): Changing a light bulb on panel C3 caused a short and resulted in a "scram."
SEE 5C017 INVESTIGATION

5C017I
5C018
5C018A 2 GENERAL CHARACTERISTICS OF GRAPHIC RECOR PDC DERS (Use): Recorder #146 provides confusing values. This HEO is supported by OER-030.

5C018B 6 GENERAL CHARACTERISTICS OF GRAPHIC RECOR VERIFY COMPLETE DERS (Use): Recorder #146 provides confusing values. This HEO is supported by OER-030.

5C019 6 GENERAL CHARACTERISTICS OF GRAPHIC RECOR VERIFY COMPLETE DERS (Visibility): The channel being recorded cannot be determined without opening the door and advancing the paper on: Panel 904: #1025 Panel C1: #14 and 15

5C020 2 USABILITY OF DISPLAYED VALUES (Scale Sel PDC ection): The units on instruments #912 and 894 are worn away and one is replaced with tape.

5C021 6 USABILITY OF DISPLAYED VALUES (Scale Sel VERIFY COMPLETE ection): The power value is shown in percent power to a level of 125 percent for #1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1145, 1147, 1149, 1151, 1153, 1155, 1157, and 1159. What does 125 percent refer to?

5C022 2 SCALE MARKINGS (Use of Graduations): Scale PDC les with more than 9 graduations between numbers: Panel C170: #438, 449. Panel C171: #1339, 1331. Panel 903: #618, 619, 621, 583, 584, 632, 633, 635, 636, 582, 602. Panel 904: #829, 830, 861, 862, 863, 877, 889, 890, 907, 908. Panel 905: #1078, 1079, 1171, 1192, 1193. Panel C2: #133, 145. Panel CP600: #466, 468, 469, 477, 478. Panel C7: #1460.

5C026 6 USABILITY OF DISPLAYED VALUES (Elimination of Operator Conversion): The plaque identifying reference RPV water levels for use with 1173 & 1174 (panel 905) contains arrows pointing to various positions on the scale of 1173 which differ from the standard level by ~8 inches. The scale pointer is between the arrows and scale easily allowing the incorrect association of the pointer with the arrows on the plaque.

6B072 2 NEED FOR LABELING: Labels on Panel CP600 PLT MODS

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- : #466, 465 missing. Panel C7:
#1454, 1455, 1448 have operator notation to indicate the label is in error. Panel 903: #581 should be relabeled torus air temperature; #601, 610 have no label. Panel 903 and 904: #626 and 842 no direction for increase. This observation is supported by OER-037 and OER-042.
- 6B073 2 HIERARCHICAL SCHEME: The limited hierarchical labeling does not adequately satisfy these guideline criteria. This observation is supported by OER-041.
- 6B074 2 PLACEMENT (Normal Placement): Labels not placed above their associated controls are: Panel CP600: #472, 473, 500, 501, 527, 528, 518, 519, 529. Panel 903: #604, 608, 587, 592, 594, 599, 591. Panel 904: #1005, 1022, 836, 866, 868, 880. Panel 905: #1265, 1266, 1299, 1300, 1302, 1305, many pushbuttons. Panel C1: #26, 27, 46, 48, 56, 57. Panel C4: #1520, 1521, 1522, 1523, 1524, 1525, 1526, 1527, 1528.
- 6B075 2 PLACEMENT (Panel Labeling): All display labels are placed below the instrument and does not conform to guideline criteria.
- 6B076 2 CONSISTENCY (Internal Consistency and Compliance with Procedures): No standard list of abbreviations or acronyms is used on the labels, e.g., PREHEATER/PREHTR, BLOCK/BLK, HYDROGEN/H₂. This observation is supported by OER-039.
- 6B077 2 BREVITY: There is an inconsistency in labeling. Some labels use complete words for abbreviations that are in common usage by operators, e.g., RCS/Reactor Cooling System. This observation is supported by OER-039.
- 6B078 2 FUNCTIONAL GROUPS (Functional Relationships and Location): Controls for fast start-up test and fast injection procedures require a set of control actuations in sequential series. The controls associated with these sequential actions are scattered across the panel requiring the operator to search for proper controls in sequence. This observation is supported by OER-036.

