REVISION 0
February 27, 1984

Control Room Design Review

Executive Summary

The South Texas Project

HOUSTON LIGHTING & POWER COMPANY

REVISION LOG

Revision No	Date	Description	Pages Affected
0	1/30/84	Initial Issue	

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ACRONYMS AND ABBREVIATIONS

ARO	Auxiliary Reactor Operator
ASSOC	Associated
ASST	Assistant
AUX	Auxiliary
CAT	Category
CLO	Checklist Observation
CONT	Control
CR	Control Room
CRDR	Control Room Design Review
CRT	Cathode Ray Tube
CVCS	Chemical Volume Control System
EES	Emergency Event Sequences
EOF	Emergency Operating Facility
EOP	Emergency Operating Procedure(s)
EPRI	Electric Power Research Institute
ESF	Engineered Safety Feature(s)
EST	Estimate(d)
EXPER	Experience
FW	Feedwater
HE	Human Engineering
HED	Human Engineering Discrepancy
HHSI	High Head Safety Injection
HL&P	Houston Lighting & Powr Company
HPSI	High Pressure Safety Injection
I&C	Instruments and Controls
INPO	Institute of Nuclear Power Operators
INSTR	Instrument
LDR	Leader

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ACRONYMS AND ABBREVIATIONS (Cont.)

LHSI	Low Head Safety Injection
LOCA	Loss of Coolant Accident
LOSP	Loss of Offsite (AC) Power
LPSI	Low Pressure Safety Injection
LR01	Licensed Reactor Operator #1
LR02	Licensed Reactor Operator #2
M/M	Man/Machine
MCP	Main Control Panel
MON	Monitor
MSR	Moisture Separator Reheater
MT	Management Team
MW(e)	Megawatts (electric)
NOS	Numbers
NRC	Nuclear Regulatory Commission
OERT	Operating Experience Review Task Group
OSC	Operational Support Center
PORV	Power Operated Relief Valve
PRT	Project Review Team
PSAR	Preliminary Safety Analysis Report
RAS	Recirculation Actuation Signal
PZR	Pressurizer
RCB	Reactor Containment Building
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RECIRC	Recirculating
REQ'D	Required
RG	Regulatory Guide

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ACRONYMS AND ABBREVIATIONS (Cont.)

RHR	Residual Heat Removal
RO	Reactor Operator
RWST	Refueling Water Storage Tank
RX	Reactor
SBCS	Standby Cooling System
SFTA	System Function and Task Analysis
SG	Steam Generator
SIS	Safety Injection System
SOE	Selected Operational Event(s)
SPDS	Safety Parameter Display System
SRO	Senior Reactor Operator
SS	Subsystem
STAT	Systems Task Analysis Team
SUPVR	Supervisor
SW	Switch
SYS	System
TMI	Three-Mile Island
TSC	Technical Support Center

SUMMARY

This report summarizes the results of the detailed Control Room Design Review (CRDR) of the South Texas Project Nuclear Power Generation Station and addresses NRC audit comments noted in the NRC letter to Mr. J. H. Goldberg dated October 31, 1983 (Docket Nos. 50-498 and 499).

This CRDR was initiated to address the NRC identified control room design problems following its investingations of the Three Mile Island accident; namely:

1. Non-compliance of control facilities with human factors principles.

2. Deficiencies in information and controls available to plant operators.

3. Inadequate operating procedures.

This program is based on an overall HL&P plan to integrate the following pertinent TMI action plan (NUREG-0660) andf NUREG-0737 Supplement 1 related activities.

1. Implementation of a safety parameter display system (SPDS)

2. Implementation of Regulatory Guide 1.97 instrumentation for minimizing risk to plant safety

3. Implementation of instrumentation to monitor critical parameters following an accident (post-accident monitors)

4. Training to enhance coping with emergencies

5. Development of symptom-based emergency operating procedures (EOPs), and

6. Design of emergency response facilities.

This review was performed by a multi-discipline consortium of specialists from Houston Lighting & Power Company, Bechtel Energy Corporation and Torrey Pines Technology. This review was initiated in September 1982, and will be on-going until the Unit 1 Control Room becomes operational. The control room for Unit 2 is planned to be identical to Unit 1, which was reviewed. Any differences will be reviewed using human factors guidelines to assure the same quality as the Unit 1 control room.

The program was conducted in compliance with NUREG-0700 as defined in the Program Plan submitted by HL&P to the NRC on October 11, 1982. The principal working tools for this program were the full scale mock up of the control room, Figure S-1, located in the Bechtel engineering office in Houston, Texas and the plant simulator located at the Gould Simulator facility, at Long Island.

The CRDR and design evolutions (TMI requirements) resulted in major revisions of the panel layouts, design features, and a series of special studies to effect major control room design changes consistent with NUREG-0700 guidelines.

The program made extensive use of operations and training personnel in the data collection phase, panel relayout work, enhancement phase, particularly the major studies (annunciator, demarcation and hierarchial labeling), and in the final validation phases.

The two meetings with the NRC, reviewing the Program Plan and the in-process audit conducted at the mockup, were very useful in the overall conduct of the program and in particular to the many task efforts to resolve disrepencies that were of major concern.

The principal elements of the human factors program developed the following major discrepancies and recommmended actions:

1. Major panel relayouts as a result of the system function and task analysis, control room survey, design evolutions and Reg. Guide 1.97 implementation.

2. Major modifications of the annunciator design as a result of the control room survey and the annunciator study program.

3. Addition of hierarchial labeling and extensive revision of individual nameplates.

4. Changeover of many switches to effect continuity with plant design conventions.

5. Removal of many panel devices from the prime panel locations by relocation on back panels or elimination altogether.

6. A panel surface paint technique (color pads) to show the association of panel devices in a system or subsystem resulted from a demarcation study. This study resulted in a change of the basic panel background color from seamist green to beige.

7. Timely application of human factor engineering to the design of the control room operator work stations.

8. A logical development of CRT and plasma displays to complement the symptom-based emergency operating procedures.

The criteria report lists 816 guidelines in the nine NUREG-0700 topical subjects. The review of the ten main control room panels, the HVAC and recorder back panels and the auxiliary shutdown panel showed that 441 of these guidelines were assessed as Human Engineering Discrepancies (HEDs) as follows:

Category A (Safety Consequences) - 45
Category B (Availability Enchancement) - 323
Category C (Reliability Enhancement) - 20
Category D (Minor) - 53

Total - 441

There were 55 Category E (review of item delayed until control room is operational) generic guidelines that require an operational control room for evaluation. These will be completed when the Unit 1 control room becomes operational.

PREFACE

The control room design review (CRDR) of the South Texas Project (STP) Nuclear Generating Station was started in September 1982. This review is being performed by Torrey Pines Technology for Houston Lighting & Power Company (HL&P) with Bechtel Energy Corporation (Bechtel) acting as agent.

The program plan was presented to the NRC at the STP mock-up in October 1982. The basic review work for operator experience review, system function and task analysis and control room survey was completed in October 1982. In November 1982 the management team put a hold on CRDR activities, and authorized a design study to correct mounting evolutionary engineering changes and discrepancies with the NUREG 0700 guidelines.

In November 1982, a decision was made by HL&P to completely relayout six panels and upgrade the four remaining main control panels based on the design study. This redesign effort was required to accommodate design changes resulting from plant design evolution and Reg. Guide 1.97 requirements and to correct discrepancies with NUREG 0700. In December 1982 the management team selected one of five alternatives studied for design implementation.

The mock-up was revised considering the 441 identified HEDs and evolutionary engineering changes. As the Bechtel layout engineers advanced the layouts of the 10 panels, Torrey Pines Technology engineers reviewed the rework for correction of known discrepancies and compliance with good human factor principals. The redesign effort on the main control panels was completed in April 1983. The NRC performed an in progress audit in May 1983 after which the panel vendor was provided with firm layout drawings. The NRC audit comments required the addition of several special studies to those already in progress, i.e., demarcation, and hierarchial labeling. The most significant addition was the evaluation of specified parameters which resulted in a net reduction of 51 panel meters. The extensive relayout required a repeat of the System Function and Task

Analysis with verification and walk-through/talk-through validation. Likewise a specially structured control room review and human factors review of the corrective measures for all Category "A" and representative Category "B" discrepencies were performed. The demarcation and hierarchial labeling studies resulted in continued upgrading of the mock-up. The completion of the panel relayout allowed the redesign of the annunciator system consistent with the relocations of many systems and subsystems, and a reduction of active windows from 1055 to 642.

The documentation for this program was necessarily extensive in view of its design development nature.

Documentation describing the work performed during the CRDR is summarized below and in figure P-1:

1. Program Plan - Defines the plan for performing the CRDR.

2. Criteria Report - Provides the detailed guidelines and basis for the CRDR and describes the interface between the control room and plant systems. This report also includes review procedures, plant conventions and Human Factors data developed during the CRDR that will facilitate future control room modifications.

