November 1990

Detailed Control Room Design Review

Final Summary Report

Pilgrim Station

BOSTON EDISON

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF FIGURES

LIST OF TABLES

LIST OF EXHIBITS

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

The Supplementary Summary Report was submitted in May 1989, providing some of the additional information requested in the NRC's Safety Evaluation. A revised Program Plan was submitted in July 1989.

This report is the Final Summary Report. Its submittal satisfies a commitment made in the Supplementary Summary Report and completes the reporting requirements of NUREG-0737 for the Pilgrim Station Detailed Control Room Design Review. It includes the identification of corrective actions and the schedules for implementation.

SECTION I

INTRODUCTION

A. PURPOSE

The purpose of this Final Summary Report is to complete the description of the Detailed Control Room Design Review (DCRDR) for Pilgrim Station. In two previous reports (References 1 and 2)[1] Boston Edison described the DCRDR project to date, tabulated the identified Human Engineering Discrepancies (HEDs) and described the corrective actions for a portion of the HEDs. This report provides information on the remainder of the Pilgrim Station DCRDR, and is meant to complete the DCRDR reporting requirements of NUREG-0737.

In summary, this report will:

- Describe the status of DCRDR at Pilgrim Nuclear Power Station, by providing an update to information provided earlier in Reference 2.
- Describe additional control room survey, inventory, and task analysis work done in 1989-90, and tabulate the HEDs identified by that effort.
- Identify corrective actions for both:
  - The "new" HEDs identified by the 1989-90 DCRDR efforts.
  - HEDs identified earlier (References 1 and 2) for which corrective actions were not identified in Reference 2.
- Provide status and schedules for the identified corrective actions.
- Identify HEDs for which corrective actions are completed (with an emphasis on those completed since early 1989).
- Identify the safety-significant HEDs for which no corrective action is planned, and the basis for not correcting them.
- Respond to the comments in the NRC's inspection report of mid-1989 (Reference 3) and in the NRCs review (Reference 10) of the Program Plan and Supplementary Summary Report (References 2 and 6).

B. BACKGROUND

Boston Edison originally prepared and submitted a Program Plan and a Summary Report (References 4 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 HEDs identified during the review, and outlined a series of corrective actions.

---

1 References are listed in Appendix A.

The 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 5). 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. The NRC required that a supplemental report be prepared and submitted to resolve their concerns.

In April 1986, we committed to prepare and submit a Supplementary Summary Report. That report (Reference 2) was submitted in May 1989. The Supplementary Summary Report summarized the key activities on the Pilgrim DCRDR project since 1984; described physical improvements that enhance the operators' ability to prevent and mitigate accidents; described additional corrective actions that were planned; and identified the remaining engineering tasks needed to allow selection of corrective actions for the remaining HEDs.

The Supplementary Summary Report also committed to:

- Prepare and submit a revised Program Plan, which was completed in July 1989 (Reference 6).
- Update the DCRDR to include:
  - Update of the control room inventory.
  - Performance of a partial control room survey, including a survey of all plant equipment installed in the control room since the original (1984) DCRDR survey.
  - Perform a new System Function and Task Analysis, including verification and validation activities, encompassing the current set of Emergency Operations Procedures (EOPs).
- Submit a Final Summary Report conforming to NUREG-0737 requirements by November 30, 1990. The report is to include the scope and schedule for the remaining corrective actions for Pilgrim's HEDs.

In March 1989, NRC conducted an in-process review of the Boston Edison DCRDR project. This report addresses NRC's comments provided during that review (see Reference 3).

C. DCRDR EVALUATION CRITERIA

BECo 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 Program Plan (Reference 6) that describes compliance with each criterion for the BECo DCRDR.

Note that this report will describe any instances in which the DCRDR data collection and analysis activities were substantially different from the planned activities as described in the Program Plan (Reference 6). Otherwise, the Program Plan can be assumed to provide a description of the DCRDR processes.

D. ACTIVITIES SINCE APRIL 1989

This sub-section describes the principal activities of the Pilgrim DCRDR project since our submittal in April 1989 of the Supplementary Summary Report (Reference 2).

For the purpose of this discussion and for other discussion throughout this report, it is convenient to separate the projects into several major elements. These elements coincide with items identified in the Pilgrim Station Long Term Program (LTP); the LTP numbers are in parentheses.

1. Performance of additional data collection, analysis, identification of HEDs, and selection of corrective actions (LTP #299)

   As committed to NRC in Reference (2), Boston Edison planned and conducted an effort to update the Pilgrim DCRDR. General Physics was the contractor selected to conduct the additional data collection and human factors review. The update effort included the following elements:

   a. Update of the control room inventory -- The inventory of control room instruments and controls was revised to include hardware changes since 1984, and to include additional panels added to the scope of the DCRDR in 1989.

   b. Additional control room surveys -- Human factors surveys were performed to complete several NUREG-0700 requirements not previously done (including noise and HVAC), and to include panels added to the DCRDR scope since the 1984 survey.

   c. Review of Operating Experience as documented in PNPS Licensee Event Reports (LERs) -- LERs from the last five years were examined to identify potential human factors problems that have origins in the control room.

   d. Task analysis -- A complete new System Function and Task Analysis (SFTA) was conducted, using the latest Emergency Operating Procedures (EOPs). A Verification of Task Performance Capabilities and Validation of Control Room Functions was also conducted.

   e. Identification and screening of additional HEDs -- The collected data resulted in the identification of additional Human Engineering Observation (HEOs). The Boston Edison Design Review Team (DRT) was convened, and reviewed the HEOs. HEOs were categorized as to importance and corrective action types.

TABLE I-1

COMPLIANCE WITH DCRDR EVALUATION CRITERIA

Criteria	Reference[2]
1. Establishment of a qualified multiuisciplinary review team.	Section VI and Program Plan
2. Function and task analyses to identify control room operator tasks and information and control requirements during emergency operations.	Section II and Program Plan
3. Comparison of display and control requirements with a control room inventory.	Section II and Program Plan
4. Control room survey to identify deviations from accepted human factors criteria.	Section II 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 III and V and Program Plan
7. Verification that selected design improvements will provide necessary correction.	Program Plan
8. Verification that improvements will not introduce new HEDs.	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 and Section V

2 Section numbers refer to this report; Program Plan refers to revised Program Plan (Reference 6).

f. Selection of Correction Actions -- As detailed in Section III of this report, corrective actions have been identified and scheduled for the HEDs to be corrected. Safety-significant items not to be corrected are identified in Section III.

2. Continue Installation of Enhancements (LTP #300)

BECo has continued the design and installation of control panel enhancements, including: labels, mimics, and demarcations; rewiring of switches and replacement of switch escutcheons; removal of abandoned equipment; and other minor items. In general, progress has been slower than scheduled. (Revised schedules are in Section IV.) We also submitted to the NRC a detailed report on the labels, mimics, and demarcation effort, Reference 7.

3. Complete Annunciator Conceptual Design Study (LTP #327)

Boston Edison planned a conceptual design study to select the course of action to correct HEDs on the alarm annunciator system, selected a contractor (NUS Corp.), and conducted the study. The study has been completed and the planned corrective action is discussed in Section III.C.

4. Design of Lighting Improvements (LTP #375)

As previously committed, Boston Edison engaged a contractor (Stone & Webster), who prepared a detailed design for lighting improvements. The design is complete and material procurement is underway.

Each of these activities is described further in Section II (the data collection effort) and Section III (corrective actions) of this report. Section IV provides schedules for the corrective actions.

E. ACTIVITIES IN PROGRESS

At the present time, activities in progress include the following. Each of these items is discussed in greater detail in Section II (Corrective Actions).

1. Panel Enhancements -- Design and implementation is continuing on the panel enhancements program referred to earlier (and described in detail in Section III and in References 2 and 7). Labels, mimics, and demarcations are installed first in the simulator for review, then in the plant control room. The bulk of this installation work can be done while the plant is operating. Design work is continuing on the remaining panels to be enhanced. Installation of these enhancements will continue through 1991 and after, until completed.

   Design work is also underway for a number of other panel enhancements planned for installation in Refueling Outage #8 (RFO 8) in 1991, including:

   - Repainting and refurbishment of all panels.
   - Removal of additional equipment previously abandoned in place.
   - Rewiring and replacement of selected switches.
   - Replacement of switch escutcheons.
   - Other minor hardware replacements and rearrangements.

2. Design of Additional Control Panel Improvements -- Additional control panel improvements (including those involving significant panel cutting, hardware replacement, or rearrangement) are being defined and scheduled in this report. As this report is being written, scoping and planning are underway and some detailed design is underway.

3. Annunciator Improvements Design -- A conceptual design has been selected (see Section III). As this report is being written, the effort to develop a detailed design of the improvements is being scoped, estimated, and planned. Detailed design is expected to begin in early 1991.

4. Verification -- As corrective actions are completed, BECo performs a field review of the completed work to verify that the original HED was corrected and that no new HED is created. This verification process is a requirement of BECo procedures and will continue throughout the implementation of the project.

5. Design Manual -- As design proceeds on corrective actions, standards are being developed for such control room features as switches, labels, meter scales, mimics, demarcation, and others. These standards are to be published as a Design Manual for guidance to future modifications in the control room. Manual preparation is underway, with publication of the initial scope expected in late 1990 or early 1991.

F. REMAINING WORK

What remains is to design and implement the corrective actions that have been selected but have not yet been completed. Section III describes the corrective actions, and Section IV discusses the schedule for the work.

In addition, two other tasks remain:

1. Completion of the Design Manual. As work proceeds, the manual is expected to require modifications (both expansion and revisions to reflect experience).

2. Verification that completed corrective actions resolve the original human factors concerns, and do not create new concerns. This process will continue throughout the implementation period.

This Final Summary Report completes BECo's DCRDR reporting requirements as provided in NUREG-0737 and we do not plan to submit additional reports. Implementation schedules are subject to confirmation and refinement through the Long Term Program process.

SECTION II

1989-90 CONTROL ROOM SURVEYS AND SYSTEM FUNCTION TASK ANALYSIS

A. INTRODUCTION

1. Background

In 1989-90, Boston Edison completed a comprehensive update of the Pilgrim DCRDR. The updating effort conformed with the most recent revision of the Pilgrim Program Plan (Reference 6).

The first task in the update effort was to develop a specification for a human factors consultant. The specification (Reference 8) was based closely upon the relevant sections of the Program Plan. Next, General Physics Corp. (GP) was selected to perform the data collection and analysis effort. General Physics also was designated as the lead human factors consultant for the Pilgrim DCRDR project, to assist in other human factors tasks. Refer to Section VI for discussions on the project organization.

2. Scope of 1989-90 Effort

General Physics began their data collection in October 1989. The scope of their wo on this project can be summarized as follows.

- Update the inventory of control panel instrumentation, controls, and other equipment, to reflect changes in equipment since the inventory was prepared in 1984, and to expand the scope to several additional panels. (See Figure II-1.)

- Perform a human factors survey for the added panels, revised hardware, and certain equipment (e.g., SPDS) not previously surveyed.

- Perform a review of operating experience as documented in Licensee Event Reports.

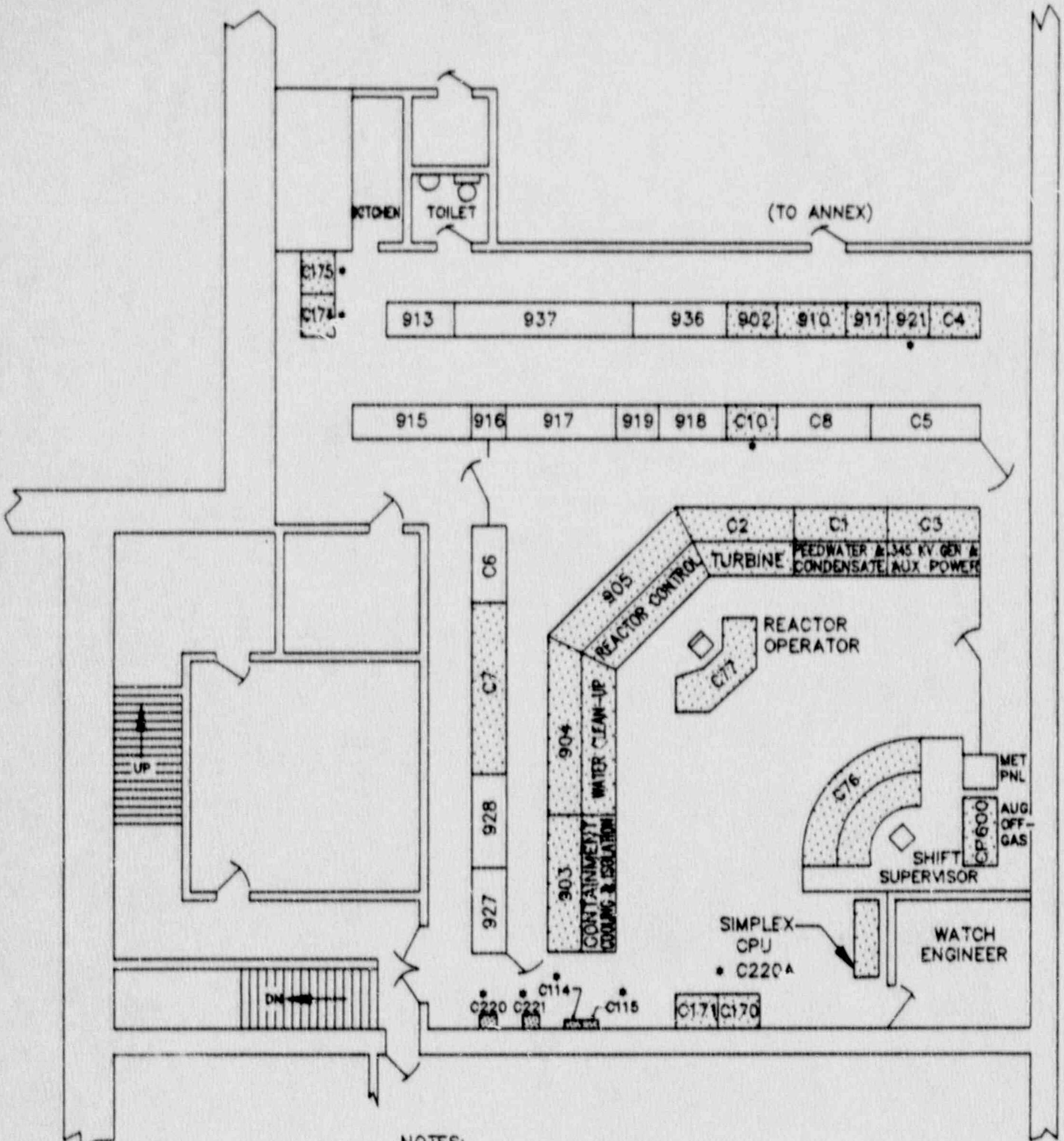
- Perform an entirely new System Function and Task Analysis, including verification and validation.

Each of these elements is described in detail in reports provided by the contractor and summarized in the section that follows.

B. DATA COLLECTION METHODS

1. Updated Control Room Inventory

The control room inventory is a comprehensive computerized listing of the instrumentation, controls, and other equipment contained in the control room. This list was used in subsequent tasks of the DCRDR to determine the adequacy of control room components for supporting operator information and control requirements identified during the task analysis. It is also available to engineering for reference purposes and for use in design of future control room modifications.



NOTES:

1. CRDR PROJECT SCOPE SHOWN BY [shaded pattern]
2. • DENOTES PANELS ADDED BY 1989-90 EFFORT.
3. SOME DETAILS OMITTED FOR CLARITY.

FIGURE II-1. LAYOUT OF PILGRIM STATION CONTROL ROOM

The control room inventory will be kept up to date to reflect component changes made in the control room during and after the DCRDR.

Project personnel conducted a systematic inspection and review of the control room and relevant control room documentation (e.g., instrument lists) to update the existing control room inventory. Emphasis was on two scope elements: hardware changes since 1984 when the inventory was compiled, and the additional panels incorporated in the DCRDR scope in 1989.

The inventory records contain the following information for each component:

- Instrument number/designation number
- Component nomenclature or description
- System number
- Manufacturer
- Component characteristics (e.g., scale ranges)
- Panel number
- Identification of Regulatory Guide 1.97 instrumentation
- Annunciator identification (where applicable)
- Comments

The product of the control room inventory is a comprehensive record of the instrumentation, controls, and other equipment contained in the control room. The control room inventory was used in the verification of availability and suitability of the existing control room instrumentation. Exhibit II-1 is a sample page from the completed inventory.

2. Control Room Survey

A systematic human factors survey of control room design features was started in 1984. The portions of the survey that were completed in 1984 were updated in 1989/90 to include the control room components added to the revised inventory. Both the 1984 and 1989/90 surveys were performed using checklists provided in NUREG-0700, Section 6.

Besides surveys of hardware changes on the previously-surveyed panels, the survey also included:

- The additional panels added to the DCRDR scope in 1989 (see Figure II-1).

- Survey of the Safety Parameter Display System (SPDS) per relevant items in NUREG-0700, Section 6.7 (which had not been available for survey in 1984).

- Survey of the control room HVAC performance, per NUREG-0700, Section 6.1.5.1 and 6.1.5.2.

- Survey of control room noise levels, per NUREG-0700, Section 6.1.5.5

December 1,1990

PAGE: 8

Pilgrim Nuclear Power Station
Control Room Inventory Report

Line No.	Instrument Number	Service Description	System Number	Manuf/Model	Range/Control Position/ Indicator Color	Scale Incr	Control Type	Annun ID	Board No	RG 1.97 Req'd	Comments
0078	42-23146/CS	CONDENSER OUTLET VALVE MO-3883 1-2 WEST	27	GE SBM	CLOSE,BLANK,OPEN & G-R LITES	NA	J3&21	NA	C1	N	WHITE MIMIC
0079	42-231[illegible]/CS	CONDENSER OUTLET VALVE MO-3880 1-3 EAST	27	GE SBM	CLOSE,BLANK,OPEN & G-R LITES	NA	J3&21	NA	C1	N	RED MIMIC
0080	42-23143/CS	CONDENSER OUTLET VALVE MO-3881 1-4 EAST	27	GE SBM	CLOSE,BLANK,OPEN & G-R LITES	NA	J3&21	NA	C1	N	WHITE MIMIC
0081	42-23136/CS	WEST CONDENSER OUTLET CROSSOVER VLV MO-3866	27	GE SBM	CLOSE,BLANK,OPEN & G-R LITES	NA	J3&21	NA	C1	N	RED & WHITE MIMIC
0082	42-23133/CS	EAST CONDENSER OUTLET CROSSOVER VLV MO-3876	27	GE SBM	CLOSE,BLANK,OPEN & G-R LITES	NA	J3&21	NA	C1	N	RED & WHITE MIMIC
0083	42-23134/CS	WEST CONDENSER INLET CROSSOVER VLV MO-3865	27	GE SBM	CLOSE,BLANK,OPEN & G-R LITES	NA	J3&21	NA	C1	N	RED & WHITE MIMIC
0084	42-23131/CS	EAST CONDENSER INLET CROSSOVER VLV MO-3875	27	GE SBM	CLOSE,BLANK,OPEN & G-R LITES	NA	J3&21	NA	C1	N	RED & WHITE MIMIC
0085	SV-3351/CS	CONDENSATE PUMPS MINIMUM FLOW VLV FV-3351	6	GE SBM	CLOSE AUTO & G-R LITES	NA	J2&21	NA	C1	N	
0086	42-23124/CS	CONDENSER INLET VLV MO-3872 1-1 WEST	27	GE SBM	PULL-TO-LOCK,CLOSE,BLAN K,OPEN & G-R-W LITES	NA	J4&31	NA	C1	N	RED MIMIC
0087	42-23126/CS	CONDENSER INLET VLV MO-3873 1-2 WEST	27	GE SBM	PULL-TO-LOCK,CLOSE,BLAN K,OPEN & G-R-W LITES	NA	J4&31	NA	C1	N	WHITE MIMIC
0088	42-23126/CS	CONDENSER INLET VLV MG-3870 1-3 EAST	27	GE SBM	PULL-TO-LOCK,CLOSE,BLAN K,OPEN & G-R-W LITES	NA	J4&31	NA	C1	N	RED MIMIC

EXHIBIT II-1. SAMPLE INVENTORY PAGE

- Panel layout survey and control/display integration survey per NUREG-0700, Sections 6.8 and 6.9.

Human Engineering Observations (HEOs) resulting from these surveys are discussed in later sections of this report.

In the future, we will perform a survey update for each control panel as we complete installation of control panel improvements. As part of the verification step after modifications are installed, the completed panel will be reviewed against NUREG-0700 criteria and checklists will be prepared. (See Section III for description of the enhancements program.) Three panels have received a post-enhancements survey (as of October 1, 1990).

3. Operating Experience Review

A partial Operating Experience Review (OER) was conducted, to determine if there were documented problems in control room operation that could indicate human factors concerns. The review consisted of a review of the last five years of Licensee Event Reports (LERs). Items potentially related to control room human engineering problems were documented as HEOs.

Note that the Program Plan had indicated that the OER would also include interviews with control room operating personnel. Because of resource constraints, that portion of the OER was not performed. NRC (NRR) concurred with this change in scope (Reference 10).

4. System Function and Task Analysis

a) Background -- When the Boston Edison Detailed Control Room Design Review began in early 1984, the symptom-based Emergency Operating Procedures (EOPs) had been drafted but not issued. Also, two additional EOPs based on the Rev. 4 BWR Owner's Group Emergency Procedure Guidelines (EPGs) had not been drafted. We committed to the NRC to perform System Function and Task Analysis (SFTA) on the two additional EOPs when they were issued (see Reference 1). The initial set of EOPs was based upon revision 2 of the EPGs.

   In 1988-1989, the entire set of Pilgrim EOPs was rewritten and reissued, including the two EOPs not included in the 1984 SFTA. The EOPs were upgraded to revision 4 of the EPGs, which are substantially different from the revision 2 guidelines. The changes in the EOPs were extensive. Boston Edison decided to perform a new SFTA on the entire set of EOPs.

   The purpose of the SFTA was to determine the action and information requirements and performance criteria for the tasks that operators are required to accomplish under emergency conditions as defined by the PNPS EOPs and their associated satellite procedures. (Analysis of operator tasks associated with normal, abnormal, and alarm procedures was excluded from this analysis, except where they led the operator into emergency procedures). These requirements and the performance criteria served as the benchmarks for examination of the adequacy of control room equipment and instrumentation during the verification and validation activities.

b) SFTA Methodology Overview -- The SFTA methods and procedures established an objective, top-down approach to accomplish the following objectives:

i) Identification of the PNPS plant-specific systems used for response to emergency conditions.

ii) Detailed development of operator information and control requirements from the function descriptions and emergency tasks.

Throughout the SFTA process, the emphasis was on identifying and analyzing operator action and information requirements for those tasks performed under emergency conditions. The identification of event sequences and operator functions, the performance of function analysis, operator task identification, and task analysis utilized expertise in systems engineering and analysis, human factors analysis, and plant operations. The process was conducted independent of instrumentation and controls utilized in the control room. Human factors experts from General Physics Corp. conducted all phases of the SFTA with participation by BECo operating and engineering personnel where required.

c) Identification of the PNPS Plant-Specific Systems and Subsystems -- The identification of PNPS systems and subsystems required for response to emergencies has essentially been performed as part of the Procedure Generation Package for the PNPS Plant-Specific EOPs.

The PNPS EOPs are based upon the Boiling Water Reactor Owner's Group (BWROG) Emergency Procedure Guidelines (EPGs), which were developed in accordance with the requirements of NUREG-0737, item I.C.1. Revision 4 of the EPGs have been submitted to and approved by the NRC. These generic EPGs have been made plant-specific by the preparation of the PNPS Plant-Specific Technical Guidelines (PSTGs) and appendices of the EOPs. These PSTGs served as the technical foundation for the development of the PNPS EOPs. The development of the PSTGs included the substitution of plant-specific values for setpoints, design limits, etc., in the generic guidelines. The calculation of plant-specific limit curves and values was performed using the appropriate calculational methodology provided by Appendix C of the EPGs. Where the EPGs specify the systems to be used, the appropriate or equivalent PNPS systems were incorporated.

d) Identification of the operating events to be analyzed and their translation into functional requirements -- BECo used the PSTG as the function and system basis for conducting the SFTA. The EOP Procedure Generation Package, particularly the PSTGs and EOPs, define the PNPS systems and system functions. The allocation of functions to associated plant systems, and needed operator and plant equipment actions are all demonstrated in the structure of the EOPs. Since the SFTA requires that all of the emergency actions performed by control room operators be analyzed, the EOPs were selected and used in determining the operators' informational and control needs during the SFTA process. Satellite procedures were also analyzed to the extent that they govern actions to be taken as directed by the EOPs.

e) Detailed development of operator information and control requirements from the function descriptions -- The initial step in the detailed development was to separate the functional requirements from the PSTGs, EOPs, and satellite procedures into specific tasks. This included all entry conditions, procedure steps, cautions and notes. All task identification information, including a description of the task itself, was recorded on the first page of a two page Task Analysis Worksheet (TAW). Then, the analysts determined the behavioral elements necessary to accomplish each task. This information was compiled on "Element Tables" (also included on page 1 of the TAW). The element tables summarize the basis for the step, and data beneficial for determining the action and information requirements for each task. Included in these element tables are:

   - Task initiation information requirements
   - Task feedback information requirements
   - Task decision requirements
   - Task knowledge requirements
   - Task action requirements
   - Consequences of task error/omission

   Exhibit II-2 is an example of a Page 1 TAW that has "task identifier" information and "behavioral elements".

   The next step in the SFTA process was to generate a list of action and information requirements for each task specified above. Confirmatory or alternate indications and controls that might be needed to confirm the performance of operator task steps were also annotated on the data sheet.

   The tasks and behavioral element data on page 1 were analyzed by a team composed of a human factors engineer, a BECo subject matter expert (licensed senior reactor operator) and a subject

EOP / Satellite Procedures
PNPS Task Analysis Worksheet
Page 1

Page 1 December 1,1990

TASK IDENTIFIER				BEHAVIORAL ELEMENTS					
EOP/Sat Step	EPG Number	Description	Sys/Func ID	Knowledge Required	Initiation Required	Decision Required	Action Required	Feedback Required	Consequence of Error
2.2.92-00100	5.0	5.0 PRECAUTIONS AND LIMITATIONS		N/A	ENTRY	N/A	N/A	N/A	N/A
2.2.92-00200	5.1	5.1 PRECAUTIONS	1	N/A	ENTRY	N/A	N/A	N/A	N/A
2.2.92-00300	5.1-1	[1] OPEN THE OUTBOARD MSIVs PRIOR TO OPENING THE INBOARD MSIVs TO ALLOW THE TRAPPED CONDENSATION TO DRAIN - DO NOT ATTEMPT TO OPEN THE MSIVs WITH A PRESSURE DIFFERENTIAL ACROSS THE VALVE GREATER THAN 200 PSID	1	CONDITIONS WHICH INDICATE MSIV STATUS - ABILITY TO OPEN MSIVs - CONDITIONS WHICH INDICATE PRESSURE DIFFERENTIAL OF GREATER THAN 200 PSID - PURPOSE OF LIMIT	ANYTIME DURING PERFORMANCE OF 2.2.92	IS DP GREATER THAN 200 PSID? ARE INBOARD MSIVs OPEN? ARE OUTBOARD MSIVs OPEN?	OPEN INBOARD MSIVs PRIOR TO OUTBOARD MSIVs - EQUALIZE PRESSURE TO WITHIN 200 PSID PRIOR TO OPENING AN MSIV	INDICATION OF MSIV POSITION - INDICATION OF MSIV DP	DISREGARD OF THIS CAUTION COULD RESULT IN EQUIPMENT DAMAGE
2.2.92-00400	5.1-2		1	CONDITIONS WHICH INDICATE AUTOMATIC ISOLATION - ABILITY TO RESET ISOLATIONS - ABILITY TO DETERMINE WHEN TO RESET - ABILITY TO VERIFY PROPER ISOLATION ACTUATION	ANYTIME DURING PERFORMANCE OF 2.2.92	IS AN ISOLATION AUTOMATICALLY INITIATED? DID THE VALVE CLOSE? CAN THE ISOLATION BE RESET? HAVE CONTROL SWITCHES BEEN PLACED IN "CLOSE"?	VERIFY VALVES CONTINUE TO CLOSE EVEN IF CONDITION CLEARS - OPERATE ISOLATION RESET WHEN ABLE - PLACE CONTROL SWITCHES FOR MSIVs IN "CLOSE" PRIOR TO RESET	INDICATION OF STATUS ISOLATION SIGNAL - INDICATION OF VALVE STATUS - INDICATION OF CONTROL SWITCH POSITION	DISREGARD OF THIS PRECUATION COULD RESULT IN AN ISOLATION MALFUNCTION TO GO UNIDENTIFIED, CHALLENGE PROTECTIVE INTERLOCKS, AND CAUSE INADVERTENT RADIOACTIVITY RELEASE
2.2.92-00500	5.1-3	[3] THE TURBINE BYPASS VALVE OPENING JACK WILL TAKE CONTROL AWAY FROM THE INITIAL PRESSURE REGULATOR - THE TURBINE BYPASS VALVE JACK WILL NOT OPEN THE BYPASS VALVES UNTIL THE OPENING OF THE CONTROL VALVES IS LIMITED	1	CONDITIONS WHICH INDICATE BYPASS VALVE JACK IN CONTROL - CONDITIONS WHICH INDICATE CONTROL VALVE OPENING BEING LIMITED	ANYTIME DURING PERFORMANCE OF 2.2.92	IS OPENING OF THE CONTROL VALVES LIMITED?	VERIFY OPENING JACK OPENS BYPASS VALVES ONLY WHEN OPENING OF CONTROL VALVES IS LIMITED	INDICATION OF BYPASS AND CONTROL VALVE POSITION - INDICATION OF CONTROL VALVE DEMAND	DISREGARD OF THIS PRECAUTION COULD CHALLENGE PROTECTIVE INTERLOCKS
2.2.92-00600	5.1-4	[4] IF THE REACTOR PRESSURE IS ALLOWED TO EXCEED 600 PSIG WITH THE REACTOR MODE SWITCH IN SHUTDOWN, REFUEL OR STARTUP POSITION, WITH THE MAIN STEAM ISOLATION VALVES CLOSED A REACTOR SCRAM WILL RESULT	1 45.3 45.1	CONDITIONS WHICH INDICATE REACTOR PRESSURE EXCEEDING 600 PSIG, MODE SWITCH IN SHUTDOWN, REFUEL OR STARTUP AND MSIVs CLOSED - ABILITY TO VERIFY A SCRAM	ANYTIME DURING PERFORMANCE OF 2.2.92	IS RX PRESSURE ABOVE 600 PSIG? IS MODE SWITCH IN STARTUP, SHUTDOWN OR REFUEL? ARE MSIVs CLOSED? DID RX SCRAM?	DO NOT EXCEED 600 PSIG WITH MSIVs CLOSED WHILE MODE SWITCH IS IN STARTUP, SHUTDOWN OR REFUEL	MSIV POSITION MODE SWITCH POSITION - RPS SCRAM VALVE STATUS - CONTROL ROD POSITION	DISREGARD OF THIS PRECAUTION COULD CAUSE A SCRAM, OR CHALLENGE PROTECTIVE INTERLOCKS
2.2.92-00700	5.1-5	[5] HAND-OPERATED VALVES HO-220-61, HO-220-62, HO-220-63, HO-220-64, AND HO-220-65 MUST BE CHECKED TO ASSURE THEY ARE LOCKED OPEN PRIOR TO PLANT STARTUP	1	NOT IN CONTROL ROOM	ANYTIME DURING PERFORMANCE OF 2.2.92	N/A	N/A	N/A	N/A

EXHIBIT II-2. EXAMPLE OF PAGE 1 OF TASK ANALYSIS WORKSHEET matter expert from General Physics (BWR certified) to identify the instrumentation and control requirements for each step. This table-top analysis was done independent of the control room. During this analysis the human factors engineer and the subject matter experts identified, within each procedure (sequence of tasks) and for each EOP step, the required instrumentation component and/or parameter, as well as the relevant characteristics of the information needed.

Informational characteristics for the instrumentation include parameters monitored, dynamic range, setpoints, precision (accuracy) at which the reading must be made (reflected in required scale increments), units, and the need for trending and alarming. Control characteristics include the type (discrete or continuous). If the type of control needed is discrete, then the control characteristics such as detent versus spring-loaded, momentary contact positioning, and position (open-closed, stop-start, on, off, auto) are specified, as well as feedback information associated with control. This data was recorded in the initial columns of page 2 of the TAW (see Exhibit II-3). The procedure record number was also included for cross-reference to page 1.

This information was tabulated and entered into a comprehensive database. This database, along with the control room inventory database, was used as input into the verification of task performance capabilities. This verification assessed the availability and suitability of instruments and equipment used by control room operators. In addition, the results of the SFTA was used to assist in selecting event sequences for analysis during the validation of control room functions.

5. Comparison of Display and Control Requirements to Control Room Inventory

The next phase utilized the products of the previous phases, namely the updated control room inventory and the database of operator information and control requirements. The comparison of requirements to actual control room features involves two steps, referred to as verification and validation.

a. Verification of Task Performance -- The objective of this activity was to ensure the availability and suitability of required control room instrumentation and controls. As recommended by NUREG-0700, this activity was conducted in two parts: verification of availability, and verification of suitability. After completion of both the verification and validation activities, the problems identified were documented as Human Engineering Observations (HEOs).

EOP Procedures
PNPS Task Analysis Worksheet
Page 2

Page: 1 December 1,1990

I & C REQUIREMENTS			BEHAVIORAL ELEMENTS					
EOP/Sec Step	Component/Parameter	Relevant Characteristics	Service Description	Instrument Number	Board No	Avail	Suit	Comments
01-101	RX WATER LEVEL (WIDE RANGE) INDICATION	METER, LINEAR, ANALOG RANGE -150 TO +50 INCHES, 50 MAJ, 10 INT, 2 MIN	1. NARROW RANGE PRESS/ TURB STM FLOW/REACTOR WTR LEVEL 2. REACTOR WATER LEVEL METER 3. REACTOR WATER LEVEL METER 4. REACTOR WTR LEVEL A METER 5. REACTOR WTR LEVEL B	1. XMPR-640-28 2. XLI-263-100A 3. XLI-263-100B 4. XLI-640-29A 5. XLI-640-29B	1. 905 2. 905 3. 905 4. 905 5. 905	Y	N	EOPs REQUEST INDICATION OF -49, -126.3, -157, -169 INCHES (HEO #151)
01-102	RX WATER LEVEL INDICATION	DIGITAL INDICATION FROM PLANT PROCESS COMPUTER/SPDS;RANGE -50 TO +50 IN	1. PROCESS COMPUTER WITH 82 FUNCTION PUSHBUTTONS, NUMERIC KEYBOARD,3 KEYSWITCH & 3 DIGITAL DISPLAYS	1. -	1. C77	Y	Y	
01-103	RX WATER (FUEL ZONE RANGE) INDICATION	METER, CONTINUOUS RECORDER, LINEAR, ANALOG;RANGE -310 TO -110 INCHES;50 MAJ, 10 INT, 2 MIN WITH TIC MARK DENOTING -126.3 IN FOR TAF	1. REACTOR LEVEL FUEL ZONE 2. REACTOR LEVEL FUEL ZONE METER 3. TORUS LEVEL (FUEL ZONE/LONG RANGE RECDR)ZEROS-FZ @ 77.5 & LR @127.5 INCH ATF 4. REACTOR LEVEL FUEL ZONE 5. REACTOR LEVEL FUEL ZONE 6. TORUS LEVEL(FUEL ZONE/LONG RANGE RECDR)	1. LI-263-106A 2. XLI-263-106B 3. LR-1001-604A 4. LI-1001-650A 5. - 6. LR-1001-604B	1. 903 2. 903 3. C170 4. C170 5. C171 6. C171	Y	N	EOPs REQUEST INDICATION OF -49,-126.3, 157,-169 INCHES (HEO #151)
01-104	RX WATER LEVEL/PRESSURE PAM INDICATION	CONTINUOUS 2 PEN RECORDER, LINEAR, ANALOG, WATER LEVEL PEN RANGE -150 TO +50 INCHES;50 MAJ, 10 INT, 2 MIN WITH TIC MARK DENOTING -126.3 IN FOR TAF;PRESSURE PEN, RANGE 0-15 PSIG X 100;2 MAJ, 1 INT, .2 MIN	1. TORUS LEVEL (FUEL ZONE/LONG RANGE RECDR)ZEROS-FZ @ 77.5 & LR @127.5 INCH ATF 2. TORUS LEVEL(FUEL ZONE/LONG RANGE RECDR)	1. LR-1001-604A 2. LR-1001-604B	1. C170 2. C171	Y	N	EOPs REQUEST INDICATION OF -49,-126.3,-157,-169 INCHES (HEO #151)
01-105	RX WATER LEVEL (NARROW RANGE) INDICATION	METER, CONTINUOUS RECORDER, LINEAR, ANALOG;RANGE -50 TO +50 IN, 10 MAJ, 5 INT, 1 MIN	1. REACTOR WATER LEVEL METER 2. REACTOR WATER LEVEL METER	1. XLI-263-100A 2. XLI-263-100B	1. 905 2. 905	Y	N	MINOR INCREMENTS DO NOT MEET NUREG-0700 GUIDELINES (HEO #162).
01-106	ANNUNCIATOR	ILLUMINATED WITH AUDIBLE ALARM-PREDETERMINED SETPOINT REACHED INDICATING ABNORMAL CONDITION/NOT ILLUMINATED-NORMAL	N/A	N/A	N/A	Y	Y	
01-201	ANNUNCIATOR	ILLUMINATED WITH AUDIBLE ALARM-PREDETERMINED SETPOINT REACHED INDICATING ABNORMAL CONDITION/NOT ILLUMINATED-NORMAL	N/A	N/A	N/A	Y	Y	
01-202	RX PRESSURE INDICATION	METER, CONTINUOUS RECORDER, RANGE 0-1200 PSIG, 100 MAJ, 20 INT, 2 MIN	1. REACTOR PRESS A METER 2. REACTOR PRESS B METER 3. REACTOR PRESSURE METER 4. REACTOR PRESSURE METER 5. REACTOR STM FLOW/WIDE RANGE PRESS (RECORDER;WARNING LABEL ATTACH) 6. NARROW RANGE PRESS/ TURB STM FLOW/REACTOR WTR LEVEL	1. XPI-640-25A 2. XPI-640-25B 3. PI-263-49A 4. - 5. XMPR-640-27 6. XMPR-640-28	1. 905 2. 905 3. C170 4. C171 5. 905 6. 905	Y	N	EOPs REQUEST INDICATIONS OF 125, 1085, 181, 246, 376, 767 PSIG (HEO #150)

EXHIBIT II-3. EXAMPLE OF PAGE 2 OF TASK ANALYSIS WORKSHEET

i) Verification of Availability -- The verification of availability was done by comparing the operator information and control requirements identified during the task analysis with the control room inventory. The action and information requirements identified were analyzed to determine the essential characteristics of control room instrumentation and controls that are needed by the operators for acceptable task performance. This comparison was performed on a component level, in order to verify the presence or absence of the required instruments and controls for each task analyzed during the SFTA. For any action or information requirement where an appropriate instrument, control, or other device could not be found in the inventory, an HEO was generated.

ii) Verification of Suitability -- Verification of suitability involves the examination of the human engineering characteristics of instrumentation and controls identified during the verification for availability. For this process, selected guidelines from NUREG-0700 and the criteria derived from the task analysis were used. Such aspects of component design as the adequacy of the display range, usability of displayed values, adequacy of the display range, usability of displayed values, adequacy of control type, adequacy and completeness of component labels, component location, and other characteristics which are unique to specific task sequences were considered. Any deviations from the established criteria were documented as HEOs.

b. Validation of Control Room Functions -- The objective of this activity was to determine if the functions allocated to the control room operating crew during emergencies can be accomplished effectively within the structure of the EOPs and their satellites, and the present design of the control room. Emphasis was placed on determining the adequacy of the control room design for supporting operator task sequences. In addition, the location of the required information and control characteristics was considered, with particular attention paid to the unique characteristics of specific accident sequences.