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 6B079 6 CONTROL POSITION LABELING (Direction): T VERIFY COMPLETE
he direction of movement does
not conform to convention on: Panel 903
: #626, 599 Panel 904: #842, 9
45, 951, 952, 956 Panel C1: #45, 46, 48
(turn left to increase tempera
ture) Panel C7: #1448, 1454, 1455, 1413;
operator pencil markings indi
cate directions differ from labels Panel
C3: #356, 372, 377, 380 This
observation is supported by OER-024.
- 6B080 2 READABILITY (Character Height): Characte PLT MODS
r heights are not consistent,
e.g., Panel C3 - #411, 415, 421, 423. A
lso Panel C2: #146, 165. The s
maller character size does not meet guid
eline criteria. This observati
on is supported by OER-038.
- 6B081 2 READABILITY (Contrast): All labels are w PLT MODS
hite characters on black or da
rk background. This does not conform wit
h the guideline criteria and
contributes to the observation reported
under HEO 6.6.005 (HED 6C023.7
- 6B082 2 USE (Necessity and Human Factors Practic PLT MODS
es): Temporary labels have bee
n on the panels for an extended period o
f time, e.g., many dynotape l
abels as on Panel C3: #246, 247, 248 ann
unciators or C170: #450, 451,
452, 453, 454, 455, 456, 457, 1340, 1341
, 1342, 1343, 1344, 1345, 1347
, 1338. On Panel C7 operators have penci
led in label identification wh
ich conflicts with permanent label, e.g.
, #1454. This observation is s
upported by OER-040.
- 6B083 6 USE (Adjacent Devices): Panel C7 - #1433 VERIFY COMPLETE
covers labels on #1440. Asses
sment of this criteria is limited becaus
e the tags were removed durin
g panel photography.
- 6B084 2 DEMARCATIION (Permanence): Stick-on tape PLT MODS
is used for most of the demarc
ation lines on Panels #903, 904, C1, CP6
00 Board Title: Rx CLG, Rx C1
nup, FW & Cond, AOG
- 6B085 2 COLOR: Colors are not associated with sp PLT MODS
ecific functions. Board Title:
Rx CLG, Rx Clnup, FW & Cond, Electrical
, PAM, Cntmt Vent Board No.:
#903, 904, C1, C3, CP600, C7
- 6B086 2 USE OF MIMICS (Color): The mimic lines o PANEL C3 MODS
n Panel C3 are not color discr
iminative.

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 6B087 2 USE OF MIMICS (Color): Mimic lines on Pa PLT MODS
nel C3 do not have adequate co
lor contrast with the panel surface.
- 6B088 2 USE OF MIMICS (Color): The origin of all PLT MODS
lines for the containment iso
lation mimic are not clear. This observa
tion is supported by OER-044.
- 6B089 2 INTERNAL CONSISTENCY: The bus indicator PANEL C3 MODS
numbers do not increase progre
ssively (#240 out of sequence). In addit
ion, two different colored li
ght caps are used.
- 6B090 2 CONSISTENCY (With Procedures): Panel 903 PLT MODS
: Containment spray Signal lab
el #755 and 770 should be changed to Con
tainment Spray Permissive. Pa
nel 904: Displays 885,886,887 read lbs/h
r times 10 to the 6th and Proc
edure 2.2.84 (pg 18) indicates gal/min.
Panel C2: #168 reads in mils;
the instructions (2.2.99) reads in inche
s.
- 6B091 2 CONSISTENCY (Internal Consistency): Pane PLT MODS
l 904: Labels for 992 and 1008
are different but the controls perform
the same function. Panel C3:
Label wording on controls 429,430 is con
fusing to relate to control fu
nction.
- 6B092 2 NEED FOR LABELING: Panel C1: Labels for PLT MODS
lights above #36 and 37 are mi
ssing. Panel C2: 4 lights associated wit
h control #231 do not have la
bels. Panel 904: Labels on 888,913 are m
issing.
- 6B120 2 CONTROL POSITION LABELING (POSITION): Th SWITCH MODS
e functional control positions
are worn off or have never been etched
on the control plate (escutch
eon) for a large number of switches
- 6B121 2 NEED FOR LABELING: There are 8 key contr PLT MODS
ol selector switches on each o
f the PAM panels C170 and C171. The syst
em function for the use of th
ese controls is not identified.
- 6B125 2 NEED FOR LABELING: The red and green lig PLT MODS
hts associated with valve cont
rols 720,721,750,751 indicate valve posi
tion command as opposed to va
lve position for all other valve control
s in the control room. Valve p
osition is indicated on panel C171, inst
rument 1338.
- 6C023 6 VISIBILITY (Cleaning): The number of lab VERIFY COMPLETE
els obscured by dirt or foreig