3. Operating Experience Review (OER) Report - Describes the operations personnel review process results, conclusions and recommendations of this task defined in the Program Plan.

4. System Function and Task Analysis (SFTA) Report - Describes the methodology, results, conclusions and recommendations for this SFTA effort defined in the Program Plan.

5. Control Room Survey (CRS) Report - Describes the review process, results, conclusions and recommendations of this task defined in the Program Plan. This report also includes the final results and dispositions for the human factor observations obtained from the OER and the SFTA.

6. Annunciator Report - Describes the review process, results, conclusions and recommendations of the annunciator review task defined in the Program Plan, and the annunciator study guide.

7. Special Studies Report - Describes details of miscellaneous studies performed as part of the CRDR. This includes the anthropometric study, the hierarchial labeling study, the demarcation study, evaluation of specified parameters and many minor studies to resolve NRC audit comments.

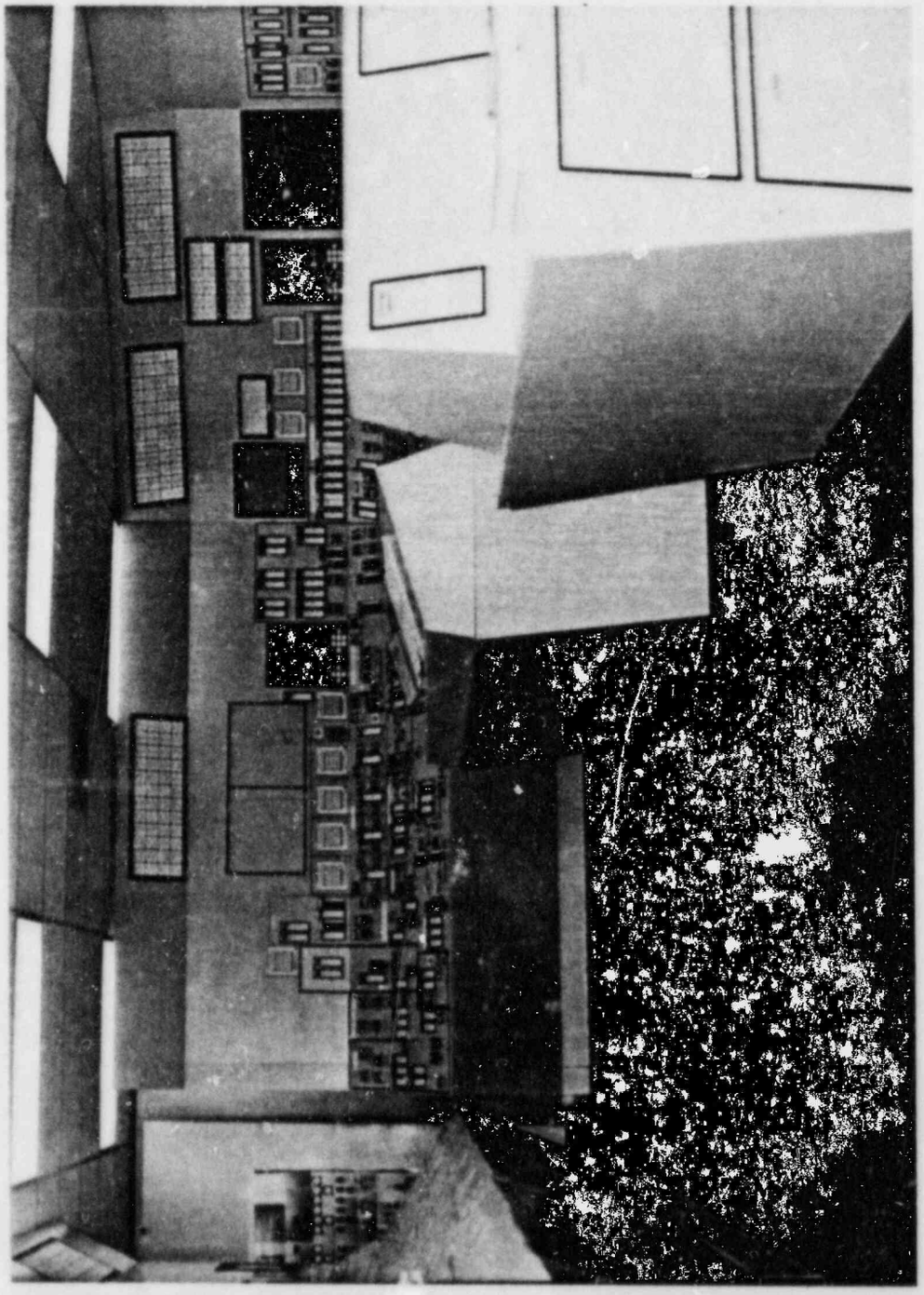
8. Implementation Plan Report - Summarizes the control panel design changes resulting from the implementation of Reg. Guide 1.97 requirements, engineering design requirements and preliminary observation of the CRDR design review team. It describes the reasons for major changes to the control panel layouts.

9. SFTA Validation Report - Summarizes the second review required because of the extensive revisions made to the control panel layouts and also includes walk-through/talk-through exercises performed in the mock-up area.

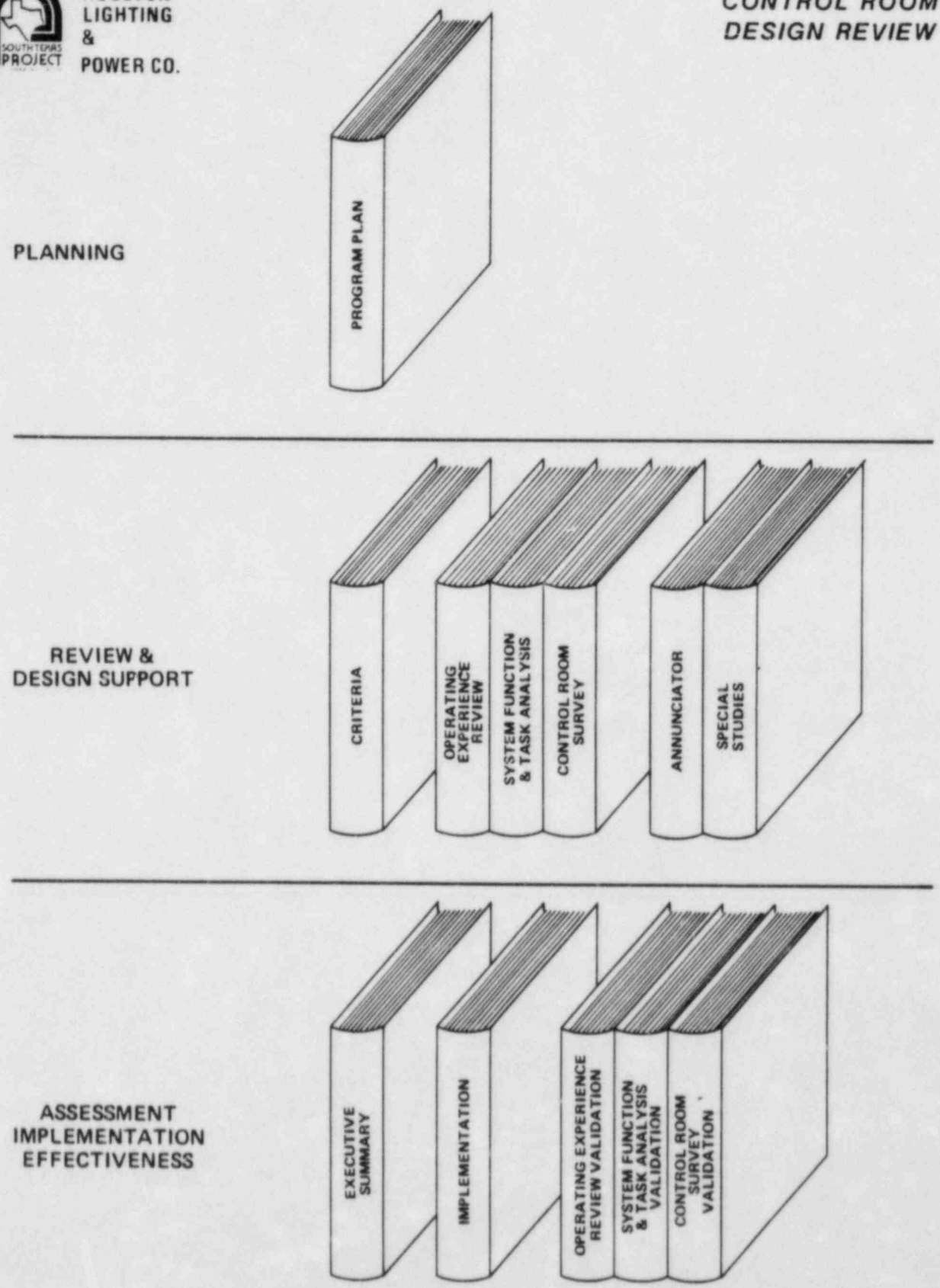
10. OER Validation Report - Summarizes the review made by operators to determine if the redesigned panels corrected reported operator concerns and evaluated if any new problems were created as a result of the corrective measures taken.