The EOP validation sequences were used, to ensure that all of the emergency tasks required by the EOPs were examined, to cover all of the systems in the EOPs, and all the controls and displays used in the EOPs.

The validation was conducted by observing operators walking through the EOP validation sequences on the PNPS plant-specific simulator. Two GP human factors engineers and a GP operations expert (BWR SRO certified) made up the observation team. The participants in the validation were briefed concerning the objectives of the validation process, as well as initial plant conditions for the scenario being used.

The control room operators were observed as they performed each sequence. As they performed the sequence, the operators were prompted to describe their actions, and to be aware of and comment on the following:

a) the cues by which they initiate a task
b) the sources and adequacy of information (instruments, procedures, personal knowledge, etc.)
c) the application of information, including any mental conversions required, or uncertainties in the information provided
d) controls selected and expected system response
e) methods for verifying system response and selection of alternative actions if response is not obtained
f) indications that the sequence is proceeding as expected
g) indications that the sequence is complete
h) other comments as appropriate

The observers recorded all relevant operator comments, as well as any observations that relate to the performance of the EOPs or satellite procedures. They also recorded:

1) any difficulties the operators had in responding to the scenario
2) the impact on operator performance of any previously identified HEOs or HEDs
3) any additional discrepancies identified during this task

Each scenario was videotaped for later review (as necessary) during the human factors evaluation of the validation activity. The operating crew was also interviewed and debriefed as a group to verify observations noted and to discuss the adequacy of the control room instrumentation and controls for managing the event. Comments on how the SPDS could be used in supplementing other control room equipment was also requested from the participating Shift Technical Advisor (STA).

The results of the validation observations were analyzed to identify any problems with the control room layout, obstructions to line of sight or operator movement, location of instrumentation and controls, operator workload, or other human engineering concerns. These results helped assess the impact of previously identified HEOs and HEDs on actual operator performance. HEOs identified during the validation process were recorded and assessed in the same manner as the other HEOs.

C. RESULTS - NEW HEDs

1. HEOs

As a result of the 1989-90 CRDR update effort described above, General Physics identified 226 new Human Engineering Observations (HEOs).

Table II-1 shows the number of HEOs identified during each phase of the 1989-90 update effort.

It should be noted that the NUREG-0700 survey was limited to the panels added to the DCRDR scope in 1989 (see Figure II-1) plus panel devices known to have been replaced since the original survey in 1984.

General Physics produced HEO reports for each major data collection task (verification, validation, etc.). These reports are available in BECo files. All new HEOs were compiled and entered into an HEO computer database for ease of tracking and sorting.

2. Initial Screening Results -- New HEDs

Following the completion of the data collection effort, the DCRDR Design Review Team was convened and the screening process was conducted. The initial screening process reviews each HEO and:

- Classifies the HEO according to safety significance (categories A through D). Category A-C HEOs are considered HEDs. Category D HEOs are not considered HEDs and were set aside until they were considered for cumulative and interactive effects, discussed below.

- Places the accepted HEDs in implementation catego ies (1 through 8).

- Identifies a recommended implementation priority.

- Adds comments, notes, questions, or suggested co rective actions as appropriate in each instance.

The Design Review Team also decided which HEDs would be subjected to the detailed screening process.

The Design Review Team (DRT) included the following personnel:

- one or more engineers (including the Principal Investigator) from the Boston Edison Control Systems Division

TABLE II-1. NEW HEOs IDENTIFIED IN 1989-90 CRDR EFFORT

Task	Quantity Identified	HEO #s
SPDS Review	22	1-22
Historical Documentation Review	7	51-57
Verification	65	101-165
Validation*	48	201-248
NUREG-0700 Survey of Additional Panels	84	301-384
Design Review Team Meetings	2	400,401
TOTAL	228	

*Note: Two HEOs from Validation (#230 and #244) relate to SPDS issues.

- one or more engineers from the Boston Edison Systems and Safety Analysis Division

- an experienced nuclear plant operator from Pilgrim Station

- one or more human factors experts from General Physics Corp.

Additional BECo engineering personnel participated in the discussions, as required for particular HEDs.

The DRT screened the HEOs identified by General Physics and listed in Table II-1 plus:

- 51 HEOs previously identified by BECo but not previously screened, most of which were tabulated in Appendix B of Reference 2. These include 5 HEOs from the lighting survey.

- 2 HEOs resulting from the HVAC survey.

- Several additional HEOs identified by either BECo or GP during the review team meetings or during related work.

As part of the DCRDR assessment process, individual HEOs were reconsidered due to cumulative or interactive effects of multiple HEOs (Reference #6). That is, the PNPS HEOs which were classified as non-significant (Category D) when evaluated by themselves were reconsidered as they might cumulatively affect other related HEOs. In doing this, the Category D HEOs were sorted by control room panel and the DRT reviewed these groupings for cumulative effects. For any cumulative effects, the team generated new HEDs that summarized the associated discrepancies.

The results of the DRT's actions following initial screening are shown in Tables II-2, II-3, and II-4.

Table II-2 tabulates the new (and old) HEDs by safety category (A,B,C).

Table II-3 summarizes the Category A (safety-significant) HEDs by implementation category. Each of the Category A HEDs is discussed individually in Section III.

Table II-4 lists the new (and old) HEDs by implementation category. As in the 1984 survey, the largest share of the new HEDs (64 out of 164) will be addressed by surface enhancements (Category 2).

Category 8 is the new implementation category for the "EPIC" plant computer, which incorporates the SPDS function.

Appendix B lists all of the HEDs.

Table II-5 defines all of the assessment (safety) and implementation categories.

TABLE II-2. HEDs By Safety Category

Safety Category	Number of HEDs 1984*	1989-90	Total
A	8	7	15
B	120	84	204
C	25	73	98
Total, HEDs	153	164	317

*As originally defined in Reference 1. Some HEDs were later sub-divided. See Table II-3 of Reference 2.

TABLE II-3. Category A HEDs by Phase and Implementation Category

Implementation Category #	Category Name	Number of Category A HEDs Phase I*	Phase II	Total
1	Annunciator	0	1	1
2	Surface Enhancements	4	0	4
3	Habitability	0	1	1
4	Equipment type	0	3	3
5	Equipment location	3	2	5
6	Potentially resolved	4	0	4
7	Non-engineering resolutions	0	0	0
8	EPIC computer-related	N/A	0	0
	TOTAL	11**	7	18

* Status as of April 1989 Supplementary Summary Report to NRC (Reference 2).

** Originally identified as 8 HEDs; 3 were subdivided in 1987 re-screening.

NOTE: Category A HEDs 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.

Table II-4. Initial Screening Results

Implementation Category #	Category Name	Number of HEDs (1984 Survey)	(1989 Survey)	Total
1	Annunciator	26	3	29
2	Surface Enhancements	69	64	133
3	Habitability	5	7	12
4	Equipment type	5	14	19
5	Equipment location	7	23	30
6	Potentially resolved	45	11	56
7	Non-engineering resolutions	16	29	45
8	EPIC computer-related	N/A	13	13
	TOTAL	173*	164	337

*NOTE: Some Phase I HEDs were split into 2 or more implementation categories; the original number of whole HEDs is 153.

TABLE II-5. Category Definitions

A. Assessment (Safety) Categories

1. **Category A** - Human Engineering Deficiencies (HEDs) associated with documented or high potential errors with safety consequence. This includes HEDs which are known to have previously caused or contributed to an operating error as documented in a Licensee Event Report (LER) or other historical record, or as established by the interview responses of operations personnel, or which have the potential to cause an error of high safety consequences.

2. **Category B** - HEDs associated with safety considerations. This includes HEDs which have been determined by documentation or by potential to be of low safety consequence or to cause an unsafe condition.

3. **Category C** - HEDs associated with availability or reliability considerations. This includes HEDs which have been determined to have potential for causing or contributing to human error that adversely affects the commercial aspect of electrical generating capabilities.

4. **Category D** - Human Engineering Observations (HEOs) that are minor or non-significant or that are not to be acted upon (with justification). This includes HEOs that have been evaluated and determined neither to increase the potential for causing or contributing to a human error nor to have adverse safety consequences.

B. Implementation Categories (for HEDs only)

1. Annunciator-related HEDs.

2. HEDs for correction by surface enhancements (paint/label/tape/meter scale), minor relocations of instruments, or switch improvements (handles, escutcheons, rewiring or replacement).

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.)

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. HEDs that are potentially resolved, pending verification.

7. HEDs with non-engineering (administrative or operations) disposition. (Example: operations procedure changes.)

8. HEDs related to the plant monitoring system computer ("EPIC"), including the Safety Parameter Display System.

3. Detailed Screening

a. Detailed Screening Process -- This process provided a detailed analysis of selected HEDs, principally those in Category 4 (hardware type) and Category 5 (hardware location).

HEDs 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 are selected without the detailed analysis, or the type of HED is not suited to this type of analysis (e.g., no potential impact on plant safety or availability). Nineteen (19) of the new HEDs were subjected to the complete screening analysis. Forty-six (46) of the old HEDs had been reviewed by this process, as reported in Reference 2.

The detailed analysis was performed by the Design Review Team using the approved procedure (Reference 9). To guide the team, the procedure includes forms and tables of HED rating criteria guidelines. Details of the process were provided in the Program Plan, Reference 6.

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) potential for the HED to 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, including the 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:

i) Identify and summarize all relevant information concerning the HED impact on the station operations procedures (normal and emergency) that use the equipment.

ii) Develop quantitative risk impact indices for those HEDs that affect plant transient response or that may contribute to the initiation of an event.

iii) Develop quantitative cost impact indices for those HEDs that affect any of the four cost elements identified earlier.

iv) 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 HEDs according to the benefit of correcting them.

b. Detailed Screening Results -- Table II-6 summarizes the results of the quantitative impact analyses, including the results (previously reported in Reference 2) of the analyses of the "old" HEDs.

TABLE II-6

RESULTS OF QUANTITATIVE IMPACT ANALYSES (UPDATED)

HED No.	CAT	O/N	SUBJECT (See Appendix B for Complete Description)	RELATIVE BENEFIT SCORES RISK	COST
5B195A	4	New	Displays - adequacy - Panel C905	139.70	2.80
4B131	4	Old	Controls - Direction of Movement	110.00	20.50
8A008B	5	Old	Panel layout - C7 not logical	109.00	17.90
5B216	5	New	Display - completeness of information - Panel C7	83.31	0.00
1B163	5	New	Panel layout - lateral spread - Panel C7	35.82	17.89
5B196A	4	New	Displays - adequacy - Panel C905	71.20	0.00
5C090B	4	New	Controls - valve position indication - Panel C903	62.77	0.00
5B188	4	New	Displays - adequacy - Panel C903	62.70	3.00
4B213	5	New	Displays - grouping by importance - Panel C905	57.73	15.04
1B015	5	Old	Control Room layout - accessibility of equipment	0.60	NE
5A016	4	New	Displays - adequacy - Panel C905	57.59	4.50
4B209	4	New	Controls - status indication - Panel C903	39.23	0.00
5B067	5	Old	Displays - completeness of information	28.00	7.50
5B119	4	Old	Displays - readability	27.00	1.50
4C066	5	New	Controls & displays - availability	23.71	7.52
5B175	4	New	Displays - adequacy - Panel C903	11.77	0.00
8B211	5	New	Panel layout - not logical - Panel C904	10.23	0.00
4B148	5	New	Panel layout - functional arrangement - C174/175	9.20	0.00
8A007B	5	Old	Panel layout - CP600 not logical	8.70	1.70
1B005B	5	Old	Console dimensions -display height	7.60	NE
4B191	5	New	Controls - availability	4.68	0.00
8C095	5	New	Panel layout - assigning panel contents - C1	2.66	0.00
5A015	4	New	Displays - alarm needed	1.56	2.00
1A011	4	New	Controls - status indication - Panel C915	0.15	62.30
8B101	5	Old	Panel layout - sequence of use	0.10	0.40
8C096	5	New	Panel layout - assigning panel contents - C1	0.00	1.99
8B214	5	New	Panel layout - not effective - Panel C904	0.00	0.00
4B051B	4	Old	Controls - direction of movement	0.00	0.00
4B060B	4	Old	Controls - unused equipment	NE	0.10
4B115	4	Old	Controls - adequacy	NE	NE
8B094B	5	Old	Panel layout - clusters of components	See 1B005B	

Notes:
"CAT" means implementation category (defined in text).
Items are listed in order of "risk" score, except when related items are grouped.
"Old" vs. "new" in O/N column refers to old ('84) or new ('90) HED set and corresponding set of impact evaluations.
"NE" means HED was not subjected to NEDWI 344 quantitative analysis.
For definitions of "risk" and "cost," see text or Reference 6.
Scores are on an arbitrary scale with no absolue meaning.
Some analyses apply to other HEDs not listed here. E.g., analysis of HED 1B163 is considered to apply to 1A012 and others involving panel C7 layout.
This is an update of Table II-3 in Reference 2.
Category 1 HEDs are omitted from this table (four were analyzed - see Reference 2).

SECTION III

CORRECTIVE ACTIONS

A. INTRODUCTION

This Section describes the planned corrective actions for the identified Human Engineering Discrepancies (HEDs). Most corrective actions are physical improvements, but others include procedure or process changes and training.

Corrective actions fall into three broad groupings: (1) those already completed; (2) those previously committed (in Reference 2) for completion, some of which are completed and some not; and (3) those identified in this report for completion in the future.

In all cases, this report either identifies the planned corrective action or explains why no action will be taken (in the case of safety-significant HEDs). In the case of most of the actions newly identified in this report, conceptual designs have been established, and detailed design will proceed on the schedules shown in Section IV.

In some instances, detailed design may reveal that the selected conceptual design should be changed, or that the corrective action is impractical, undesirable, or unnecessary. Boston Edison will inform the NRC if major changes occur in our planned actions, but will not attempt to update this report for changes in plans regarding individual HEDs or other minor scope evolution.

To a large extent, HEDs are being addressed in groups according to the "screening" categories previously described in Section II. Therefore the following text is organized according to the screening categories, following a discussion of Category A (safety-significant) HEDs from all categories.

Table III-1 outlines the implementation status of the HEDs by category.

Section IV presents the schedules for the implementation programs.

Note that this Section refers to "old" and "new" HEDs. The new HEDs are those identified by the DCRDR update effort conducted in 1989-90 and described in Section II, above. This Section will emphasize the discussion of new HEDs and all HEDs for which corrective actions were not identified previously (in Reference 2).

B. CATEGORY A HEDs

Category A HEDs 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. Table III-2 provides a cross-reference to the implementation categories for all the Category A HEDs, including both the old (1984) and new set.

HED CATEGORY & DESCRIPTION	COMPLETED OR NO ACTION NEEDED	IMPLEMENTATION UNDERWAY	CONCEPT SELECTED; DESIGN UNDERWAY	CONCEPT SELECTED; DESIGN IN 1991-92 FOR IMPLEMENTATION IN RFO9
1 - Annunciator				X
2 - Panel Enhancements		X		
3 - Environmental				
HVAC	X			
Noise	X			
Lighting		X		
4 - Panel Equipment Type		X (Some)	X (Some)	X (Some)
5 - Panel Equipment Location			X (Some)	X (Some)
6 - Potentially Resolved	X			
7 - Non-Engineering Resolutions	X (Some)		X (Some)	
8 - EPIC/SPDS	X			

Note: Generalized data for overview purposes. See text for details on all categories. Also see Section '') for schedule information.

TABLE III-1 GENERALIZED IMPLEMENTATION STATUS, BY CATEGORY

TABLE III-2

CATEGORY A (SAFETY-SIGNIFICANT) HEDs

HED NO.	TITLE (Note 1)	IMPLEMENTATION CATEGORY (Note 2)
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	6
8A006	Panels need operator enhancement aids	2
*8A007	Panel CP600 not logically arranged	6
8A008	Panel C7 not logically arranged	2,5
3A014	Alarm horns too loud/not distinct	1
1A017	Need emergency lighting in watch engineer's office	3
1A011	RPS circuit breaker position unclear	4
*5A015	No alarm for drywell bulk temperature	4
*5A016	Inconsistent reactor water level indications	4
1A012	RBIS switch positions confusing	5
1A013	Controls too low on panel C7	5

Notes

1) See Appendix B for more complete description of HED.

2) Implementation categories are defined in Section II.

* HED for which no corrective action is planned, or whose corrective action will not completely resolve HED; see text for discussion.

The status of each of the Category A HEDs is as follows.

1. <u>HED #4A003</u>

   This HED related to the reactor mode switch, which had worn and no longer had positive detents. 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 has been verified and closed out.

2. <u>HED #5A004</u>

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

   Of the total of eleven recorders on panels C170 and C171[3] 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). Additional problems were 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 has been verified and closed out.

3. <u>HED 5A005</u>

   This HED cites the differing zeros on the reactor water level indicators. As part of the Analog Trip System instrumentation modification, all read-out instruments in the control room associated with Reactor Water Level 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 has been verified and closed out.

4. <u>HED 5A009</u>

   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. Four instruments are on panels C170/C171, one instrument is on C903, and one instrument is on C7.

---

[3] See Figure II-1 for Panel Locations.

An operator aid plaque was placed at panels C170/171, 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.

5. <u>HED 5A010</u>

This HED was identified during the 1984 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.

The EOPs have been revised to use EOP bulk (average) temperature rather than at two separate elevations. (There is a new HED relating to the bulk temperature; see item #12 below.)

This HED requires no further action and has been transferred to Category 6.

Note that the original HED may have been in error, or was misinterpreted. The relevant temperatures are available at a multi-point recorder on panel C7 in the control room. The recorder was not clearly marked for those temperatures, however. The recorder labelling will be improved through the surface enhancements program, and its replacement will be considered as part of the response to HED #5A015.

6. <u>HED 8A006</u>

HED 8A006 involves the lack of operator enhancement aids on four panels: CP600, C7, C170 and C171. Panel CP600 has since received i"s enhancements. All panels are being enhanced as described in Section III.D.

7. <u>HED 8A007</u>

This HED deals with the arrangement of displays and controls on panel CP600 (augmented off-gas panel). After completion of the panel enhancements, including mimics and demarcations, both operator interviews and human factors review confirmed that no further action is required. This HED was therefore moved to Category 6.

8. <u>HEDs 8A008 and 1A013</u>

These HEDs both refer to inadequate layout of panel C7. This panel is being redesigned and will be rebuilt or replaced. In the interim, enhancements will improved the panel's clarity.

9. HED 3A014

The 1989 sound survey found that some of the alarm annunciator horns were too loud, and others were not loud enough; and that the directionality of some horns was poor. Resolution of this HED will be included in the annunciator replacement project to be discussed in Section III.C.

10. HED 1A017

This HED identified the lack of emergency lighting in the Watch Engineer's office. This will be corrected by the control room lighting improvements, previously identified and planned for 1991.

11. HED 1A011

This HED concerns a circuit breaker in the reactor protective system whose positions are difficult to identify with certainty. To avoid confusion, a modification will be implemented to better identify the status of the breakers.

12. HED 5A015

In the validation activity, it was found that there is no alarm for the EOP entry condition of excessive drywell bulk temperature. The EPIC computer monitors drywell temperatures and provides an indication of bulk temperature, however. An existing system of temperature monitors may be modified to calculate the bulk temperature and alarm at the EOP entry condition, as part of the overall redesign of panel C7 (discussed in Section III.G). Otherwise, no corrective action is considered necessary for this HED.

13. HED 5A016

Inconsistent reactor water level indications can result from various instruments, depending upon plant conditions. The planned action is to replace four of the meters with digital meters with greater precision.

While the digital meters will address concerns of readability and precision, they will not resolve the inconsistencies among indicators. Such inconsistencies are inherent in the reactor water level system, because of the effects of varying coolant temperature and pressure on indicated water level. Some instruments are calibrated for normal operating conditions and are used during normal power operation. Others are calibrated for startup or shutdown conditions when water temperatures and pressures are lower.

The reasons for these differences and proper actions are addressed in training. The Operations Department has also addressed this concern by posting a "Standing Order" that provides guidance to operators regarding which instruments to use for each plant condition.

This is a generic BWR design factor, not an item specific to Pilgrim.

14. HED #1A012

The RBIS channel A control switch, mounted low on panel C7, was moved to the "test" position instead of the "Test logic" position, resulting in a Reactor Building Isolation and a standby gas treatment system actuation. The intermediate solution is to improve the switch labeling and replace the switch escutcheon, to improve visibility. (In addition, improved lighting in this area will reduce the risk of error.) The final solution will be to relocate this switch to a higher, more visible position as part of the effort to redesign the entire panel (see item #8, above).

In summary, corrective actions are planned for the Category A (safety-significant) HEDs as described above. No action will be taken on HEDs 5A009 or 5A015 because the conditions are considered acceptable as is. No action will be taken on HED 5A010 because the EOPs have been changed and no action is needed. No further action will be taken on 8A007 because completed enhancements work has obviated the need for further work. Partial action will be taken on 5A016; complete resolution is not possible because of generic BWR design characteristics.

C. CATEGORY 1 -- ANNUNCIATOR-RELATED HEDs

Category 1 HEDs are annunciator-related HEDs that have been identified for resolution or partial resolution within the Annunciator Design project. Twenty-six annunciator-related HEDs were identified in the DCRDR project work of 1984. Three additional annunciator-related HEDs were identified in the DCRDR update conducted in 1990. These 29 HEDs are summarized in Table III-3. Only one of these HEDs is a Category A HED.

BECo committed (in Reference 2) to conduct an annunciator conceptual design study. This study has produced recommendations for resolution or partial resolution of the Category 1 HEDs. These recommendations have resulted in an annunciator project that will replace the current annunciator system. The project is scheduled for installation to begin during RFO #9. Based upon the conceptual design study, we expect that the new system will include the following key features (detailed design will finalize these features):

- New annunciator panels that will provide larger annunciator windows that will enhance readability with improved engraving.
- New lightboxes that will increase the number of windows by 25%, accommodating the need for increased alarm capacity.
- A distinct audible signal for ringback that will allow for cleared alarms having a different audible tone from incoming alarms.
- A silence feature that will allow for silencing the audible signal while allowing the annunciator window to continue flashing.

(Text continues on page III-11)

TABLE III-3

CATEGORY 1--ANNUNCIATOR-RELATED HEDs

HED Number	Summary Description
1B005	The lamp cabinets are mounted too high and therefore cause reading difficulties.
3B023	The lamp cabinets need to accommodate new alarms to provide information that is currently obtained by an auxiliary operator in response to a general trouble alarm.
3B024	The lamp cabinets need to accommodate new alarms created by splitting multi-parameter alarms currently displayed on common windows.
3B025	First-out alarm sequencing needs to be provided for the reactor system and turbine-generator system alarms.
3B027	Cleared alarms should have a distinctly different audible signal (ringback).
3B037	Alarm windows should address specific conditions, not multiple parameters, and alarms which refer the operator to another panel located outside the primary operating area should be minimized.
3B038	Window tiles should be of sufficient size to accommodate letter heights that are easily viewed from the annunciator response switch.
5B066	Graphic recorders should be relocated to primary operating area. (This HED is included because it affects the number of annunciator windows.)
ESR 88-824*	The annunciator system should provide the ability to silence the horn before acknowledging the alarm.

(Table Continues on Next Page)

*Requests from Plant Department to be included in the new design of the annunciator system.

TABLE III-3 (CONTINUED)

3B026	The annunciator windows should be prioritized so that the operators can differentiate the most important alarms from the least important alarms.
3B028	Some annunciator windows should be relocated to above the related controls or displays required for the corrective action.
3B029	Individual annunciator panels need to be labeled.
3B030	The existing annunciator lamp cabinets need to be repaired so that they no longer have the potential to shock personnel.
3B031	The contrast between annunciator windows should be high enough so that the operators can differentiate among alarming, steady on, and non-illuminated windows.
3B032	Annunciator windows should all be non-illuminated under normal operating conditions ("dark board" concept).
3B033	Vertical and horizontal axes of the annunciator panels should be labeled for unique identification of individual annunciator windows.
3B034	Two light cabinets (C905 Left and Right) exceed the recommended matrix density of 50 windows (each has 63).
3B035	Annunciator windows should be logically grouped to facilitate pattern recognition which can help in diagnosing and mitigating problems
3B036 & 3C042**	Annunciator window engravings should be consistent and unambiguous.
3B039	Annunciator window engravings should be simple, consistent and only upper-case.

(Table Continues on Next Page)

**HEDs identified in 1989-90 DCRDR work.

TABLE III-3 (CONTINUED)

3B040	Annunciator window lettering should be black characters and engraved on a light background.
3B043	The annunciator control stations should all have the same arrangement and relative location, and should be coded by color, shape or demarcation.
3B044	Unused engraved annunciator windows should be replaced with blank windows.
3B045	The audible annunciator alarm volumes need to be adjusted.
3B047	Provide an audible annunciator alarm at each workstation so that the operators can identify the system or workstation where tha alarm originated.
2C010	The Post Accident Monitoring Panel audible alarm and audible fire alarm need to be adjusted or replaced so that they no longer cause discomfort to the operators.
3C012	Annunciator windows with multiple alarm inputs need a reflash capability.
ESR 87-465*	Annunciator power supply failure problems need to be resolved.
ESR 88-550*	A reflash feature or separate windows should be added for the diesel generator starting circuit alarm.
ESR 89-587*	A control room annunciator dark board concept should be adopted.
3A014**	Annunciator horns should vary in sound or volume to increase horn discrimination.
6B180**	Instrument Bus Power Failure Annunciator alarms should be added in the control room.

*Requests from Plant Department to be included in the new design of the annunciator system.

*HEDs identified in 1989-90 DCRDR work.

- Improved grouping of annunciator windows so that the windows are co-located with associated controls and displays.

- Annunciator window prioritization through hierarchical positioning.

- A "dark board" concept which means windows will not be illuminated under normal operating conditions.

- New engraved windows that will allow for consistent presentation of information, nomenclature, abbreviations and engraving standards.

- A "reflash" capability which will allow two or more abnormal process conditions to initiate or re-initiate the alarm state of one alarm point at a time.

- The capability to separate multiple input windows where necessary.

- A reduction in annunciator lamp shock hazard and power supply failure.

- Additional annunciator control stations allowing for the closer proximity of the windows to the separate control stations.

D. CATEGORY 2 -- CONTROL PANEL ENHANCEMENT HEDs

The Category 2 HEDs represent the bulk of the HEDs for which corrective actions have been identified. These HEDs will be resolved or partially resolved in several Control Panel Enhancement projects. These projects include the following:

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

Sixty-nine (69) Category 2 HEDs were identified in the DCRDR project work of 1984. Sixty-four (64) additional Category 2 HEDs were identified in the DCRDR update conducted in 1990. Each of the Enhancement projects and the status of the Enhancement projects described in the Supplementary Summary Report (Reference 2) are discussed below:

1. Control room standards development

Control room standards have been drafted and used for the control panel enhancements program. These human factors engineering standards will be finalized and used as guidelines for future related control panel design changes.

Standards drafted to date and in trial use are:

a). Control Panel Labels and Nameplates
b). Control Panel Demarcation
c). Instrument Scales
d). Abbreviations & Acronyms (PNPS Procedure 1.3.4-2)
e). Control Panel Mimics

We will also prepare a standard for control panel switch applications, as part of the effort to resolve various switch-related HEDs. We will consider issuance of additional standards as work proceeds either to document the work or to resolve design issues that may arise. Potential topics for standards include:

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

Work on the control room standards is currently ongoing. Revisions to current draft standards have been required as a result of necessary changes that were identified during the implementation of the control panel demarcation. For example, it became necessary for BECo to reconsider the colors used for the control panel demarcation as a result of operator comments and the control room lighting.

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). Labels, Mimics and Demarcation - The 30 original HEDs assigned to labels, nameplates, mimics and demarcation are as follows. (Note - these HEDs were identified in the 1984 DCRDR efforts.)

HED No.	TITLE
8A006	Panel layout - enhancements
8A007A	Panel CP-600 not logically arranged
8A008A	Panel C-7 not logically arranged
4B056	Controls - legend pushbuttons/displays
4B126	Labels - Completeness of information
5B066B	Displays - missing labels
6B072	Need for labels
6B073	Hierarchical label scheme
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

(list continues on next page)

Labels, Mimics, Demarcations HEDs, Continued

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	Panel layout - clusters of components
8B095	Demarcation - groups of components
8B099	Demarcation - spacing/separation
8B100	Demarcation - emergency controls
1C005	Labels - shadowing

Twenty-three (23) additional HEDs were identified in the 1990 DCRDR efforts. These HEDs, also assigned to the labels, nameplates, mimics and demarcation project, are as follows.

HED No.	TITLE
6B150	Hierarchical label scheme - Panel C174, C175
6B151	Label placement - Panel C174, C175
6B152	Label readability - Panel C174, C175
6B153	Label content/consistency - Panel C174, C175
6B154	Label content - Panel C174
6B155	Label colors - Panel C174, C175
6B156	Label colors - Panel C174, C175
8B174	Demarcation - emergency indicators
6B176	Label content - Panel C7
6B177	Mimic improvements - Panel C7
6B205	Location aids - demarcation - Panel C7
8B215	Panel layout - demarcation - Panel C904
6C030	Label readability - Panel C220, C221
8C031A	Strings of similar components - Panel C220, C221
9C032	Associated controls & displays - Panel C220, C221
6C038	Label placement - Panel C174, C175
6C040	Label readability - Panel C114, C115
6C043	Label readability - Panel C921
6C044	Label placement - Panel C921
4C068	Demarcation - Emergency controls - Panel C7
6C073	Labels - content - Panel C904
5C090A	Need for labels - Panel C903
6C093	Label content - Panel C1

These HEDs are being addressed by an integrated design of panel enhancements, incorporating new labels, area-type demarcations, and improved or additional mimics. Designs are based upon the control room standards for labels, demarcation, scales, abbreviations and acronyms and mimics (as described above). The enhancement design for each panel will be evaluated in part by installation of the design in the simulator.Once the enhancements are applied to a simulator panel, operating crews are asked to review and comment on the improvements. The 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. Three panels in the main control room (CP600, C1 and C2) and five panels in the simulator had received enhancements by mid-November, 1990.

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 enhancement project are as follows.

i.) Labels

A label standard has been drafted and a complete new set of labels has been designed for the control room (original defined scope). 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. Additional small designators (made from label stock) will be used to identify those instruments associated with Regulatory Guide 1.97 and to identify certain isolation valves. 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 aqua with black characters; the warning labels are yellow with black characters. All characters are engraved to present the most visible appearance. 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 components. As many as six shades of color will be used. A seventh 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.

Design of the PNPS demarcation is currently being re-evaluated. We are re-evaluating the colors that were originally identified as background/base colors because these colors are not distinctive enough under the existing control room lighting. We are considering the following alternatives for demarcation.

- Change demarcation colors to beige tones and implement demarcation after the control panels are painted an almond beige. (The control panels are currently green.) Repainting is being planned for the 1991 refueling outage (RFO #8).

- Eliminate one or two levels of demarcation which will demarcate the panels at the system levels only.

iii.)<u>Mimics</u>

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 material.

b). <u>Instrument Scales</u> - HEDs involving instrument scales are as follows (9 HEDs). (Note - these HEDs were identified in the 1984 DCRDR efforts.)

HED No.	TITLE
5B061	Usability of displayed values - conversion
5B062	Visual displays - contrast
5B063	Visual displays - parameter scales

(list continues on next page)

Instrument Scales HEDs, Continued

5B064	Visual displays - unit graduations
5B111	Visual displays - zone markings
5C016A	Visual displays - scale selection
5C018A	Visual displays - quality of information displayed
5C022	Visual displays - scale graduations

Eighteen (18) additional instrument scale HEDs were identified in the 1990 DCRDR efforts. These HEDs are as follows.

HED No.	TITLE
5B160	Recorder scales - scale graduations - Panel C903
5B161	Meter scales - scale graduations - Panel C903
5B162	Recorder scales - scale graduations - Panel C905
5B167	Meter scales - scale graduations - Panel C170, C171
5B168	Recorder scales - scale graduations - Panel C170, C171
5B178	Recorder scale labels - Panel C171
5B192	Meter scales - zone coding - Panel C903
5B194	Meter scales - zone coding - Panel C910
5B208	Meter scales - scale graduations - Panel C903
5C048	Recorder scales - scale graduations - Panel C904
5C049	Recorder scales - scale graduations - Panel C1
1C060	Recorder scales - zone coding - Panel C1
5C061	Recorder scales - scale graduations - Panel C2
5C065	Recorder scales - scale graduations - Panel CP600
5C070	Recorder scale - scale graduations - Panel C2
5C076	Meter scales - zone coding - Panel C3
5C078	Recorder scale - scale graduations - Panel C2
5C081	Meter scales - zone coding - Panel C1.

A plant design change (PDC) will be issued to replace all instrument scales with human engineering discrepancies that can be resolved by replacement of the scale alone. Approximately 70 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

Ten (10) HEDs identified in the 1984 DCRDR efforts 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 is in progress. If design work shows that any of the corrective actions is 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 HEDs are as follows:

HED No.	TITLE
4B051A	Controls - violations of population stereotype
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

HED #4B057 is listed in this group but will be reconsidered. The HED cites the lack of barriers between the pushbuttons in the control rod selection array on the benchboard section of Panel C905. Further review indicates that installation of a barrier would probably require re-spacing the switches, which would be a major modification. No problems were observed with use of this array during the validation activity. Furthermore, discussion with the Operations Section indicates that current operating practice is for a second operator to verify each rod selection step, minimizing the risk of error. Therefore there seems to be no need for a major revision of this panel layout. HED 4B057 will be referred to the DRT for reconsideration of the appropriate corrective action.

Three (3) additional HEDs identified in the 1990 efforts have been designated for minor relocations. The HEDs are as follows:

HED No.	TITLE
1B159	Recorders too high - Panel C902
8B185	Functional grouping - Panel C171
8B204	Functional grouping - Panel C1

Design work for the rearrangement of recorders identified in HED 1B159 and the rearrangement of components identified in HED 8B185 has begun. Refer to Section IV for discussion on the implementation schedules.

The evaluation of HED 8B204 assessed the relocation of a compartment door open indicator light to the vertical section of the panel. The indicator light is currently located on the bench board. It was determined that this light is unnecessary. Therefore the indicator light will remain in its current location for now, and it will be considered for abandonment and removal.

4. Removal of Abandoned Equipment

Certain panel devices no longer needed are being removed, to eliminate visual clutter and to provide free space. The three (3) HEDs in this group, which were identified in the 1984 DCRDR efforts, are as follows:

HED No.	TITLE
4B060A	Equipment not connected or used
5B071	Equipment not connected or used
5B124	Equipment not connected or used

One additional HED was identified in the 1990 DCRDR efforts.

HED No.	TITLE
4C091	Unnecessary equipment - Panel C905

Items cited in the HEDs, plus other known to be abandoned, will be removed from the panels during the enhancements program. (Three of four panels have been completed as of November 1990.)

5. Switch Enhancements

Switch enhancements HEDs are those related to switch applications but that do not require replacement or rewiring of switches. Seven (7) such HEDs were identified in the 1984 DCRDR efforts.