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- n matter would indicate that no procedure for cleaning exists.
- 8A006 2 ENHANCEMENT RECOGNITION AND IDENTIFICATION PLT MODS ON Panels CP600,C7,C170,C171 lack operator enhancement aids. This observation is supported by OER-0 43.
- 8A007
- 8A007A 2 LOGICAL ARRANGEMENT AND LAYOUT (Other Ex CONCEPT DESIGN expectations): The arrangement of Panel CP600 is not arranged for sequential operations.
- 8A007B 5 LOGICAL ARRANGEMENT AND LAYOUT (Other Ex SFTA expectations): The arrangement of Panel CP600 is not arranged for sequential operations.
- 8A008
- 8A008A 2 SEPARATION OF CONTROLS: Panel C7: All controls are too close and too cluttered.
- 8A008B 5 SEPARATION OF CONTROLS: Panel C7: All controls are too close and too cluttered.
- 8B094
- 8B094A 2 STRINGS OR CLUSTERS OF SIMILAR COMPONENT PLT MODS S (String Length): Panel 904:
48 pairs of red/green indicator lights produce a display grouping which exceeds length criteria of 20 inches.
Panel 905: Control rod matrix lights exceed maximum string length criteria of 20 inches.
- 8B094B 5 STRINGS OR CLUSTERS OF SIMILAR COMPONENT SFTA S (String Length): Panel 904:
48 pairs of red/green indicator lights produce a display grouping which exceeds length criteria of 20 inches.
Panel 905: Control rod matrix lights exceed maximum string length criteria of 20 inches.
- 8B095 2 STRINGS OR CLUSTERS OR SIMILAR COMPONENT PLT MODS S (Number of Components): Components that exceed 5 in a row or column are: Panel 904: Secondary containment lights. panel 905: Control rod drive indicators 1187,1188,1189,1190,1191,1192,1193. Panel C3: Diesel generator indicators for A and b. Canal and Bridgewater line indicators. Panel C7: Controls #1474,1475,1476,1477,1478,1479,1480,1481,1482,1483, 1484,1485,1486,1487,1488,1489,1465,1466,1467,1468,1469,1470,1471.
- 8B097
- 8B097A 2 MIRROR IMAGING: Panel C1: Loop A and B of CONCEPT DESIGN

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- or RBCCW and TBCCW are mirror imaged. Panel C3: Diesel generator A and B controls are mirror imaged . Panel C3: UAT & startup transfer controls 359,369 are mirror imaged. Panel 905: #1107/1108 mirror imaged with 1162/1163 and their associated controls. This observation is supported by OER-045.
- 8B097B 6 MIRROR IMAGING: Panel C1: Loop A and B if VERIFY COMPLETE or RBCCW and TBCCW are mirror imaged. Panel C3: Diesel generator A and B controls are mirror imaged . Panel C3: UAT & startup transfer controls 359,369 are mirror imaged. Panel 905: #1107/1108 mirror imaged with 1162/1163 and their associated controls. This observation is supported by OER-045.
- 8B098 2 SEQUENCE FREQUENCY OF USE AND FUNCTIONAL CONCEPT DESIGN CONSIDERATIONS (Functional Considerations): Cleanup controls #966, 967, 968, 969, 970, 971 separate controls #976, 977, 978, 979, 980, 981, 983, 984, 985, 986, 987, 988, 989, 990, 991. This observation is supported by OER-022.
- 8B099 2 ENHANCING RECOGNITION AND IDENTIFICATION PLT MODS (Spacing): Set of controls for recorders #1107/1108 and #1162/1163 are not separated to indicate boundaries.
- 8B100 2 ENHANCEMENT RECOGNITION AND IDENTIFICATION PLT MODS ON (Emergency Controls): No distinctive enhancements are used for emergency controls.
- 8B101 5 SEQUENCE, FREQUENCY OF USE AND FUNCTIONAL SFTA L CONSIDERATIONS (Sequence of Use): Operator must activate controls #768 and 753 on Panel 903 then go to Panel C1 to activate controls #101, 108, or 121, 124.
- 8B102 6 SEQUENCE, FREQUENCY OF USE AND FUNCTIONAL VERIFY COMPLETE L CONSIDERATIONS (Functional Considerations): Recorder 1171 on Panel 905 and recorders 814 and 898 on Panel 904 values must be taken along with TR263-104 on panel 921 every 15 minutes during heatup & cooldown. Instrument #614 on Panel 903 used with instruments #861, 862, 863 on Panel 904.
- 8B102I SEE 8B102
- 8B103 2 LOGICAL ARRANGEMENT AND LAYOUT (Order and Labeling): Panel C2: #218,21 INVESTIGATION CONCEPT DESIGN