11. CRS Validation Report - Summarizes the review made to determine if the Category A and representative samples of the Category B HEDS were satisfactorily corrected and if any new problems were created.

12. Executive Summary - Summarizes the CRDR results, conclusions and recommendations. Technical details are in the Operating Experience Review Report, the System Function and Task Analysis Report, the Annunciator Report, the Control Room Survey Report, the Special Studies Report, the Implementation Plan Report and various Validation reports.



SOUTH TEXAS PROJECT
AT BECHTEL - HOUSTON OFFICE
Figure S-1



STP CRDR MAJOR REPORTS
Figure P-1

ACKNOWLEDGEMENTS

The following individuals are acknowledged for their participation in this program:

HOUSTON LIGHTING & POWER COMPANY

- Plant Operators and Training
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1.0 INTRODUCTION

1.1 GENERAL COMMENTS

The South Texas Project Control Room Design Review has proceeded as far as possible without the use of an operational control room. This report covers activities from this program initiated in September 1982 through February 1984.

The review was conducted as described in the Program Plan and expanded to include activities normally handled in post CRDR programs. The motivation for this expanded activity was to incorporate the identified changes in the control board manufacturing cycle. This will provide a product consistent with NUREG-0700 guidelines.

The program represents a vigorous effort to comply with NUREG-0700, NUREG-0801 and implements to related program integration recommended in Generic Letter 82-33 (Supplement 1 to NUREG 0737). The following were considered throughout the program:

1. Design control room modifications that correct conditions adverse to safety (reduce significant contributions to risk), and add instrumentation necessary to implement Regulatory Guide 1.97.

2. The use of Westinghouse Owners group produced symptom-based Emergency Response Guidelines.

3. Training to enhance coping with emergencies.

4. NRC program plan review and control room audit comments.

5. In process integration of NUREG 0737 Supplement 1 related programs such as: SPDS, Regulatory Guide 1.97, EOPs, training and emergency response facilities.

Figure 1-1 is a block diagram showing the relationship of the NUREG-0660 Task Action items HL&P is addressing.

1.2 CRDR PURPOSE AND OBJECTIVES

The purpose of this CRDR is to identify and implement control room design improvements that offer high probability for meeting plant safety and availability objectives. The following are the objectives of the program:

1. Determine that the control room provides the system status information, control capabilities, feedback, and analytical aids necessary for control room operators to effectively accomplish their functions.

2. Identify characteristics of the existing control room instrumentation, controls, and physical arrangements that may impact optimum operator performance.

3. Analyze and evaluate potential problems as identified in this review.

4. Define and put into effect a plan of action that applies additional human factors principles to enhance operator effectiveness. Particular emphasis is placed on improvements affecting control room design and operator performance under abnormal or emergency conditions.

5. Integrate the CRDR review with other areas of human factors inquiries identified in the NRC Task Action Plan (Generic Letter 82-33/NUREG-0737, Supplement 1).

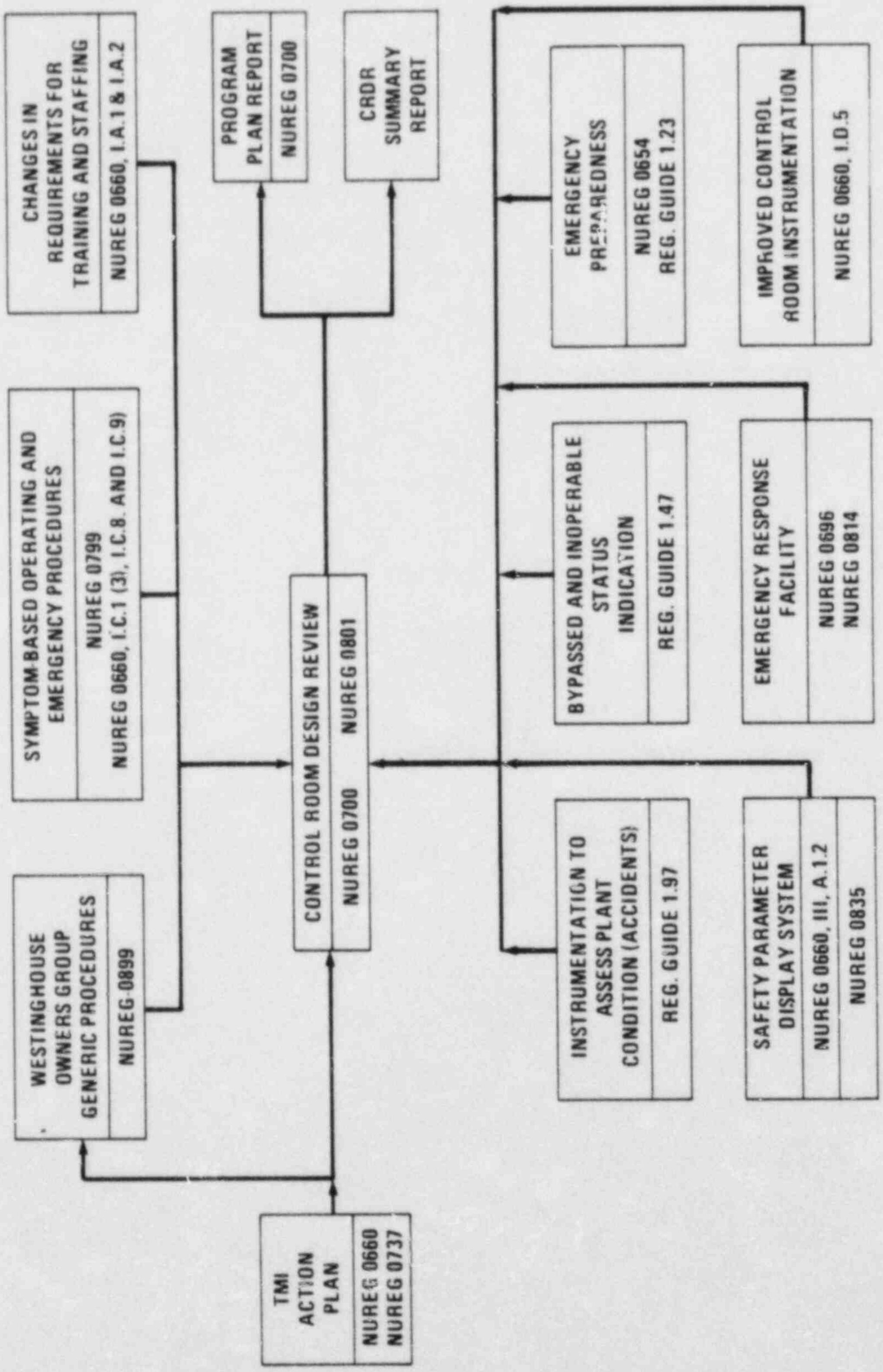
1.3 PLANT DESCRIPTION

The South Texas Project (STP) is currently under construction in south-central Matagorda County on a site 89 miles southwest of Houston, Texas (see Figure 1-2) . Bechtel is the architect/engineer and Ebasco is the constructor. The station will consist of two 1250-MW(e) (nominal) units. Each unit is powered by a Westinghouse Electric Corporation nuclear steam supply system consisting of a four-loop, pressurized water reactor and supporting auxiliary systems.