HED No.	TITLE
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

Twelve (12) additional HEDs were identified in the 1990 DCRDR effort that require switch enhancements. These HEDs are as follows:

HED No.	TITLE
6B189	Controls - position indications - Panel C905
6B197	Escutcheons not legible - Panel C3
4B206	Controls - covers or guards - Panel C903, C904
6C072	Escutcheons - position indications - Panel C10
6C074	Controls - position indications - Panel C1
6C075	Escutcheons - not legible - Panel C3
6C077	Escutcheons - position indications - Panel C3
6C079	Controls - position indications - Panel C2
6C082	Control - position indication - Panel C904
6C083	Control - position indication - Panel C1
6C085	Escutcheons - position indications - Panel C3
4C089	Control - position indication - Panel C1

These switch enhancement HEDs will be resolved by: (1) handle shape/color coding; (2) escutcheon engraving; (3) engraving of switch positions not previously identified (e.g., NORMAL, AUTO, etc.); (4) improved means to prevent inadvertent actuation. Approximately 300 switches will be affected. Included in the resolution of this group of HEDs is preparation of a standard for application of switches and associated devices in the PNPS control room.

Refer to Section IV for implementation schedules.

6. <u>Switch Modifications</u>

Three (3) HEDs related to more complex problems, which require replacement and/or re-wiring of switches, were identified in the 1984 work and are as follows:

HED No.	TITLE
4B051B	Controls - direction of movement
4B115A	Controls - adequacy
4B131	Controls - direction of movement

Three (3) additional HEDs were identified in the 1990 DCRDR efforts.

HED No.	TITLE
4B149	Controls - direction of movement - Panels C174 & C175
4C037	Key-operated switches - key orientation conventions - Panels C174, C175
4C046	Key-operated switches - key orientation convention - Panel C903.

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 mentioned earlier will be used as basis for purchases of new switches.

The evaluation of HEDs 4C037 and 4C046 assessed the modifications of key-operated switches in order to follow the "teeth up" conventions for key insertion. It was determined that the switches would have to be replaced and a modification of the current switches was not possible. Replacement of the key-operated switches was determined to be unnecessary. The switch specification will be modified to establish a PNPS convention for all key-operated switches, for future switch installations or replacements.

HED # 6.4.024, previously included in this group (now defined as HED 4B217), has been determined not to require action.

7. Electrical Systems Panel Enhancements

The six (6) Electrical Systems Panel (C3) HEDs, identified in 1984, are as follows:

HED No.	TITLE
4B050	Controls - covers or guards
4B053	Controls - mirror imaging
5B062	Visual displays - contrast of scales
5B069	Visual displays - consistency
6B086	Mimics - color discrimination
6B089	Visual displays - 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.

8. Communication Improvements

Two HEDs identified in the 1990 DCRDR efforts are designated as communication improvements.

HED No.	TITLE
2B179	Communication link needed between Supervisors' Station and Panel C7
2C071	Page phone controls - inconvenient locations

We will address the need for a direct communication link by installation of a Gai-Tronics paging/intercom station at or near Panel C7. Replacing the control room page phones with a model that has controls located on the handsets is also planned.

Refer to Section IV for implementation schedules.

E. CATEGORY 3--HABITABILITY-RELATED HEDs

Category 3 HEDs are those related to ambient lighting, sound (noise), heating/ventilation/air conditioning, and architectural design. One Category A HED is in this group, related to lighting.

1. Lighting

Two HEDs related to lighting were identified in the 1984 survey as follows:

HED No.	TITLE
1B012	Illumination - levels and uniformity
1B013	Illumination - glare and reflectance

The 1988 lighting survey, reported in the April 1989 Supplementary Summary Report (Reference 2), identified five HEOs. In the 1990 Design Review Team meetings, the HEOs were designated as six new HEDs including one Category A (safety-significant) HED. These HEDs are as follows:

HED No.	TITLE
1A017	Emergency lighting needed in Watch Engineer's Office
1B221	Insufficient illumination level, vertical panels
1B222	Variations in area light levels
1B223	Insufficient emergency illumination levels
1C105	Variations in lighting levels
1C106	Lighting levels -- shadowing

The control room lighting will be modified to resolve these HEDs. 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.

2. Control Room Noise

HED 1B014, identified in the 1984 DCRDR effort, is related to control room noise. One major noise source is the existing (old) computer system peripherals. No action was 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.

A new noise survey was taken in 1989 as part of the DCRDR effort. No additional noise-related HEDs were identified.

3. Heating/Ventilation/Air Conditioning

Previously-reported HEDs relating to heating, ventilation and air conditioning (HVAC) are as follows:

HED No.	TITLE
1B011	HVAC - insufficient fresh air quantity
0B123	HVAC - static electricity from low humidity

HED 1B011 has been determined to be resolved by maintenance performed on the HVAC in 1990.

HED 0B123 relates to the effects of static electricity (during dry winter weather) on instruments. There have been no reports of this problem recurring since the control room carpet was replaced with a lower-static carpet in 1987. The HED is considered resolved.

In 1990, an effort was undertaken to improve operation of the control room HVAC. Several maintenance tasks were performed and one modification was installed, the effects of which were to substantially improve air flow and air conditioning performance. Following that, a new survey was performed of the air temperatures, humidity, and air flows, in accordance with Section 6.1.5 of NUREG-0700. No HEDs were identified from that survey.

4. Architectural Item

In the 1989-90 DCRDR effort, HED 1B147 was identified, which relates to a control panel access door that represents a potential personnel hazard. The Design Review Team suggested that the door be removed. Recently, however, the Plant Department has raised objections to removal of the door. Nuclear Engineering and Operations will investigate the alternatives and determine what action to take.

F. CATEGORY 4 -- HEDs RELATED TO HARDWARE TYPE

Category 4 HEDs are HEDs associated with a less-than desirable choice of equipment type or manufacturer based on human factors concerns. These HEDs will be resolved or partially resolved in several hardware-related projects.

The five (5) HEDs identified in the 1984 DCRDR effort have been resolved or are in the process of being resolved. These HEDs are as follows.

HED No.	TITLE
4B051B	Controls - direction of movement
4B060B	Controls - unused equipment
4B115A	Controls - adequacy
4B131	Controls - direction of movement
5B119	Display - readability

As discussed in Section III.D above, HED # 4B115A, 4B051B and 4B131 are being resolved or have been resolved with switch changes under the panel enhancements program. HED # 4B060B is complete. Two components identified in the HEDs were determined to be active and will not be removed.

Twelve (12) additional HEDs were identified in the 1990 DCRDR efforts. These HEDs are as follows.

HED No.	TITLE
1A011	Controls - status indication - Panel C915
5A015	Displays - alarm needed
5A016	Displays - adequacy - Panel C905
5B175	Displays - adequacy - Panel C903
5B188	Displays - adequacy - Panel C903
5B195A	Displays - adequacy - Panel C905
5B196A	Displays - adequacy - Panel C905
5B202	Displays - adequacy - Panel C905
4B209	Controls - status indication - Panel C903
4B210	Controls - status indication - Panel C904
5C090B	Controls - valve position indication - Panel C903
3C097	Displays - rewire alarms - Panel C904
0C099	Controls & displays - adequacy - Panels C220, C221

The Category A HEDs (1A011, 5A015, 5A016) are discussed in Section III.B above. The Category 4 HEDs will be resolved or partially resolved within several hardware-related projects. These projects include the following:

- Replacing conventional analog meters with combined analog/digital displays to allow better resolution of displayed parameters.
- A redesign of Panel C7.
- An improved indication of the status of the RPS power bus breakers.
- Improvements in valve position indications.
- Providing a drywell bulk temperature indication.
- Improvements in the conductivity alarms for demineralizer outlet conductivity.

The projects outlined above are in various stages of design. Please refer to Section IV for implementation schedules. Also, refer to Appendix D for a preliminary list of all category 4 and 5 implementation packages.

G. CATEGORY 5--HEDs RELATED TO EQUIPMENT LOCATION

Category 5 HEDs are 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. These HEDs will be resolved or partially resolved in several equipment relocation projects.

Eight HEDs that required the relocation or rearrangement of multiple devices were identified in the 1984 DCRDR efforts. These HEDs are as follows.

HED No.	TITLE
5A010	Drywell temperature - no indication by height
1B005B	Console dimensions - display height
1B015	Control room layout - accessibility of equipment
5B067	Control room layout - accessibility of equipment
8A007B	Panel layout - CP600 not logical
8A008B	Panel layout - C7 not lcgical
8B094B	Panel layout - clusters of components
8B101	Panel layout - sequence of use

The status of the Category A HEDs (8A007B, 8A008B and 5A010) is discussed in Section III.A of this report. Design work for the switch relocations identified in HED 5B067 and the design work to install scram valve position indication and MSIV logic indications (HED 1B015 and 4B213) has begun. Refer to Section IV of this report for the implementation schedules.

The evaluation of HED 8B094B assessed the relocation of a matrix of indicator lights on Panel C904. Relocation of these indicators was determined to be infeasible. The indicators can benefit from demarcation and have been incorporated into the labeling and demarcation project for Panel C904 (described earlier). The evaluation of HED 1B005 assessed the relocation of annunciators and indicator lights that were located more than 80 inches above the floor. The height of the annunciators is being addressed in the annunciator project with the proposed improved annunciator tiles that are easier to read. Relocation of the indicator lights was determined to be infeasible. These indicator lights, which include the indicator lights on Panel C904, will benefit from improved labeling/demarcation and have been incorporated into the labeling and demarcation projects for each panel.

HED 8B101 addresses the sequence of use for RHR controls that are located on Panel C903 and Panel C1. The validation conducted in 1990 determined that, even with minimum shift complement, the sequence of operation for the RHR controls was not a problem. Therefore, no further action is required for this HED. It should be noted that the RHR controls will receive improved labels and demarcation within the labeling and demarcation projects for Panels C903 and C1.

Twenty-three (23) additional Category 5 HEDs were identified in the 1990 DCRDR efforts. The HEDs are as follows.

HED No.	TITLE
1A012	Control - incorrect operation - Panel C7
1A013	Controls - too low on Panel C7

(list continues on next page)

Additional Category 5 HEDs, Continued

4B148	Panel layout - functional arrangement - Panel C174, C175
8B157	Panel layout - not logical - Panel C174, C175
9B158	Panel layout - control/display association - Panel C174, C175
1B163	Panel layout - lateral spread - Panel C7
1B164	Controls - too low and too high on Panel C7
1B165	Displays - too low on Panel C7
4B191	Controls - availability
8B211	Panel layout - not logical - Panel C904
4B213	Control Room layout - accessibility of equipment
8B214	Panel layout - not effective - Panel C904
5B216	Display - completeness of information - Panel C7
8B218	Panel layout - not effective - Panel C904
8C031B	Strings of similar components - Panel C220, C221
1C063	Controls - too high on Panel C7
1C064	Controls - too low on Panel CP600
4C066	Control Room layout - accessibility of equipment
5C088	Displays - unnecessary information - Panel C1
8C095	Panel layout - assigning panel contents - Panel C1
8C096	Panel layout - assigning panel contents - Panel C1
9C098	Panel layout - control/display association - Panel C1
5C104	Display availability

The status of the Category A HEDs (1A012 and 1A013) is discussed in Section IIIA of this report.

A large number of HEDs were written against Panel C7. Twelve HEDS were identified in the 1984 DCRDR. Two of those HEDs were Category 5 (equipment relocation) HEDs. We decided to delay the correction of any Panel C7 HEDs until the SFTA upgrade was complete. The 1990 SFTA and surveys identified another 17 HEDs on the panel, including 7 in Category 5. Because of the significant number of HEDs and their seriousness we have decided to replace or redesign Panel C7. This redesign will also consider whether it is necessary or beneficial to relocate some components to front panels. The Category 5 HEDs (from the list above) that will be resolved or partially resolved within this project are 1A012, 1A013, 1B163, 1B164, 1B165, 5B216, 1C063, and 8A008B.

The remaining Category 5 HEDs will be resolved or partially resolved with several equipment location-related projects. These projects include the following.

- Relocating four RWCU control switches to co-locate these switches with the other RWCU components on Panel C904 (HED 8B211).
- Relocating the first point heater outlet valve switches from Panel C4 to C1 (HED 4C066 and 5B067).
- Rearranging switches on Panels C174 and C175 so that the switches are in a logical order (HEDs 4B148, 8B157, 9B158 and Category 2 HED 4B149).

- Relocating the condensate pump suction conductivity recorder from Panel C904 to C1 (HEDs 9C098 and 5C088).

- Removal of two control switches on Panel C904 and the reloca[illegible] of the N_2 flow controller from Panel C904 to C7 (HEDs 8B214, 8B[illegible]), possibly in conjunction with the Panel C7 redesign discussed above.

- The addition of two control switches to Panel C903 to provide the capability for securing all drywell fans (HED 4B191).

- The installation of labels, demarcation, and mimics, as required on the fire alarm panels (HED 8C031B, Category 2 HEDs 6C030, 6C040, 9C032, 8C031A and Category 4 HED 0C099).

The projects outlined above are in various stages of design. Please refer to Section IV for implementation schedules.

HED 1C064 identifies two controls on Panel CP600 that are 5.8 inches below the height requirement for a 95th percentile male operator. The operators stated that the heights of the switches is not a problem because the operators normally operate this panel while sitting in front of the panel with a procedure in their lap. The DRT determined that no further action is required.

HED 8C095 recommends that the indication for the off-gas holdup line drain valve be relocated from Panel C1 to CP600. Further evaluation determined that, to functionally group this indicator, it should be located on Panel C902. The operators stated, however, that having the indicator in its current position is useful, therefore it was determined that the indicator would be left in its current location.

HED 5C104 identified the need for a status indication for the feedwater startup regulator bypass valve. The valve has recently been removed; therefore it was determined that a status indication is not required.

H. CATEGORY 6--POTENTIALLY RESOLVED HEDs

The HEDs below were identified in the 1984 DCRDR efforts and categorized as "potentially resolve[illegible] 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.

Since the DCRDR Summary Report (Reference 2) was issued nineteen (19) HEDs have been closed out through the close-out verification process. The close-out verification process verifies the extent of correction for each HED, documents justifications for partial correction (or no correction), and verifies that no new HED has been created by the correction methodology.

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.

Table III-4 lists the HEDs from the 1984 DCRDR efforts that are still in the close-out process. Table III-5 lists the nineteen (19) HEDs that have been closed-out.

Category 5 HEDs identified in the 1990 DCRDR efforts are as follows.

HED No.	TITLE
5B193	Display - suitability
6B201	Control - worn switch escutcheon
4B212	Controls - switch handle conventions
0C027	Surveillance test missed - (LER 85-024)
0C028	Removal of fuse - (LER 88-007)
0C029	Procedure error - (LER 88-025)
1C045	Simplex CPU uncovered
6C080	Controls - position indications
0C087	R.G. 197 exceptions
4C092	Controls - abandoned equipment
6C094	Recorders - not labeled

HEDs 4B212 and 0C087 require no further action and are ready for final close-out. HEDs 5B193, 6B201, 0C027, 0C028, 0C029, 1C045, 6C080, 4C092 and 6C094 require the close-out verification process to be performed.

Refer to Section IV for discussions on implementation schedules.

I. CATEGORY 7--NON-ENGINEERED HEDs

HEDs in Category 7 are associated with non-engineered corrective actions, such as those involving procedure changes, training, or maintenance. Sixteen (16) HEDs in this Category were identified in the 1984 DCRDR effort, as follows.

HED No.	TITLE
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
0B113	Training - maintaining proficiency
1C001	Document storage
1C002	Operating expendables and tools - storage
1C004	Protective equipment - availability
1C026	Protective equipment - replacement
2C011	Fire station - false alarms
4C013	Protective equipment - use
5C014	Matching recorder paper with proper recorder
5C017	Change of lamps - proper methods
0C024	Communications - number of plug-ins

TABLE III-4

CATEGORY 6 HEDs NOT YET CLOSED-OUT

HED No.	TITLE
1B002	Furniture and equipment layout
1B009	Desk dimensions
2B018	Announcing system (volume)
2B019	Lack of priority paging
5B133	Visual displays - information displayed
8B102	Frequency of use
8B129	Sequence of use - functional considerations
5C019	Graphic recorders - visibility
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
[illegible]08	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
5C020	Visual displays - unit scales

TABLE III-5

CATEGORY 6 HEDs THAT ARE CLOSED-OUT

HED No.	TITLE
4A003	Reactor Mode Switch - no detent
5A004	Recorders not satisfactory
5A005	Inconsistent reactor water level meters
1B003	Supervisor access
1B008A	Procedures/reference materials at consoles
1B128	Nitrogen flow to drywell indication
2B016	Conventional telephone system
2B020	Point-to-point intercom system
4B059A	Prevention of accidental activation
5B070	Discrete recorders - channel select
5B127	Usability of displayed values - scale increments
6B083	Tag-outs
1C003	Dimensions - control height
1C006	Personal storage
5C015	Recorder labels
5C021	Usability of displayed values - scales
5C026	Usability of displayed values - operator conversion
6C023	Visibility of labels - cleaning
5B065*	Visual displays - direction of movement

* HED 5B065 was listed as a Category 2 HED in Reference 2.

Corrective actions have been completed for the following HEDs:

HED No.	TITLE
1B008	New procedure racks installed
2B022	Signs posted re: VHF communications
0B113	STA training completed (continuing)
1C001	Procedures have been clearly marked
4C013	Adequate periodic training is conducted
5C017	Panel indicator bulk changeout tool was purchased.

The Plant Department determined that the following HEDs do not present operational problems and that no action is required:

HED No.	TITLE
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
2C011	Fire alarms now very infrequent
5C014	Recorder scales and chart paper coordinated by procedure
0C024	Current communications jacks are sufficient

HED 2B017 involved Gai-Tronics paging system problems. A "priority paging" system was installed in 1989 to address this, but is not yet functioning correctly. Trouble-shooting is underway and is expected to complete the modification. In addition, conceptual design has been initiated on a major improvement to the PNPS Gai-Tronics system, which is expected to further reduce system noise and improve communications.

The 1989-90 DCRDR effort identified twenty-eight (28) additional Category 7 HEDs as follows.

HED No.	TITLE
5B170	Area radiation monitors do not conform to EOPs
4B171	Need to hold jog valv. controls for lengthy periods
5B172	Torus level instruments not precise enough
5B173	EOP may have error in temperature limit
5B182	Emergency action level chart color coding
5B183	Need alarms for area temperature monitor
5B184	Drywell temperatures difficult to read precisely
5B187	Need to convert units from indicator (gallons) to % (EOP)

(list continues on next page)

Additional Category 7 HEDs, Continued

5B195B	Reactor pressure difficult to read precisely
5B196B	Reactor water level difficult to read precisely
5B198	No indicator of torus pressure indication in range requested by EOP
5B199	Difficult to read EOP values or area temperature indicators
5B200	EOP requires reading drywell water level outside instrument range
0B203	Instrument does not indicate radioactivity in units required by R.G. 1.97
5B219	EOP difficult to read
0B220	Torus water level difficult to read precisely at EOP values
1C036	Steps are potential tripping hazard
5C039	Lack of bulb test capability on fire alarm annunciator panel
1C041	Missing annunciator tiles - Panel C921
5C047	Pointers obscure minor graduations on scales
5C050	Pointers obscure minor graduations on scales
1C062	Aisle between panels less than 50 inches
1C067	No laydown area for EOPs
2C069	Confusion between safety valves and safety relief valves
6C086	Revise operating procedure
0C100	Unplanned scram because of leaking feedwater valves
2C101	Logarithmic scale used on SPDS
5C102	Intermediate scales not used on SPDS screens (conformance to EOPs)

The following HEDs will be addressed by appropriate revisions to the EOPs or to operating procedures. (In most cases, these changes involve changing the EOPs to use rounded-off measurements rather than odd intermediate measurements that cannot be read precisely on existing meters or recorders.) In the meantime, certain items are being addressed through training.

5B170	5B196B	1C067
5B172	5B198	6C086
5B173	5B199	
5B183	5B200	
5B184	0B203	
5B187	5B219	
5B195B	0B220	

Two additional HEDs (2C101 and 5C102) are indirectly related to pending EOP revisions. These two HEDs relate to SPDS displays that emulate charts in the EOPs and which do not comply with guidelines regarding minor graduations on scales. The EOP charts are being revised or replaced in the next round of EOP revisions. Once that is completed, a decision will be made regarding how to reflect the EOP changes in the SPDS displays. The HEDs will remain open until the SPDS displays are resolved.

HED 4B171 concerned the occasional need for operators to hold the switch for certain jog valves for a prolonged period of time. The Design Review Team suggested that the Training Department address the need for additional training on the use of these valves. The Training Department has suggested an alternative approach that would require changes to the valve control logic. This HED will be re-assigned to Category 4 for additional engineering effort, to evaluate the Training Department's recommendation.

HED 5B182 involved the organization and color scheme of the Emergency Action Level chart used in the Control Room. The Design Review Team consensus was that the chart is acceptable. This HED will be referred to the Emergency Response organization for their consideration in any future revision of the EAL chart.

HED 1C036 identified potential tripping hazards in the control room (e.g., steps into watch engineer's office, shift supervisor's area, back panel area). We will install a colored hazard marking on the steps, consistent with similar locations at PNPS.

HED 5C039 referred to the lack of bulb-testing on fire alarm panels C114 and C115. Investigation determined that these bulbs are rarely illuminated (only for periodic surveillances and for actual fire alarms) and therefore have extremely long service lifes. Only one bulb (a power available lamp) has required replacement. No further action is planned.

HED 1C041 concerns two missing annunciator tiles on Panel C921. Replacement tiles will be ordered and installed as part of the enhancements project for this panel.

HEDs 5C047 and 5C050 refer to meter/recorder pointers that nearly overlap the minor graduations on the scales. The Design Review Team requested that the pointers be adjusted to one side, reducing the degree of obstruction. Investigation determined this is not feasible. These HEDs will be transferred to Category 2 to determine if replacement scales or pointers could improve the situations.

HED 1C062 refers to the width of the aisle between the back of the main control panels (C903, C904) and the panel C7. The aisle is 40 inches, vs. the guideline of 50 inches. The DRT requested consideration of a guardrail to help prevent personnel from inadvertently striking the controls on Panel C7. Operations objected to the guardrail, because it would result in further reduction of the aisle width, and noted that there [illegible] no history of personnel inadvertently operating the controls. Nothing [illegible]ther will be done on the HED. (Note, however, redesign of panel C7, discussed in Section III.G, will take into account the restricted space at this location.)

HED 2C069 concerned possible confusion between the "safety valves" and the "safety relief valves." Training, labels and procedures will be changed to refer to these as "safety valves" and "main steam relief valves." This HED will be transferred to Category 2 to be implemented in the label update (enhancements) project.

HED OC100 refers to feedwater control problems resulting from leaking feedwater valves. The root cause is a leaking feedwater valve, which recently was repaired. This HED will be closed.

J. CATEGORY 8--HEDs RELATED TO PLANT COMPUTER ("EPIC")

The HEDs in this category are related to the plant monitoring system computer ("EPIC") which includes the Safety Parameter Display System (SPDS). The computer survey was conducted during the 1990 DCRDR effort. Thirteen (13) HEDs were identified in the survey, as follows.

HED No.	TITLE
7B137	Override of trend plot displays
7B138	Selection of displays
7B139	Graphic coding and highlighting
7B140	Documentation of error messages
7B141	Computer restart and reload time
7B142	Computer function controls
7B143	Multiple-page considerations
7B144	Character luminance
7B145	Screen contrast
7B146	Display formats
4C033	Computer function controls
4C034	Computer function controls
4C035	Computer function controls

The status of the Category 8 HEDs is as follows.

- HED 7B140, error message documentation has been resolved with Rev. 3 of Procedure 2.6.1.
- HED 7B143 has been resolved and HED 7B142 has been partially resolved by SPDS keyboard improvements.
- HEDs 4C033, 4C034 and 4C035 will be resolved with the replacement of the old Honeywell computer.
- HEDs 7B144, 7B145, and 7B137 cannot be resolved because of system limitations with the Toshiba terminals. If and when the Toshiba terminals are replaced, we will address the related NUREG-0700 requirements in the specifications for replacement equipment.
- HED 7B141 requires no action. The 30 minute system reload and restart duration is inherent in the generic system design.
- HED 7B139, which address dual meanings for the color yellow, will receive no action. The number of colors available with the Toshiba terminals is limited and no other color combination was found to be clearly preferable.

- HEDs 7B138 and 7B146 address the use of the trackballs and tab/cursor. We are not planning to implement trackball cursor control because of previous reliability problems with the trackballs. Effective cursor control is achieved on EPIC now by either the tab key or arrow key.

SECTION IV

IMPLEMENTATION SCHEDULE

A. INTRODUCTION

This Section outlines the schedule for the work described in this report. It includes schedules for the work newly identified in this report, as well as an updated schedule for the work previously identified in the Supplementary Summary Report (Reference 2).

The schedules presented here are based upon the relative priority of DCRDR tasks (including consideration of the detailed screening results discussed in Section III), the status of design, and the projected pace of engineering for the projects to be done. Boston Edison has not, however, performed any detailed planning for the outages beyond the 1991 refueling outage (RFO8). Therefore the schedules described here are subject to revision as work proceeds, design is completed and other work is defined for completion in the same period. Schedule adjustments, if required, will be provided to NRC by Boston Edison through the semi-annual Long Term Program submittals.

For correlation to the text in Section III describing corrective actions, the schedule for DCRDR work will be discussed by implementation category. The schedules described herein are summarized in Figure IV-1.

B. CATEGORY 1 -- ANNUNCIATOR

The conceptual design has been selected, as described in Section III; the planned modification is to remove the entire annunciator and replace it. The first step will be to perform detailed design, beginning with a signal-by-signal review of the type described in EPRI NP-3448-L. That review will begin in 1991.

The target schedule is to complete detailed design, order materials, and begin installation of the new annunciator in refueling outage #9 (RFO9), currently scheduled to begin in the Spring of 1993.

Because of the magnitude of this task, it will require two or three refueling outages to complete. Because of the preliminary state of annunciator design and because there has been no planning for the refueling or mid-cycle outages beyond RFO8 (in 1991), we cannot say with certainty when the annunciator replacement will be completed. We plan to begin installation in RFO9 and will include a schedule for completion of this work in the Long Term Program.

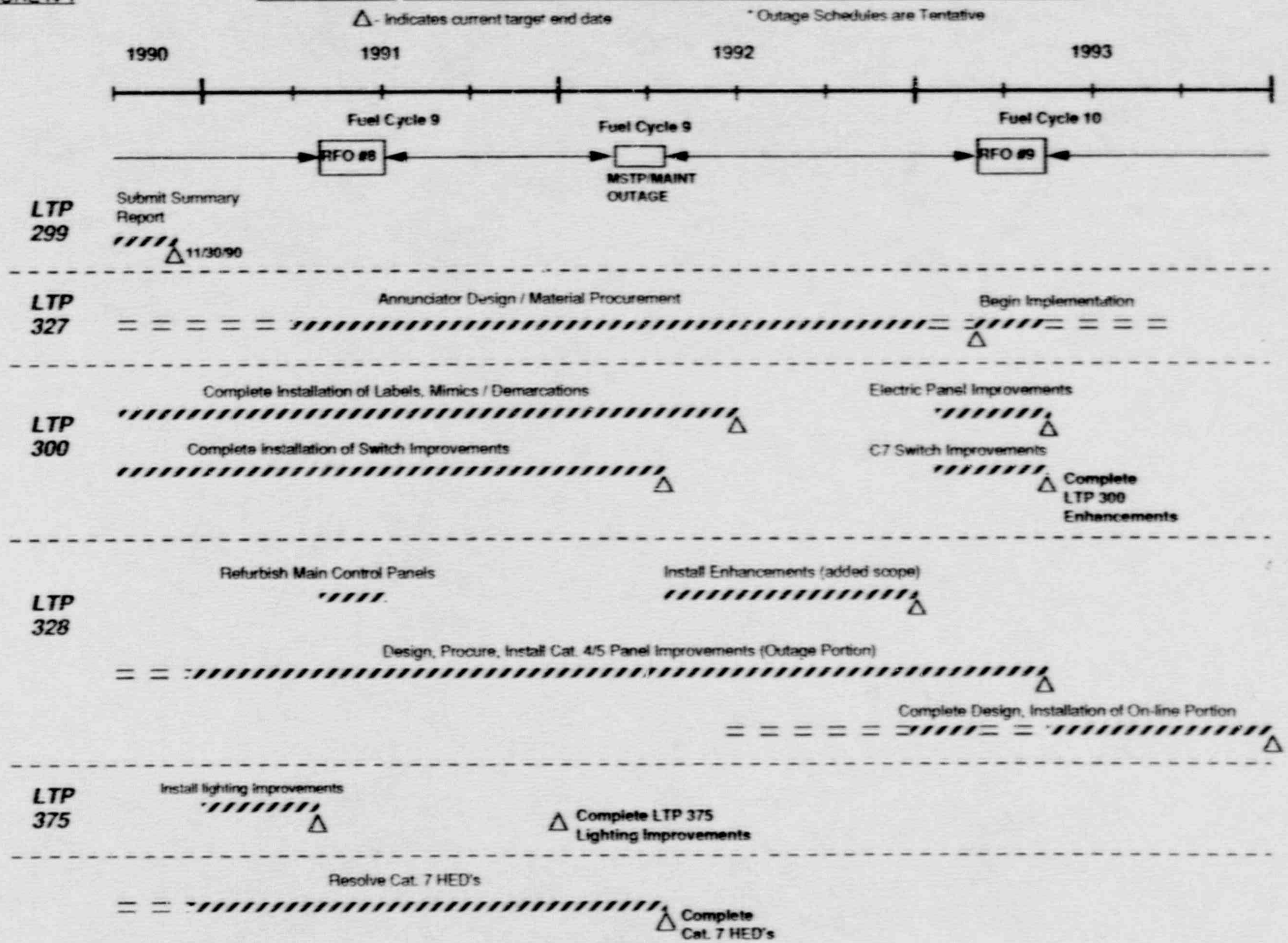
C. CATEGORY 2 -- ENHANCEMENTS

1. Previously Committed Scope

Work is underway to complete the implementation of the previously-committed control panel enhancements, including labels, mimics, demarcations; meter and recorder scales; switch handles, escutcheons, and rewiring; and minor relocations.

FIGURE IV-I

SUMMARY SCHEDULE - PILGRIM STATION CONTROL ROOM DESIGN REVIEW



This scope was previously scheduled (in Reference 2) for completion by the end of RFO8 in mid-1991.

The schedule for the original enhancements scope (referred to in our Long Term Program as LTP 300) is revised as follows:

a. We will plan to finish all labels, mimics, and demarcations (to be done on-line) in the original scope by June 30, 1992.

b. We expect to finish most of the switch improvements by the end of the 1992 mid-cycle outage. The switch rewiring task has been prioritized so that the highest priority switch rewiring will be done in RFO8 as originally committe . Handle and escutcheon replacements are expected to be done by the end of RFO8 as previously committed.

c. We plan to complete the switch rewiring and replacement on panel C7 in RFO9, <u>or</u> resolve them as part of the C7 panel reconstruction.

d. We plan to complete electrical panel enhance on panel C3) by the end of RFO9.

Thus, the <u>on-line</u> portion of the original sc planned for completion by June 30, 1992 and the <u>outage</u> on for completion by RFO9.

There are three reasons for this schedule re ision:

- Other projects judged to be more important than the enhancements are scheduled for RFO8. In particular, we plan to:

  - Perform panel refurbishment and painting
  - Install lights indicating status of scram solenoid valve groups and MSIV trip logic on Panel C905.
  - Relocate several instruments and controls

  In addition, several other newly-identified corrective actions will be scheduled for the mid-cycle outage, ahead of some of the remaining original enhancements scope.

  We consider the rearrangements in priority to be in the best interest of the control room operators.

- Some work is taking longer than expected. In particular, development and installation of new labels, mimics, and demarcations has encountered several difficulties. Resolving comments on label content has taken much longer than expected. Access to the simulator has been restricted, reducing opportunities for installation and for review by operating crews. Procedure revisions are also taking longer than expected.

We are substantially increasing the level of effort in 1991 to accelerate this program.

- RFO8 cannot accommodate all the work originally committed. We have prioritized the remaining switch work so that the most important rewiring (considering human factors and operational viewpoints) will be done in RFO8, and the balance done in the next outages. Panel enhancements that can be done on-line will only be worked during the outage if they cause no interference to other outage work.

2. New Scope

Section III describes extension of the program of labels, mimics and demarcation to additional panels not originally in the CRDR scope. In addition we plan to refurbish and repaint the main control panels, to facilitate the continued installation of enhancements and other modifications.

We plan to complete the outage-related portion of this additional scope by the end of RFO9. We plan to complete most of the work on-line, with a target for completion by December 31, 1992.

D. CATEGORY 3 -- HABITABILITY

Control room lighting improvements were previously scheduled to be completed by the end of RFO8.

We are currently planning to install the lighting improvements on-line, before RFO8. In the event that the lighting work is not completed before RFO8, the installation will be completed by December 31, 1991.

The control room rear panel access door will be removed (or modified), tentatively by December 31, 1992.

E. CATEGORIES 4 AND 5 -- EQUIPMENT TYPE AND LOCATION

We plan to complete the outage-related relocations and replacements of panel hardware in these categories, including the replacement of panel C7, by the end of RFO9. We have prioritized the scope of this effort and will perform portions in RFO8 in 1991 and portions in the mid-cycle outage.

The on-line portion of this work is planned to be completed by December 31, 1993.

The tentative schedule for the individual tasks in this groups is given in Appendix D.

F. CATEGORY 6 -- POTENTIALLY RESOLVED

These HED's were those classified as resolved (or that required no corrective action). Verification will be done at periodic intervals as implementation proceeds. Any HEDs found not resolved, or new HEDs created, will be reassigned to other categories and reviewed for further action in accordance with project procedures.

G. CATEGORY 7 -- NON-ENGINEERED SOLUTIONS

Most of Category 7 HEDs that require corrective actions will involve procedure changes, and most of these involve changes to the EOPs. EOPs are only revised on a refueling outage cycle to allow retraining. We plan to resolve current EOP-related HEDs by the end of the next EOP revision cycle, currently planned for RF08.

Other procedure changes are planned for completion by December 31, 1991.

Other Category 7 HEDs will either be transferred to other categories (see discussion in Section II.I) or will be resolved by March 31, 1992.

H. CATEGORY 8 -- HEDs RELATED TO PLANT COMPUTER (EPIC)

All Category 8 HEDs are resolved or require no action.

SECTION V

RESPONSE TO NRC COMMENTS

A. INTRODUCTION

This Section will respond to two NRC documents:

1) Reference 3, which reports on an NRC inspection of the Pilgrim DCRDR (and SPDS) in March 1989.

2) Reference 10, which provided a review of the Supplementary Summary Report (Reference 2) and Program Plan, Revision 2 (Reference 6).

B. RESPONSE TO INSPECTION REPORT

NRC performed an inspection of the DCRDR program in March 1989, shortly before Boston Edison submitted the Supplementary Summary Report and about four months before the revised Program Plan was submitted.

To a large extent, the NRC's audit report deals with issues that we were asked to address in the Supplementary Summary Report or Program Plan.

Subsequently (as will be discussed below), NRC expressed the view that the Boston Edison DCRDR was expected to satisfy the appropriate criteria of NUREG-0737 so long as the revised Program Plan was carried out.

Therefore, we will not address here the various NRC inspection report comments regarding process, because they are superseded by the NRC's later comments in Reference 10.

The inspection report did, however, tabulate a number of specific human engineering comments regarding the Pilgrim control room, and asked that BECo address these.

Following is a response to each of NRC's comments. (Note: item numbering corresponds to the NRC Technical Evaluation Report.)

1. Recorder Labels

   a. NRC Comment: Labeling of recorders is incomplete (four examples provided).

   b. BECo Response: Labeling of recorders is being addressed by the enhancement program. The specific examples are being addressed by PDC 87-78B, C, G.

2. Recorder Pen Assignments

   a. NRC Comment: Recorder pen color assignments are inconsistent (two examples provided).

b. BECo Response: BECo disagrees with the first example. Reactor Steam Flow is only on recorder #640-27. BECo concurs with the second example and HEO 6.5.062 has been created and will be screened by the Design Review Team per NEDWI 344 and 392.

3. Scram Solenoid Indicator Lights

a. NRC Comment: The SCRAM solenoid indicator lights are on a back panel behind the main control panel (horseshoe). It is necessary to check these lights to verify that SCRAM has occurred (that the plant is not in an ATWS condition). These four lights should be up front on Panel 905.

b. BECo Response: HEDs 1B015 & 4B212 were previously identified for these items. PDC 90-070 will provide lights on C905 that are wired in parallel with the lights on C915/C917.

4. EOP Wording

a. NRC Comment: The wording of Caution 1, in EOP-01, is confusing. However, it appears to require the operator to determine the usability of RPV water level instrumentation in the control room by one of two methods: (1) comparing temperatures near the instrument reference leg vertical runs to a criterion value, "maximum RB run temperature"; or (2) comparing the control room instrument readings to the criterion value of "minimum usable level." To use the temperature criterion, the control room operator would have to send an AO to take readings in the plant. Regarding the level criterion, there is insufficient scale range on the Fuel Zone level indicator and recorder to determine in all cases whether level is above the specified minimum of -263 in.

b. BECo Comment: The caution directs the operator that if the reactor building temperatures are above the temperature listed, the water level indicator will not be valid for trend information below the level indicated.

If there is a temperature control concern in the reactor building, the operators will be determining reactor building temperature, to the best of their abilities.

The operators are trained that if there is a potential that the temperatures exceed the Max RB Run Temperature, that the operators not use the water level instruments for trend information below the indicated level.