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

- 9,227,228,232,233 are not arranged in a logical sequence. Panel 903: Controls #750 and 751 do not follow sequentially.
- 8B105 2 SEQUENCE, FREQUENCY OF USE, AND FUNCTIONAL CONCEPT DESIGN
CONSIDERATIONS (Sequence): The Primary & Secondary containment isolation status lights are positioned right-to-left and labels numbered from bottom-to-top.
- 8B122 2 LAYOUT CONSISTENCY (REPEATED FUNCTIONS): CONCEPT DESIGN
The meters on HFCI and RCIC are not in the same sequence. Meter #585 and 586 on HPSI and 831 and 832 are reversed. The indicator lights for 138, 139, 140, 141, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163 and 164 on panel C2 are not in the same layout as #2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13 on panel C1.
- 8B129 6 SEQUENCE, FREQUENCY OF USE, AND FUNCTION VERIFY COMPLETE
AL CONSIDERATIONS (Functional
Considerations): On the suction line from the recirc loop for shutdown cooling using RHR, the inboard isolation valve control (703) is grouped with RHR loop A and the outboard valve (715) with loop B. These valves are not loop-dependent and are ~ 6 ft apart.
- 9B106
- 9B106A 2 GENERAL MOVEMENT RELATIONSHIPS (Rotary C CONCEPT DESIGN
controls): Panel 903: Control #626 increases clockwise, indicator #629 increases downward. Panel 904: Control #842 increases clockwise, indicator #833 increases downward.
- 9B106B 6 GENERAL MOVEMENT RELATIONSHIPS (Rotary C VERIFY COMPLETE
controls): Panel 903: Control #626 increases clockwise, indicator #629 increases downward. Panel 904: Control #842 increases clockwise, indicator #833 increases downward.
- 9B107
- 9B107A 2 SINGLE CONTROL AND DISPLAY PAIRS (Associ CONCEPT DESIGN
ation): Control #1185 for recorders 1171 and 1172 and control 1196 for controllers #1299 and 1300 are not located so that association is apparent.
- 9B107B 6 SINGLE CONTROL AND DISPLAY PAIRS (Associ VERIFY COMPLETE
ation): Control #1185 for recorders 1171 and 1172 and control 1196 for controllers #1299 and 1300 are not located so that association is ap

HED #.. IMPL. HED DESCRIPTION..... NEXT ACTION.....
CATEG

parent.
9B108 6 SINGLE CONTROL AND DISPLAY PAIRS (Associ VERIFY COMPLETE
ation): The direction of movement of controls and light colors are not
consistent with convention.
Controls (e.g., #206, 207, 208, 215, 216
) move counterclockwise to raise. Red/Green lights above controls #206
, 404, 406 are reversed.
SEE 9B108 INVESTIGATION
9B109
9B109A 2 SINGLE CONTROL AND DISPLAY PAIRS (Proxim CONCEPT DESIGN
ity): Indicator #168 and control #191 are not in close proximity to each other. Indicators #166 and
167 are distant from controls #229, 230
, 231. Indicators #169, 170 are distant from controls #204, 205.
9B109B 6 SINGLE CONTROL AND DISPLAY PAIRS (Proxim VERIFY COMPLETE
ity): Indicator #168 and control #191 are not in close proximity to each other. Indicators #166 and
167 are distant from controls #229, 230
, 231. Indicators #169, 170 are distant from controls #204, 205.

204 items listed.

APPENDIX D

SCOPE OF PILGRIM STATION DCRDR

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SCOPE OF PILGRIM STATION DCRDR

For the purposes of the DCRDR project, Boston Edison defines the Pilgrim Station Control Room as the following control panels, work stations and adjacent areas used by plant operators for normal and emergency operations:

| <u>Panel No.</u> | <u>Panel Name</u> |
|------------------|---|
| 903 | Core Standby Cooling Systems |
| 904 | Reactor Auxiliary Systems |
| 905 | Reactor Control |
| C-1 | Feedwater & Condensate |
| C-2 | Turbine Control |
| C-3 | Electrical Systems |
| C-170/C-171 | Post-Accident Monitoring |
| CP-600 | Augmented Off-Gas |
| 902 | Area & Process Radiation Recording |
| 910 | Process Radiation Monitoring |
| 911 | Area Radiation Monitoring |
| C-4 | Feedwater Heaters Control |
| C-7 | Containment Ventilation & Gas Treatment |
| C-76 | Shift Supervisor Console |
| C-77 | Operator Console |

HED's and corrective actions discussed in this report are related to the scope defined above. Potential changes to the defined control room for the remainder of the project, if any, will be identified in the forthcoming Program Plan revision.