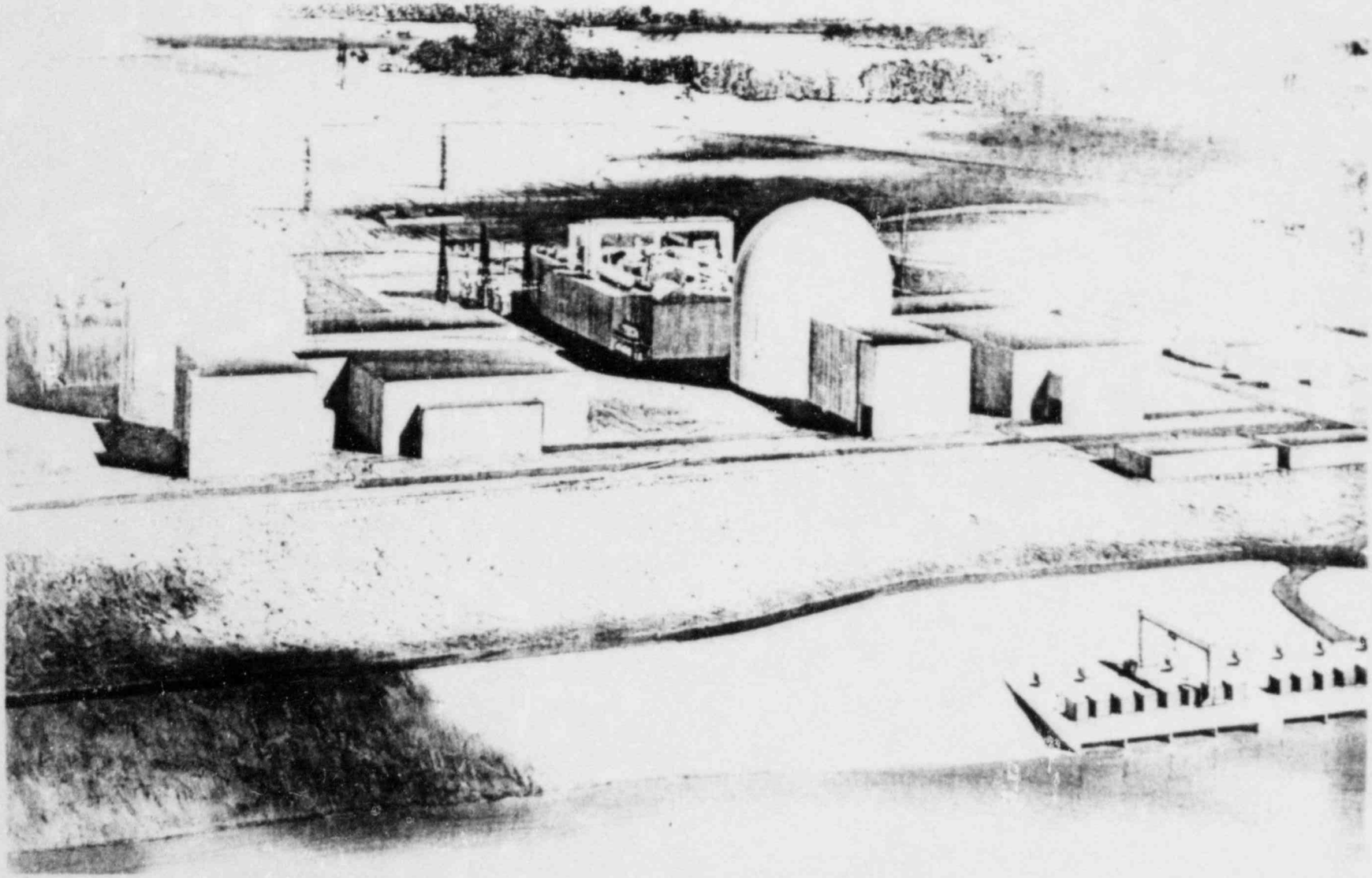
The basic power conversion unit is also furnished by Westinghouse. Each turbine-generator is an 1800 rpm tandem compound unit and is furnished with electrohydraulic controls. Commercial operation for Units 1 and 2 is scheduled for June 1987 and June 1989, respectively.

1.4 DEFINITION OF CONTROL ROOM

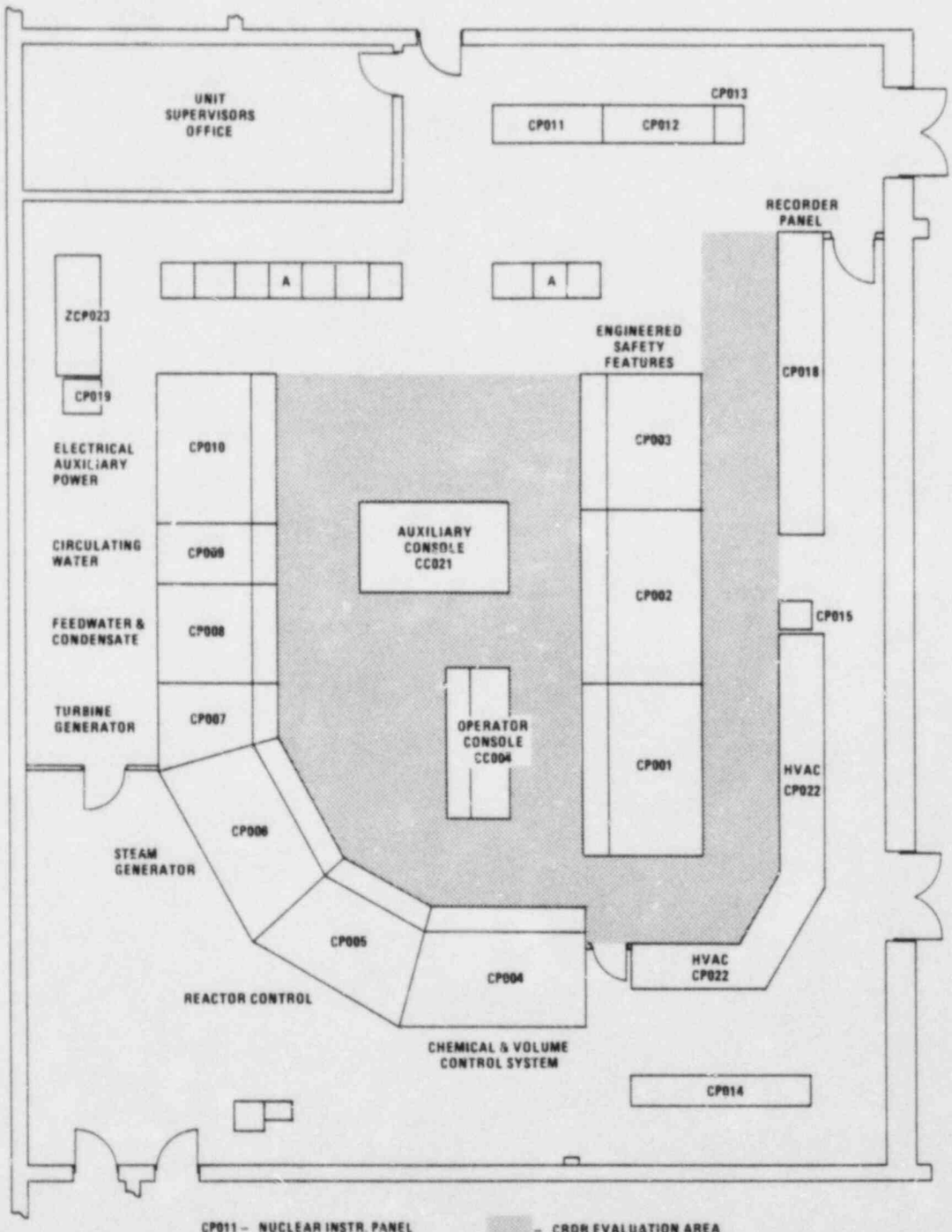
The STP Control Room is defined as area panels CP-001 through CP-010 in the central control room, including new panels CP-018 and CP-022 (located behind panels CP-001, CP-002 and CP-003), and the auxiliary shutdown panel. Figure 1-3 illustrates the layout in the central control room. The Unit 1 and 2 control rooms are essentially identical. See the SFTA report for a listing of all systems and subsystems located in these panels.



RELATIONSHIP OF
NUREG 0660 TASK ACTION ITEMS
Figure 1-1



ARTIST'S RENDITION OF SOUTH TEXAS PROJECT PLANT
FIGURE 1-2



CONTROL ROOM LAYOUT
Figure 1-3

2.0 CONTROL ROOM DESIGN REVIEW PLAN, METHODOLOGY AND RESULTS

The overview of the CRDR process is shown in Figure 2-1, which is a copy of Exhibit 3-1 of NUREG-0700.

2.1 PLANNING

Houston Lighting & Power organized a management team to guide, monitor and implement this program. The overall review structure is shown in Figure 2-2. Qualification of the participants is included in the program plan. The management team made provisions for designated alternates to key positions. The functions of this team corresponded to those recommended for Management in NUREG-0700 as follows:

1. Assure proper relationships and awareness between this project and other NUREG-0660 efforts.

2. Assign key management and Project Review Team personnel (see Figure 2-2).

3. Approve detail Program Plan.

4. Provide resources required to carry out the program plan.

5. Identify and assure that plant operational constraints and project requirements are properly coordinated.

6. Monitor CRDR progress.

7. Review and approve control room improvement recommendations.

8. Establish and initiate the control room improvement program.

The management team gave consideration to the advantages and disadvantages of performing the CRDR prior to completion of operating procedures, training, and construction of the control room complex. The decision to proceed with the review was based on the advantage of identifying major departures from good human factors design, if any, of the control panels prior to completion of manufacture. This would minimize negative transfer and retraining problems. To facilitate this review, project management authorized the construction of a full scale, realistic mock-up and provided facilities for an extensive review by human factors and systems specialists at the Bechtel-Houston engineering offices with the reviewers performing most phases of their tasks in the vicinity of the mock-up.

2.2 REVIEW

The review phase was the investigative phase. This effort was organized into specialty task groups per Figure 2-3. Specialized personnel were selected as required for each task group from HL&P, Bechtel, and Torrey Pines Technology. Approximately 25 engineers and key operations personnel participated in the detailed reviews and evaluations of the task groups.