5. EOP-01, Figure 1.1

a. NRC Comment: EOP-01, Figure 1.1, requires indication of Torus Pressure in the high range. There is none in the control room. The PAM panel Containment Pressure High meter, PI-1001-600B, is used (incorrectly) to provide this parameter.

b. <u>BECo Response</u>: The EOPs do require Torus pressure to be read in the high range. Similar to item 6, a calculation is required to determine torus airspace pressure.

The next revision of EOPs, to be put in place in RFO8, will replace torus airspace pressure with torus bottom pressure, taking advantage of the torus bottom pressure indicators.

6. <u>Calculate Drywell to Torus Differential Pressure</u>

a. <u>NRC Comment</u>: To determine torus pressure >2.5 psig, the operator must perform a calculation using drywell pressure and differential pressure.

b. <u>BECo Response</u>: HED 5B133 was previously identified to track corrective action for this item.

7. <u>Scale Faces Incorrectly Labeled</u>

a. <u>NRC Comment</u>: The scale faces on PID-5067A and 5067B are incorrectly labeled psid. The correct unit of measure is psig.

b. <u>BECo Response</u>: HED 5B192 was previously identified to track corrective action on this item.

8. <u>Inappropriate Scale</u>

a. <u>NRC Comment</u>: EOP-01, Caution 2, requires the operator to ensure HPCI turbine speed >715 rpm. The meter scale is in increments of 50 rpm. It is also missing a label.

b. <u>BECo Response</u>: HED 5B192 was previously identified to track corrective action on this item.

9. <u>Abandoned Equipment</u>

a. <u>NRC Comment</u>: The HPCI vibration meter on Panel 903 is an "abandoned" component and is not so labeled. The same is true of the N2 recycle blower isolation valves. (These and other abandoned components should be removed.)

b. <u>BECo Response</u>: The equipment was removed per PDC 88-47.

10. <u>Top of Active Fuel</u>

a. <u>NRC Comment</u>: EOP-01 specifies top of active fuel (TAF) as -126.3. An engraved label on Panel 903 gives TAF as -127.5 inches, which is an obsolete value.

b. <u>BECo Comment</u>: The label was corrected in accordance with the BECo corrective action program via a PCAQ (Potential Condition Affecting Quality).

11. Label Nomenclature

   a. NRC Comment: There are numerous problems with labels and nomenclature (14 examples provided)

   b. BECo Response: HEDs 6B076 and 6B077 were pre... ..ly identified to track the corrective actions on these it...

12. Mimics and Panel Layouts

   a. NRC Comment: No mimics for HPCI, RHR (all modes), core spray, MSIVs and bypass/drain valves, RCIC, RWCU, feed and condensate demin (except for backboard heater mimic), CRD drive and cooling, recirc loops, RBCCW, steam seal and SJAEs, and TBCCW

   b. BECo Response: Mimics will be provided (as appropriate) by the enhancement program.

   c. NRC Comment: Steam line drains/MSIV bypasses are separated from the MSIVs by RCIC.

   d. BECo Response: HEO 6.8.035 has been identified for this item and will be screened by the Design Review Team per NEDWI 344 and 392.

   e. NRC Comment: RWCU valves are separated from head vents and DW/torus sample controls.

   f. BECo Response: HEDs 8B211 and 8B214 were previously identified to track the corrective action on this item. (Note: we think the NRC's comment should have read "by" instead of "from".)

   g. NRC Comment: Feedwater heater controls are located on back panel C4, separate from the other feedwater system components. This is at best, inconvenient, and it could create problems in post-SCRAM response.

   h. BECo Comment: HED 4C066 was previously identified to track corrective action on this item.

13. TI5021-01A is Difficult to Read

   a. NRC Comment: Torus water temperature meter TI5021-01-A on Panel 903 is difficult to read because of glare and poor contrast.

   b. BECo Response: HEDs 5B063, 5B188, and 5B119 have noted deficiencies with this meter and will track the corrective action for this item.

14. PR3392 Scale is Inappropriate

   a. NRC Comment: PR3392 on Panel C2 provides information that is inconsistent with operator thinking/expectations. This recorder displays condenser pressure. The parameter of interest to the operators is condenser vacuum. The procedure refers to condenser vacuum. The recorder is labeled condenser vacuum, but is displays absolute pressure (in. of mercury). Operators stated that they would like very much to have this instrument changed.

b. BECo Response: HED 5B061 was previously written to track corrective action for this item.

15. Annunciator

a. NRC Comment: A number of annunciator discrepancies were observed (nine examples provided).

b. BECo Response: An Annunciator Study has been completed to document possible changes to the annunciator system to address the discrepancies provided. A window-by-window review will be initiated in 1991 and then the exact resolution to the various HEDs will be determined.

16. Indicating Light Reliability

a. NRC Comment: Reliability of indication is a potential problem. Except for the alarm tiles and the isolation mimic, all control room indication is single bulb, single filament. The licensee should ensure that redundant control illumination is available, particularly for ES systems which are normally dark.

b. BECo Response: An engineering evaluation will be performed to determine the acceptability of replacing the bulbs with long life LEDs, as an alternate to redundant illumination.

C. RESPONSE TO 1989 TECHNICAL EVALUATION REPORTS

In reference 10, NRC forwarded two contractor Technical Evaluation Reports (TERs). One included a discussion of our April 1989 Supplementary Report; the second commented on the Program Plan.

The TER on the Supplementary Summary Report contained no specific comments on hardware or corrective actions. its discussions of process concluded by referring to the (later) Program Plan as (essentially) adequate. Therefore, that TER requires no specific comment.

The second TER (SAIC-89/1145) provided a review of the revised Program Plan. In essence, it concluded that the Pilgrim DCRDR would be expected to meet NUREG-0737 requirements if it followed the Program Plan, subject to three comments on specific aspects.

Boston Edison has followed the Program Plan, as described earlier in this report. Therefore, we will respond here only to the exceptions identified in the TER.

1. Adequacy of Human Factors Contractor

a. NRC Comment: The TER said (pg. 3), "... the review team could not judge the adequacy of the human factors contractor because the contractor had not been selected by the licensee."

b. BECo Response: As noted earlier, General Physics Corp. was chosen as the human factors contractor for the 1989-90 effort. General Physics conducted the inventory upgrade, additional surveys, task analysis, and verification and validation, and participated in the Design Review Team for screening of HEDs and selections of corrective actions. The General Physics effort was led by Dr. Lothar Schroeder (until November 2, 1990). Resumes for the General Physics personnel are included in Appendix C of this report.

Ms. Danna Beith of Human Factors Interfaces has continued to participate in the project, particularly in the development of the design manual.

2. Selection of Corrective Actions

a. NRC Comment: The TER concluded (pg. 9) that the BECo DCRDR would not meet the requirement for design improvements "...unless they included training and emergency operating procedures modifications in the plan."

b. BECo Response: Boston Edison has not only considered the use of EOP modifications and training as corrective actions, we have selected those approaches for several HEDs.

By procedure, one of the defined types of corrective actions to which the Design Review Team can assign an HED is Category 7. Category 7 is defined in the relevant Nuclear Engineering Department Work Instruction (Reference 11) as:

> Category #7: Administrative changes including operations and administrative procedures as well as other changes which can be accomplished without hardware changes.

Thus the procedure by which all HEDs are screened inherently prompts the DRT to consider either training or procedures (as well as other non-engineering solutions) as a method of correcting HEDs. (This is not a change in our process; it may be that we did not present this information clearly during discussions with NRC.)

In the current set of HEDs discussed in Section III of this report, two were assigned to Training for corrective action*, and 18 to the EOP project.

---

* Both of the HEDs assigned to Training resulted in further review of possible physical improvements to partially resolve the HEDs; see Section III.I.

Other non-engineered corrective actions were also assigned to groups responsible for emergency planning, industrial safety, and maintenance.

Non-engineered HEDs (i.e., Category 7) assigned to other departments are tracked by the NED HED tracking program (as are all other HEDs), and completion will be verified in accordance with the applicable procedure (Reference 11).

It should be noted that coordination with the EOP project is facilitated by the fact that responsibility for EOP development rests with the Nuclear Engineering Department.

3. Coordination with Operator Training

a. NRC Comment: The TER commented that BECo's "coordination process did not include coordination with operator training."

b. BECo Response: There are two principal elements to the coordination of DCRDR with training. One is formal and generic to all projects, and the other is project-specific.

The formal coordination with training is through the design control process. A control room design change, like any other design change, is implemented through the Plant Design Change (PDC) process. Training-related aspects of this process include the following:

i) The PDC preparation procedure (Reference 12) requires that the PDC include recommended changes to operating or maintenance procedures, which later could affect training.

ii) After issuance of a proposed PDC by Nuclear Engineering, approval of the PDC by the Operations Review Committee (ORC) requires review and sign-off by the Training Department (as well as other affected organizations). Either the affected department (e.g., Nuclear Operations) or the Training Department can identify the need for training (or procedure changes) as a prerequisite for accepting the modification.

iii) Once a PDC is approved and issued, automatic distribution includes the Training Department. Training reviews each issued PDC from two perspectives: Whether the PDC requires specific training (e.g., on-shift training for current crews on new equipment) or modification to existing training programs; and whether the PDC affects the hardware or software in the simulator.

iv) Before a PDC is accepted by the Plant Department as operational, Operations must agree that necessary training is completed and procedure changes are implemented (or that a waiver of such training is accepted by the plant manager).

Also by procedure, the Engineering Department is required to purchase any panel devices (e.g., new recorders or switches) required for the simulator to emulate the revised plant installation.

We consider that this formal process meets the requirement of NUREG-0737 for coordination.

In addition, however, the Pilgrim DCRDR has included a number of project-specific activities that linked the training and engineering elements.

Several phases of DCRDR have involved training personnel, training facilities, and training materials. By utilizing these resources, the DCRDR project has obtained input from the training process as well as sensitizing the training organization to DCRDR concerns and objectives. These connections have included:

i) One of the members of the Design Review Team (Mr. Gerlits) was formerly an instructor in the Training Department and was a licensed SRO, which helped the DRT understand and consider the training perspective when it was screening HEDs and selecting corrective actions.

ii) Participation by the Training Department in both (1984 and 1989) verification/validation activities, including use of the simulator (in 1989).

iii) Use of the simulator for trial installation of control panel enhancements, and for operator reviews.

iv) Use of training materials as one of the reference sources for development of enhancements.

In addition, Nuclear Engineering has provided input to the training function. The Nuclear Engineering Department prepared a special information document to assist the Training Department in preparations for training operators on the new system of labels, mimics, and demarcations.

We believe that these additional informal coordination steps have helped to insure a successful integration of training and Control Room Design Review objectives and programs.

SECTION VI

PROJECT ORGANIZATION AND QUALIFICATIONS

A. PILGRIM STATION ORGANIZATION

The Boston Edison nuclear organization is illustrated by Figure VI-1. Responsibility for the Detailed Control Room Design Review Project is assigned to the Nuclear Engineering Department for technical leadership and project management. Considerable support to the project is provided by departments reporting to the PNPS Station Director, including the Nuclear Training Department and the Plant Department.

The engineering department organization is shown in Figure VI-2. A Project Manager, reporting to Department Management, has responsibility for coordinating the DCRDR project.

Technical responsibility for the processes, procedures and corrective actions rests with the line managers for the respective discipline groups in the Nuclear Engineering Department. Division managers assign personnel, either on a full-time basis or on a task-by-task basis, to accomplish project tasks assigned by the project manager. In this fashion the normal Boston Edison engineering and construction processes for design control and coordination can be used thus minimizing the need for project-specific processes and controls.

B. PROJECT STRUCTURE

Table VI-1 shows the key activities and the assignments of technical disciplines to each activity. As shown in the table, we assumed the leadership roles, but substantial support was obtained from consultants, particularly for the inventory, survey, and SFTA activities.

Data collection was conducted under the direction of personnel from the Control Systems Division (lead on inventory and survey updates) and the Systems and Safety Analysis Division (lead for Task Analysis and associated activities). Consultant assistance for the 1989-90 data collection and analysis efforts was provided by General Physics Corporation.

Design of physical corrective actions (i.e., plant design changes) is under the direction of the Control Systems Division in most cases. The corrective action designs will be performed under the normal Boston Edison procedures for Pilgrim Station design changes.

Particular emphasis was placed on the need for and value of substantial review and input from the Operations Section; Operations assigned a senior staff SRO to act as liaison to DCRDR and help assure coordination.

Table VI-2 lists specific personnel assigned to the project. Appendix B includes resumes for those personnel and for additional General Physics personnel who participated in DCRDR activities.

NUCLEAR ORGANIZATION CHART

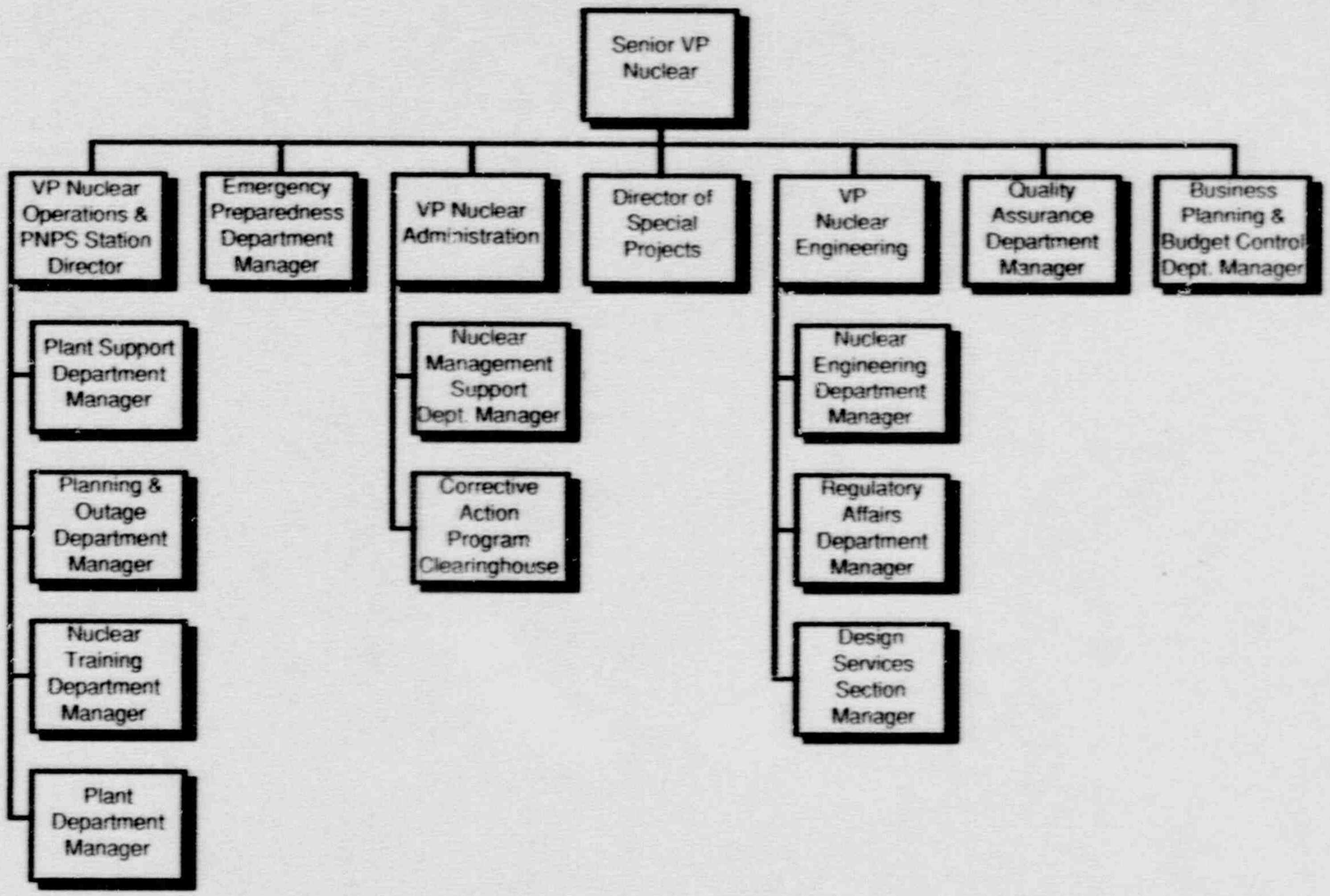


FIGURE VI - I. BOSTON EDISON NUCLEAR ORGANIZATION CHART

NUCLEAR ENGINEERING DEPARTMENT

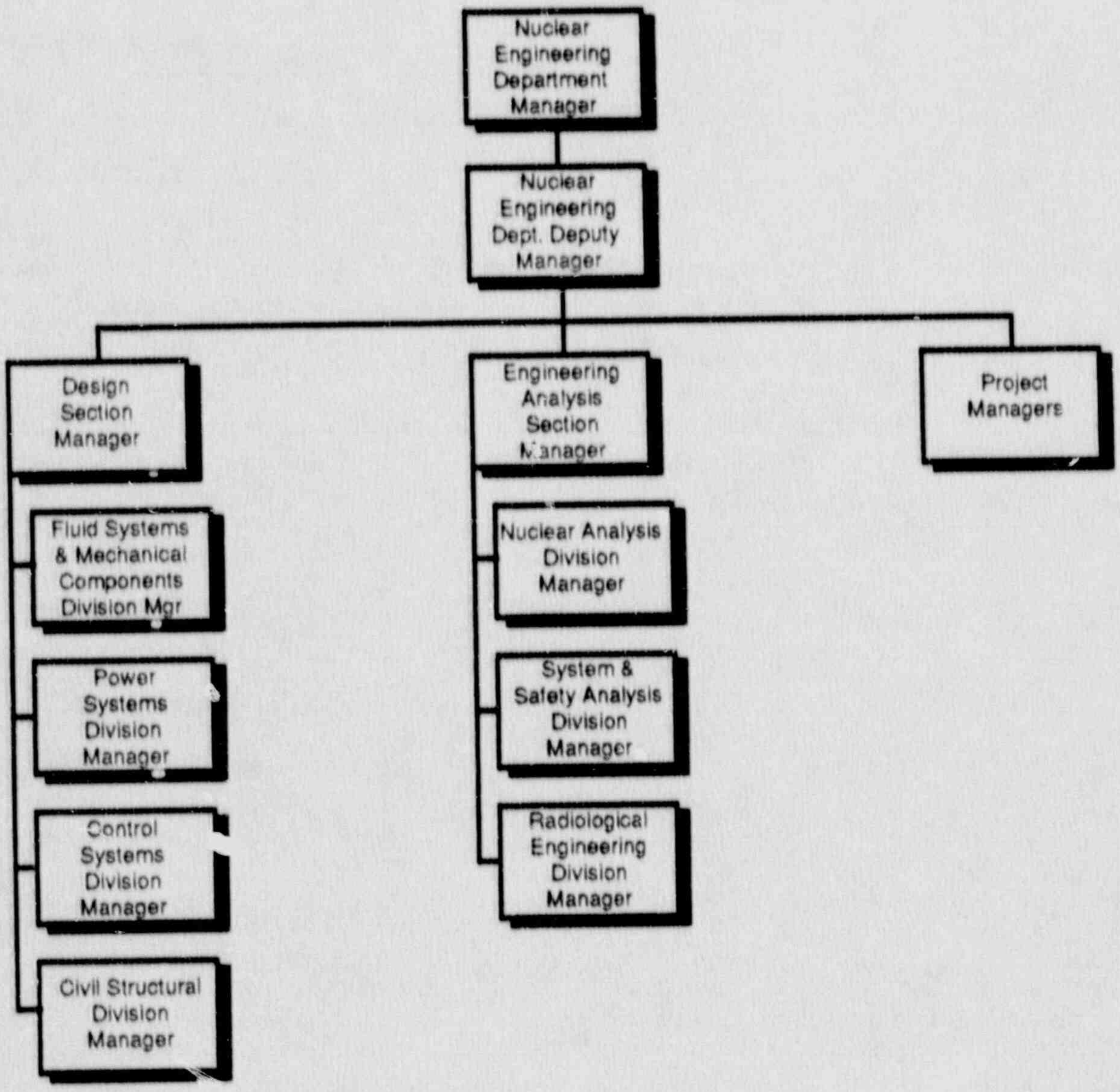


FIGURE VI-2. BOSTON EDISON NUCLEAR ENGINEERING ORGANIZATION

TECHNICAL PERSONNEL ASSIGNED TO TASK BY CATEGORY	DCRDR TASK								
	SFTA	INVENTORY	TASK VERIFICATION	VALIDATION	SURVEY	CER	HED ASSESSMENT	DESIGN SELECTION	VERIFICATION
BECO Personnel (1)*									
I/C Engineers (2)	Support	Lead	Support	Support	Lead	Support	Support	Lead	Lead
Systems Engineers (3)	Lead	xx	Lead	Lead	xx	Lead	Lead	Support	xx
Other Design Engineers (4)	xx	Support	xx	xx	xx	xx	xx	Lead/Support	Support
Operations Liaison (5)	Support	Support	Support	Support	Support	Support	Support	Support	Support
Miscellaneous Support (6)	Support	Support	Support	Support	xx	Support	Support	xx	xx
Contractor Personnel									
HFE Specialists	Major	Minor	Major	Major	Major	Major	Support	Support	Major
SRO/OPS Specialist	Major	xx	Minor	Minor	xx	Minor	xx	xx	xx
Computer Specialists	Major	Major	xx	xx	Support	xx	xx	xx	Minor
Panel Design Specialist	xx	xx	xx	xx	xx	xx	xx	Major	Minor
Other Design Specialist	xx	xx	xx	xx	xx	xx	xx	Major	Minor

<u>Table Definitions for Role Effort</u>

"Lead" = Technical ownership; bulk of effort may be delegated

"Major" = Major share of effort

"Support" = Minor share of effort

* Numbers in ( ) refer to notes on next page

TABLE VI-1. TECHNICAL DISCIPLINES ASSIGNED, BY TASK

NOTES TO TABLE VI-1

1. BECo personnel include seconded contractor personnel working under BECo supervision and BECo QA program.

2. I/C means electrical, electronics, or controls engineers from the BECo Nuclear Engineering Department Control Systems Division. The Principal Investigator (Warren Babcock, Jr.) is included in this category.

3. Systems engineer means a senior engineer from the NED Systems and Safety Analysis Division. This discipline corresponds to the nuclear systems engineer in NUREG-0700.

4. Other design engineers means civil, mechanical, or electrical engineers assigned to specific corrective actions tasks (e.g., design of lighting improvements); or whose knowledge of existing design is needed for data collection or for decisions on corrective actions.

5. Operations liaison for the 1989-90 period included Mr. Ken Taylor, an SRO, who participated in the SFTA and related reviews; and Mr. Charles Leonard, a former SRO assigned to coordinate Operations Section involvement in the Design Review Team. Additional control room personnel were used as required in various tasks.

6. Miscellaneous support includes Training Department personnel for procedure revisions, training on design changes, and coordination with the simulator for access and modification (personnel not specifically assigned to DCRDR).

7. Other design specialists means contractor engineers delegated to design corrective actions (e.g., lighting improvements).

C. KEY INDIVIDUALS

Key Boston Edison individuals on the project team for the 1989-90 efforts and their responsibilities were as follows:

1. Project Manager

David A. Bryant is the DCRDR Project Manager. He has served as the Project Manager of the DCRDR since 1985 and will continue to have overall management responsibility for implementation of corrective actions and close-out of all items. He is responsible for the DCRDR budget, schedule, and inter-group coordination. He reports to the Manager of the Nuclear Engineering Department.

2. Principal Investigator

Warren Babcock Jr., is the Principal Investigator of the DCRDR. He has served as the DCRDR Principal Investigator since 1984 and will continue to serve as the technical lead of the Design Review Team. He reports to the Control Systems Division Manager (in the Nuclear Engineering Department) and is responsible for understanding the applicable requirements (NUREG-0700) and applying them through the procedures described in this plan to produce appropriate design standards and corrective actions. Mr. Babcock is an experienced instrumentation and control engineer with substantial experience in panel design and additional training in human factors engineering.

3. Lead I/C Design Engineer (Panel Improvements)

Norman Eisenmann is the Lead I/C Design Engineer for DCRDR corrective actions. He reports to the Control Systems Division Manager (in NED) and is responsible for coordination of the panel-related corrective actions. Mr. Eisenmann supervises a group of contractor engineers preparing the corrective action design change packages, and also supervised portions of the recent data collection effort by General Physics. Mr. Eisenmann is an experienced instrumentation and control engineer with additional training in human factors. Mr. Eisenmann was a member of the Design Review Team.

4. Lead I/C Design Engineer (Annunciator Replacement)

Robert Byrne is the Lead I/C Design Engineer for the annunciator replacement project. He reports to the Control Systems Division Manager (in NED). He was responsible for supervising the recent annunciator conceptual design study, and is assigned to supervise the annunciator replacement design. Mr. Byrne is an experienced instrumentation and control engineer with additional training in human factors.

5. Lead Systems Engineer

The lead systems engineer assigned to the DCRDR was Mr. David Gerlits II. His principal responsibility was the new System Function and Task Analysis and associated tasks. Mr. Gerlits has held a Senior Reactor Operator's license, which facilitated the integration of the operating aspects with the engineering aspects of the SFTA. Mr. Gerlits was a member of the Design Review Team. Mr. David Long is replacing Mr. Gerlits in this role. Mr. Long is a former shift technical advisor.

6. Operations Liaison

Mr. Ken Taylor, a senior SRO, was the operations representative during the data collection phase, including the Task Analysis. Charlie Leonard was assigned more recently as liaison between the engineering organization and the plant operations section for the DCRDR project. Mr. Leonard formerly held a Senior Reactor Operator's license and has more than fifteen years of experience as a nuclear plant operator and watch engineer. Mr. Leonard was the operations member of the Design Review Team.

TABLE VI-2

PERSONNEL ASSIGNED TO DCRDR OR PROVIDING MAJOR SUPPORT

Position	Individual	Participation
Project Manager	David A. Bryant	• Manages entire DCRDR project (full-time).
Control Systems Division Manager	Siben Dasgupta	• Supervises all Control Systems Division Engineers; responsible for technical quality of all I/C tasks; manages ongoing HFE review of design changes initiated outside of DCRDR.
Principal Investigator	Warren Babcock, Jr.	• Lead technical advisor to Control Systems Div. Mgr. for DCRDR; member of Control Systems Division, ongoing department responsibility for human factors aspects of design process; responsible for design standards.
Lead I/C Design Engineer - Panel	Norman Eisenmann	• Lead for design of panel corrective actions; supervises contractor designers; supervised survey and inventory portions of data collection.
Lead I/C Design Engineer - Annunciator	Robert Byrne	• Lead for annunciator conceptual design study; lead for design of replacement annunciator.
Sr. Systems Analysis Engineer	David W. Gerlits, II David G. Long	• Lead for systems engineering; responsible for planning and supervision of SFTA and related tasks.
Operations Liaison	Kenneth N. Taylor Charlie Leonard	• Coordinates Operations participation in all phases; contact for information and operations input.
I/C Engineers	John Turner Robert L. Poltrino* Robert F. Foley* Richard Poznysz* Charles Greland*	• Responsible for design of assigned corrective actions; reporting to Control Systems Division.

(Table continues on next page)

(Table VI-2, cont'd)

Contractor Control Panel Improvements Designer	E.L. (Rett) Considine (General Atomics)	• Conceptual design of control panel enhancements system.
Human Factors Consultant	Danna M. Beith (Human Factors Interfaces)	• Assistance in program design and enhancements design; responsible to plan and develop an integrated design manual.
Human Factors Consultants for 1989-90 DCRDR Update Effort	General Physics Corporation -- Lothar Schroeder Diane Wisniewski Neil Danzig Mark Venters Jeff Klein (and others)	• Lead for 1989-90 data collection and analysis, including updated inventory and survey, SFTA, and Design Review Team Screening Process. Assists in design of corrective actions and verification of corrective actions; project lead HFE.
Operations Section Manager	Leon Olivier	• Supervises all control room operators and associated staff; provides guidance on DCRDR scope and direction, and resources for SFTA and related activities.
Simulator Division Manager	Thomas Beneduci	• Coordination and support for all activities in simulator.

<u>Notes to Table</u>

1. Only currently or recently assigned key individuals are listed. Many other personnel have contributed or will contribute.

2. Personnel designated with * are seconded contractor personnel working under BECo supervision and QA program.

3. See resumes in Appendix C.

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; Supplementary Summary Report; April 1989; Boston Edison Co.; forwarded to NRC by letter BECo 89-064 dated May 2, 1989

(3) In-Progress Audit Reports of Detailed Control Room Design Review (DCRDR) and Safety Parameter Display System (SPDS) -- Pilgrim Nuclear Power Station; reports forwarded by NRC letter dated April 26, 1989, from Daniel G. McDonald to Ralph G. Bird, Boston Edison Co.; Reference: TAC Number 59239

(4) Detailed Control Room Design Review; Program Plan; June 1984, Rev. 1; Boston Edison Co.

(5) 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)

(6) Detailed Control Room Design Review; Program Plan, Rev. 2, July 1989; Boston Edison Co.; forwarded to NRC by letter BECo 89-112 dated July 24, 1989

(7) Report on Control Panel Enhancements; Boston Edison Co., June 1989; Attachment (A) to letter BECo 89-102 dated July 6, 1989

(8) Preliminary Engineering Scope of Work for Control Room Design Review Including SFTA, OER, Inventory and Survey: Boston Edison Co., Nuclear Engineering Department, Specification No. E548, Rev. 0, dated July 1989

(9) Boston Edison Company Nuclear Engineering Department Work Instruction No. 344, Revision 1, dated May 18, 1987. "Assessment of Human Engineering Discrepancies."

(10) NRC letter dated November 6, 1989, from Daniel G. McDonald to Ralph G. Bird, re: "Detailed Control Room Design Review Supplemental Summary Report and Program Plan, Revision 2," Reference TAC Number 59329

(11) Boston Edison Company Nuclear Engineering Department Work Instruction No. 392, Revision 1, dated December 12, 1988. "Process for Documentation of New Human Engineering Discrepancies (HEDs) and Verification of Design and Implementation Completion for Correction of HEDs"

(12) Boston Edison Company Nuclear Engineering Department Procedure No. 3.02, "Preparation, Review Verification, Approval and Revision of Design Documents for Plant Design Changes"

(13) Boston Edison Company Nuclear Organization Procedure No. NOP 83E1, "Control of Modifications for Pilgrim Station"

APPENDIX B

HUMAN ENGINEERING DISCREPANCIES

APPENDIX B

HUMAN ENGINEERING DISCREPANCIES

This listing includes all the Human Engineering Discrepancies (HEDs) referred to throughout this report, including both the "old" HEDs (from the 1984 CRDR effort) and the "new" HEDs found in the 1989-90 CRDR update.

Data included in this listing is as follows:

HED Number: The first 5 digits (e.g., 1B005) are the HED numbers as used in the first DCRDR Summary Report (Reference 1) and in the Supplementary Summary Report (Reference 2). 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.

As discussed in Section II, some HEDs were assigned to 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 HEDs required investigation before the next step. Such HEDs are identified with the suffix I.

The system for numbering HEDs is further defined in the original Program Plan (Reference 4, Section 4.4.2).

Implementation Category: This refers to the pre-screening categories defined in Table II-5 of this report.

Source: A code of "GP" in the column identifies an HED from the 1989-90 CRDR update effort.

CR Panel #: Panel(s) to which the HED applies.

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

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
0B113	7	NA		HOW DO YOU MAINTAIN YOUR TECHNICAL PROFICIENCY? Lack of STA simulator training for retaining and updating technical proficiency.
0B123	3	All		TEMPERATURE & HUMIDITY (Comfort Zone): Touching 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
0B203	7	C170	GP	R.G. 1.97 (TABLE 2, TYPE C) REQUIRES PROVIDING INDICATIONS OF EFFLUENT RADIOACTIVITY IN A RANGE OF 10E-6 TO 10E3 MICRO Ci/cc. EFFLUENT RADI OACTIVITY INSTRUMENTATION ON PANEL 170 (RR-1001-608, RAI-1001-608, RAI -1001-609, AND RAI-1001-610) PROVIDES INFORM
0B220	7	C170	GP	EOPS REQUIRE IDENTIFYING TORUS WATER LEVEL AT VALUES OF 130,127,82,46, 300, AND 183 INCHES. THESE VALUES ARE DIFFICULT TO DETERMINE ACCURATEL Y USING EXISTING INSTRUMENTATION ON THE BOARDS (SEE ALSO HEO #208).
0C024	7	NA		DO ANY COMMUNICATIONS SYSTEMS INTERFERE WITH CONTROL ROOM OPERATIONS? General Requirements (Plug-in Jacks): There is an insufficient number of plug-in phone jack positions at the console panels (one at either end of the control room panels).
0C027	6	N/A	GP	A WEEKLY SURVEILLANCE TEST (REQUIRED BY TECH SPECS) OF STATION 250 VOL T BATTERIES WAS MISSED.
0C028	6	C941	GP	THE REMOVAL OF A FUSE FROM THE POWER SUPPLY OF A LOGIC CIRCUIT (WHILE SHUTDOWN) RESULTED IN THE AUTOMATIC CLOSING OF THE "A" TRAIN VENTILATI ON DAMPERS OF THE SECONDARY CONTAINMENT SYSTEM AND THE AUTOMATIC START OF THE "A" TRAIN OF THE SCS/STANDBY GAS TRE
0C029	6	C903	GP	WHILE IN COLD SHUTDOWN AND AS PART OF SHUTDOWN COOLING (PROCEDURE 2.2. 86), OPERATORS WERE DIRECTED TO OPEN VALVE MO-1001-50 AND MO-1001-47. THIS ACTION FLOODED THE RHR's LOOP A SUCTION PIPES AND REACTOR VESSEL WATER LEVEL DECREASED BELOW SETPOINT.
0C087	6	C903	GP	R.G. 1.97 (TABLE 2, TYPE D) REQUIRES PROVIDING INDICATIONS WITH A RANG E OF 40 DEGREES F TO 440 DEGREES F FOR INFORMATION REGARDING DRYWELL A TMOSPHERE TEMPERATURE. RECORDER TRU-9044 HAS A RANGE OF 0-400 DEGREES F.
0C099	4	C220,C221	GP	EQUIPMENT ON PANEL DOES NOT MEET HUMAN FACTORS STANDARDS.
0C100	7	N/A	GP	AN UNPLANNED SCRAM OCCURRED DURING PLANT STARTUP. WATER LEVEL WHICH WA S FLUCTUATING WAS BEING CONTROLLED WITH THE STARTUP REGULATING VALVE. A LOW REACTOR WATER LEVEL OCCURRED BEFORE OPENING DOWNSTREAM BLOCK VAL VES AND PLACING A F. REGULATING VALVE IN SER
1A011	4	C915	GP	WHILE IN COLD SHUTDOWN, OPERATOR ATTEMPTED TO RESET BREAKER 5A-CB1A BY OPENING AND CLOSING IT THUS DE-ENERGIZING LOGIC CIRCUITRY AND CAUSING A SCRAM SIGNAL.
1A012	5	C7	GP	DURING A SEMI-ANNUAL SURVEILLANCE TEST, AN OPERATOR INADVERTENTLY MOVE

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				D THE KEY-LOCKED RBIS CHANNEL A CONTROL SWITCH TO THE "TEST" POSITION INSTEAD OF THE "TEST LOGIC" POSITION. THIS RESULTED IN ACTUATION OF SG TS.
1A013	5	C7	GP	INVENTORY #1462 TO #1509 CONTROLS ARE ALL BELOW THE STANDARD C 25.8 I NCHES.
1A017	3	N/A	GP	EMERGENCY LIGHTING IS NEEDED IN THE WATCH ENGINEER'S OFFICE FOR REVIEW ING THE EMERGENCY CLASSIFICATION CHART (SCENARIO #5).
1B001	6	C7		ACCESSIBILITY OF INSTRUMENT/EQUIPMENT Instrumentation requiring contin uous monitoring by operators during emergency operations: Panel C7: Drywell temperatures, #1358, 1361 Containment purge and vent control , #1412,1413, 1447,1448,1449,1450,1451,1452,1453,1454,1455,1456, 1472 ,1473 Torus temperature, #1427,1428
1B002	6	Near 905		FURNITURE AND EQUIPMENT LAYOUT: There is a limited amount of work spac e for the operator. The space available is used to hold two printers and a computer terminal. This observation is supported by OER-001.
1B003	6	NA		SUPERVISOR ACCESS: Shift Supervisors' Office (Watch Engineer) does not permit prompt physical access to the control room. In addition, ther e is no dedicated communications link between these two spaces. This H ED is supported by observations OER-005 AND OER-010.
1B005				
1B005A	1	903,04,05,C1,2,3		STAND-UP CONSOLE DIMENSIONS (Display Height and Orientation): Displays that exceed 80 in. in height include all the annunicator panels, con tainment isolation mimic and the upper portion 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 5, 246,247,248
1B005B	5	903,04,05,C1,2,3		STAND-UP CONSOLE DIMENSIONS (Display Height and Orientation): Displays that exceed 80 in. in height include all the annunicator panels, con tainment isolation mimic and the upper portion 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 5, 246,247,248
1B008				
1B008A	6	NA		USE OF PROCEDURES AND OTHER REFERENCE MATERIALS AT CONSOLES: No provis ion for use of procedures and other reference material at the console

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				s (benchboards).
1B0088	7	NA		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	NA		DESK DIMENSIONS: There is inadequate work station (space) to perform administrative tasks. This observation is supported by OER-001.
1B011	3	NA		VENTILATION (Air Quantity): Fresh air introduced into the control room is not adequate. This observation is supported by OER-006.
1B012	3	NA		ILLUMINATION (Levels and Uniformity): The variability and control of lighting levels do not conform to the guideline criteria. See lighting survey - luminance record.
1B013	3	All		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	NA		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	915,917		ACCESSIBILITY OF INSTRUMENT/EQUIPMENT (Arranged to facilitate coverage): Instrumentation requiring continuous monitoring by operators during emergency operations located on back panels 915 and 917 are the scram solenoid lights and MSIV isolation lights(2). This observation is supported by OER-001.
1B015I				SEE 1B015
1B128	6	NCR		ACCESSIBILITY OF INSTRUMENTATION/EQUIPMENT (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
1B147	3	C220,C221	GP	A DOOR IS LOCATED DIRECTLY BEHIND THIS PANEL THAT SWINGS OPEN TOWARD THE PANEL. SUFFICIENT SPACE DOES NOT EXIST FOR AN OPERATOR AND THE OPEN DOOR.
1B159	2	C902	GP	INVENTORY LINE #1641,1642, AND 1645 ARE ABOVE THE 70 INCH LIMIT.
1B163	5	C7	GP	THE LATERAL SPREAD FOR C7 IS 120 INCHES.
1B164	5	C7	GP	INVENTORY #1439,#1448,#1454 TO #1456, AND #1462 TO #1509 CONTROLS ALL FALL BELOW 34 INCHES. INVENTORY #1351 AND #1352 ARE ABOVE 70 INCHES.
1B165	5	C7	GP	INVENTORY #1459 TO #1463 ALL FALL BELOW 41 INCHES.
1B221	3	N/A	GP	LIGHTING LEVELS DO NOT MEET MINIMUM REQUIREMENTS ON VERTICAL PANEL SURFACES.