The following types of personnel were included:

1. System design and analysis engineers
2. Human factors consultants
3. Control board designers
4. Instrumentation and control engineers
5. Computer engineer
6. Plant operators

7. Licensing engineer

2.3 METHODOLOGY

2.3.1 Criteria Report

The Design Review and Technical Task Team prepared control room design and review criteria that was presented in the Criteria Report. This report stresses the human factors considerations and requirements for the control room design. This document describes the function of the control room and plant systems related to external communications. It also addresses one of the major post-TMI concerns: the systems and human factors features for Annunciator/Computer/ESF Status Monitor interfaces relative to prioritization, consistency, and overall integration.

The following topics are included in this document:

1. Introduction
2. General
3. Control Room Layout and Features
4. Main Control Panels and Auxiliary Shutdown Panel Layouts and Features
5. Human Factors Guidelines (plant specific adaptations of NUREG-0700, Section 6, guidelines not covered in other major topics)
6. Communications Criteria
7. Control Room Annunciation Features

8. Post-Accident Monitoring Features

9. Bypassed and Inoperable Status Features

10. Safety Parameter Display System Features

11. Plant Computer Features

12. References

This document also includes the following appendicies:

1. Anthropometric and Workspace Design Guidelines for Stand-up Consoles, Sit-Down Consoles, Sit-Stand Work Stations, and Vertical Panels

2. Guidelines for Control Room Desks and Chairs

3. Guidelines for Emergency Equipment Used by Control Room Operators

4. Control Room Environment Guidelines

5. Guidelines Specific to Pushbuttons, Rotary Controls, and Joysticks

6. Visual Displays General Guidelines

7. Meter Displays Guidelines

8. Indicator Lights Guidelines

9. Graphic Recorders Guidelines

10. Guidelines Specific to Drum-Type Counter Displays

11. Guidelines Specific to Electronic Counter Displays

12. Standard Abbreviations List for all STP Labeling

13. Label Lettering Guidelines

14. Location Aids Guidelines

15. Process Computer Guidelines

16. Guidelines Pertaining to Keyboards, Function Controls, Computer Response Times, and Access Aids

17. Computer Response Times, and Access Aids

18. Guidelines Specific to CRT Displays

19. Printers Guidelines

20. Guidelines for the Use of Color in Control Room Design

21. Guidelines for Applying HFE Principals to CR Changes

22. Demarcation Study Guide

23. Labeling Design Guide

The criteria were developed considering:

1. Those human factors engineering practices that have general industry acceptance and have resulted in proven performance.

2. Pertinent NUREG documents and Regulatory Guides.

3. Established criteria from general industry, EPRI, INPO, government sources, HL&P, Westinghouse, and Bechtel standards and practices.

4. Current plant systems and operations requirements.

5. Firm human factors-related criteria stated by suppliers of major equipment and systems.

2.3.2 Operating Experience Review

The operating experience review task team (OERT) reviewed pertinent operating experience documents and conducted a survey of control room operations personnel. In addition to typical human factors operator concerns, the OERT emphasized systems operability. It received valuable input for use by the other task groups, particularly the Systems Task Analysis Team (STAT). Specific attention was placed on those normal plant procedures that experienced operators identified as having the greatest potential for human factors engineering enhancements. This information was used in the selection process for those events that were analyzed by the STAT.

A special meeting was held to review the methodology used in the preparation of operating procedures. Sample procedures were reviewed and comments submitted to the operations department.

The OERT:

1. Reviewed, with key operations and training personnel, the pertinent information on training, assigned duties, anticipated work scheduling, a walk through of a generic operating procedure which was completed for general operator orientation prior to the OER, and the availability of the various classes of operations personnel

2. Prepared questionnaires and interview forms (See OER Report) which were reviewed by the Project Review Team and completed by operations personnel

3. Evaluated the responses to the questionnaires

4. Interviewed plant personnel

5. Evaluated the interview results and included them in the OER report

6. Prepared an OER report.

The following NUREG-0700 topics were included in this OER:

1. Workspace layout and environment

2. Panel design

3. Annunciator warning system

4. Communications

5. Process computers

6. Corrective and preventive maintenance

7. Procedures

8. Staffing and job design

9. Training

The following summarizes the items identified by plant operations as areas of concern:

1. Work Space

   - o Instruments too high on panel
   - o Annunciators and status lights hard to read
   - o Recorders hard to reach for maintenance

2. Controls

   - o Wide variety of controls not functionally grouped
   - o Some controls difficult to identify and reach
   - o Inconsistent or illogical arrangement
   - o Excessive operator movement required to address controls
   - o Nonstandard usage of controls

3. Annunciators

   - o Need prioritizing in arrangement
   - o Layout inconsistent or poor functional arrangement
   - o Tile engraving inconsistent, not clear and hard to read
   - o Permissives need auditory tone
   - o Poor location and arrangement of alarm switches
   - o Many alarms not required on main panel and/or on any panel
   - o No first out alarms

4. Labels and Location Aids

   - o Inconsistent with plant documentation
   - o Poor message content
   - o Lack of hierarchial labels
   - o Lack of system and subsystem demarcation

5. Panel Layout/Integration

- o Illogical and nonfunctional groupings
- o Prime panel areas lacking devices located on peripheral panels
- o Controls and associated displays too far apart

Following the completion of the redesign of the main control board layout, a second questionnaire was prepared. This questionnaire contained the responses to the original survey, with space provided for responses and comments. A group of four plant operators were requested to execute a normal startup procedure and to respond to the questionnaire, which was organized according to the content areas of NUREG-0700. Comments were also solicited concerning any new observations generated as a result of the new control board layout. The responses indicated that no new observations were introduced as a result of the redesign of the control boards. The comments made by the original reviewers have been resolved. The results of the subsequent review is presented in the OER Validation Report.

2.3.3 System Function and Task Analysis

The Systems Task Analysis Team performed a structured review and analysis of the STP control room complex in compliance with NUREG-0700 and with the Program Plan. This review was performed to document and determine the design adequacy for safe plant operation. It included a review of: plant systems, emergency response documents, selection of operational events, and task analysis to identify pertinent operator actions.

The SFTA team reviewed pertinent plant documents, such as P&IDs, Westinghouse ERGs, the FSAR and system descriptions. They also attended a series of lectures to become familiar with the systems. Data forms for system information such as safety function, and failure modes were filled out, and simplified systems flow diagrams were prepared. After becoming familiar with the systems, a set of criteria for the selection of events to be analyzed was prepared. The criteria are:

1. Broad range of functions
2. Time dependent
3. Multi-system coverage
4. High stress situations

Using these criteria, the team reviewed the events listed in the FSAR and the Westinghouse ERGS and chose the following set of events. It was confirmed during discussion with a group of experienced operators that these events best satisfied the criteria:

1. Small break loss of coolant accident
2. Steam line break
3. Steam generator tube rupture
4. Loss of offsite power
5. Turbine load rejection
6. Plant startup

The six events established evolutions that created a high-stress potential, multi-system operation, rapid operator action, and involvement of a broad range of control room functions.

The analysis of each event involved the following phases:

1. System functional review

2. Traffic flow analysis

3. Spatial operational sequence analysis

The functional review identified the broad functions involved in each event. A flow diagram, with decision-action points, documented this review. The traffic flow analysis required the identification of each device used in the sequence, whether required for monitoring or for actuation. Traffic-link diagrams were prepared, showing the operator travel paths between control boards for the event. The spatial operational sequence analysis traced the sequence of actions required at a given control position, and through diagrams, identified the patterns involved. Tracing the operating path in this manner identified improperly located devices.

2.3.3.1 Results

Panel 001, 002 and 003

The traffic link diagrams for all selected events were considered, as a group, to determine the overall patterns of traffic. The most obvious problem was the number of repeated trips necessary between the ESF panels in order to control any one ESF system. If these controls were arranged by system, with those used most often located on CP-001 and those used least on CP-003, then control would be much easier. This is especially true since any emergency requires the same set of early diagnostic activities to determine exactly which type of emergency occurred.

Another major potential problem was the controls for Auxiliary Feedwater, which were spread among the three ESF Panels and Panel 006. Pump and valve controls and flow indication were located on the ESF panels, but the flow regulators were on Panel 006.

The ESF traffic link diagrams were also used to rank the systems by frequency of use and at what sequential point in the procedure it was used. This information was used to decide which systems should be nearest the "center of action", and minimize operator travel. The data indicated that High Head Safety Injection (HHSI) and Low Head Safety Injection/Residual Heat Removal (LHSI/RHR) were most important with component cooling water (CCW) and containment spray next, followed by the diesel generators. This layout results in a system-oriented arrangement.

Panel 004

The sequence diagrams showed that the operator had to move around almost randomly during start-up and emergency procedures using the charging and letdown systems. The panel equipment for these events were not arranged according to the sequence defined by the procedures.

Panel 005

The reactor control panel operational sequences were examined and the following systems were found to be not functionally grouped:

1. Pressurizer heaters, spray and pressure controls

2. Pressure relief tank controls

Panel 006

A review of the steam generator control panel indicated the layout of the controls was not acceptable. The Auxiliary Feed Water (AFW) controls from the ESF panels needed to be relocated on this panel and integrated into the layout. The controls for the steam generators were not functionally grouped. Indicators for monitoring were not adjacent to controllers, and valve controls for supplying feedwater were not integrated. Dump, isolation and blowdown were scattered - either on 007 or off by themselves on the extreme left of 006. There was a row of indicators for Post Accident Monitoring (PAM), which should be integrated with their respective systems.

Panel 007

The controls for condenser steam dump were not grouped and the isolation (PORVs, MSIVs and Bypass) valves referred to above needed to be relocated to 006 with other SG devices. The condenser steam dump system was not arranged by functional groups. The controls for sychronizing the generator should be relocated to panel 007 from 010 so that they are with the turbine controls.

Panel 010

The electrical auxiliary panel is not used often in the selected events, except for startup and turbine load rejection. The generator sychronization controls should be moved closer to the turbine controls.

2.3.3.2 SFTA Supplemental Review and Validation

After the redesign of the main control board layout was completed, the SFTA was reviewed to verify that the observations had been corrected and no new ones introduced. The operator task identification sheets for the six selected events were revised to show the new locations of devices, both within panels, and between panels. In some cases, devices had been removed or added, requiring the revision of the instrument detail section of these forms. The traffic link diagrams were then revised to reflect the movement of instruments from panel-to-panel. The spatial operational sequence diagrams were revised to reflect the relocation of subsystems and of instruments within a subsystem. The six sets of diagrams were then evaluated for efficiency of operator motion.

The new layout resulted in significant improvement in the functional arrangement of the control boards. Operator travel between boards was reduced. The results of this review are presented in the SFTA Validation Report.

2.3.4 Control Room Inventory

The inventory of controls, instrumentation, displays, and other equipment on the control room man/machine interfaces was performed at the time of the construction of the STP control room mockup. The information source used was the control room equipment list. Each item on the list was located on the mockup in accordance with the issued panel layout drawings. The equipment list is prepared on a panel-by-panel basis, categorized by equipment type, and is maintained as a data base for ease of updating, revising, and sorting.

The inventory data base was updated to reflect the additions and deletions of equipment, relocations between panels as work progressed in the SFTA, the revision of panel layouts, and verification. Devices identified by the control room survey as not complying with the control room criteria, such as wrong switch types, were also entered in the data base. A significant number of panel additions resulted from Reg. Guide 1.97 requirements and design evolution. The decision to add two control boards, for HVAC and for recorders, resulted in the relocation of many panel devices.

Only those recorders and HVAC equipment necessary for immediate operator attention were retained on the main control panels CP-001 thru CP010.

2.3.5 Control Room Survey

A survey of the full scale mock-up and the simulator was performed to document compliance with the human factors criteria document. The use of a realistic mock-up, including sample control panel hardware, permitted completion of the bulk of the checklist items developed. Those items that could not be checked, such as voice communication devices, control room noise, illumination, use of protective clothing, and other environmental considerations were deferred and will be completed when the control room is put into service.

The Control Room Survey Task Group performed the following tasks.

1. Prepared plant specific checklists for the following:

   - o Control room workspace
   - o Communications
   - o Annunciator warning system
   - o Controls
   - o Visual displays
   - o Labels and location aids

- o Process computers
- o Panel layouts
- o Control-display integration

2. Submitted checklists for Project Review Team review.

3. Finalized checklists.

4. Performed control room survey.

5. Evaluated data; summarized observations.

6. Rechecked significant modifications resulting from the above work, as necessary.

The Control Room Survey Task Group performed a representative survey of the revised panel layouts to validate compliance with the criteria document.

The program produced 441 HEDs in the following categories.

1. Category A (Safety Consequences) - 45

2. Category B (Availability Enchancement) - 323

3. Category C (Reliability Enhancement) - 20

4. Category D (Minor) - 53

There were 55 guidelines, classified as Category E (items delayed until control room is operational), that cannot be evaluated until the control room becomes operational.

After the redesign of the panels, each of the 45 Category A HEDs and a representative sample of the Category B HEDs were reexamined. The results indicated that the observations had been corrected and no new ones created. These are presented in the Control Room Survey Validation Report.

2.3.6 Verification of Control Room Function

The verification task group verified the availability of instruments and equipment needed to implement each task. This verification was made by comparing the requirements identified by the SFTA to the Control Room Inventory List. An adequacy determination of operator-equipment interfaces for task accomplishment was made and the observations were recorded. Formatted information developed during the inventory and system function task analysis activities was used.

2.3.7 Validation of Control Room Functions

In conjunction with the SFTA update, and after the control boards were revised, the CRDR team performed a validation of the control room layout. This validation was performed by two separate operating crews using walk-through/talk-through techniques, and procedures developed for two SOEs; i.e., steam generator tube rupture and startup. These two sequences are included in those analyzed in the SFTA.

The two walk-through/talk-through sessions were videotaped to allow examination of the operator responses using the new panel layouts. Each team of operators made specific recommendations for displays to be included in the Qualified Display Processing System (QDPS). These are detailed in the SFTA Validation report. The suggested graphic displays are tailored for the following specific operating evolutions:

1. Steam generator level and pressure, feedwater and steam flow.

2. Reactor Coolant System heatup and cooldown rate.

3. Subcooled margin parameters.

4. Containment status parameters.

5. Nuclear instrumentation parameters.

The graphics display software for the QDPS has not been finalized, and these recommendations will be considered for inclusion in the set of displays finally agreed upon. The results of this validation are presented in the SFTA Validation Report.

2.3.8 Annunciator Review

The annunciator review was conducted by the Annunciator Study Task Group (ASTG) in accordance with the Program Plan and the annunciator review guide. Twenty-six meetings were held with an average of seven attendees per meeting. The review included all alarms of the main plant annunciator, plant computer, ESF bypass and inoperable status system, and the operators' alarm cubicle in the basement of the turbine building.

The review was performed in two phases. In the preliminary phase, a review of design documents, including various EPRI and NRC studies pertaining to annunciator systems, was completed; criteria for the annunciator and computer systems were prepared; checklists for the evaluation of the design compared to the criteria were generated and performed; and preliminary recommendations made. These recommendations were recorded as observations and included in the Control Room Survey Report.

The decision to redesign the control board layout invalidated the location of many alarm windows, and the final phase of the review was conducted after the control board redesign was complete. A study guide was prepared to control this effort. The group performed a functional integration of the identified annunciators, assigned priorities, and reviewed each window for applicability, position, wording, and operator actions. Design documents were examined to determine possibilities for eliminating windows of little utility, and for combining those windows of similar operator response. The study resulted in: a reduction of main panel active tiles from 1055 tiles to 642, a reduction in the basic window box size from 96 tiles to 48 tiles, messages reconciled with a standard abbreviation list, calculations to enhance visibility of engraving, elimination or redistribution of alarms not essential to prime panel space and integration with the ESF status displays and computer displays. The detailed results are reported in the Annunciator Report.

2.3.9 Special Studies

During the CRDR, several observations were made of discrepancies that affected the overall control room. These items were assigned to small task groups for determination of the correct course of action to integrate corrections into the control room design. The results of these studies are summarized below and presented in the Special Studies Report.

2.3.9.1 Anthropometry Study

An anthropometry study was performed to evaluate the control board profile. This study concluded that the control board profile was acceptable with allowance for "extended reach" for operators from 20th percentile female to 95th percentile male.

2.3.9.2 Labeling Study

The control room survey identified labeling as a human factors observation. There was no apparent hierarchial labeling, the labels lacked consistent abbreviations, and some labels were unclear in meaning. A study group was assigned, and a study guide issued. The study guide is an appendix to the Criteria Report. The study guide includes label parameters, character height, label size, color, and a uniform label format. Hierarchial labels were made to conform to the criteria established. The abbreviations from the Criteria Report were used to prepare consistent messages. The mock-up was modified to include the review recommendations and reviewed by appropriate operations personnel. This effort resulted in a listing from which the panel vendor is to prepare labels for the control panels. Extensive use was made of operator reviews of labeling techniques that resulted in immediate recognition of the labeling content. After the initial labeling review, labeling refinements where made considering the results of the Demarcation Study.

2.3.9.3 Demarcation Study

The control room design review noted that the original panel layout provided for minimal demarcation of systems. This lack of demarcation could have caused operator confusion and delay in responding in times of high stress due to delay in locating the desired controls or displays.

A design guide was prepared to structure and document a demarcation scheme that was the result of both industry survey and a broad technical input, through a study team. The guide was added to the Criteria Report as Appendix U.