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
1B222	3	N/A	GP	LIGHTING DOES NOT MEET REQUIREMENTS FOR UNIFORMITY WITHIN TASK AREAS O N CERTAIN PANELS.
1B223	3	N/A	GP	CONTROL ROOM EMERGENCY ILLUMINATION LEVELS ARE LESS THAN 10 FOOTCANDLE S FOR PANELS C1, C2, C3, C905, C904, C903, C171, C170, C7, C902, C910, C911, AND C4.
1C001	7	NA		DOCUMENT ORGANIZATION AND STORAGE: Location aids to access appropriate procedures do not conform to guideline criteria to identify, disting uish and access documents. In addition, the documents are not protecte d against wear.
1C002	7	NA		SPARE PARTS, OPERATING EXPENDABLES AND TOOLS: Spare parts are not read ily accessible. The storage space is limited and there is no inventor y accounting to ensure that an adequate supply of spares and expendabi les is readily available.
1C003	6	903		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 heigh t are: Panel 903: HPCI inverter (toggle switch) Panel 904: RCIC invert er (toggle switch)
1C004	7	NA		OPERATOR PROTECTIVE EQUIPMENT (Types of Equipment): No protective equi pment other than the Scott Air Paks are available in the control room
1C005	2	NA		ILLUMINATION (Shadowing): Labels below instrumentation on vertical pan els are shadowed. This is especially true for recorders which project beyond the panel surface.
1C006	6	NA		No space is provided for personal storage.
1C025	6	905		CONSISTENCY OF MANNING WITH EQUIPMENT LAYOUT (COVERAGE): The overhead TV monitor used to display computer generated data at the 905 panel i s not located in a convenient position for operator viewing. This obse rvation is supported by OER-002.
1C026	7	NA		OPERATOR PROTECTIVE EQUIPMENT (Expendables): There are no replacement air tanks that are readily available.
1C036	7	C76	GP	A SINGLE STEP DOWN TO THE PRIMARY OPERATING AREA COULD CAUSE A TRIPPIN G HAZARD.
1C041	7	C921	GP	THERE ARE TWO HOLES IN PANEL C921 WHERE TWO ANNUNCIATOR TILE ARE MISSI NG.
1C045	6	N/A	GP	THE SIMPLEX CPU IS UNCOVERED AND UNPROTECTED. ITEMS COULD ACCIDENTLY D ROP INTO THE PRINTER OR INTO THE KEYBOARD.
1C060	2	C1	GP	INVENTORY ITEM #14 IS 80 INCHES FROM THE FLOOR
1C062	7	C7	GP	PANEL C7 IS A BACK PANEL THAT HAS ONLY 40 INCHES OF SEPARATION BETWEEN AN OPPOSING SURFACE

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
1C063	5	C7	GP	INVENTORY #1351 & 1352 CONTROLS ARE 74.25 INCHES HIGH. THEY SHOULD BE NO HIGHER THAN 73.6 INCHES.
1C064	5	CP600	GP	INVENTORY #520 TO #533 COMPONENTS ARE BELOW THE REQUIREMENT OF THE 95TH PERCENTILE MALE (25.8 INCHES). THESE CONTROLS ARE AT 20 INCHES.
1C067	7	C76	GP	FLOWCHARTS ARE DIFFICULT TO USE BECAUSE THERE IS NO LAYDOWN AREA FOR THEM. THE EASEL NOW BEING USED IS TOO SMALL AND FACES AWAY FROM THE PANELS (SCENARIO #1,4,5,7,10,12,14,15).
1C105	3	N/A	GP	LIGHTING LEVELS VARY BETWEEN GIVEN TASK AREAS.
1C106	3	N/A	GP	LABELS, INSTRUCTIONS, AND OTHER WRITTEN INFORMATION ARE IN SHADOWED POSITIONS WHEN THE OPERATOR'S HAND AND BODY ARE IN THE NORMAL POSITION FOR READING OR OPERATING.
2B016	6	NA		CONVENTIONAL POWERED TELEPHONE SYST (Handsets): The phones at the shift supervisor's workstation are not identified or coded by circuit or function. It should be noted that the communications equipment at this workstation is "jury rigged" and not functionally arranged. Some phones are inoperative and others broken or not connected to a live circuit. This observation is supported by OER-005.
2B017	7	NA		ANNOUNCING SYSTEM (Intelligibility and Coverage): Loud speaker voice messages cannot be heard in some rotating machinery areas, e.g., diesel generator space. Speaking from noisy areas masks the voice message. This observation is supported by OER-011.
2B018	6	NA		ANNOUNCING SYSTEMS (Loudspeaker Volume): Speaker gain control can reduce volume below audible level. This observation is supported by OER-007.
2B019	6	NA		ANNOUNCING SYSTEMS (Priority): Channel 3 is reserved for emergency or control room voice traffic but there is no priority procedure or capability for interrupting an announcement in progress.
2B020	6	NA		POINT-TO-POINT INTERCOM SYSTEMS: There is no point-to-point intercom between the control room and the watch engineer's office. This observation is supported by OER-010.
2B021	7	NA		EMERGENCY COMMUNICATIONS (Equipment Usability and Voice Communications) Voice communications while wearing a face mask is unsatisfactory. This observation is supported by OER-008.
2B022	7	NA		FIXED BASE VHF TRANSCEIVERS (Procedures): Procedures are written for this system but not posted.
2B179	2	C7	GP	THE SRO HAD TO LEAVE SUPERVISOR'S STATION AND WALK BACK TO PANEL C7 TO RECEIVE FEEDBACK FROM THE OPERATOR WHO WAS THERE MONITORING EQUIPMENT. A DIRECT COMMUNICATION LINE TO C7 WOULD BE BENEFICIAL (SCENARIO #4).
2C009	6	NA		ANNOUNCING SYSTEM (General): The 5 voice channels are continuously in

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION........
				use. During plant shutdown, when contractors are at the plant, they generate nuisance sounds that interferes with control room communications. This observation is in support of OER-007.
2C010	1	C170,C171		SIGNAL INTENSITY (Comfort): The PAM alarm and fire alarm produce sounds that are a discomfort to the operator.
2C011	7	NA		READABILITY (False Alarms): Fire alarm is activated by cigarette smoke in areas of the Administration Building, Control Room Annex and Security Alarm Station (SAS).
2C069	7	C171	GP	THERE WAS SOME CONFUSION AS TO WHETHER SAFETY VALVES AND SAFETY RELIEF VALVES COULD BE USED INTERCHANGEABLY (SCENARIO #9).
2C071	2	N/A	GP	THE LOCATION OF CONTROLS FOR PAGE PHONES ON THE LOWER CONSOLES NECESSITATES THAT OPERATORS STOOP AND LOSE SOME MOBILITY WHEN COMMUNICATING WITH THESE DEVICES (SCENARIO #10).
2C101	7	N/A	GP	SCREEN 040 (MAX CORE UNCOVERY TIME LIMIT) USES A LOGARITHMIC SCALE.
3A014	1	C3	GP	ALARMS ON THE PANEL C3 SIDE OF THE CONTROL ROOM ARE TOO QUIET (SUBJECTIVELY). THOSE ON THE C170/171 ARE TOO LOUD (SCENARIO #1,5,12). OPERATORS ALSO HAD SOME DIFFICULTY LOCALIZING ALARMS (SCENARIO #12,15).
3B023	1	NA		ALARM PARAMETER SELECTION (General Alarms): 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	902, 904, 905		ALARM PARAMETER SELECTION (Multi-channel or Shared Alarms): There are at least 5 alarms that are shared: Panel 904: TORUS THOUGH ALARM HI/LO #782. Panel 904: RECIRC PUMP OIL LEVEL HI/LO #781. Panel 904: DRYWELL PRESSURE HI/LO #780. Panel 904: REACTOR WATER HI/LO LEVEL #1033. Panel C1: A/B/C SERVICE WATER PUMPS LOW DISCHARGE PRESSURE #38. This observation is supported by OER-014.
3B025	1	905,C2		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	NA		PRIORITIZATION (Levels of Priority): There is a lack of a systematic ann. prioritization scheme. The tiles that shoud be prioritized are: Panel 903: HPCI ISOLATED, OFF GAS TIME INITIATED. Panel 904: PCIC ISOLATELD, CLEAN-UP HI TEMP, NONREGEN [illegible], DRYWELL 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, - TBCCW 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

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				TRIP, - RPS M/G SET B BKR TRIP, STATOR COOLING WATER. THIS OBSERVATI ON SUPPORTED BY OER-015.
3B027	1	NA		CLEARED ALARMS (Auditory Signal): There is no distinct audible signal to distinguish cleared alarms from alerting alarms.
3B028	1	NA		VISUAL ANNUNCIATOR PANELS (Location): Some annunciator tiles are on di fferent panels than their controls (e.g., the OFFGAS TIMER tile is on Panel 903 with associated control on Panel C1). This observation is s upported by OER-017.
3B029	1	NA		VISUAL ANNUNCIATOR PANELS (Labeling): Individual annunciator panels ar e not all labeled.
3B030	1	NA		VISUAL ANNUNCIATOR PANELS (Lamp Replacement): 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	905		VISUAL ALARM RECOGNITION AND IDENTIFICATION (Contrast Detectability): The opaque yellow annunciators on panel 905 (#1033) are difficult to distinguish between 'ON' and 'OFF' states. This observation is support ed by the annunciator OER-049.
3B032	1	NA		VISUAL ALARM RECOGNITION AND IDENTIFICATION ("Dark" Annunciator Annunc iators are lit to indicate equipment is out of service (continuous). This observation is in support of OER-019.
3B033	1	NA		ARRANGEMENT OF VISUAL ALARM TILES (Labeling of Axes): Annunciator pane ls are not labeled to conform with this criteria.
3B034	1	905		ARRANGEMENT OF VISUAL ALARM TITLES (Pattern 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	NA		ARRANGEMENT OF VISUAL ALARM TILES (Pattern Recognition): Tiles are not grouped by logical organization because of changes subsequent to the original design. This Observation is supported by OER-049.
3B036	1	NA		VISUAL TILE LEGENDS (Unambiguous and Abbreviations) Some contain exces sive information and others contain insufficient information. In addi tion, abbreviations and acronyms are not used consistently on all time s e.g., Delta-;/Diff Press, REAC/Reactor/Rx. This observation is suppo rted by annunciator OER summary.
3B037	1	NA		VISUAL TILE LEGENDS (Singularity and Specificty): Some tiles refer the operator to annunciator panels outside the main control area. In add ition, there are tiles that alarm for two 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	NA		VISUAL TILE READABILITY (Distance and Letter Dimensions and Spacing):

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				The lettering size on the annunciator tiles do not conform to the guideline criteria. This observation is supported by OER-016.
3B039	1	NA		VISUAL TILE READABILITY (Type Style): The letter type style and size differ on the annunciator lettering. This observation is supported by OER-016.
3B040	1	NA		VISUAL TILE READABILITY (Legend Contrast): There are several annunciator tiles that have light letters on dark background (panel 905 #1034). Other annunciators are labeled using dynotape (panel C3 #248 and panel 905 #1033).
3B043	1	NA		CONTROL SET DESIGN (Positioning of Repetitive Groups etc.): All control set designs are not alike, e.g., Panel C7 has two sets, one horizontal and one vertical. Panel C6 only has two pushbuttons and C170 has three pushbuttons arranged in a triangular formation.
3B044	1	NA		ARRANGEMENT OF VISUAL ALARM TILES (Out of Service Alarms etc): Tiles labeled for equipment that has not been used and will not be used are still included on the annunciator panels, e.g., PLANT HEAT EXCHANGERS A AND B. This observation is supported by OER-018.
3B045	1	NA		SIGNAL DETECTION (Intensity): There is a large discrepancy in the audible alarm intensities. The PAM alarm is too high and the alarm intensity on panels C1, C2 and C3 are too low. This observation is supported by OER-021.
3B047	1	NA		SIGNAL DETECTION (Identification): The auditory alarm does not provide for workstation or system identification. This observation is supported by OER-019.
3C012	1	NA		ALARM PARAMETER SELECTION (Multi-channel or Shared Alarms): The annunciator system does not have a reflash capability.
3C042	1	C921	GP	THE "HPCI TORUS PIPING HIGH TEMP" (TS-2340-8A) ANNUNCIATOR HAS A PRESS-ON OVERSIZED LABEL.
3C097	4	C904	GP	THIS SYSTEM USES "HOME-MADE" ALARMS ON PANEL RATHER THAN USING ANNUNCIATOR SYSTEM.
4A003	6	905		ROTARY SELECTOR CONTROLS (Positioning): No positive detent feedback for reactor mode switch on Panel 905 (#1264).
4B048	2	All		GENERAL PRINCIPALS (Human Suitability): All "J" handles are the same for pumps, valves and switches - some of two position, others are "jog" - poor discrimination by function or mode of operation. This observation is supported by OER-023.
4B049	2	C3		PREVENTION OF ACCIDENTAL ACTIVATION (Movable Covers or Guards): Panel C3: Switch #410 should be guarded. Back Panels: Instrument air nitrogen to drywell and FW heater block valves were identified during the OE

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				R as controls that should be guarded. This observation is supported by OER-026.
4B050	2	C1, C3, 904		PREVENTION OF ACCIDENTAL ACTIVATION (Movable Covers or Guards): Protec tive covers on controls that interfere with adjacent controls: Panel C1: Control #122 interferes with control #107, 119 and 120. Panel C3: Control #425 interferes with control #403. Panel 904: Control #955 int erferes with control #960.
4B051				
4B051A	2	904, C3, C7		DIRECTION OF MOVEMENT: Controls that violate 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, 1377, 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, 1477 have operator notation that indicates control movement violates population sterotype permanent lab els on the controls. Panel C2: #192, 206, 207, 208, 215, 216 turn coun terclockwise to raise and clockwise to lower. This observation is supp orted by OER-024.
4B051B	4	904, C3, C7		DIRECTION OF MOVEMENT: Controls that violate 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, 1377, 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, 14[illegible]8, 1454, 1455, 1477 have operator notation that indicates control movement violates population sterotype permanent lab els on the controls. Panel C2: #192, 206, 207, 208, 21[illegible], 216 turn coun terclockwise to raise and clockwise to lower. This observation is supp orted by OER-024.
4B051C	6	904, C3, C7		DIRECTION OF MOVEMENT: Controls that violate 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, 1377, 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

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				"J" handles #1413, 1448, 1454, 1455, 1477 have operator notation that indicates control movement violates population sterotype permanent labels on the controls. Panel C2: #192, 206, 207, 208, 215, 216 turn counterclockwise to raise and clockwise to lower. This observation is supported by OER-024.
4B051I				SEE 4B051C
4B052	2	All		CODING OF CONTROLS (Consistency): There is a limited amount of color coding 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	C1,C3		CODING OF CONTROLS (Location Coding): Mirror 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	All		CODING OF CONTROLS (Shape Coding): Shape 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	All		CODING OF CONTROLS (Color Coding): Except 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	905		LEGEND PUSHBUTTONS (Discriminability): The rod selector pushbuttons on the bench board are the same in size and appear- ance 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	905		LEGEND PUSHBUTTONS (Barriers): No barriers provided for contiguous pushbuttons. Panel 905.
4B058	2	C1		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	905		PREVENTION OF ACCIDENTAL ACTIVATION (Resistance to Movement): During the OER, operators reported that rod control switch #1268 and notch override switch #1261 have excessive spring loading. This observation is supported by OER-025.

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
4B059B	7	905		PREVENTION OF ACCIDENTAL ACTIVATION (Resistance to Movement): During the OER, operators reported that rod control switch #1268 and notch override switch #1261 have excessive spring loading. This observation is supported by OER-025.
4B060				
4B060A	2	See below		GENERAL PRINCIPLES (Economy): Controls not used or not connected are: Panel 903: #638, 663, 677, 645, 690, 589 Panel 904: #927,1023,997,1001,1013,1017 Panel 905: #1257 Panel C2: #221 Panel CP600: #512. GENERAL PRINCIPLES (Economy): The key switch on control #512 violates tech specs and should be removed and circuit frozen in position 2.
4B060B	4	See below		GENERAL PRINCIPLES (Economy): Controls not used or not connected are: Panel 903: #638, 663, 677, 645, 690, 589 Panel 904: #927,1023,997,1001,1013,1017 Panel 905: #1257 Panel C2: #221 Panel CP600: #512. GENERAL PRINCIPLES (Economy): The key switch on control #512 violates tech specs and should be removed and circuit frozen in position 2.
4B060C	6	See below		GENERAL PRINCIPLES (Economy): Controls not used or not connected are: Panel 903: #638, 663, 677, 645, 690, 589 Panel 904: #927,1023,997,1001,1013,1017 Panel 905: #1257 Panel C2: #221 Panel CP600: #512. GENERAL PRINCIPLES (Economy): The key switch on control #512 violates tech specs and should be removed and circuit frozen in position 2.
4B060I				SEE 4B060A
4B115				
4B115A	4	903		GENERAL PRINCIPLES (ADEQUACY): The pushbuttons #666 and 645 on panel 903 have a "cheater capability" to keep the pushbutton activated
4B115B	6	903		GENERAL PRINCIPLES (ADEQUACY): The pushbuttons #666 and 645 on panel 903 have a "cheater capability" to keep the pushbutton activated
4B115I				SEE 4B115A
4B126	2	905,C1		CODING OF CONTROLS (Location Coding): Control 1301 is located on panel 905 with its associated system located on panel C1.
4B131	4	C7		DIRECTION OF MOVEMENT: Switches 1434, 1435, 1436, 1443, and 1445 have "open" at the left position and "auto" at the right position. Switches 1400, 1401, 1402, 1403, 1404, 1405, 1406 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-auto" and "open". The functional positions of the controls do not conform with convention.
4B131I				SEE 4B131
4B132	6	903		GENERAL PRINCIPLES (Human Suitability): In executing the task "Inhibit Auto ADS" (1T: 31.00), the operator must remember to reset ADS timer

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				A, 653, and B, 698 (panel 903) within every 120 seconds. Failure to r eset the timers could alter the plant response such as to erroneously indicate to the operator that additional failures have occurred and un neccessarily aggravate operator tasks.
4B148	5	C174,C175	GP	THERE IS POOR GROUPING OF CONTROLS ON C174 AND C175 DUE TO POOR COMPON ENT LABELING AND NO HIERARCHICAL LABELING OR DEMARCATION.
4B149	2	C174,C175	GP	42-17A14/CS ON C174 AND 42-18A14/CS ON C175 BREAK THIS STANDARD CONVEN TION BY HAVING OFF TO THE RIGHT. 42-17A16/CS ON C174 AND 42-18A16/CS O N C175 BREAK THIS CONVENTION BY HAVING OFF IN THE MIDDLE POSITION.
4B166	2	C7	GP	THE DISPLACEMENT BETWEEN THE CLOSE AND OPEN POSITIONS IS 45 DEGREES.
4B171	7	C1	GP	THE RHR Hx INL VLV B1783 AND 1784 AND E1883 AND 1884 JOG VALVES MAY BE HELD FOR LENGTHY PERIODS (SCENARIO #1,3,6,8,11,13,15).
4B191	5	N/A	GP	SEVERAL PROCEDURES (EOP-03, 5.3.25) REQUIRE STARTING THE DRYWELL COOLI NG SYSTEM FANS. CONTROLS FOR THIS OPERATION ARE NOT AVAILABLE IN THE C ONTROL ROOM.
4B206	2	C904,C903	GP	TURBINE TRIP PUSHBUTTON SWITCHES NOT EQUIPPED WITH GUARDS.
4B209	4	C903	GP	TURBINE CONTROL & STOP VALVE INDICATORS ARE "OFF" IN MID-STROKE, CONTR ARY TO CONVENTION.
4B210	4	C904	GP	TURBINE CONTROL & STOP VALVE INDICATORS ARE "OFF" IN MID-STROKE, CONTR ARY TO CONVENTION.
4B212	6	C7	GP	TORUS VENT SWITCH HAS "T-HANDLE" GRIP. NO OTHER SWITCH IS LIKE THIS.
4B213	5	C905	GP	THE "HALF SCRAM" & "MSIV" LAMPS ON PANELS C915/C917 BELONG ALSO ON C90 5.
4B217	4	C904, C7	GP	LISTED SWITCHES ARE TWO-POSITION WITH "DEAD" INTERMEDIATE POSITION & N O DETENTS. SEE ATTACHED LIST OF SWITCHES.
4C013	7	NA		GENERAL PRINCIPLES (Compatibility with Emergency Gear): Operators have no experience using controls while dressed in protective clothing.
4C033	8	C77	GP	ONE LEGEND PUSHBUTTON ON THE PROCESS COMPUTER IS NOT READABLE UNDER TH ESE CONDITIONS.
4C034	8	C77	GP	THE PUSHBUTTONS ON THE PROCESS COMPUTER ARE 0.625 BY 0.625 INCHES. THI S DOES NOT MEET THE MINIMUM REQUIREMENTS.
4C035	8	C77	GP	A THREE POSITION KEYSWITCH (OFF, ON, MEMORY CHANGE) DOES NOT MEET REQU IREMENTS. THE DISPLACEMENT BETWEEN OFF AND ON IS 150 DEGREES, AND THE DISPLACEMENT BETWEEN ON AND MEMORY CHANGE IS 30 DEGREES.
4C037	2	C174,C175	GP	CS-K17X6 ON C174 AND CS-K18X6 ON C175 HAVE THE TEETH FACING DOWN.
4C046	2	C903	GP	THE TEETH ARE POINTING DOWN ON INVENTORY LINE #1806,1807, AND 1809.
4C066	5	C4	GP	FW BLOCK VALVE CONTROLS/INDICATIONS (M03427,3428,3471,3472,3477,3478,3 479,3480) ARE ON C4 IN BACK PANELS AREA RATHER THAN IN PRIMARY OPERATI NG AREAS. THESE VALVES WERE REQUIRED EARLY DURING SOME SCENARIOS (SCE

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				NARIOS #1,11).
4C068	2	C7	GP	THE DIESEL FIRE PUMP START PUSHBUTTON AND THE MOTOR DRIVEN FIRE PUMP A RE SIMILAR IN APPEARANCE TO ALARM ACKNOWLEDGE CONTROLS (SCENARIO #4).
4C084	2	C7	GP	THE FOLLOWING RBCCW DAMPER CONTROLS DO NOT HAVE UNITS INDICATED ON THE IR SCALES (INVENTORY NUMBER): 1357,1359,1360,1362,1377,1379,1380,1382, 1385,1387,1390,1391,1392,1394,1395,1397,1398. ALSO CONTROL DIRECTION I S CLOSE-CLOCKWISE. THIS IS CONTRARY TO POPUL
4C089	2	C1	GP	SWITCH FOR AIR DRYER BYPASS VALVE HAS CAUTION LABEL (DO NOT OPEN).
4C091	2	C905	GP	STABILIZING VALVES ARE MECHANICALLY BLOCKED, YET SWITCH IS ON PANEL. S HOULD SWITCH BE REMOVED?
4C092	6	C904	GP	TWO PUSHBUTTON SWITCHES LABELLED "ABANDONED IN PLACE".
5A004	6	C170, C171		SCALE MARKINGS (Multi-scale Indicators); Recorders on these panels (43 4,439,441,444,448,449,1327,1332,1334,1337,1339) have only one scale w ith three different colored pens. Further the metal pens tear the pape r. This observation is supported by OER-029.DO THE CHART RECORDERS PRO DUCE INFORMATION THAT IS EASY TO READ & USE? The GE Recorders are diff icult to read and often fail. Recorder failure results in activating f alse annunciator alarms.
5A005	6	SEE ITEM 1		SCALE MARKINGS (Compatibility): The core water level display indicator s on panels 903, 904, 905, 170 and 171 all differ. Panel 903: #620, 6 34 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
5A009				
5A009A	2	C170, 903		USABILITY OF DISPLAY VALUES (Elimination of Operator Conversion): Reco rders 439,1429 and 615 display the same parameter but use different s cales requiring conversion to compare. This observation is supported b y OER-046.
5A009B	6	C170, 903		USABILITY OF DISPLAY VALUES (Elimination of Operator Conversion): Reco rders 439,1429 and 615 display the same parameter but use different s cales requiring conversion to compare. This observation is supported b y OER-046.
5A010	5	903,C7		COMPLETENESS OF INFORMATION: Monitoring the drywell (DW) temperature f or EOP entry conditions and for decision points therein, requires the temperatures above & below the 40 ft. point in the DW. The DW tempera ture indicators/recorder 582,637 (panel 903) and "Plant Air Temperatur e Monitor," KAYE Assembly: 1376, 1418, 1419, 1420, 1421, 1422, 1423, 1 424, 1425, 1426 (panel C7), with multiple readout points, do not disti nguish the temperatures relative to the 40 ft. point.

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
5A015	4	N/A	GP	ALARMS ARE NEEDED FOR DRYWELL BULK TEMPERATURE AT EOP ENTRY CONDITIONS (e.g. < 152 AND 281 DEG F) (SCENARIO #1).
5A016	4	C905	GP	REACTOR WATER LEVEL INDICATIONS ARE NOT ALWAYS CONSISTENT OR SUFFICIEN T ACROSS DIFFERENT INSTRUMENTS (MISMATCH) (SCENARIO #1,4,5).
5B061	2	903, C2, CP600		USABI'ITY OF DISPLAYED VALUES (Elimination of Operator Conversion): In strumen.. on panels requiring conversion are: Panel 903: #603,606,613 require mu..iplying by 5. Panel C2: #146 subtract value from 30. #147 multiply by 50 Pane. CP600: #479 multiply value by 5 This observation is supported by OER-30 and OER-033.
5B062	2	C3, C7		CONTRAST: Indicators with white letters on black background are: Panel C3: #332, 342, 329, 318. Panel C7: 1459.
5B063	2	All		PRINTING ON THE DISPLAY FACE (Provision 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: Foxboro indicators. Panel C170: #44 2, 443. Panel CP600: #466.
5B064	2	All		SCALE MARKINGS: (Values Indicated by Unit Graduations): Scale graduati on values that do not agree with guideli.. criteria for progression: Panel 903: #602,631,632,633,635,583,584,586,618,619,621. Panel 904: #8 29, 830, 831, 875, 876, 877, 878, 889, 890, 907, 908, 1025, 813. Panel 905: #1099, 1100, 1101, 1102, 1175, 1176, 1177, 1178, 1188, 1192, 119 3, 1171, 1107, 1108, 1162. Panel C2: #130, 133, 136. Panel C1: #14, 15 , 18, 19, 20, 25. Panel C3: #283, 287, 297, 301, 345. Panel CP600: #46 8, 469. Panel C7: #1367,1368,1369,1374,1375,1358,1378,1386,1393,1384,1 430,1361,1381,1389, 1396,1383.
5B065	6	903, 904		DIRECTIONALITY OF MOVEMENT AND NUMBERING WITH MOVING-POINTER METERS (V ertical Straight Scales): Values increase in downward movement. Panel 903: #629. Panel 904: #833.
5B066				
5B066A	1	See Below		GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS (Placement of Recorders): Recorders that must be verified and attended should be located in th e primary operating area. Panels C7 and 902 both con'ain recorders. Re corder on panel C2 #165 should be on Panel 903. Bo.. Title: Cntmt Ven t,Turbine,Process Rad,Rx Clg.
5B066B	2	See Below		GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS (Placement of Recorders): Recorders that must be verified and attended 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 Panel 903. Board Title: Cntmt Ven t,Turbine,Process Rad,Rx Clg.

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE HED DESCRIPTION..
5B066C	6	See Below	GENERAL CHARACTERISTICS OF GPAPHIC RECORDERS (Placement of Recorders): Recorders that must be verified and attended 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 Panel 903. Board Title: Cntmt Ven t,Turbine,Process Rad,Rx Clg.
5B066I			SEE 5B066C
5B067	5	NA	INFORMATION TO BE DISPLAYED (Completeness 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	C3, C2	CHARACTERISTICS AND PROBLEMS OF LIGHT INDICATORS (Precautions to Avoid Misinterpretation): The indicator lights above controls #206, 404, 4 06 have red lens on left and green lens on right (reversal from conven tion).
5B068I			SEE 5B068
5B069	2	C3	COLOR CODING (Consistency of Meaning): BUS trouble lights on Panel C3 use amber and white covers with the same meaning.
5B070	6	CP600	DISCRETE RECORDERS (Channel Selection Capability): Recorder #460 does not have the capability of selecting a single channel display.
5B071	2	904	INFORMATION TO BE DISPLAYED (Unnecessary Information): Indicator Light s #870 and 871 not needed or used.
5B110	6	C2	USABILITY OF DISPLAYED VALUES (Scale Range): 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 markings.
5B111	2	All	ZONE MARKINGS: The majority of instruments have no zone markings on th e instrument faces to identify opreating ranges, upper or lower limit s and danger zones used throughout the control room. Existing markings were applied without use of a standard or criteria.
5B119	4	903	READABILITY (CHARACTER HEIGHT): The character heights on meter #601 an d 610 do not subtend a visual angle of 15 minutes of arc
5B124	2	903	INFORMATION TO BE DISPLAYED (Unnecessary Information): The amber light s on instruments 720,721,750,751 are disconnected and their function removed.
5B127	6	903	USABILITY OF DISPLAYED VALUES (Scale Selection): RHR flow indicators 6 17, Loop A and 631, Loop B, and flow recorder 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 gpm increments o 602 : 200 gpm increments
5B133	2	904, C171	INFORMATION TO BE DISPLAYED (Completeness of Information): Monitoring

HED #..	IMPL. CATEG	CR PANEL #................	SOURCE	HED DESCRIPTION..
				SP pressure for EOP entry and decision points therein requires a range of 0-60 psig. SP pressure is available on 862 (panel 904), having a range of -1.0 to +2.0 PSID, or by combining DW/SP Delta-P, 863 (panel 904), with DW pressure, 1329 or 1330 (panel C171).
5B134	7	905		USABILITY OF DISPLAYED VALUES (Elimination of Operator Conversion): The plaque, 2004, defining reactor power level vs. IRM channel range position specifies reactor power in KWT or MWT whereas operator decision points in the EOPs require % power. Thus the operator must work with 2 different sets of power units during emergency events.
5B134I				SEE 5B134
5B135	6	C7		INFORMATION TO BE DISPLAYED (Completeness of Information): During the OER operators reported that they do not have feedback as to whether the torus or the drywell O-2 concentration sample points are being monitored. This observation is supported by OER-027.
5B135I				SEE 5B135
5B136	6	905		USABILITY OF DISPLAYED VALUES (Scale Range): The cooling water flow in the CRD hydraulic system is ~65 gpm but the flow indicator range, 1191, is 0-50 gpm.
5B160	2	C903	GP	THE GRADUATIONS HEIGHTS FOR INVENTORY ITEMS #602, #615, AND #636 HAVE .16 INCH MAJOR, .13 INCH INTERMEDIATE, AND .09 INCH MINOR MARKINGS WHICH ARE BELOW STANDARD. #636 HAS 19 GRADUATION MARKINGS BETWEEN NUMBERS ON BOTH SCALES
5B161	2	C903	GP	THE GRADUATION HEIGHTS FOR THE FOLLOWING INVENTORY ITEMS ARE BELOW STANDARD: #583 AND #584 HAVE .16 INCHES FOR MAJORS, .13 INCHES FOR INTERMEDIATES, AND .09 INCHES FOR MINOR MARKINGS. #620 HAS .16 INCHES FOR MAJORS AND .13 FOR MINOR MARKINGS. #1802 AND #
5B162	2	C905	GP	#1181, #1188, AND #1194 HAVE .19 IN. FOR MAJORS, .13 IN. FOR INTERMEDIATES, AND .09 IN. FOR MINOR MARKINGS. #1078 TO #1080 & #1082 HAVE .16 IN. FOR MAJORS AND INTERMEDIATES AND .09 IN. FOR MINOR MARKINGS. #1107-08 & #1162-63 HAVE .06 IN. FOR MAJORS AND I
5B167	2	C170,C171	GP	INVENTORY #438 ON C170 AND #1331 ON C171 HAVE 19 GRADUATIONS BETWEEN NUMERALS.
5B168	2	C170,C171	GP	INVENTORY #434,#439,#441,#449 ON C170 AND #1327,#1332,#1334,#1339 ON C171 DO NOT MEET GUIDELINES FOR THE MAJOR AND INTERMEDIATE MARKINGS. THE MAJORS ARE .16 INCHES AND INTERMEDIATES ARE .125 INCHES.
5B170	7	C911	GP	ARMs ARE NOT AVAILABLE FOR ALL AREAS CALLED OUT IN TABLE 4.2 OF EOP-4 (SCENARIO #1,7).
5B172	7	C170,C171	GP	TORUS LEVEL INSTRUMENTS (LI-1001-604A AND B) ARE NOT SENSITIVE ENOUGH TO READ TO NEAREST INCH AS REQUIRED (SCENARIO #1,3).

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
5B173	7	N/A	GP	THE MAXIMUM NORMAL OPERATING MAIN STEAM TUNNEL AREA TEMPERATURE IN TAB LE 4.3 (EOP-4) IS 105 DEG F. OPERATORS INDICATE THAT THIS VALUE MAY BE INCORRECT (SCENARIO #1).
5B175	4	C903	GP	PRECAUTION IN PROCEDURE 2.2.19 REQUIRES DETERMINING WHETHER RHR FLOW R ATE EXCEEDS 5100 GPM. THE SCALE ON RHR FLOW METER 1040-1A IS NOT SENSI TIVE ENOUGH TO DETERMINE THIS VALUE ACCURATELY (SCENARIO #2).
5B178	2	C171	GP	THE CONTAINMENT H2 RECORDER (AR-1001-612A) WAS FOUND DIFFICULT TO READ ON SEVERAL OCCASIONS. THE RED INK CAN BE DIFFICULT TO READ. ALSO, THE RED PEN SHOULD APPEAR AS THE TOP SCALE AND SHOULD BE BETTER LABELED (SCENARIO #4,10,15,17).
5B182	7	N/A	GP	THE EMERGENCY CLASSIFICATION CHART WOULD BE COLOR CODED BETTER IF IT W AS CODED BY CLASSIFICATION AND NOT BY PLANT CONDITION (SCENARIO #8,10, 18).
5B183	7	C921	GP	ALARM POINTS NEED TO BE PROVIDED FOR THE CLEANUP PUMP B AREA TEMP MONI TOR (TABLE 4.3 OF EOP-4) (SCENARIO #9).
5B184	7	C903	GP	DRYWELL TEMPERATURES ARE DIFFICULT TO READ TO THE NEAREST 1 DEGREE ON TRU-9044 (REQUIRES FINDING 152, 212, AND 281 DEGREES F). THE CREW FELT THIS WAS NOT A MAJOR PROBLEM FOR THEM (SCENARIO #10).
5B187	7	C905	GP	THE STANDBY LIQUID CONTROL (SLC) LEVEL INDICATOR (LI-1140-2) READS IN GALLONS IN THE CONTROL ROOM RATHER THAN PERCENT AS REQUIRED (SCENARIO #12), ALTHOUGH A CONVERSION IS MADE WITH AN OPERATOR AID.
5B188	4	C903	GP	TORUS WATER TEMPERATURE INDICATION (TI-5022-01B) IS NOT SENSITIVE ENOU GH TO PERMIT READINGS OF ONE DEGREE (e.g., 135 DEGREES F) (SCENARIO #1 3).
5B192	2	C903	GP	PROCEDURE 2.2.21 REQUIRES OPERATING THE TURBINE AT A MINIMUM SPEED OF 715 RPMs. IT IS DIFFICULT TO DETERMINE THIS VALUE WITH ACCURACY ON THE EXISTING TURBINE SPEED INDICATOR. ITS RANGE IS 0-6000 RPM AND SCALE I NCREASES FROM TOP TO BOTTOM IN VIOLATION OF
5B193	6	C910	GP	EOP-04 REQUESTS AN INDICATION OF REACTOR BUILDING VENTILATION EXHAUST RADIATION OF GREATER THAN 710 CPS. EXISTING METERS HAVE A RANGE TO 10E 6 CPS MAKING THE TASK DIFFICULT TO PERFORM.
5B194	2	C910	GP	EOP-04 REQUESTS AN INDICATION OF 16 MR/HR FOR REFUEL EXHAUST RAD LEVEL . EXISTING METERS HAVE EXTENDED SCALE (0-1 X 10E3) AND ARE NOT SENSITI VE ENOUGH IN THE REQUIRED RANGE.
5B195 5B195A	4	C905	GP	EOPs require indications of reactor pressure of 125, 1085, 181, 246, 376, 767 psig. These values are difficult to determine on existing wide range meters/recorders. The narrow range meter spans a range of 950 to 1050 psig.