The team prepared a set of criteria for demarcing the control boards. After studying various methods, a recommendation was made to use beige for a basic panel color, with a color pad technique used for highlighting and grouping controls (see figure 2-4).

2.3.9.4 Meter Scales

The control room survey reported observations concerning meter scales, for example: wrong progressions (sheet number 331)* no zone markings (sheet number 006), too many, and confusing gradations (sheet numbers 359 and 361), gradation dimensions (sheet number 475), and different type styles (sheet number 357).

A study was performed to quantify examples of correct gradations, and to provide samples of zone markings for application to the meters that are to be zoned. The results are included in the Special Studies Report.

* See Control Room Survey Report for details

2.3.9.5 Recorder Survey

The revision to the panel layout included the relocation, from the main control panels to a new recorder panel, of approximately 50 recorders that were considered unnecessary to the operation of the plant, during either normal or emergency evolutions. Nineteen recorders were retained on the main control boards. During the NRC Audit of May 1983, concerns were raised relating to these recorders. There is no dual speed capability to allow the operator to scroll down the record and view the parameter value quickly. A survey was performed on the main control board recorders to determine if any were used by the operator in normal plant evolutions. One set of four recorders are used for indication, i.e., the RCP seal water flows on panel 004. The operator uses these to establish and monitor flows before starting a RCP. The remaining 15 recorders are used for either trending or for historical recording. In none of these cases is there a need for the capability to review fast transient developments. However, fast transients may be displayed and examined on the Emergency Response Facilities (ERF) computer displays.

2.3.10 Effectiveness

An NRC audit of the redesigned control room was conducted during the week of May 2, 1983. As a result of that audit the following post CRDR activities were performed:

2.3.10.1 Knurled Knob Position Indicator Problem

A study was made to correct the problem of 71 switch handles obscuring switch position markings. Twelve of the switches were changed to Honeywell selector switches which do not have the problem. The remaining 59 switch handles will be replaced with lever handles as recommended by VanCott and Kinkade in "The Human Engineering Guide to Engineering Design".

2.3.10.2 Distinguishing Legend Pushbutton From Legend Lights Problem

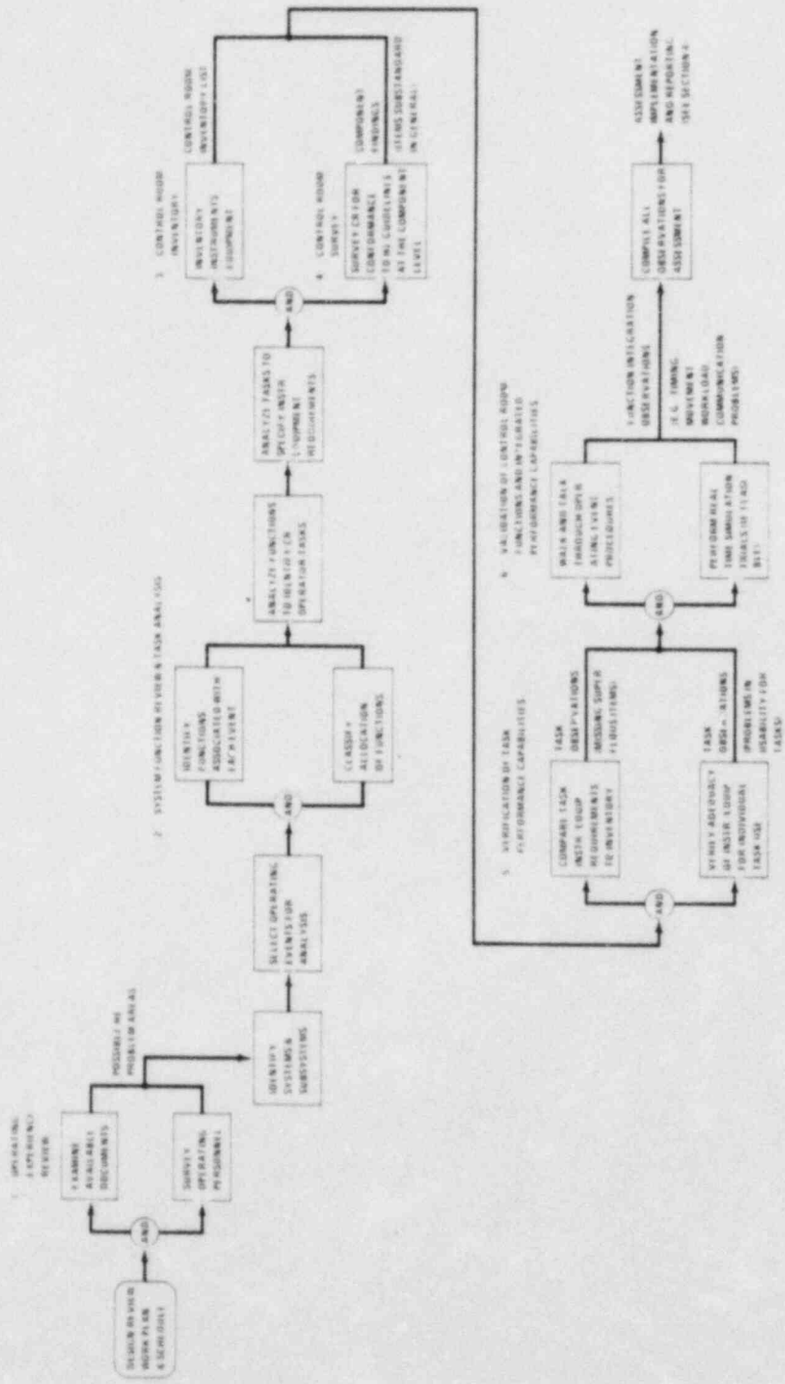
A survey study was made to select a method of distinguishing legend pushbuttons from legend indicating lights. The "close corner octagon" was selected by a consensus of operations staff and engineering personnel.

2.3.10.3 Lack of Defined Color Usage Conventions in Published Form

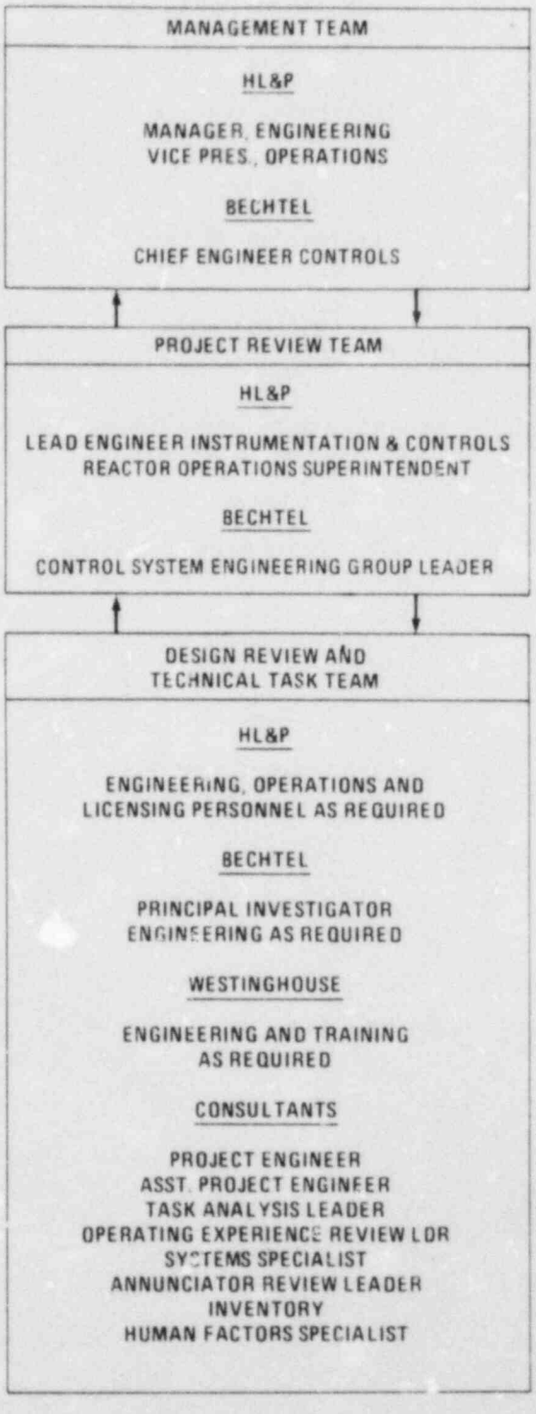
A survey was made to determine the color conventions that were used in the STP control room design. This information was organized and added to the Criteria Report as Appendix S.