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
5B195B	7	C905	GP	EOPs require indications of reactor pressure of 125, 1085, 181, 246, 376, 767 psig. These values are difficult to determine on existing wide range meters/recorders. The narrow range meter spans a range of 950 to 1050 psig.
5B196				
5B196A	4	N/A	GP	The EOP's require identifying reactor water level indications of -49 in., -126.3 in., -157 in., and -169 in. (see also HEO #207). Existing instrumentation on boards is difficult to read to this level of accuracy.
5B196B	7	N/A	GP	The EOP's require identifying reactor water level indications of -49 in., -126.3 in., -157 in., and -169 in. (see also HEO #207). Existing instrumentation on boards is difficult to read to this level of accuracy.
5B198	7	N/A	GP	EOPs REQUEST AN INDICATION OF 11 PSIG TORUS PRESSURE (SEE ALSO HEO #20 9). THIS INFORMATION IS NOT AVAILABLE.
5B199	7	C903	GP	EOPs REQUEST INDICATIONS OF SECONDARY CONTAINMENT AREA TEMPERATURES OF 180, 310, 105, 120, 214, 213, 238, 258, 130, 309, 251, AND 224 DEGREE S F. EXISTING METER (TI-260-19) IS DIFFICULT TO READ TO A 1 DEGREE ACC URACY.
5B200	7	C903	GP	THE DRYWELL LEVEL INDICATOR (LI-5008) HAS A RANGE APPROXIMATELY 46-80 FT. EOP 5.3.24 REQUIRES READING LEVEL AT 11 FT.
5B202	4	C905	GP	REACTOR WATER LEVEL NARROW RANGE INDICATORS 263-100A AND 263-100B HAVE MINOR SCALE INCREMENTS OF 2.5 INCHES. THIS MAKES THESE SCALES DIFFICU LT TO READ TO THE NEAREST INCH (SEE ALSO HEO #207 AND #114).
5B208	2	C903	GP	METER SCALES DO NOT MEET GUIDELINE
5B216	5	C7	GP	SBGT SYSTEM STATUS/OPERATION CANNOT BE OBSERVED FROM THE PRIMARY OPERA TING AREA.
5B219	7	N/A	GP	GRID AXES ON EOP CURVES ARE REPRESENTED AS SMALL DOTS. THESE VARY IN N UMBER FROM CURVE TO CURVE (e.g., FIGURE 3.2). THE GRID[illegible] [illegible]O NOT PROVIDE ACCEPTABLE MINOR SCALE GRADUATION INFORMATION FOR AC[illegible] ATELY READING CURVES.
5C014	7	All		GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS (Scale Compatibility): Re corder scales and recorder paper that are 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. Panel CP902: Area Rad FR 705-4, AR 5075-A.
5C015	6	CP600		SPECIFIC RECORDER TYPES (Continuous Recorders-Labeling): There is no r ecorder labeling on Panel CP600 - #466.
5C016				

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
5C016A	2	905,C2		USABILITY OF DISPLAYED VALUES (Scale Selection): The scales on APRM meters #1162,1163,1107,1108 on Panel 905 and #168 on Panel C2 do not provide the required precision. This observation is supported by OER-031
5C016B	6	905,C2		USABILITY OF DISPLAYED VALUES (Scale Selection): The scales on APRM meters #1162,1163,1107,1108 on Panel 905 and #168 on Panel C2 do not provide the required precision. This observation is supported by OER-031
5C017	7	NA		PRECAUTIONS TO ASSURE AVAILABILITY (Bulb Changing Hazard): Changing a light bulb on panel C3 caused a short and resulted in a "scram."
5C017I				SEE 5C017
5C018				
5C018A	2	C2		GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS (Use): Recorder #146 provides confusing values. This HED is supported by OER-030.
5C018B	6	C2		GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS (Use): Recorder #146 provides confusing values. This HED is supported by OER-030.
5C019	6	904, C1		GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS (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	904		USABILITY OF DISPLAYED VALUES (Scale Selection): The units on instruments #912 and 894 are worn away and one is replaced with tape.
5C021	6	905		USABILITY OF DISPLAYED VALUES (Scale Selection): The power value is shown in percent power to a level of 125 percent for #1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1145, 114[illegible] [illegible]149, 1151, 1153, 1155, 1157, and 1159. What does 125 percent refer to?
5C022	2	All		SCALE MARKINGS (Use of Graduations): Scales 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	905		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 stated 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.
5C039	7	C114,C115	GP	NO DIRECT BULB-TEST CAPABILITY AVAILABLE.
5C047	7	C904	GP	THE POINTER FOR INVENTORY #814 OVERLAPS NEARLY THE ENTIRE MINOR GRADUATION
5C048	2	C904	GP	THE GRADUATION HEIGHTS FOR #814 ARE .16 INCHES FOR MAJORS, .13 INCHES

HED #..	IMPL. CATEG	CR PANEL #..............	SOURCE	HED DESCRIPTION..........
				FOR INTERMEDIATES, AND .09 INCHES FOR MINOR MARKINGS
5C049	2	C1	GP	INVENTORY ITEMS #23 TO #25 HAVE .16 IN. FOR MAJORS, .13 IN. FOR INTERMEDIATES, AND .09 IN. FOR MINOR MARKINGS.
5C050	7	C1	GP	THE POINTERS FOR INVENTORY ITEMS #14, #15, AND #24 TO #25 OVERLAPS NEARLY THE ENTIRE MINOR GRADUATION
5C061	2	C2	GP	INVENTORY ITEMS #144 TO #146, AND #165 HAVE .16 IN. FOR MAJORS, .13 IN. FOR INTERMEDIATES, AND .09 IN. FOR MINOR MARKINGS. ITEM #175 HAS .13 IN. FOR MAJORS, .09 IN. FOR INTERMEDIATES, AND .06 IN. FOR MINOR MARKINGS
5C065	2	CP600	GP	INVENTORY #475 TO #478 RECORDERS ON CP600 DO NOT MEET GUIDELINES FOR THE MAJOR MARKINGS. THE MAJORS ARE .16 INCHES.
5C070	2	C2	GP	THE SCALE FOR CONDENSER VACUUM ON PR-3392 HAS UNIT INCREMENTS OF 8 AND IS THEREFORE DIFFICULT TO USE (SCENARIO #10).
5C076	2	C3	GP	PROCEDURE 2.2.146 REQUIRES OPERATOR TO VERIFY AN INDICATION OF 4160 VOLTS ON THE SHUTDOWN TRANSFORMER VOLTAGE INDICATOR. THE EXISTING METER IS DIFFICULT TO READ TO THE NEAREST 10 VOLTS.
5C078	2	C2	GP	MS PRESSURE WIDE RANGE RECORDER SCALE (PR-3050) HAS UNIT INCREMENTS OF 350. THIS IS NOT A PREFERRED MULTIPLE FOR THIS SCALE.
5C081	2	C1	GP	PROCEDURE 2.2.96 REQUIRES OBSERVING THAT FEEDWATER PRESSURE REMAINS ABOVE 1140 PSIG. RFP DISCHARGE PRESSURE INDICATORS (PI-3448, PI-3458, PI-3468) ARE DIFFICULT TO READ TO THAT LEVEL OF ACCURACY.
5C088	5	C1	GP	RECORDER CRU-3361 IS MULTI-CHANNEL, BUT ONLY ONE CHANNEL USED.
5C090A	2	C903	GP	LIGHTS FOR CONTROL VALVES CV9068A & B SHOW COMMAND, NOT STATUS.
5C090B	4	C903	GP	Lights for control valves CV9068A & B show command, not status.
5C102	7	N/A	GP	INTERMEDIATE AND MINOR GRADUATIONS WERE OFTEN NOT USED.
5C103	7	N/A	GP	A NUMBER OF THE SCALES HAVE INCREMENTS THAT DO NOT MEET THE GUIDELINE SUCH AS SCREEN 022 TORUS WATER LEVEL (0,75,150,225,300).
5C104	5	N/A	GP	THERE IS NO INDICATION IN THE CONTROL ROOM OF FWSU REG BYPASS VALVE (6-HO-443).
6B072	2	CP600,C7,903,904		NEED FOR LABELING: Labels on Panel CP600: #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	All		HIERARCHICAL SCHEME: The limited hierarchical labeling does not adequately satisfy these guideline criteria. This observation is supported by OER-041.
6B074	2	All		PLACEMENT (Normal Placement): Labels not placed above their associated controls are: Panel CP600: #472, 473, 500, 501, 527, 528, 518, 519,

HED #..	IMPL. CATEG	CR PANEL #................	SOURCE	HED DESCRIPTION..
				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, 13 05, many pushbuttons. Panel C1: #26, 27, 46, 48, 56, 57. Panel C4: #15 20,1521,1522,1523,1524,1525,1526,1527,1528.
6B075	2	All		PLACEMENT (Panel Labeling): All display labels are placed below the in strument and does not conform to guideline criteria.
6B076	2	All		CONSISTENCY (Internal Consistency and Consistency 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 suppo rted by OER-039.
6B077	2	All		BREVITY: There is an inconsistency in labeling, Some labels use comple te words for abbreviations that are in common usage by operators, e.g ., RCS/Reactor Cooling System. This observation is supported by OER-03 9.
6B078	2	903		FUNCTIONAL GROUPS (Functional Relationship and Location): Controls for fast start-up test and fast injection procedures require a set of co ntrol actuations in sequential series. The controls associated with th ese sequential actions are scattered across the panel requiring the op erator to search for proper controls in sequence This observation is s upported by OER-036.
6B079	6	903,904,C1		CONTROL POSITION LABELING (Direction): The 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 c[illegible] directions differ from labels Panel C3: #356, 372, 377, 380 This o[illegible]ation is supported by OER-024.
6B080	2	All		R[illegible]ILITY (Character Height): Character heights are not consistent, e.g., Panel C3 - #411, 415, 421, 423. Also Panel C2: #146, 165. The s maller character size does not meet guideline criteria. This observati on is supported by OER-038.
6B081	2	All		READABILITY (Contrast): All labels are white characters on black or da rk background. This does not conform with the guideline criteria and contributes to the observation reported under HEO 6.6.005 (HED 6C023.7
6B082	2	NA		USE (Necessity and Human Factors Practices): Temporary labels have bee n on the panels for an extended period of time, e.g., many dynotape l abels as on Panel C3: #246, 247, 248 annunciators or C170: #450, 451, 452, 453, 454, 455, 456, 457, 1340, 1341, 1342, 1343, 1344, 1345, 1347 , 1338. On Panel C7 operators have penciled in label identification wh ich conflicts with permanent label, e.g., #1454. This observation is s

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION........
				upported by OER-040.
6B083	6	C7		USE (Adjacent Devices): Panel C7 - #1433 covers labels on #1440. Assessment of this criteria is limited because the tags were removed during panel photography.
6B084	2	See Below		DEMARCATION (Permanence): Stick-on tape is used for most of the demarcation lines on Panels #903, 904, C1, CP600 Board Title: Rx CLG, Rx Clnup, FW & Cond, AOG
6B085	2	See below		COLOR: Colors are not associated with specific functions. Board Title: Rx CLG, Rx Clnup, FW & Cond, Electrical, PAM, Cntmt Vent Board No.: #903, 904, C1, C3, CP600, C7
6B086	2	C3		USE OF MIMICS (Color): The mimic lines on Panel C3 are not color discriminative.
6B087	2	C3		USE OF MIMICS (Color): Mimic lines on Panel C3 do not have adequate color contrast with the panel surface.
6B088	2	903		USE OF MIMICS (Color): The origin of all lines for the containment isolation mimic are not clear. This observation is supported by OER-044.
6B089	2	C3		INTERNAL CONSISTENCY: The bus indicator numbers do not increase progressively (#240 out of sequence). In addition, two different colored light caps are used.
6B090	2	903,904,C2		CONSISTENCY (With Procedures): Panel 903: Containment spray Signal label #755 and 770 should be changed to Containment Spray Permissive. Panel 904: Displays 685,886,887 read lbs/hr times 10 to the 6th and Procedure 2.2.84 (pg 18) indicates gal/min. Panel C2: #168 reads in mils; the instructions (2.2.99) reads in inches.
6B091	2	904,C3		CONSISTENCY (Internal Consistency): Panel 904: Labels for 992 and 1008 are different but the controls perform the same function. Panel C3: Label wording on controls 429,430 is confusing to relate to control function.
6B092	2	C1,C2,904		NEED FOR LABELING: Panel C1: Labels for lights above #36 and 37 are missing. Panel C2: 4 lights associated with control #231 do not have labels. Panel 904: Labels on 888,913 are missing.
6B120	2	All		CONTROL POSITION LABELING (POSITION): The functional control positions are worn off or have never been etched on the control plate (escutcheon) for a large number of switches
6B121	2	C170 and C171		NEED FOR LABELING: There are 8 key control selector switches on each of the PAM panels C170 and C171. The system function for the use of these controls is not identified.
6B125	2	903,C171		NEED FOR LABELING: The red and green lights associated with valve controls 720,721,750,751 indicate valve position command as opposed to va

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				lve position for all other valve controls in the control room. Valve position is indicated on panel C171, instrument 1338.
6B150	2	C174,C175	GP	INCONSISTENT USAGE OF LABEL SIZES THROUGHOUT PANELS. CONTROL POSITION LABELS WERE TOO LARGE AND WERE THE SAME SIZE AS COMPONENT LABELS.
6B151	2	C174,C175	GP	THE LABELS ON C174 AND C175 ARE INCONSISTENTLY PLACED AND DO NOT FOLLOW THIS GUIDELINE.
6B152	2	C174,C175	GP	THE LABELS HAVE NOT BEEN CLEANED. THEY HAVE PAINT PARTIALLY ON THEM AND THE LABELS ARE WORN OUT.
6B153	2	C174,C175	GP	OCCASIONALLY ABBREVIATIONS USE PUNCTUATION AND OTHER TIMES USE ONLY ABBREVIATION. ALSO OCCASIONAL ABBREVIATION IS MIXED WITH THE FULL SPELLING OF WORDS ON THE SAME PANEL.
6B154	2	C174	GP	THE LABELS ON THE H2 0-10% AND H2 0-20% RANGE INDICATOR LIGHTS COULD BE READ AS H20-10% AND H20-20%.
6B155	2	C174,C175	GP	ON PANELS C174 AND C175, THE WARNING LABEL "DO NOT RESET POST LOCA REFER PROC. 2.3.133" DOES NOT MEET THE COLOR CONVENTION FOR WARNING LABELS. THE OTHER WARNING LABELS ARE RED AND THIS ONE IS BLACK.
6B156	2	C174,C175	GP	ALL LABELS HAVE LIGHT CHARACTERS ON A DARK BACKGROUND.
6B17[illegible]	2	C7	GP	THE SECONDARY CONTAINMENT ACCESS LOCK INLET DAMPER (AON-114) IS INCORRECTLY DESIGNATED AS DAMPER #1 WHILE THE OUTLET DAMPER (AON-116) IS INCORRECTLY DESIGNATED DAMPER #2 (SCENARIO #3).
6B177	2	C7	GP	THE CREW INDICATES THAT THE MIMIC ON PANEL C7 IS HARD TO FOLLOW AND NEEDS IMPROVEMENT (SCENARIO #3).
6B180	1	N/A	GP	OPERATORS SUGGESTED THAT THE APPLICABLE POWER SUPPLY SHOULD BE INDICATED ON CONTROL LABELS (SCENARIO #5,8).
6B189	2	C905	GP	THE AIR DUMP SYSTEM TEST SWITCH SHOULD BE BETTER LABELED AS TO ITS FUNCTION.
6B197	2	C3	GP	POSITION INDICATION LABELS ON ESCUTCHEON PLATE FOR THE DIESEL GENERATOR START CONTROL AND THE DIESEL GENERATOR A VOLTAGE REGULATOR MODE SELECTOR CONTROLS ARE WORN AND UNREADABLE.
6B201	6	C3	GP	THE DIESEL GENERATOR GOVERNOR SPEED CONTROL HAS ITS LABEL SWITCH POSITIONS WORN.
6B205	2	C7	GP	CONTROLS FOR TORUS VACUUM BREAKERS AND AIR SUPPLY ARE EASILY CONFUSED.
6C023	6	All		VISIBILITY (Cleaning): The number of labels obscured by dirt or foreign matter would indicate that no procedure for cleaning exists.
6C030	2	C220,C221	GP	MOST OF THE LABELS ON C220 AND C221 HAVE WHITE CHARACTERS ON A BLACK BACKGROUND.
6C038	2	C174,C175	GP	THE TAG-OUTS COMPLETELY COVER THE LABELS.
6C040	2	C11[illegible],C115	GP	SOME LABELS ARE ENGRAVED INTO THE METAL MAKING THEM DIFFICULT TO READ. OTHER MARKINGS ARE ON DYMOTAPE. THE LARGER PANEL DESIGNATORS HAVE LIG

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				HT TEXT ON A DARKER BACKGROUND MAKING THEM DIFFICULT TO READ.
6C043	2	C921	GP	ALL THE LABELS HAVE LIGHT CHARACTERS ON A DARK BACKGROUND.
6C044	2	C921	GP	LABELS SHOULD BE PLACED ABOVE THE RECORDERS RATHER THAN ON THE RECORDER THEMSELVES (THESE LABELS OBSCURE A PORTION OF THE RECORDER).
6C072	2	C10	GP	THE MECHANICAL VACUUM PUMP CONTROL WOULD BE BETTER LABELED "OFF/NORMAL/START" TO REFLECT THE PROCEDURE (2.1.5) REQUIREMENT TO START THE PUMP. IT IS CURRENTLY LABELED "CLOSE/OPEN."
6C073	2	C904	GP	THE NITROGEN PURGE SUPPLY CONTROLLER (FC 5030B) HAS NO SYSTEM/PARAMETER IDENTIFYING INFORMATION ON ITS LABEL.
6C074	2	C1	GP	THE MID-POSITION IS NOT LABELED ON THE ESCUTCHEON PLATE OF A AND B SEA PUMP CONTROLS, THE C SERVICE WATER PUMP DISCH BLOCK VALVES(MO-3808,MO-3813), THE TBCCW NON-ESSENTIAL BLOCK SUPPLY(MO-4127), AND THE CONDENSER INLET VALVES (MO-3870, MO-3871, MO-3872,
6C075	2	C3	GP	THE SWITCH POSITIONS ARE NOT LEGIBLE ON THE MAIN GENERATOR FIELD BREAKER SELECTOR SWITCH.
6C077	2	C3	GP	MID POSITION IS NOT INDICATED ON THE BLACKOUT DIESEL GENERATOR START SWITCH AND THE BLACKOUT DIESEL GENERATOR TO BUS 1-AB SWITCH.
6C079	2	C2	GP	THE MID POSITION HAS NOT BEEN LABELED ON THE FOLLOWING CONTROLS: MECH PRESS REG SET PT SEL, ELECT PRESS REG SET PT SEL, CONTROL VLVS ABOVE SEAT DRAINS, AND STEAM LEAD LOW POINT DRAIN (MO-3096).
6C080	6	C1	GP	THE MID POSITION FOR THE REACTOR FEED PUMP CONTROLS A, B, AND C (A-101, A-205, A-102), AND THE CONDENSATE PUMP A, B, C (A-201, A-105, A-202) ARE NOT INDICATED ON THE ESCUTCHEON PLATE.
6C082	?	C904	GP	MID POSITION IS NOT LABELED ON THE RWCU PUMP SWITCHES (P-1205A, P-1205B).
6C083	2	C1	GP	THE MID POSITION IS NOT LABELED ON THE FOLLOWING RBCCW CONTROLS (INVENTORY NUMBERS): 104,108,121,124,120,123,102,109,103.
6C085	2	C3	GP	MIDPOSITION/AUTO IS NOT LABELED ON THE FOLLOWING SWITCHES: MAIN GENERATOR FIELD, EXCITER FIELD, ACB BREAKERS 105, BREAKER 104.
6C086	7	C904	GP	PROCEDURE 2.2.70 (STEP 7.2.3) REQUIRES MONITORING TORUS PRESSURE ON PI-5067B. ONLY INSTRUMENT PID-5067B IS AVAILABLE.
6C093	2	C1	GP	COARSE/FINE MAKEUP & REJECT CONTROLS HAVE LABELS WHICH ARE NOT CLEAR. MORE INFORMATION NEEDED.
6C094	6	C2	GP	THREE "SPEEDOMAX" RECORDERS ON PANEL HAVE NO LABELS.
7B137	8	N/A	GP	CANNOT OVERRIDE TREND PLOT DISPLAY FORMATS UNTIL THE TREND HAS BEEN PLOTTED (APPROXIMATELY 30 SECONDS).
7B138	8	N/A	GP	TRACKBALL WAS REMOVED LEAVING ONLY THE TAB CURSOR AND ARROW KEYS. THIS REQUIRES THE OPERATOR TO PERFORM TOO MANY MOVEMENTS TO MAKE A SELECTION.

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION............
7B139	8	N/A	GP	THE COLOR YELLOW HAS TWO DESIGNATED MEANINGS, CAUTION AND UNVALIDATED DATA.
7B140	8	N/A	GP	THERE IS NO DOCUMENTATION EXPLAINING THE ERROR MESSAGES READILY AVAILABLE FOR THE OPERATORS. THE ERROR MESSAGES ARE NOT SELF-EXPLANATORY.
7B141	8	N/A	GP	RESTARTING THE SYSTEM AFTER A CRASH TOOK A 1/2 HOUR.
7B142	8	N/A	GP	TAB EXECT KEY IS NOT GROUPED WITH OTHER TAB KEYS. ALSO, THERE ARE SEVERAL NON SPDS FUNCTION KEYS WHICH ARE COLORED BLUE (BLUE KEYS HAVE BEEN ALLOCATED TO SPDS).
7B143	8	N/A	GP	THE FORMAT MENU HAS NO INDICATION FOR THE TOTAL NUMBER OF PAGES (THREE PAGES).
7B144	8	N/A	GP	ALL COLORS FELL WELL BELOW THE M[illegible]MUM. THE FOLLOWING VALUES WERE OBTAINED IN FT-L: WHITE=11, BLUE=5.6, GREEN=6.5, CYAN=8.95, YELLOW=5.74, RED=3.[illegible]3, MAGENTA=5.97.
7B145	8	N/A	GP	3.3 FT-L WAS THE MEASURED BACKGROUND. THE RA[illegible]O BETWEEN THE LIGHTEST CHARACTER (WHITE) AND THE BACKGROUND WAS 3.5:1.
7B146	8	N/A	GP	CURSOR DIFFICULT TO SEE AND FOLLOW DUE TO: SMALL SIZE, CHANGING COLORS DEPENDING ON LOCATION ON THE SCREEN, AND UNSYSTEMATIC TABBING. THE CURSOR IS EASIER TO FOLLOW IF THE CROSSHAIRS ARE TURNED ON. HOWEVER, THE CROSSHAIR DISAPPEARS WITHIN A SHORT AMOUNT
8A006	2	CP600,C7,C170/171		ENHANCEMENT RECOGNITION AND IDENTIFICATION Panels [illegible]00,C7,C170,C171 lack operator enhancement aids. This observation is [illegible]ported by OER-043.
8A007				
8A007A	2	CP600		LOGICAL ARRANGEMENT AND LAYOUT (Other Expectations): The arrangement of Panel CP600 is not arranged for sequential operations.
8A007B	5	CP600		LOGICAL ARRANGEMENT AND LAYOUT (Other Expectations): The arrangement of Panel CP600 is not arranged for sequential operations.
8A008				
8A008A	2	C7		SEPARATION OF CONTROLS: Panel C7: All controls are too close and too cluttered.
8A008B	5	C7		SEPARATION OF CONTROLS: Panel C7: All controls are too close and too cluttered.
8B094				
8B094A	2	904, 905		STRINGS OR CLUSTERS OF SIMILAR COMPONENTS (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	904, 905		STRINGS OR CLUSTERS OF SIMILAR COMPONENTS (String Length): Panel 904: 48 pairs of red/green indicator lights produce a display grouping whi

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..........
				ch exceeds length criteria of 20 inches. Panel 905: Control rod matrix lights exceed maximum string length criteria of 20 inches.
8B095	2	904, 905, C3, C7		STRINGS OR CLUSTERS OR SIMILAR COMPONENTS (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	C1,C2,905		MIRROR IMAGING: Panel C1: Loop A and B for 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	C1,C2,905		MIRROR IMAGING: Panel C1: Loop A and B for 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	904		SEQUENCE FREQUENCY OF USE AND FUNCTIONAL 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	905		ENHANCING RECOGNITION AND IDENTIFICATION (Spacing): Set of controls for recorders #1107/1108 and #1162/1163 are not separated to indicate boundaries.
8B100	2	NA		ENHANCEMENT RECOGNITION AND IDENTIFICATION (Emergency Controls): No distinctive enhancements are used for emergency controls.
8B101	5	903,C1		SEQUENCE, FREQUENCY OF USE AND FUNCTIONAL CONSIDERATIONS (Sequence of Use): Operator must activate controls #768 and 753 on Panel 903 then go to Panel C1 to activate controls #101, 103, or 121, 124.
8B102	6	904, 905, 921		SEQUENCE, FREQUENCY OF USE AND FUNCTIONAL 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, 362, 863 on Panel 904.
8B102I				SEE 8B102
8B103	2	C2, 903		LOGICAL ARRANGEMENT AND LAYOUT (Order and Labeling): Panel C2: #218,21

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				9,227,228,232,233 are not arranged in a logical sequence. Panel 903: Controls #750 and 751 do not follow sequentially.
8B105	2	904		SEQUENCE,FREQUENCY OF USE,AND FUNCTIONAL CONSIDERATIONS (Sequence): The Primary & Secondary containment isolation status lights are positioned right-to-left and labels numbered from bottom-to-top.
8B122	2	903,C2 & C1		LAYOUT CONSISTENCY (REPEATED FUNCTIONS): The meters on HPCI 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	903		SEQUENCE, FREQUENCY OF USE, AND FUNCTIONAL 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.
8B157	5	C174,C175	GP	THE SWITCH NUMBERS ON THE J-HANDLE CONTROLS ARE BOTH ASCENDING AND DESCENDING IN NUMERICAL ORDER.
8B174	2	N/A	GP	THERE WAS A SUGGESTION THAT EOP RELATED INSTRUMENTATION COULD MORE EASILY BE FOUND IF IT WAS CODED AS SUCH (SCENARIO #1).
8B185	2	C171	GP	SRVs ON PANEL C171 SOMETIMES NEED TO BE MONITORED AT PANEL 903. THESE VALVE INDICATIONS NEED TO BE VISUALLY DISTINCT FROM THE SAFETY VALVES IN THE SAME GROUPING (SCENARIO #10).
8B204	2	C1	GP	"COMPARTMENT DOOR OPEN" LIGHT ON BENCHBOARD SHOULD BE ON VERTICAL SECTION OF PANEL WITH LESS IMPORTANT DEVICES.
8B211	5	C904	GP	LAYOUT OF SWITCHES NOT LOGICAL WHEN COMPARED TO SYSTEM (SEE COMMENTS).
8B214	5	C904	GP	PANEL NOT EFFECTIVELY ARRANGED (SEE COMMENTS).
8B215	2	C904	GP	MAIN STEAM LINE DRAIN CONTROLS SHOULD BE ON PANEL C2.
8B218	5	C904	GP	Panel not effectively arranged (see REMARKS)
8C031				
8C031A	2	C220, C221	GP	There are unbroken rows containing 7 and/or 8 components on panels C220 and C221.
8C031B	5	C220, C221	GP	There are unbroken rows containing 7 and/or 8 components on panels C220 and C221.
8C095	5	C1	GP	INDICATION FOR OFF-GAS HOLDUP LINE DRAIN VALVE (AO-3750) DOES NOT BELONG ON PANEL C1.
8C096	5	C1	GP	CONDENSATE PUMPS MIN FLOW VALVE (FV-3351) NOT WITH REST OF SYSTEM. IT IS LOCATED WITH SEA WATER SYSTEM.
9B106				
9B106A	2	903, 904		GENERAL MOVEMENT RELATIONSHIPS (Rotary Controls): Panel 903: Control #

HED #..	IMPL. CATEG	CR PANEL #...............	SOURCE	HED DESCRIPTION..
				626 increases clockwise, indicator #629 increases downward. Panel 904 : Control #842 increases clockwise, indicator #833 increases downward.
9B106B	6	903, 904		GENERAL MOVEMENT RELATIONSHIPS (Rotary Controls): Panel 903: Control # 626 increases clockwise, indicator #629 increases downward. Panel 904 : Control #842 increases clockwise, indicator #833 increases downward.
9B107				
9B107A	2	905		SINGLE CONTROL AND DISPLAY PAIRS (Association): Control #1185 for reco rders 1171 and 1172 and control 1196 for controllers #1299 and 1300 a re not located so that association is apparent.
9B107B	6	905		SINGLE CONTROL AND DISPLAY PAIRS (Association): Control #1185 for reco rders 1171 and 1172 and control 1196 for controllers #1299 and 1300 a re not located so that association is apparent.
9B108	6	C2, C3		SINGLE CONTROL AND DISPLAY PAIRS (Association): The direction of movem ent of controls and light colors are not consistent with convention. Controls (e.g., #206, 207, 208, 215, 216) move counterclockwise to rai se. Red/Green lights above controls #206, 404, 406 are reversed.
9B108I				SEE 9B108
9B109				
9B109A	2	C2		SINGLE CONTROL AND DISPLAY PAIRS (Proximity): Indicator #168 and contr ol #191 are not in close proximity to each other. Indicators #166 and 167 are distant from controls #229, 230, 231. Indicators #169, 170 ar e distant from controls #204, 205.
9B109B	6	C2		SINGLE CONTROL AND DISPLAY PAIRS (Proximity): Indicator #168 and contr ol #191 are not in close proximity to each other. Indicators #166 and 167 are distant from controls #229, 230, 231. Indicators #169, 170 ar e distant from controls #204, 205.
9B158	5	C174,C175	GP	THE CONTROLS ARE TOO EVENLY SPACED ACROSS THE PANEL AND IT IS DIFFICUL T TO SEE THE RELATIONSHIPS BETWEEN CONTROLS AND DISPLAYS.
9C032	2	C220,C221	GP	THE METER LOCATED IN SLOT A5 ON C220 AND C221 IS NOT WELL MARKED. IT I S DIFFICULT TO DISCERN WHICH SET OF CONTROLS AFFECT ITS OPERATION.
9C098	5	C904, C1	GP	RECORDERS CRU-E1, CRU-E2 ARE ON C904. THEY SHOULD BE ON C1 WITH REST O F SYSTEM.

371 items listed.

APPENDIX C

RESUMES OF KEY PERSONNEL

APPENDIX C

RESUMES

Resumes are in the following order:

- All General Physics Personnel
- All Boston Edison Personnel
- Other Contractor Personnel

LOTHAR R. SCHROEDER
Consultant

EDUCATION

Ph.D., Experimental/Applied Psychology, Lehigh University
M.S., Engineering Psychology, Lehigh University
B.S., General Engineering, University of Illinois
B.A., Psychology, University of Illinois

EXPERIENCE
1982 - Present

General Physics Corporation
Dr. Schroeder's areas of expertise include job and task analysis, procedures validation, systems development and equipment design, operations research, and organizational design and management. Representative projects include:

- Research & Development of Human Factors Guidelines
  Current managing a two-year research program with the Electric power Research Institute to develop new human factors guidelines for controls system enhancements and human-computer interface issues associated with fossil power plant control rooms.

- Development of Human Factors Program Plans
  Managed a project to assist du Pont in developing a program plan and integrating human factors into the system development cycle for new reactor facilities at DOEs Savannah River Plant.

- Integration of Distributed Digital Control and Display Systems
  Managed projects providing human factors assistance to Baltimore Gas & Electric's Wagner, Crane, and Brandon Shores Fossil Stations. This effort included support for the development and integration of distributed digital control and display workstations into the control room.

- Control Room Crew Task Analysis, U.S. Nuclear Regulatory Commission
  Supported an NRC research project applying control crew task analysis data in areas of human engineering design and staffing. Managed a follow-on research project for the NRC that has used the existing task analysis database to identify training needs and to evaluate emergency operating procedures.

- Emergency Response Capability Support
  Managed projects providing human factors emergency response capability support services to utilities in control room redesign, SPDS evaluation, emergency response facility review, and overall program integration.

- Procedure Development and Review
  Responsible for developing and supporting the implementation of procedures and verification/validation programs for plant operations, maintenance and emergency activities.

- Training Program Evaluation
  Participated in the evaluation of training programs for the Technology Transfer Group and supported the development of job aids for milling machine operators for General Motors' Advanced Engineering Staff.

- Diagnostic Skills and Supervisory Skills Training
  Developed and conducts supervisory skills and diagnostic skills workshop for operations and technical staff of various industries.

1981 - 1982 **UNC Nuclear Industries**
Dr. Schroeder worked as a human factors specialist, interfacing with engineers and other staff in identifying and solving problems relating to equipment design, the use of procedures, and training efforts at Hanford's N-Reactor. He also performed a human factors review of the control room in support of an ongoing control room upgrade program.

1974 - 1980 **Department of Psychology, Moravian College**
Dr. Schroeder's responsibilities as Assistant Professor and Department Chairperson included planning and coordinating a day and evening program in psychology involving more than 100

majors; serving on several college committees; supervising individual field study, independent study, and honors projects; and serving as academic advisor to day and evening session students having an interest in applied psychology.

1973 **Wigdahl Electric Company**

Dr. Schroeder worked as a consultant, identifying potential organization problems and conducting problem-solving sessions.

1972 **Jewish Employment and Vocational Services**

As an industrial psychologist, Dr. Schroeder consulted with several industries and government agencies to develop, validate, and administer job-related personnel selection tests under a U.S. Department of Labor contract.

PROFESSIONAL AFFILIATIONS

Member, Human Factors Society
Member and Past President of Chesapeake Chapter of the Human Factors Society
Vice Chairman of ISA Man-Machine Interface Committee

PUBLICATIONS

"Application of GERTS Network Analysis and Simulation Programming to Problem Areas in Psychology," Dissertation, Lehigh University, 1976.

"A Human Factors Guided Survey for Systems Development," American Nuclear Society Winter Meeting, December 1981. Coauthor with D. R. Fowler.

"Control Room Human Factors in Context," American Nuclear Society Winter Meeting, November 1982. Coauthor with D. R. Fowler and D. E. Friar.

"Learning Style Data Applied to Nuclear Pow[illegible] Plant Training Programs." American Nuclear Society Ann[illegible] Meeting, June 1983.

"Task Analysis of Nuclear Power Plant Control Room Crews, Volume 1-4," NUREG/CR-3371, U.S. Nuclear Regulatory Commission, June 1983. Coauthor with D. Burgy, C. Lempges, A. Miller, H. Van Cott, and B. Paramore.

"Crew Task Analysis Database: SEEK System Users Manual," NUREG/CR-3606, U.S. Nuclear Regulator Commission, March 1984. Coauthor with D. Burgy.

"An Evaluation of the Equipment Tagging Process in Nuclear Power Stations," Volume I of Proceedings of the Human Factors Society 27th Annual Meeting, October 1983. Coauthor with P. Doyle and S. Brewer.

"How to Apply Ergonomic Principles to Minimize Human Error and Maximize Human Efficiency," Chapter 3 in Handbook of Occupational Safety & Health, 1987. Coauthor with C. Gaddy.

"Emergency Operating Procedures in Flowchart Format: Human Factors Considerations," Volume I of Proceedings of ANS Topical Meeting on Anticipated and Abnormal Transients in Nuclear Power Plants, April 1987.

"Incorporating Human Engineering Principles in Distributed Controls Upgrades", Proc. of the 31st Power Instrumentation Symposium, May 23-25, 1988. Co-author with S. Stultz.

"Human Factors Considerations at Hazardous Waste Incineration Facilities," Sixth National Conference and Exhibition on Hazardous Wastes and Hazardous Materials, April 12-14, 1989. Co-author with C. Gaddy.

"Developing Human Factors Criteria for a New Reactor Plant", Proceedings of the Human Factors Society 33rd Annual Meeting, Vol. 2, Oct. 1989. Authored with R. Waters and D. Burgy.

"New Control Technologies Require Good Human Factors Engineering", Power Engineering, November 1989, Authored with C. Gaddy and D. Burgy.

5/90

DANIEL E. CLARK
Senior Engineer

EDUCATION

MBA, Virginia Commonwealth University

B.S., Nuclear Engineering, University of Michigan

Westinghouse Station Nuclear Engineer School

General Physics - Fundamentals of Classroom Instruction

General Physics - Fundamentals of Procedure Writing

LICENSES AND CERTIFICATES

Certified Senior Reactor Operator, Limerick

EXPERIENCE
1985 - Present

General Physics Corporation
Mr. Clark is currently assigned to the Nuclear Services Group in Columbia, Maryland. He is responsible for technical and training services for PWR and BWR utility clients. Representative projects include:

- Nuclear Thermal Performance Advisor Expert System
  Assisted in development and testing of a computerized thermal performance expert system used for diagnosing thermal efficiency problems at a nuclear power plant.

- NRC Exam Bank Development
  Developed open reference multiple choice questions for Salem Generating Station.

- EOP Lesson Plans, Yankee Atomic Electric Company
  Developed lesson plans for the upgraded Emergency Procedures for Yankee Nuclear Power Station.

- Detailed Control Room Design Review, Pilgrim Nuclear Power Station
  Analyzed Pilgrim EOPs to determine information and control needs for emergency control room operator actions as part of the system functions review and task analysis portion of the DCRDR.

- EOP Upgrade, Yankee Atomic Electric Company
  Served as Project Supervisor for the upgrade of plant-specific Emergency Procedures for Yankee Nuclear Power Station. The project included technical and human factors upgrade of existing procedures and conversion to a dual-column format.

- EOP Upgrade, Salem Generating Station
  Served as Project Supervisor for the technical and human factors upgrade of WOG-based EOPs and their conversion to a flowchart format. The EOP Writer's Guide was also updated and used to govern the EOP upgrade. The project involved a complete verification and validation of the flowcharts.

- Emergency Operating Procedures
  Developed high level logic diagrams and lesson plans for Emergency Operating Procedures for the Virginia Power Company's Surry Power Station and North Anna Power Station, and the Maine Yankee Atomic Power Company.

- QA Audit Assistance, Salem Generating Station
  Provided technical assistance to the Salem Nuclear QA audit team during Technical Specification and reactor engineering outage audits.

1978 - 1983

Virginia Power Company
Mr. Clark was the Reactor Engineer, responsible for start-up physics testing and coordinating reactor related projects. He completed the North Anna Senior Reactor Operator training course and qualified as a Shift Technical Advisor. Mr. Clark improved and performed technical specification surveillance and test procedures, and provided engineering support for station operations.

Mr. Clark performed nuclear fuel quality assurance inspections. He developed procedures for performing inspections, and assisted in performing vendor-quality assurance audits.

PROFESSIONAL AFFILIATIONS

Member, American Nuclear Society

(9/90)

SAMUEL M. COHEN
Staff Specialist

EDUCATION

General Physics Senior Reactor Operator Certification Course
U. S. Naval Nuclear Power Training Program

LICENSES AND CERTIFICATIONS

Certified Senior Reactor Operator Instructor: Limerick Generating Station

EXPERIENCE
1985 - Present

General Physics Corporation
Mr. Cohen is responsible for the design, development, and implementation of Boiling Water Reactor training programs. Additionally, he is involved in the development and review of nuclear and non-nuclear related technical procedures.

- Procedure Development, Tennessee Valley Authority, Browns Ferry Nuclear Plant
  Participated in the production of emergency operating procedure flowcharts in support of the BFN Rev. 4 upgrade program. Responsibilities included development of the BWROG EPG to PSTG conversion document, development of the PSTG to Flowchart conversion document, production of the Rev. 4 emergency operating procedure flowcharts, and lesson plan development.

- Detailed Control Room Design Review, Boston Edison Company, Pilgrim Nuclear Power Station
  Participated in the development of system function review and task analysis and supported the Verification effort.

- Material Development, Public Service Electric and Gas Company, Hope Creek Generating Station
  Participated in the production of Category B exam questions for the Hope Creek Generating Station Licensed and Senior Licensed Operator exam banks.

- License Operator Training, Philadelphia Electric Company, Peach Bottom Atomic Power Station
  Participated in the presentation of two nine-week reactor theory and fundamentals courses for PBAPS license operator candidates. Responsibilities include the writing and grading of all course quizzes and examinations, classroom instruction, and all associated administrative duties.

- Procedure Development, Burns and Roe Industrial Service Company, Pine Bluff Arsenal
  Participated in the production and review of logic flowcharts for existing Emergency Operating and Unusual Event Procedures in support of the Agent BZ Demilitarization Program.

- Material Development, Burns and Roe Industrial Services Company, Pine Bluff Arsenal
  Participated in the production of instructor lesson plans, student handouts and exams in support of the Agent BZ Demilitarization Program.

- Nuclear Professional Training, Philadelphia Electric Company, Peach Bottom Atomic Power Station
  Instructed 3-week Nuclear Professional Training Program at Peach Bottom Atomic Power Station.

- Representative Materials Development Projects
  Participated in the development of criterion-referenced training materials, encompassing all operations disciplines, for the following clients in support of INPO accreditation efforts:
  - Public Service Electric and Gas Company, Hope Creek Generating Station
  - Long Island Lighting Company, Shoreham Nuclear Power Station
  - Vermont Yankee Nuclear Power Corporation, Vermont Yankee Generating Station
  - Boston Edison Company, Pilgrim Nuclear Power Station

1979 - 1985 United States Navy
As a mechanical operator aboard the USS Sea Devil, Mr. Cohen qualified as Engine Room Supervisor. His duties involved operation and maintenance of the nuclear propulsion plant. He also assumed the duties as Leading Ship's Welder for emergency welding repairs.

(10/90)

GP

NEIL DANZIG
Staff Specialist

EDUCATION:

M.A. Candidate, Administrative Sciences and Human Resource Management, George Washington University
B.S. Psychology and Business Management, Frostburg State College

EXPERIENCE:
1987 - Present

General Physics Corporation
Mr. Danzig provides Human Factors support for projects in the Industrial Systems Technology Group. Project work includes control room modifications as well as Emergency Operating Procedure Upgrades. In addition, Mr. Danzig maintains and markets Job/Task Analysis, and CBT, software programs that were designed within the Human Performance Systems Department. Also, Mr. Danzig performs job/task analysis and test and training development. Representative projects include:

- Human Factors
  Lead Human Factors representative for General Physics in the Public Service Electric & Gas Company's Salem Unit 2 refueling outage. Responsible for applying Human Factor principles to control room modifications as well as maintaining up-to-date revisions of control room drawings. Supervised computer support for control room drawing modifications on a Macintosh II computer.

  Performed a control room instrument inventory at Wisconsin Electric Power Company's Point Beach Nuclear Power Plant. Created a data bank of instruments and controls used to develop a control room simulator.

- Procedure Upgrade Support
  Mr. Danzig assists the Industrial Systems Technology Group in the development and preparation of task analysis methodologies to be utilized in the collection of dynamic human performance data. These tasks include procedure

analyses, verification, and validation processes. Additionally, Mr. Danzig develops Human Factors Standards for both BWR and PWR commercial power plants and aids those utilities in implementing design changes in accordance with those standards.

- Math, Physics, and Chemistry Courseware
  Sole responsibility for converting, modifying, and testing General Physics' 529 Math, Physics, and Chemistry CBT lessons and modules. The primary tasks for this project included learning the Summit authoring system, adding General Physics copyright/title screens, rebranching screens, and incorporating first revision user comments for each lesson and module. In addition, Mr. Danzig developed 10 lessons using the Summit authoring system and wrote the largest section of the user manual.

- Job/Task Analysis Software
  Responsible for marketing the software to potential clients in several industries including: the utility industry, educational systems, government agencies, and the private sector. Perform demonstrations of the software when requested by potential buyers.

- Training Module Development
  Developed training modules for Con Edison's Power System Operation project. Responsibilities included performing job incumbent interviews, observing job incumbents perform Power System Operation duties, and writing training material.

1984-1987

Human Systems Technology Corporation
As a Staff Industrial Psychologist, Mr. Danzig specialized in job/task analysis of technical positions in the utility industry as well as professional positions within the public sector. His other responsibilities included: test development and validation of selection systems for both entry-level and promotional purposes; writing training objectives based upon the critical tasks identified in the job/task analysis; and maintaining the computer data bases for all job/task analyses. Representative projects included:

- <u>Job/Task Analysis</u>
  Conducted analyses of technical and professional positions using a modified ISD methodology. Analyses included, for example, Plant Equipment Operator, Control Room Operator, Engineering Fieldman, Lineman, Keypunch Operator, and Computer Operator positions. Conducted job incumbent interviews and observations, generated job task lists, developed surveys, statistically analyzed survey results, and presented all findings to the client.

- <u>Test Development and Validation</u>
  Developed and statistically validated entry-level and promotional tests for 10 job positions at Delmarva Power. The tests developed included hands-on type tests as well as paper and pencil tests. Test development was based upon a thorough job/task analysis.

- <u>Training Objective Development</u>
  Developed training objectives for two positions at Delmarva Power based upon critical tasks identified by the job/task analysis.

- <u>Performance Measurement and Improvement</u>
  Participated in evaluating the impact of the ALARA program at the Public Service Electric & Gas Company. Conducted interviews with job incumbents affected by the ALARA program at Salem and Hope Creek Nuclear Power Plants.

PROFESSIONAL AFFILIATIONS: Personnel Testing Council of Metropolitan Washington

3/89

C. EVERETT HARRIS
Principal Specialist

EDUCATION

U.S. Navy Nuclear Training Program

LICENSES AND CERTIFICATIONS

Certified Nuclear Power Plant SRO Instructor by the National Academy for Nuclear Training
Certified SRO Instructor, DAEC
Certified Nuclear Power Plant Fire Brigade Team Member
Certified SRO Dresden Unit II
Licensed SRO and RO, TAMU-TRIGA

EXPERIENCE
1985 - Present

General Physics Corporation
Mr. Harris is a certified SRO instructor. He teaches hot license training and operator requalification. Representative projects include:

Browns Ferry Nuclear Plant, Tennessee Valley Authority
- Currently assisting in all phases of revision of BFNP 2 Emergency Operating Instructions to EPG Rev. 4, including the writing of simulator validation scenarios.

Hope Creek, Public Service Electric and Gas
- Assisted conducting System Engineering SRO course for Salem and Hope Creek System Engineers.
- Supported Engineering Training department in task analysis, exam questions and training materials development, and Technical Staff/Manager materials and instruction.
- Supported Engineering Analysis of plant electrical loads for all normal operation modes as well as for LOCA.
- Performed simulator testing for major upgrade of Hope Creek simulator models.
- Developed Category B NRC Exam Bank questions for Hope Creek.

Limerick Nuclear Power Station, Philadelphia Electric Company
- Assisted conducting simulator training for SRO class of System Eng neers and instructors.

Pilgrim, Boston Edison Company
- Supported control room design review for EOP Rev. 4 and satellite prccedures.
- Performed pre-NRC Licensed Exam Audit for 10 SRO License candidates.

- Performed simulator acceptance test procedures at CAE.

Duane Arnold Energy Center, Iowa Electric Light and Power Company

- Developed simulator training materials for hot license and requalification training on the Vermont Yankee Simulator.
- Conducted hot license and requalification simulator training. Conducted all phases of licensed and non-licensed operator and instructor training.
- Developed the training materials for plant modifications and conducted outage training for engineering staff and operations for two plant outages.
- Developed the Simulator Configuration Management System administrative procedures and procedure outlines for Simulator Certification administrative procedures.
- Administered Annual Requalification Exams (written, oral and simulator) for licensed operator requal and administered practice audit exams for hot license candidates.

Nine Mile Point, Unit 2, Niagara Mohawk

- Administered hot license audit exams (simulator, written, and oral).
- Developed EOP Rev. 4 Training documents for operator training.

1981 - 1985 Singer-Link

Mr. Harris, as a Senior Test Operator, developed test procedures for Grand Gulf, Fermi, Nine Mile Unit 2, Clinton, and Kuosheng nuclear power plant simulators. He participated in the design of mathematical models for system simulation and conducted testing of Grand Gulf, River Bend and Kuosheng simulators. He also worked on the software design of the man-machine interface for SPDS and CTSS Systems.

1979 - 1981 Mississippi Power and Light Company, Grand Gulf Nuclear Station

Mr. Harris was an On-Shift Control Room Operator responsible for coordinating plant operations during startup testing and operation of systems.

1977 - 1979 Texas A&M University

As an On-Shift Senior Reactor Operator, Mr. Harris participated in reactor operation, system operation and maintenance, water chemistry, training and scientific research (sample irradiation and handling), annual report development, and reactor operation record keeping.

1970 - 1976 **United States Navy**

Mr. Harris was a Nuclear Mechanical Operator on board the USS Bainbridge. He was responsible for primary and secondary system operation and maintenance and participated in the overhaul and refueling. In addition, he developed special tools and procedures for primary valve maintenance.

(10/90)

JOHN E. HOUSE
Principal Specialist

EDUCATION	U.S. Navy Nuclear Power Training Program
LICENSES AND CERTIFICATIONS	Certified Senior Reactor Operator: Perry Nuclear Power Plant Licensed Senior Reactor Operator: Zimmer Nuclear Power Plant Certified Senior Reactor Operator Simulator Instructor: Nine Mile Point, Unit Two
EXPERIENCE **1984 to Present**	General Physics Corporation Mr. House is involved with all levels of project supervision and completion. He also continues to provide a wide spectrum of technical services. Representative projects include:

- Operations Pre-License Audit Examination
  Mr. House provided full scope audit examinations for the Reactor and Senior Reactor levels for the Long Island Lighting Company, Boston Edison Company, Public Service Electric and Gas Company, Philadelphia Electric Company, Pennsylvania Power and Light Company, and the Vermont Yankee Nuclear Power Corporation.

- Plant Restart Effort, Pilgrim Nuclear Power Station
  Developed and implemented a comprehensive plant restart training program, including classroom lectures and simulator exercises. Also assisted in acceptance test programs for the simulator and designed the graphic instructor facility for touch screen simulator control.

- Cold/Hot License Operator Instruction
  Provided cold license program development and RO/SRO instruction for the Nine Mile Point Nuclear Power Plant. Provided hot license instruction for RO/SRO classes (Peach Bottom Atomic Power Station, Hope Creek Generating Station and Limerick Generating Station.

- System Engineer/Technical Staff and Manager Instruction
  Provided SRO certification course for Hope Creek Generating Station staff.

- Simulator Instructor Courses
  Designed, developed, implemented and provided instruction for a simulator instructor course for th Boston Edison Company and Detroit Edison Company.

- Quality Assurance Training/Audits
  Provided Quality Assurance Department assistance in the performance of operations department and Technical Specification Surveillance audits for Public Service Electric and Gas Company. Also provided design, development, implementation and evaluation for an operations introductory course for quality assurance personnel.

- Material Production Projects

  - Design/development Shift Technical Advisor/Engineering Staff Boiling Water Reactor Technology Course for the River Bend Station.

  - Design/development and instruction for Licensed Operator Diagnostics course for the Vermont Yankee Nuclear Power Station (classroom and simulator).

  - Design/development and overall project management for an Equipment Operator Training Program for the Shoreham Nuclear Power Station.

  - Design/development and implementation of an NRC Cold License Program for Nine Mile Point Unit 2 Station. Also performed acceptance testing of the plant specific simulator.

  - Developed and provided instruction for the Hot License Program for the Peach Bottom Atomic Power Station.

  - Developed Category "B" requalification test items for the Hope Creek Generating Station.

1980 - 1984 — Cincinnati Gas and Electric Company

Mr. House was Utility Staff Instructor for licensed and non-licensed operations personnel. He was responsible for cold license preparation classes, license requalification, and in-plant drill evaluation.

As a licensed member of the operations group, Mr. House performed routine on shift tasks. Additional responsibilities included human factors review of the control room and procedure development and verification.

1972 to 1980 — United States Navy

Served as a classroom and in-hull instructor for the D1G Nuclear Prototype. Supported reactor refueling and worked extensively in radiological control. Also served as a Nuclear Work Center Coordinator for the nuclear unit squadron.

(2/90)

GP

JEFFREY L. KLEIN
Director, DOE Training & Technical Services Department

EDUCATION

B.S., Nuclear Engineering, The University of Illinois
U.S. Navy Nuclear Power Training Program

LICENSES AND CERTIFICATIONS

Certified Nuclear Power Plant Senior Reactor Operator Instructor, BWR, Limerick
Certificate of Training Completion, Institute of Nuclear Power Operations, Task Analysis Training Seminar

EXPERIENCE 1981 - Present

General Physics Corporation
Mr. Klein is the Director of the DOE Training and Technical Services Department. He has overall responsibility for coordination and supervision of all General Physics' training and technical services provided to DOE facilities, other than Westinghouse Savannah River. In this capacity, his responsibilities include marketing and sales, client liason, technical performance, budgetary and cost controls, and coordination of personnel to meet client needs.

Representative past projects include:

- Director of the Instructional Services Department Directed activities of a diverse group of professionals involved in instructional technology. Responsibilities included marketing and sales, technical performance, budgetary and cost controls, and personnel utilization.

- Manager, Industrial Instructional Services Department Participated in all phases of training and managed a major design and development effort for Taiwan Power Company.

- SRO Material Production, Long Island Lighting Company Participated in the design and development of lesson plans for upgrade and direct Senior Reactor Operators at the Shoreham Nuclear Power Station.

- Project Manager, Boston Edison Company Acted as the Project Manager for the Licensed Operator Requalification Program. Additionally, he has acted as lead instructor and program administrator.

- <u>Project Coordinator, Boston Edison Company</u>
  Functioned as on-site coordinator for SRP Upgrade Program; participated in materials preparation and lesson plan development using performance-based criteria.

- <u>RO/SRO License Training, Boston Edison Company</u>
  Participated in the development and instruction of a Hot License Training Program for Boston Edison Company's Pilgrim Station.

- <u>Engineer Training Programs, Philadelphia Electric Company, Peach Bottom Atomic Power Station</u>
  As project supervisor, supervised the production of a plant-specific textbook with lesson plans and presented portions of the lecture phase for Peach Bottom Atomic Power Station engineers.

- <u>System Description Manual Development, Cleveland Electric Illuminating Company</u>
  Acted as project supervisor, coordinated the organization of a major System Description Manual project for the Perry Nuclear Power Station. His work included the editing and technical review of manuals prepared by other staff writers.

1974 - 1978 **<u>United States Navy</u>**
As an instructor at the SIC Prototype Plant, Mr. Klein qualified as an Electrical Operator. His duties included standing all in-rate watches with qualifying students, teaching and testing students on plant systems and operation, and general plant maintenance.

(11/90)

SAMUEL J. SHOPPELL
Senior Specialist

EDUCATION

M.Ed. Candidate, Curriculum and Instruction, Penn State
B.S. Behavioral Science, Iona College

LICENSES AND CERTIFICATIONS

Certified Senior Reactor Operator: Limerick Generating Station

EXPERIENCE
1985 - Present

General Physics Corporation
Mr. Shoppell designs, develops, and implements training materials. Representative projects include:

- Emergency Operating Procedures (EOP)
Participated in the production of Emergency Operating Procedures in support of Revision 4 upgrades. Developed text and flowchart format procedures; plant specific technical guidelines and bases; and training basis documents for Hope Creek Generating Station, Nine Mile Point Station Unit 2, and Browns Ferry Nuclear Plant Unit 2.

- Technical Training
Conducted BWR Indoctrination Training for Hope Creek Generating Station personel.

- Knowledge and Abilities Catalog Development, Philadelphia Electric Company
Developed a site specific knowledge and abilities catalog, including: task lists, knowledge and abilities statements, importance factors and the development/verification of the training basis matrix for the Reactor Operator and Senior Reactor Operator.

- Control Room Design Review, Boston Edison Company
Supported the Detailed Control Room Design Reviews (DCRDR) for EOP Revision 4 and satellite procedures.

- Simulator Instructor Training
Designs, develops, and conducts "Train-the-Trainer" programs to certify simulator instructors for General Physics Corporation and client personnel, including: Boston Edison Company; Consolidated Edison Company; Detroit Edison Company; EG&G, Idaho; and Gulf States Utilities. Topics include: Effective Simulator Use; Developing Diagnostic and Team Skills; Developing and Conducting Exercises.

- Classroom Instructor Training
  Designs, develops, and conducts "Train-the-Trainer" programs to certify classroom instructors for General Physics Corporation and client personnel, including: Boston Edison Company, Liberty Technologies, New England Power, Northeast Utilities, and Shell Oil Company. Topics include: Principles of Instructional Design, Lesson Development, Classroom Techniques, Presentation Skills, Training Aids, Adult Learner Characteristics.

- Training Manual and Material Development, Taiwan Power Company
  Developed sections of the Training Manual and full scope training material for technical and management positions.

- Simulator Training Program Development, Long Island Lighting Company
  Revised simulator exercise guides for plant operation, malfunction, and surveillance training on the Shoreham Nuclear Power Station Simulator.

- Technical Staff and Management Course, Boston Edison Company
  Developed a course for Pilgrim Station to assist in reducing contamination and radiation exposures.

- Task Analysis, Long Island Lighting Company
  Coordinated the task analysis of the equipment operator and radwaste operator positions for INPO accreditation of training at the Shoreham Nuclear Power Station; designed taxonomy for skill and knowledge statements; analyzed positions for system, component, and theoretical knowledge; supervised six technical analysts and three data entry clerks; modified computer programs and data bases.

- Job/Task Analysis, Boston Edison Company
  Analyzed Pilgrim Station Shift Technical Advisor position; developed skill and knowledge taxonomy and objectives for training programs.

- Materials Development, Vermont Yankee Nuclear Power Corporation
  Developed training material for INPO accreditation of the Vermont Yankee Power Station control room operators.

1984 - 1985 Institute for Resource Management
Training Instructor assigned to New York Power Authority at Indian Point III. Revised instructor outlines and student handouts. Taught General Employee, Radiation Protection, and Respiratory Protection classes.

1984	Combustion Engineering Senior Health Physics Technician at Connecticut Yankee Atomic Power Station responsible for health physics coverage during the 1984 summer refueling outage.
1983 - 1984	Long Island Lighting Company Senior Health Physics Technician at Shoreham Nuclear Power Station responsible for all phases of health physics, worked extensively on the Whole Body Counting system. Assisted in the development and revision of health physics procedures. While on assignment at V.C. Summer Nuclear Generating Station, provided health physics coverage for the 1984 spring outage.
1976 - 1982	United States Navy Qualified as Engine Room Supervisor and served as Leading Engineering Laboratory Technician on board USS Robert E. Lee, SSBN601.

(10/90)

JEFFREY H. STEVENS
Staff Specialist

EDUCATION U.S. Navy Nuclear Power School

LICENSES AND CERTIFICATIONS Certified Senior Reactor Operator Instructor, Limerick Generating Station Simulator

EXPERIENCE
3/89 - Present

General Physics Corporation

As Staff Specialist, Mr. Stevens conducts licensed and non-licensed operator training in the theory and operation of commercial BWRs.

- Conducted a 14 week Senior Reactor Operator Certification course at the Peach Bottom Atomic Power Station, with two weeks of NRC style generic fundamentals and component theory. Duties included lesson and exam preparation, classroom and simulator instruction and simulator operation.

- Conducted 14 week systems engineers certification course at Hope Creek Generating Station. Duties included classroom instruction at the Senior Reactor Operator Level, exam material generation in the form of multiple choice questions, exam preparation, and simulator instruction. During this assignment, Mr. Steven's classroom instructor techniques were evaluated as part of a INPO training audit which earned a rating of "1".

- Co-authored Hope Creek Generating Station Revision 4 EOP documentation, including Bases, Lesson Plans, Conversion Documents and BWR Knowledge and Abilities (K/A) Catalog Cross Reference for Lesson Plans.

- Co-authored Hope Creek Generating Station Category B licensed operator requalification examination questions, utilizing NUREG/BR 0122.

1980-1989

U.S. Navy

As Prototype Staff Instructor, Mr. Stevens instructed Navy and contractor students in all disciplines of propulsion plant operations. In addition to full Prototype Staff Instructor Certification, his advanced qualifications included Engineering Watch Supervisor and Crew Quality Assurance Inspector and Leading Engineering Laboratory Technician. He has extensive experience instructing and evaluating students, in both classroom and seminar formats. Mr. Stevens has been noted, on numerous occasions, as the top instructor in his crew, on student's end-of-course feedback and critique forms. His students have consistently been top scoring graduates.

(9/90)

MARK D. VENTERS
Senior Specialist

EDUCATION

B.S., Geology, University of North Carolina
BWR Systems Training, Brunswick Nuclear Project, CP&L
PWR SRO Certification Training, H.B. Robinson, General Physics
BWR SRO Certification Training, Limerick, General Physics

LICENSES AND CERTIFICATIONS

Certified BWR Senior Reactor Operator Instructor:
Limerick Generating Station

EXPERIENCE
1986 - Present

General Physics
Mr. Venters provides project management plus technical and human factors expertise to engineering, operations and training projects. Mr. Venters also assists utilities in NRC audits. Specific disciplines include:

- Emergency Operating Procedures (EOPs)
  Developed lesson plans, textual and flowchart format procedures, PSTGs, and bases and conversion documents to the BWROG Emergency Procedure Guidelines and WOG Emergency Response Guidelines; supported utilities in NRC audits; managed and performed task analysis, verification, validation, human factors reviews, procedure discrepancy documentation, assessment and resolution for River Bend Revs.3 and 4, Grand Gulf Rev.3, Vermont Yankee Rev.4, Hope Creek Rev.4, Shoreham Rev.4, Hatch Rev.3, Peach Bottom Rev.3, Nine Mile Point Unit 2 Rev.4, Browns Ferry Rev.4, Salem Rev.1A, and Yankee Atomic Power Plant Rev.1A.

- Procedure Writer's Guide/Verification and Validation Plan Development/Revision
  Incorporated requirements of NUREG-0899, NUREG/CR-5228, and NUREG-1358; developed, revised, and verified procedure generation packages to include human factored guidelines on format, step construction, vocabulary, and mechanics; checklists on content, format, and technical guidelines; verification and validation on usability. Representative power plants include River Bend, Shoreham, Hope Creek, Nine Mile Point Unit 2, Salem, and Yankee Atomic Power Plant.

- Detailed Control Room Design Review and Implementation
  Managed and conducted all NUREG-0700 based phases of Detailed Control Room Design Review as required by NUREG-0737 Supplement 1; supported utilities in NRC audits; supervised and developed engineering design change procedures for control room modification, and performed detailed design change analyses at Grand Gulf, Diablo Canyon, Point Beach, Fort Calhoun Station, Pilgrim, Hatch, Shoreham, Salem, San Onofre, Fermi 2, and Fitzpatrick.

- Material Development
  Developed and revised system descriptions in support of operator and technical staff training program at Detroit Edison's Enrico Fermi 2.

- Design and Implementation of TAG OUT PLUS
  Developed modular TAG OUT PLUS software program designed to automate plant specific tag out procedures plus develop, store, and print tag out orders and tag labels; managed implementation of TAG OUT PLUS at Miami Fort Fossil Station.

- Display System Organization Design for Digital Data, Acquisition and Control Systems (DDACS)
  Provided initial design recommendations for action-oriented plant control and information computer display hierarchy at Brandon Shores and Crane Fossil Stations.

- Design and Layout of Computer System Consoles
  Performed various system design upgrade and control room layout studies for Safety Parameter Display Systems and DDACS Systems at River Bend, Point Beach, and Brandon Shores and Crane Fossil Stations.

- Control Room Staff Upgrade
  Performed control room SRO and RO staff upgrade study based on detailed analyses and interviews at Point Beach.

- Control Room Mockup Construction
  Assisted in the design and building of full scale double layered magnetic control room photographic mockups for Salem and Kewaunee Nuclear Power Plant.

1983 - 1986 **Carolina Power and Light Company**
Brunswick Nuclear Project

As an Auxiliary A Operator, Mr. Venters trained and tested Auxiliary Operators on plant systems for qualification; generated tag outs to support various ISI and refueling programs, ILRTs, LLRTs, and extensive plant modification projects; performed troubleshooting and tagged out equipment for maintenance and repair; served on operational procedure review committee and fire protection group; provided daily surveillance testing of instrumentation and equipment in strict accordance with plant operating manual and technical specifications; operated power producing equipment as necessary to meet load demands, and participated in a continuous-rel[illegible] technical and on-the-job training program.

PROFESSIONAL AFFILIATIONS

Member, American Nuclear Society
Member, American Association of Petroleum Geologists

DIANE E. WISNIEWSKI
Staff Scientist

EDUCATION

M.A. Candidate, Human Factors, George Mason University
B.S., Engineering Psychology, Tufts University

EXPERIENCE
1988-Present

General Physics Corporation

Ms. Wisniewski provides human factors implementation and design services to nuclear and fossil power plants, and industrial facilities. She develops plant-specific human factors design documents and aids clients in implementing design changes and upgrading workstations in accordance with human factors guidelines.

Ms. Wisniewski has provided human factors support at various power plants with regard to design changes and control board enhancement efforts. Ms. Wisniewski has supported implementation projects at the following plants:

- Salem Nuclear Generating Station
- Point Beach Nuclear Plant
- Pilgrim Nuclear Power Station

- Onsite Human Factors Support
  Ms. Wisniewski has acted as lead onsite Human Factors Specialist for the Unit 1 Refueling Outage of the Salem Nuclear Generating Plant. Ms. Wisniewski applied human factors principles during the design of the Unit 1 control room and verified that all modifications resolved the related Human Engineering Discrepancies (HEDs). Ms. Wisniewski also updated all drawings to reflect the control room design changes.

- Procedure Upgrade Support
  Ms. Wisniewski assists the Industrial Services Group in the development and preparation of task analysis methodologies to be utilized in the collection of dynamic human performance data. These tasks include

procedure analyses, verification, and validation processes. Additionally, Ms. Wisniewski develops Human Factors Standards for both BWR and PWRcommercial power plants and aids those utilities in implementing design changes in accordance with those standards.

- Software Design Support
  Ms. Wisniewski created human engineering system specifications and a system design document for the proposed design of an Advanced ASW Surface Ship Combat System. Ms. Wisniewski resolved human factors issues involving display size, shape, color, content, and layout for each window of the proposed design.

1987

GTE Corporation, Waltham, MA
Ms. Wisniewski acted as a consultant who conducted research and gathered data on compressed natural and synthetic speech in an aircraft cabin environment. As well, Ms. Wisniewski designed speech prompts to provide instruction on the operation of an air-to-ground telephone.

1987

U.S. Army Research, Development & Engineering Center
Ms. Wisniewski served as a contractor for various human factors projects. She conducted human factors and safety analysis in the areas of shelters, clothing, and food using MANPRINT methodology. She formulated questionnaires, conducted interviews, gathered data, analyzed statistics, and reported results regarding the various projects. Additionally, Ms. Wisniewski obtained field experience at various military bases.

ADDITIONAL AREAS OF KNOWLEDGE

Kinesiology
Gross Anatomy
Strategies of Injury Control
Anthropometry
Biotechnology in Human Systems

2/90

WARREN BABCOCK, JR.
SR. ELECTRONICS ENGINEER
BOSTON EDISON COMPANY
PRINCIPAL INVESTIGATOR

EDUCATION

Bachelor of Science, Electrical Engineering, Brown University, 1968

Graduate Study, Industrial Engineering, Ohio University

PROFESSIONAL REGISTRATION

Control Systems Engineer, State of California

PROFESSIONAL AFFILIATIONS

Institute of Electrical and Electronics Engineers
Human Factors Society

PROFESSIONAL TRAINING

Training in Human Factors Engineering:

Massachusetts Institute of Technology - 1980
"Man-Machine Interfacing"

General Electric Nuclear Training Center - 1980
"BWR Owners' Group Human Factors Engineering Workshop"

University of Wisconsin - 1981
"Human Performance and Nuclear Safety"

PROFESSIONAL EXPERIENCE

Boston Edison Company (1979 - Present)

Sr. Electronics Engineer, Control Systems Division, Nuclear Engineering Department
Currently working as cognizant engineer for Control Room Design Review Project. Acted as team leader of a BWR Owners' Group control room survey team. Member, BWROG Control Room Improvements Sub-committee. Also responsible for design of new control systems and modifications to existing control systems at Pilgrim Nuclear Power Station, including preparation of instructions for installation of new equipment and procedures for check-out and testing of this equipment. Have served as instructor for operator training in electrical/electronic systems operation.

EXPERIENCE (Continued)

Burns and Roe, Inc. (1977 - 1979)

Sr. Engineer/Group Supervisor, Instrument and Control Department, Breeder Reactor Division
Supervision of I&C engineering group with responsibility for design of balance-of-plant I&C systems for a breeder reactor project. Lead engineer, solid-state logic systems design. Lead engineer, electronic security systems.

Ebasco Services, Inc.

Sr Instrument & Control Engineer (1974 - 1977)
Designed I&C systems for application to nuclear and fossil power plants. Reviewed vendor system design documents for compatibility with clients' specifications. Member of engineering team charged with design and layout responsibilities for control rooms at various power plants, both fossil and nuclear.

Cryogenic Technology, Inc.

Electrical Engineer (1974)
Designed control panels and control systems for nuclear power applications. Prepared field test procedures for documentation of installed system performance. Field engineer for checkout and testing or radioactive waste process systems.

Stone & Webster Engineering Corporation

Control Systems Engineer
Designed control panels and control systems for nuclear power applications. Prepared field test procedures for documentation of installed system performance. Field engineer for checkout and testing of radioactive waste process systems.

Babcock & Wilcox Company

Electrical Engineer, Nuclear Power Generation Department
Designed and/or specified electronic control systems for nuclear steam supply systems when built in B&W plants. Reviewed vendor specifications and documentation for systems built outside B&W. Instructed customers' engineering personnel on operation and maintenance of B&W's systems.

THOMAS BENEDUCI
SIMULATOR DIVISION MANAGER
BOSTON EDISON COMPANY

EDUCATION

Associate Degree, Electrical Engineering, Franklin Institute of Boston, 1975

Bachelor of Science, Industrial Technology, Northeastern University, 1986

PROFESSION TRAINING

Nuclear systems training course designed specifically for Pilgrim Station, including specific studies on RHR, Core Spray, HPCI, RCIC, TIP, Neutron Monitoring SBLC, Turbine Generator and Reactor Vessel intervals.

School (five weeks) on BWR 4 Nuclear Instrumentation including studies on the APRM, IRM, SRM, TIP, Area Rad Monitor, Log Rad Monitor and Process Rad Monitor systems.

PROFESSIONAL EXPERIENCE

Boston Edison Company (1980 - Present)

Simulator Division Manager (April 1989 - Present)
Responsibilities encompass overall operation, maintenance and modification of the Simulator Complex. This includes management of the Simulator capital and expense budgets and varying number of management, union and contractor personnel in the planning and scheduling of Simulator modifications, discrepancy corrections, and enhancements. Manages or participates on special teams in analysis of plant transients tasked with root cause corrective actions being identified, initiated and completed. Special projects include installation of a redundant Simulator computer system, installation of the Simulator EPIC computer system, installation of Simulator emergency preparedness phone systems and Simulator NRC Certification. Active member of the Utility Simulator Users Group Executive Committee, Secretary of the NETA Simulators Advisory Committee and a member of the Employees Speakers Bureau.

Sr. Simulator Hardware Engineer (October 1987 - March 1989)
Responsibilities included management of the following: the Simulator capital and expense budgets, hardware modifications for the SEP, emergency lighting, HPCI Vacuum Breaker, other minor modifications, the computer room humidifier upgrade, and completing the Simulator spare parts inventory. Assisted in and conducted Simulator tours for media and special interest groups.

Special projects were the research and approval of a backup Simulation Computer System, managing the installation of the EPIC computer system at the Simulator, and writing purchase specifications for the Simulator EPIC System and Toshiba Intelligent Display Terminal relocation. Industry-related activities included serving as secretary to the NETA Simulators Advisory Committee and being an active member of the Employee Speakers Bureau.

EXPERIENCE (Continued)

Sr. Modifications Engineer, Pilgrim Nuclear Power Station (November 1985 - October 1987)
Responsibilities included administering post-construction acceptance testing of all Plant Design Changes (PDC), hiring and directing contract personnel for the administration/coordination of post-construction testing, and providing interface with the plant maintenance, engineering, operations, and all other departments involved in the PDC process. Special activities included providing reports to Senior BECo Management and team leadership on CAL 86-10 resolution, presenting positions to NRC on questions relating to CAL 86-10 and other testing/PDC issues, and acting as Modifications Management Group Leader during the absence of the group leader.

Instrumentation and Controls Supervisor, Pilgrim Nuclear Power Station (November 1983 - 1985)
Responsibilities included direct supervision of I&C Technicians and Contractors, scheduling personnel, writing and reviewing plant procedures, acting as project manager for Plant Design Change packages, and directing installation of new plant equipment. This position required interfacing with other station groups including Nuclear Engineering for planning and implementing Plant Design Changes.

Instrumentation and Controls Technician, Pilgrim Nuclear Power Station, (August 1980 - November 1983)
Responsibilities included performance of maintenance activities on all categories of nuclear power plant equipment, writing and performing surveillance tests and postwork tests required to prove equipment performance meets technical specification criteria and operability requirements. Special projects included installation of the Seawater Differential Temperature modification, the new CRD Temperature Recorder, the Drywell Hi-Rad Monitors and various other plant design changes. Also responsible for writing and performing system logic tests required to satisfy NRC Bulletin 80-06 concerns.

DAVID A. BRYANT
PROJECT MANAGER
BOSTON EDISON COMPANY
DCRDR PROJECT MANAGER

EDUCATION

Bachelor of Science, Electrical Engineering, Tufts University, 1966
MSE, Catholic University of America, 1971

PROFESSIONAL AFFILIATION

Institute of Electrical and Electronics Engineers

PROFESSIONAL TRAINING

Certificate in nuclear power plant engineering program, Bettis Reactor Engineering School, 1967

PROFESSIONAL EXPERIENCE

Boston Edison Company (1976 - Present)

Project Manager, Control Room Design Review Project, Nuclear Engineering Department (1985 - Present)
Responsible for overall management of project, including assignment of tasks to project personnel (in-house and contractors); coordination of efforts by all involved departments; administration of purchase orders; monitoring of progress and developing corrective action as needed; budgeting, scheduling and planning; and review and approval of licensing submittals and other correspondence.

Pilgrim 2 Project Manager (1981-1984)
Responsible to manage efforts to close out cancelled nuclear power plant project, including negotiation of settlements for about 100 cancelled contracts, maintenance, marketing, and eventual disposal of $100 million of hardware; and liaison with regulators, twelve joint owner utilities, and various company organizations.

Project Engineer, Pilgrim 2 Project (1976-1981)
Project engineer and contract administrator for Nuclear Steam Supply System contract for 1100 MW PWR. Coordinated the review and approval of contractor design documents. Administered NSSS contract (approximately $100 million). Managed interface among architect-engineer, NSSS supplier, and utility staff, on technical issues, scheduling, and contractual matters.

EXPERIENCE (Continued)

GCA/Technology Division (1974 - 1976)

Senior Engineer and then Group Leader, Transportation and Land Use Planning Department
Performed and managed environmental studies, transportation planning, and land use planning projects for government clients.

Fay, Spofford & Thorndike, Inc. (1971 - 1974)

Transportation Engineer/Planner
Performed traffic engineering, transportation planning, land use studies, and environmental studies for public agencies. Performed field surveys, data collection, analysis, and report preparation.

U.S. Navy (1966 - 1971)

Nuclear Power Engineer, Naval Reactors Division, U.S. Atomic Energy Commission
Naval officer serving in navy headquarters engineering organization as cognizant engineer supervising contractor efforts for design, procurement, modification and repair of mechanical equipment in nuclear ships.

ROBERT M. BYRNE
INSTRUMENTATION & CONTROL ENGINEER
BOSTON EDISON CO.

EDUCATION

B.S., Marine Engineering, Massachusetts Maritime Academy, 1977

LICENSES

Chief Engineer of Motor Vessels of no more than 7000 hp, Mineral and Oil Industry

Third Assistant Engineer--Motor Vessels--any horsepower.

Third Assistant Engineer--Steam Vessels--any horsepower.

PROFESSIONAL TRAINING

"Applied Human Factors in Power Plant Design and Operation," General Physics Corp., 1987

EXPERIENCE

<u>Boston Edison Company (Aug. 1987 - Present)</u>

Instrument & Control Engineer Nuclear Engineering Department, Control Systems Division.
Responsible for providing engineering support to Pilgrim Nuclear Power Station through designing, analyzing and modifying I&C systems and components. Other duties include preparing Safety Evaluations and procurement documents, drawing reviews and providing engineering support to other disciplines within the nuclear organization. Familiar with NRC Regulatory Guides and IEEE Standards. Assigned to the DCRDR Project as cognizant engineer for Annunciator Conceptual Design study.

<u>Stone & Webster Engineering Corporation (1980 - 1987)</u>

Instrument & Control Systems/Turnover Coordinator
Control Systems Division, Beaver Valley II Project.
Responsible for ensuring completion of engineering and design of control systems prior to transfer to Dusquesne Light Company. Acted as liaison among engineering (SWEC, DLC, and Site), construction, and operations to ensure testing and start up of plant. Developed engineering analysis reports to management utilizing the Lotus 123 Software.

Control Systems Engineer/Change Management Coordinator
Responsible for reviewing potential changes of control systems for feasibility. Evaluated construction impact of change to system.

Instrument & Control Engineer
Responsible for developing, revising and reviewing logic diagrams and system descriptions. Prepared and reviewed controls systems section of the Final Safety Analysis Report for BVII.

EXPERIENCE (Continued)

Offshore Logistics International, (1977 - 1980)

Chief Engineer
Ensure safe and proper operation of vessel and all associated machinery. Trained and supervised foreign crews (Brazil, Chile). Responsible for maintenance and repair of vessel machinery.

First Assistant Engineer
Assisted chief engineer with vessel's propulsion units.

SIBEN DASGUPTA
CONTROL SYSTEMS DIVISION MANAGER
BOSTON EDISON COMPANY

EDUCATION

Electrical Engineer (Power Systems) Northeastern University, 1979

M.S. in Engineering Management (Operations Research), Northeastern University, 1973

Master of Engineering in Electrical Engineering (Power Systems), Calcutta University, 1969

Bachelor of Engineering in Electrical Engineering (Power Systems), Calcutta University, 1967

PROFESSIONAL REGISTRATION

Registered Professional Engineer (Massachusetts).

PROFESSIONAL AFFILIATIONS

Member of Institute of Electrical and Electronics Engineer
Chairman, IEEE Educational Committee, Boston Chapter.

Member of the Working Group of IEEE Nuclear Power Engineering Committee, Section 4.7, Auxiliary Power Systems.

PROFESSIONAL TRAINING

Combustion Engineering Nuclear Power Plant Simulator - Training course in Nuclear Power Plant Operation.

Qualification of Safety-Related Equipment for Nuclear Power.

Generating Stations - Arranged jointly by Drexel University and IEEE.

Kepner-Tregoe Management Training Course.

PROFESSIONAL EXPERIENCE

Boston Edison Company (1975 to Present)

Control Systems Division Manager, Nuclear Engineering Dept. (December 1981 to present)
Responsible for all activities within the Division, which includes planning and scheduling, workload assignments, technical assistance and supervision, and developing new standards and work procedures. Duties of the Division consisted of preparation of process and instrumentation diagrams, logical diagrams, schematic diagrams, selection and specification of all instruments and valves, panels layouts and fabrication drawings, loop drawings, tubing and wiring and installation

EXPERIENCE (Continued)

detail drawings, vendor evaluation, purchasing, field support and startup assistance. Duties also include engineering activities related to Plant Process Computer and Security Computer Systems.

Senior Electrical Engineer, Nuclear Engineering Dept. (1978 - 1981)
Responsible for review and approval of recommendations for electrical designs prepared by the principal contractors for a new power plant (Architect-Engineer, Nuclear Steam Supplier, Turbine-Generator manufacturer) in the following areas: Station Auxiliary power systems, station auxiliary power system protection, computer applications for load flow and short circuit studies, undervoltage and underfrequency studies, etc. Responsibilities also included design modifications of station auxiliary power systems for an operating plant. This included undervoltage study, relay coordination, electrical equipment selection, equipment qualification, etc.

Instrumentation and Control Engineer, Nuclear Engineering Dept. (1975 - 1978)
Responsible for logic diagrams, loop drawings, control panel layout and fabrication drawings, tubing and wiring diagrams as well as installation detail drawings.

Stone & Webster Engineering Corp. (1973 - 1975)

Engineer, Control Systems/Advisory Operations Group
Served as a startup engineer at Beaver Valley Power Station #1. Resolved acceptance and startup testing problem items (i.e., control logic troubleshooting) in the field. Prepared specifications for instrumentation. Prepared bid analyses and recommendations to utility engineers for selection of instrument suppliers. Designed control loop, logic, panel layout, P&ID and instrumentation installation drawings. Formulated calibration data for process control loops.

Bell & Howell Communications Co. (1970 -1973)

Engineer, Production Engineering Dept.
Investigated field failures of electronic components wit the aid of computer controlled test system. Investigated manufacturing problems to determine cause and to recommend corrective action. Set up test methods, trouble-shooting procedures; designed test jigs. Analyzed the production requirements of products and determine the type and sequence of operations, establishing work elements, motion patterns and machine cycles.

EXPERIENCE (Continued)

Northeastern University (1977 - Present)
Part-time lecturer in Graduate School of Engineering.

PUBLICATIONS

"Transient Performance of Three-Phase Induction Motors During Sudden Voltage Depressions": Journal of Technology (India) 1969.

"Degraded or Loss of Voltage Protection of Class IE Auxiliary Power Systems in a Nuclear Power Plant"; S. Dasgupta, J. J. Murphy; presented at the IEEE Nuclear Science Symposium, Oct. 1978. Published in the IEEE Nuclear Science Transactions, Feb., 1979.

"Maximum Frequency Decay Rate for Reactor Coolant Pump Motors"; R. S. Hahn, S. Dasgupta, E. M. Baytch, R. D. Willoughly; Presented at the IEEE Nuclear Science Symposium, Oct., 1978; published in the IEEE Nuclear Science Transactions, Feb., 1979.

NORMAN R. EISENMANN
SR. INSTRUMENTATION & CONTROL SYSTEMS ENGINEER
BOSTON EDISON COMPANY

EDUCATION

B.S., Electronic Engineering Technology, University of Lowell, 1985

A.S., Electronic Engineering Technology, University of Lowell, 1982

A.S., New York State Regents External Degree Program, 1979

PROFESSIONAL TRAINING

University of Michigan - 1990 "Human Factors Engineering"

"Applied Human Factors in Power Plant Design and Operation", General Physics Corporation, 1987

U.S. Navy Training, Nuclear Power School and Prototype Training, 1972.

PROFESSIONAL REGISTRATION

Professional Engineer, State of New Hampshire

PROFESSIONAL AFFLICATIONS

Institute of Electrical and Electronic Engineers.

American Nuclear Society.

Instrument Society of America

Human Factors Society.

PROFESSIONAL EXPERIENCE

Boston Edison Co., Nuclear Engineering Dept. (June 1988 to Present)

Assigned as the lead engineer for the implementation of modifications to the PNPS Control Room to meet the criteria of NUREG-0700. Responsible for the supervision of consultants preparing Scope and Justification Approvals and Plant Design Changes. Also responsible for supervision of consultants performing Human Factors Engineering work for Boston Edison.

Responsible for close-out documentation packages for HEDs and preparing specification for new CR Survey, Inventory, SFTA, etc. Also responsible for supporting the Equipment Qualification Project with updating Equipment Qualification Data Files and reviewing test reports. Responsible for answering Engineering Support Requests submitted to NED.

Nuclear Energy Services (January 1986 - June 1988)

Assigned to the Boston Edison Equipment Qualification Project. Consultant to the Control Systems Group of Boston Edison. Compiled data, reviewed test reports, prepared analyses, and performed calculations using the Arrhenius Methodology to complete environmental qualification of control equipment.

EXPERIENCE (Continued)

Cognizant engineer for Plant Design Changes. These plant modifications included changes to air operators, instrument air systems, ATWS panels, 4160 volt switchgear, and Reactor Protection Systems. Prepared production orders to purchase material to support the PDCs. Reviewed calculations for orifice sizing, relief valve sizing and single failure analysis using Boolean Algebra.

CYGNA Energy Services (April 1981 - January 1986)

Engineer for the Control Systems Group of Boston Edison. Cognizant engineer for 5 Plant Design Changes (PDC) at Boston Edison. The PDCs included modifications to control panels, local control switches, and shielding of components. Lead Engineer for Cygna on the Boston Edison Pilgrim 79-01B Equipment Qualification team. Duties included equipment specification and test report evaluation to ensure compliance to DOR Guidelines, NUREG-0588, or 10CFR50.49.

Responsible for the preparation of work instructions and procedures for the Equipment Qualification Program. Provided assistance with project budgeting and computerized scheduling.

For the Shoreham Nuclear Power Station Project, prepared new procedures and revised existing procedures for processing of vendor technical bulletins, design changes, client interfaces, and administration of clerical workers.

Stone & Webster Engineering Corp. (August 1979 - March 1981)

As an Engineering Associate in the Operation Services Division, evaluated equipment for the selection of spare and replacement parts requirements for Consumers Power Company's Midland Station Units 1 and 2. The evaluation encompassed a thorough analysis of vendor information, Final Safety Analysis Reports, specifications and industrial experiences. This effort involved frequent direct contact with equipment suppliers in order to obtain additional data needed to either complete documentation requirements or perform equipment performance evaluations. Duties included defining the parts by interpreting original equipment technical specifications, Quality Assurance packages, equipment qualification requirements and various codes and standards such as ASTM, ASME, ANSI, and IEEE.

While assigned to the Engineering Assurance Division, developed departmental procedures for the Procurement Control Group.

U.S. Navy (1971 - 1979)

Served seven and one-half years on the U.S. Navy Submarine Force as a Nuclear Plant Operator. For three years of this time, assigned as a Nuclear Training Instructor and Leading Electrical Division Petty Officer at the Idaho Nuclear Facility.

DAVID WILLIAM GERLITS II
SR. SYSTEMS ANALYSIS ENGINEER
BOSTON EDISON COMPANY

EDUCATION

B.S., General Science: Physics and Chemistry, University of Iowa, 1977.

LICENSE

Senior Reactor Operator, Pilgrim Nuclear Power Station, 1986.

PROFESSIONAL AFFILIATIONS

American Nuclear Society

Mensa

PROFESSIONAL TRAINING

Station Nuclear Engineer (GE BWR) - 1982

Gould SEL Computer Operating Software - 1986

PNPS Simulator Operating Software - CAE Electronics - 1986

Criterion Referenced Instruction and Instructional Materials Development (Mager/Pipe) - 1984

PROFESSIONAL EXPERIENCE

Boston Edison Company, (1982 to Present)

Senior Engineer, Systems and Safety Analysis Division, Nuclear Engineering Department (1987 - present).
General responsibilities encompass review of plant modifications to ensure Final Safety Analysis Report and regulatory compliance, and review and preparation of safety analyses. Specific assignments include: Lead systems engineer for the system function and task analysis portion of the detailed control room design review project; lead systems and safety analysis engineer for the implementation of the modifications resulting from the PNPS safety enhancement program; NRC audit co-coordinator for inspection of equipment classification, vendor interface, post-maintenance testing, adequacy and reliability of electrical distribution system; individual plant evaluation risk and reliability engineer assisting in the development and review of system descriptions and associated computer models for the PNPS IPE; lead engineer for the implementation of the plant specific technical guidelines for emergency operating procedures; and lead systems and safety analysis engineer for the PNPS 10CFR50 Appendix R fire protection analysis.

EXPERIENCE (Continued)

Nuclear Training Specialist, Nuclear Training Department (1982 - 1987)

Primary responsibilities focused on preparation and presentation of training material for initial license and licensed operator requalification training programs. Additional assignments included: project manager for the development of the training material required for INPO Accreditation of all unlicensed and licensed operators; operations training instruc for simulator software, responsible for detailed review of software model changes required by plant modifications.

<u>United States Navy (1977 - 1982)</u>

Nuclear Trained Division Officer - USS Ulysses S. Grant (SSBN 631)
After completion of Officer Candidate School and Nuclear Power Training, assigned to the ship, and held the billets of Electrical Officer, Reactor Controls Officer, Communications Officer, and Ship's Training Officer. Managed the 10-14 man divisions responsible for the operation, testing, and repair of ships engineering and communication equipment. Also responsible for scheduling and budget for the training of all ships personnel, and the maintenance of the ship's training records.

FRANCIS CHARLES LEONARD, JR.
NUCLEAR OPERATING SUPERVISOR
(OPERATIONS SECTION STAFF)
OPERATIONS LIAISON TO DCRDR

EDUCATION

N.U.S. Nuclear Prep. Course - - Certificate, 1971

Penn. State Triga Reactor Training

Peterson School of Steam Engineering
Certificate, 3rd Class Engineer, 1969
Certificate, 2nd Class Fireman, 1963

Wentworth Institute, Boston, Mass., 1956

Weymouth, (Mass.) High School, 1950

LICENSES

NRC Senior Reactor Operator/ReactorOperator (1972-1989)
Mass. Nuclear Power Plant Operating Engineer (1972)
SRO Certification, 1989 - Present

PROFESSIONAL EXPERIENCE

Boston Edison Company (1962 - Present)

Operations Section - - Nuclear Operating Supervisor (1973-Present)
Currently responsible for various staff assignments related to nuclear operations, including staff liaison between DCRDR project and Operations Section. Reviews prospective design changes, coordinates operations review and comment, and participates in Design Review Team.

As licensed SRO. responsible for supervising the Nuclear Plant operations and implementing operating maneuvers in accordance with approved station procedures and for assisting in training the Nuclear Plant Operators in the skill and knowledge required for the safe and efficient operation of a nuclear facility.

Operations Section - Nuclear Plant Operator (1970-73)
Interfaced with supervisors and PNPS operating groups for completion of assigned tasks in the operation of station equipment. Identified and reported items requiring specialized attention. Responsible to shut the reactor down when determined the safety of reactor is in jeopardy or when operating parameters exceed any of the reactor protection system setpoints and automatic shutdown does occur.

EXPERIENCE (Continued)

Nuclear Training Specialist -- Simulator Procurement (1984 - 1987)
Responsible for assisting in the design and procurement of the Pilgrim Station specific simulator through coordination of internal reviews of design specifications and vendor proposals. This assignment required relocation to the vendor's facility (CAE Electronics, Ltd.) in Montreal, Canada, for a period of nearly three years. Incumbent with these responsibilities was the creation of the Simulator Malfunction Cause and Effect Document, writing and or review of the final Acceptance Test Procedure (ATP), overall responsibility for its implementation, and negotiation of all data base post-freeze modifications and simulator enhancements.

Nuclear Watch Engineer, (1981 - 1984)
In charge of the plant during assigned shift. Responsible for the safe, efficient operation of PNPS including unit startup, shutdown, scram recovery, and administrative oversight of surveillance testing on plant systems.

Nuclear Operating Supervisor, (1978 - 1981)
Performed diversity of tasks focusing on the supervision for the operation of the control room facility in accordance with station guidelines. Responsible for maintaining awareness of station conditions, supervising the Nuclear Plant Operator and implementing operating maneuvers in accordance with policies and procedures. Assisted in training Nuclear Plant Operators in tasks required for operation of control facilities. Developed and implemented log and record system of plant operating data.

Nuclear Plant Operator, (1975 - 1979)
Interfaced with supervisors and PNPS operating groups for completion of assigned tasks in the maintenance of overall station equipment. Identified and reported items requiring specialized attention. Responsible for performing lubrication checks of station equipment. In charge of shutting the reactor down when determined the safety of reactor is in jeopardy or when operating parameters exceed any of the reactor protection system setpoints and automatic shutdown does occur.

Central Control Operator, Mystic Station
Responsible for startup and shutdown and operation of high pressure forced flow C-E boilers and station auxiliary equipment. Performed startup and shutdown of GE high pressure tandem compound Turbine-Generator and accompanying auxiliary equipment.

KENNETH NORMAN TAYLOR
NUCLEAR WATCH ENGINEER
(OPERATIONS SECTION STAFF)
OPERATIONS LIAISON TO DCRDR

EDUCATION

Currently attending Northeastern University pursuing a degree in engineering.

Nuclear Power Training Unit, West Milton, NY - 1960

U.S. Navy Power School, New London, CT (1959)
Machinist's Mate "A" School, Great Lakes, IL

Cole Trade High School, Southbridge, MA

LICENSES

Mass. Nuclear Power Plant Operating Engineer (1978)
NRC Senior Reactor Operator License (1977)
NRC Reactor Operator (1975)
Mass. License - 1st Fireman (1975)

PROFESSIONAL EXPERIENCE

Boston Edison Company

Operations Section -- Staff SRO (1988 - Present)
Responsible for various staff assignments related to nuclear operations, including staff liaison between DCRDR Project and Operations Section. Reviews prospective design changes, coordinates operation review and comment, and helps t nsure coordination between Operations and Engineering on major project activities.

Day Watch Engineer-Pilgrim Nuclear Power Station (2/81 - 1982)
Responsible for the safe, efficient operation of Pilgrim Station, under the direction of the Chief Operating Engineer in accordance with the requirements of Station Procedures and Regulatory Agencies. Responsible for rewriting procedures, update of P&ID's and ensuring a smooth accurate communication with the departments within the station.

Nuclear Watch Engineer-Pilgrim Nuclear Power Station (11/78 - 2/81 and 1982 - 1988)
Responsible for all activities relating to station and safety including, fuel loading, startup and shutdown in accordance with the requirements of the operating license, Technical Specifications, approved operating procedures, regulatory agencies, and the Operations Quality Assurance Program. Responsible for implementing the station radiation protection program, for the monitoring the performance of station equipment, for assuring that the reactor is shutdown when a condition has been identified such that continued operation would jeopardize station safety and the station security within the confines of the process building.

EXPERIENCE (Continued)

Nuclear Operating Supervisor-Pilgrim Nuclear Power Station (11/75 - 11/78)
Responsible for supervising the Nuclear Plant Operations and implementing operating maneuvers in accordance with approved station procedures and for assisting in training the Nuclear Plant Operators in the skill and knowledge required for the safe and efficient operation of a nuclear facility.

U.S. Navy

5/73 to 11/75
Served on USS Skipjack SS(N) 575 as Engineering Watch Supervisor

4/72 - 5/73
Served on staff at Engineering Repair Division, New London Conn.

8/65 - 4.72
Served on USS Francis Scott Key SSB(N) 657 as Engineering Officer of the Watch

12/62 - 8/65
Served on USS Stonewall Jackson (SSB(N) 634 as Engineering Watch Supervisor

1/61 - 12/62
Served on U.S.S. Ethan Allen SSB(N)607 as Engine Room Supervisor

1/59 - 1/61
Received US Naval Training at various schools

2/57 - 1/59
Served on USS Skate SS(N) 578 as Engineer Room Operator

12/56 - 2/57
Served on USS Leyte C.V.S 32 as Auxiliary Operator.

DANNA M. BEITH
PROJECT HUMAN FACTORS SPECIALIST
HUMAN FACTORS INTERFACES

EDUCATION

B.A., Psychology, University of California, 1976

PROFESSIONAL AFFILIATIONS

Human Factors Society

Associate Editor, Human Factors Society Bulletin

PROFESSIONAL EXPERIENCE

Human Factors Interfaces (1986 - Present)

President, Responsible for the management and direction of a consulting firm specializing in human factors engineering and research, and nuclear support services.

Brunswick Nuclear Power Plant - Served as the human factors specialist for the verification and validation of the Rev. 4 Emergency Operating Procedures (EOPs). Duties included a detailed human factors review of the procedures and flow charts for logical flow, wording and consistency. Also updated the EOP Writers Guide and Users Guide.

Conducted the human factors validation of operator performance on updated EOPs and ERFIS displays. Duties included the development and implementation of the Team Operations Performance and Procedure Evaluation (TOPPE), which was developed to assess operator performance and acceptance of procedures/operator aids; the observation of operator actions on the plant simulator; and operator interviews at the completion of simulator scenarios and data analysis.

Developed a Verification and Validation process for the evaluation of the Alternative Safe Shutdown Procedures. Duties included the training of operators on the process for the walkdown of the procedures, incorporating operator comments, and the human factors review of the procedures.

Wrote the human factors sections of the Verification and Validation procedure for EOP changes/modifications. The procedure ensures that human factors principles are considered with each procedure modification.

Participated as the Human factors specialists in the SPDS display development process. Duties included the development of displays, the evaluation of the human-interface requirements and ensured the compatibility of displayed information with the EOPs. Also conducted the human factors review of the SPDS.

EXPERIENCE (Continued)

H.B. Robinson Nuclear Power Plant - Currently developing a symptom-based flow chart for the Emergency Action Levels for the classification of emergencies. Duties include updating of Plant Emergency Procedures, developing an operator training package, and EAL User's Guide, and an EAL Writer's Guide.

Planned and conducted a human factors review of operator performance on updated EOPs. Duties included observations of operator actions on the plant simulator, operator interviews, data analysis, preparation of the final report, and assistance in the resolution of problems identified with procedures and flow paths.

Conducted a human factors review of the Dedicated Shutdown Procedures. Duties included detailed review of the procedure format, wording, and consistency between procedures; the rewriting/reformatting of the procedures; incorporating operator comments; and the preparation of the final report.

Conducted a human factors review of ERFIS/SPDS. Duties included the evaluation of the human-interface requirements, system usability and compatibility with the EOPs.

Conducted a human factors review of Maintenance Test Procedures. Duties included an analysis of trips related to these procedures, review of procedure usability/format and suggestions for improvements in the implementation of the procedure, and enhancements to the control panels involved.

Pilgrim Nuclear Power Station - Conducting a human factors review of the control room design review control panel modifications for BECo's Pilgrim Nuclear Power Plant. Assist in the planning for the completion of the DCRDR and update the Pilgrim DCRDR Program Plan and Final Summary Report for resubmittal to the NRC.

Nine Mile Point Unit One - Conducting the human factors validation of operator performance and acceptance of the EOPs. Duties include the implementation of the TOPPE, which was developed to assess operator performance and acceptance of procedures/operator aids; the observation of operator actions on the plant simulator, operator interviews at the completion of simulator scenarios; and data analysis and preparation of interim and final reports.

Shearon Harris Nuclear Power Plant - Conducted a human factors review of the Emergency Action Level procedures and flow paths for the Shearon Harris Nuclear Power Plant. Duties included a detailed review of format, wording and consistency with EOPs.

EXPERIENCE (Continued)

RMS Associates, Inc. (1984 - 1986)

Director, Human Factors Services - Managed the (NUREG-0700) Control Room Design Review for Carolina Power and Light Company at the H.B. Robinson, Brunswick, and Shearon Harris nuclear power plants. Duties included task analysis, verification and validation, SPDS reviews, control room surveys, Human Engineering Discrepancies (HED) evaluation, preparation of final report, and assistance in implementation of control room modifications. Wrote the program plan for the operating plant and the final summary report for all three plants. Developed a data base for system function task analysis which incorporated owners' group guidelines.

Essex Corporation (1980 - 1984)

Staff Scientist - Participated in the Control Room Design Review for Virginia Electric Power Company at North Anna and Surry Units 1 and 2 nuclear power plants. Conducted an operating experience review which consisted of writing operator questionnaires, interviewing operators, data reduction, and a document review of plant documentation, such as License Event Reports. Assisted in writing the VEPCO program plan and photographing the control panel photo mosaics.

Research Scientist - Directed the on-site data collection for Toledo Edison's Control Room Design Review for the Davis-Besse Nuclear Power Station. Duties included review of operating experience, conduct of control room surveys, SPDS review, and a Human factors review of upgraded EOPs. Assisted the photographing and construction of a control panel photo mosaic, data reduction, and preparation of final report.

Performed the Human Factors evaluation of the South Texas Project Main Control Panel and Control Room for Bechtel/Houston Lighting and Power (subcontract through Torrey Pines Technology). Activities included an evaluation of a full-scale, three dimensional mock-up prior to fabrication of the operational system and the set-up of a computer program for sorting and reporting data.

Project Manager for the development and production of approximately 300 nuclear power plant surveillance/test procedures for South Carolina Electric and Gas (SCE&G). work involved technical review and editing of procedures, technical direction for all project staff, and coordination of procedures production from initial writing through word processing. Responsible for technical staff of six to eight technical writers, two editors, two nuclear power plant operations specialists, and eight word processors.

EXPERIENCE (Continued)

On-site supervisor for the rewriting/reformating of nuclear power plant emergency, normal and standard operating procedures at SCE&G's Virgil Summer Nuclear Station.

Directed Human Factors evaluation of the on-site data collection for Comanche Peak Nuclear Power Plant control room. Evaluation included criteria specified in NUREG/CR-1580 and NUREG-0700. Duties also included documenting and identifying human engineering discrepancies and backfits.

Research Associate - Participated in the (NUREG/CR-1580) Human Factors evaluation of three nuclear power plants for Carolina Power and Light. One plant evaluation included a control board assessment of engineering drawings for a plant under construction. Evaluated procedures developed for control room review; identified, reported, and suggested suitable backfits for human engineering discrepancies found in the control room.

XEROX CORPORATION (1978 - 1980)

Associate Human Factors Designer - Supported Human Factors Department in the Business Machine and Copier/Duplication Divisions. Duties included control system design, behavioral testing, and new product assessments. Also wrote machine operating procedures and developed dialogues used for operator assistance.

CANYON RESEARCH GROUP, INC. (1978)

Assistant, Researcher - Contract research assistant to Xerox corporation, Industrial Design/Human Factors Department, Business Machines Division. Duties consisted of control system design and behavioral testing.

E.L. (RETT) CONSIDINE
CONTROL PANEL DESIGN SPECIALIST
MANAGEMENT ANALYSIS CO.

PROFESSIONAL TRAINING

United States Navy technical schools:

U.S. Nuclear Power School, Mare Island, California

Nuclear Power Training Unit, Idaho Falls, Idaho

Electronic Technician A. School, Treasure Island, California

Submarine School, New London, Connecticut

PROFESSIONAL AFFILIATIONS

Instrument Society of America

American Nuclear Society

Human Factors Society

Professional Reactors Operators Society

EXPERIENCE

Management Analysis Company (1986 - Present)

Project Manager for Boston Edison control room upgrades, performing analysis and application of surface enhancements to the control room panels. Information from the EOPs, OPs, P&IDs, System Descriptions were made part of the control panel through the use of demarcation, labels and meter scales. Additional work entailed the physical rearrangement of components on the control panels.

Held line management position in the Nuclear Training Department at Rancho Seco Nuclear Generating Station. As superintendent for Administrative Services, was also responsible for the Accreditation efforts. Provided expertise in three major areas for assisting control room operator: control room operations, training, and procedures.

Bechtel Power Corporation, (1969 - 1986)

Engineering specialist for control room evaluations and improvements on major nuclear power plants.

Staff engineering specialist for South Texas Project in development and implementation of control room design review per NUREG 0700.

EXPERIENCE (Continued)

Directed the control systems discipline on a 650 MW coal-fired power plant, including costs, scheduling, procurement, evaluations, budget, and performance reviews of personnel.

Control systems specialist assigned to a 950 MW nuclear power plant project in Spain. Responsible for development of requirements and preliminary design for control room, computer, and interaction of the control systems on the project.

Control systems supervisor on a seawater pipeline; coordinated implementation of 16 interactive control rooms, including all analog instrumentation and control logic.

Engineering group leader for the control room design and the control systems integration of a nuclear steam supply system contract.

Provided proposal and Preliminary Safety Analysis Report technical support for domestic and international efforts.

Served as start-up field liaison for engineering and construction for computer modifications at South California Edison, Alamitos and Huntington Beach generating stations.

Participated on the following projects as staff engineer or in-house consultant to control room design:

San Onofre Units 2 and 3 -- California
Lemoniz -- Bilbao, Spain
ASCO -- Madrid, Spain
A.W. Vogtle -- Georgia
Roy S. Nelson Unit 6 (coal-fired) -- Louisiana
Fayette Power Project, 2 units (coal-fired) -- Texas
Sayago -- Bilbao, Spain
W.A. Parish 2 Unit (coal-fired) -- Texas
Vandellos Nuclear Center Unit 2 -- Madrid, Spain
South Texas Project -- Texas

<u>United States Navy (1961 - 1969)</u>

Qualified Senior Reactor Operator and Chief Reactor Technician. Supervised reactor operators and technicians, maintenance of reactor control, protection systems and all instrumentation at U.S. Navy nuclear power training unit A1W. Also served as senior reactor control instructor for instrumentation, reactor physics, and reactor control for reactor operator trainees. Member of the Reactor Operator Qualification Board. Qualified SRO on the USS Shark.

APPENDIX D

PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE OF PANEL IMPROVEMENTS (LTP 328)

APPENDIX D

PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE OF PANEL IMPROVEMENTS (LTP 328)

This appendix provides a tabulation of engineering design "packages" to implement the panel enhancements, panel hardware replacements, and panel relocations under our Long Term Plan element #328. These scope items are those newly identified in this report (Section III), including portions of Categories 2, 4, and 5.

The implementation schedule shown here is preliminary. As explained in Section IV, no detailed schedule has been developed for outages beyond RFO8 in 1991.

The "PRI" column indicates the relative priority among these items on a H(igh)/M(edium)/L(ow) basis. The priority considers the quantitative impact analysis performed during detailed screening (when applicable), as well as other factors including operational preferences, logical engineering sequences, and condition of existing equipment. This priority is tentative, not a commitment for work sequence.

APPENDIX D TO FINAL SUMMARY REPORT
PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE OF PANEL IMPROVEMENTS (LTP 328)

PKG# PDC/SJA # (1)	DESCRIPTION	PRI (2)	IMPL\ SCHED (3)
13	Replace four Reactor Water Level Meters (LI263-100A,B and LI263-106A,B) with digital meters to allow better resolution of reactor water level.	H	M
13A	Replace two Reactor Pressure Meters (PI640-25A,B) with digital meters to allow better resolution of reactor pressure.	H	M
16	Redesign and replace panel C7; relocate some devices to front panels, as required; including possible addition of new panel in main operating area.	H	9
SJA 90-047	Install scram valve position lights and MSIV logic lights on panel C905 in parallel with lights on C915/C917.	H	8
31	Add status light to C915/C917 to indicate when the scram breakers are shut	H	M

November 26, 1990

APPENDIX D TO FINAL SUMMARY REPORT
PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE
OF PANEL IMPROVEMENTS (LTP 328)

PKG# PDC/SJA # (1)	DESCRIPTION	PRI (2)	IMPL SCHED (3)
SJA 90-050	Relocate control switches for MO1201-2,5,80 from existing location to area where the remainder of the RWCU control switches and instruments are located.	M	M
19	Modify HPCI/RCIC control and stop valves so that both position indication lights are "on" in mid-position.	M	M
23	Relocate MO3479 & MO3480 (First Point Heater Outlet Valves) from C4 to C1.	M	M
14	Remove turbine steam flow signal to recorder PR640-28 such that Reactor Water Level will always be recorded. In addition, alarm window C905L/D4 and the selector switch for PR640-28 will be removed.	M	9
15	Install direct indication (from limit switches) of valve positions for CV9068A,B.	M	9

November 26, 1990

APPENDIX D TO FINAL SUMMARY REPORT
PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE OF PANEL IMPROVEMENTS (LTP 328)

PKG# PDC/SJA # (1)	DESCRIPTION	PRI (2)	IMPL\ SCHED (3)
39	Remove or replace access door to rear panel space behind C903, C904.	M	U
06	Replace TI5021-01A and TI5022-02B with digital meters (1 for each parameter) to allow better resolution of Torus temperature	M	M
42	Rearrange Secondary Containment Modules on C921	M	M
17	Add "bands" to meters (to indicate normal ranges, setpoints, etc.)	M	U
SJA 90-052	Rearrange control switches for: main steam relief valves; turbine oil lift pumps; exhaust discharge valves; and gland seal condenser exhaust valves to achieve a consistent order among all panels. Rearrange four meters for HPCI and four meters for RCIC to achieve a consistent and logical order in the two systems. Also, move the indicators for the safety valves to the right, to allow operators at C903 to distinguish between RV indication and SV indication.	M	8

November 26, 1990

APPENDIX D TO FINAL SUMMARY REPORT
PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE OF PANEL IMPROVEMENTS (LTP 328)

PKG# PDC/SJA # (1)	DESCRIPTION	PRI (2)	IMPL\ SCHED (3)
SJA 90-053	Rearrangement of Panel C174/C175--Remove dual range controls for H2 and O2 analyzers and rearrange grab sample valves such that supply and return valves are more logically arranged	L	M
18	Relocate control switch for FV3351 from the existing location to the location of the control switch for the "A" seawater pump, which will be moved next to the "B" sea water pump.	L	M
11	Replace CRU3361 (Condensate Demineralizer Inlet Conductivity) with a smaller recorder to allow relocation of CRU-E1 (Condensate Pump Suction Conductivity) from C904 to C1.	L	9
20	Remove control switches for AO5035A and AO5036A from C904 and relocate FC5030B (N2 flow controller) from C904 to C7; potential additional rearrangements of other devices within C904. (Needs to be integrated with redesign of C7, item 16).	L	9
22	Replace Kaye Recorder to provide alarm at Drywell bulk temperature of 152F.	L	9

November 26, 1990

APPENDIX D TO FINAL SUMMARY REPORT
PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE
OF PANEL IMPROVEMENTS (LTP 328)

PKG# PDC/SJA # (1)	DESCRIPTION	PRI (2)	IMPL\ SCHED (3)
29	Rewire conductivity alarms for CRU-E2 (Demineralizer Outlet Conductivity) to eliminate cutoff switches. The alarm will only be active when the outlet valve is open.	L	9
37	Add power available indicating lights to panel C3 for power supplies Y1, Y2, Y3 and Y4.	L	9
40	Add two switches to C903 to allow the Reactor Operator to secure all drywell fans.	L	9
05	Replace front panel Gai-Tronics units with new units containing "page" button on handle; Install new Gai-Tronics station at Panel C7.	L	OL
07	Replace RBCCW temperature recorder TR3835/3836 with an up-to-date Foxboro recorder.	L	M
12	Replace FI1040-1A,B (RHR Flow) with digital meters to allow better resolution of RHR flow	L	M

November 26, 1990

APPENDIX D TO FINAL SUMMARY REPORT
PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE OF PANEL IMPROVEMENTS (LTP 328)

PKG# PDC/SJA # (1)	DESCRIPTION	PRI (2)	IMPL\ SCHED (3)
09	Rearrange recorders on C902 to allow the most important recorders to be at the optimum height	L	9
SJA 89-074	Replace TRU5021-01A and TRU5022-01B (Torus Bulk Water Temperature) with recorders that are easier to read	L	9
35	Remove stabilizing valve switch from C905	L	9
44	Replace bulbs in GE ET-16 sockets with long life LEDS	L	U

November 26, 1990

APPENDIX D TO FINAL SUMMARY REPORT
PRELIMINARY SCHEDULE FOR ADDITIONAL SCOPE
OF PANEL IMPROVEMENTS (LTP 328)

PKG# PDC/SJA # (1)	DESCRIPTION	PRI (2)	IMPL\ SCHED (3)
01	Patch the main control panels and change the color of the panels	(4)	8
87-78L	Install labels, mimics, and demarcations on panels C174/175	(4)	OL
87-78M	Ditto, panels C921, C76, C77, C10	(4)	OL
26	Ditto, panels C220, C221 C114, C115 (fire alarm panels)	(4)	OL

November 26, 1990

Notes to Table

(1) "PKG#" is an arbitrary number for identification purposes. PDC#'s or SJA#'s are listed where known.

(2) Relative priority as determined by NEDWI 344 analysis by CRDR Design Review Team, plus Operations preference and with consideration for work sequence and material condition.

(3) Planned implementation schedule. 8=RFO8; M=1992 midcycle outage; 9=RFO9; OL=on-line (after RFO8); U=uncertain.

(4) Not prioritized; required for consistency with or support to other committed work.

Note: Items with low priority or no calculated priority will be reassessed by CRDR Design Review Team as design and planning proceed.