2.3.10.4 Guidelines for Applying Human Factor Engineering Principles to Control Panel Design Changes

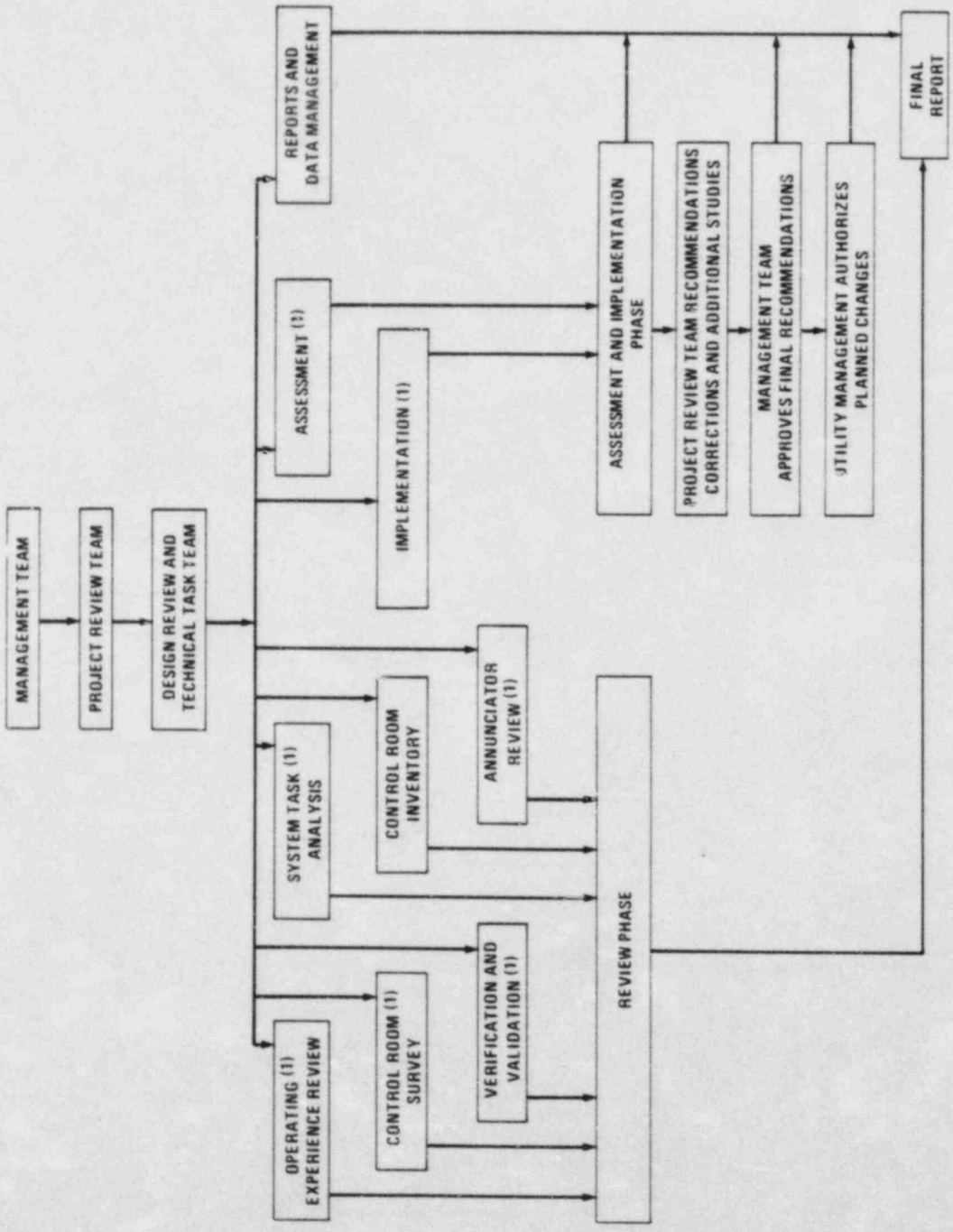
These guidelines were produced in response to the concern, expressed by the NRC audit team, that all future design changes include human factors review. This structured material was added to the Criteria Report as Appendix T.



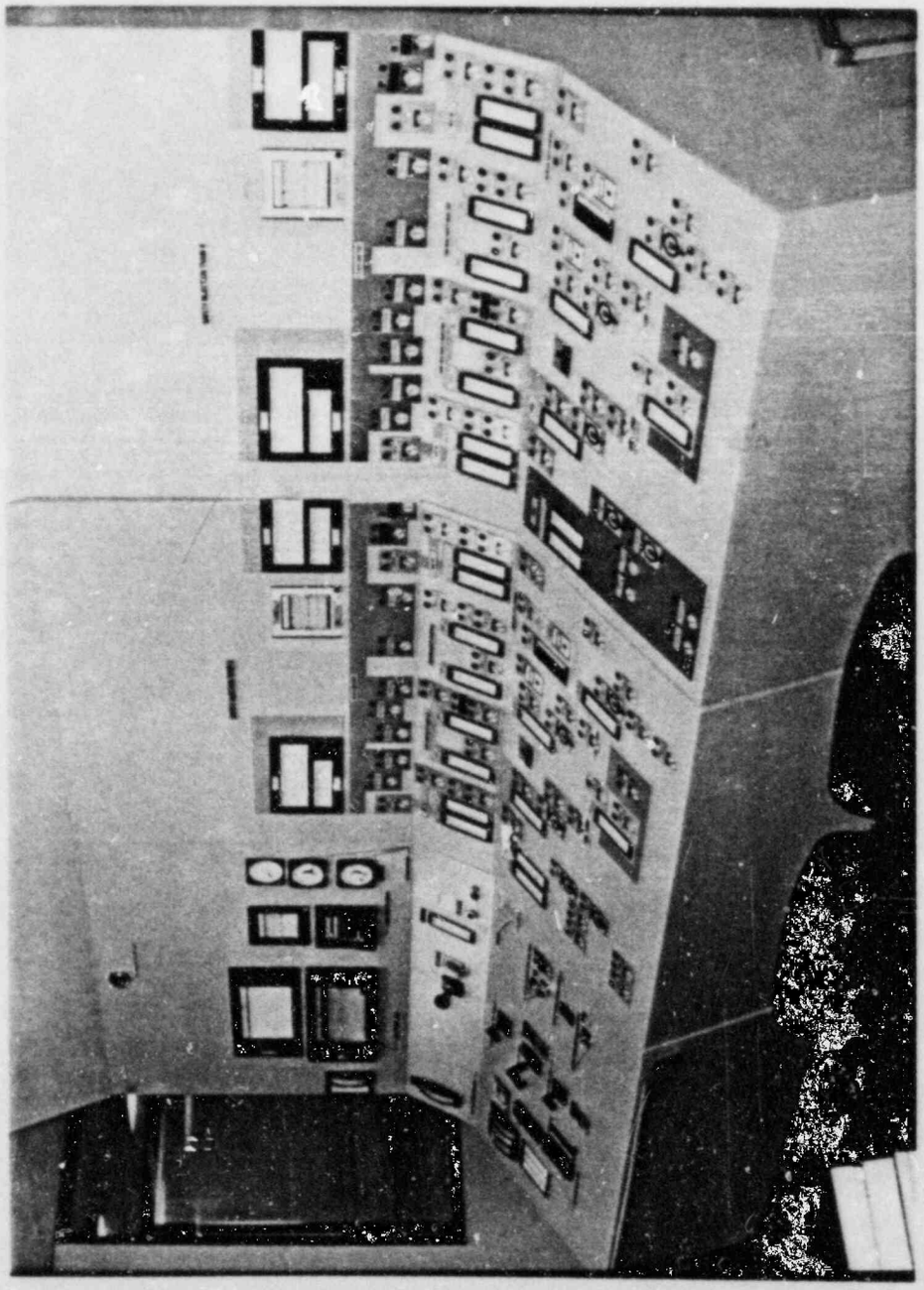
OVERVIEW OF CRDR PROCESSES
Figure 2-1



OVERVIEW OF CONTROL ROOM DESIGN REVIEW ORGANIZATION
Figure 2-2



PROGRAM TASK ORGANIZATION
Figure 2-3



DEMARCATION
STUDY PANELS
Figure 2-4

3.0 CRDR ASSESSMENT AND IMPLEMENTATION

All observations identified in this program were processed according to the assessment and implementation methodology presented in Figures 3-1 through 3-4. The Design Review and Technical Task Team documented these observations and recommendations on Checklist Observation forms (CLOs) (Figure 3-5) which were submitted to the Project Review Team for assessment.

The initial step by the Project Review Team was to accept or reject the formatted information where, in the latter case, they returned the CLO to the Design Review and Technical Task Team for further evaluation and resubmittal. Accepted CLOs were categorized according to the Assessment Factor Criteria as outlined in Selection of HEDs to be Analyzed for Correction (Figure 3-2). The criteria chosen provided for a simple, but effective, relationship between assessment factor and implementation requirements commensurate with the significance of the observation. This approach greatly reduced the need to consider various levels of safety while still accomplishing the assessment objectives of NUREGs 0700 and 0801.

All observations assigned Categories A, B or C were identified as Human Engineering Discrepancies (HEDs) and were analyzed for correction (Figure 3-3). Correction of Category D results are optional. The first step in this process was to identify those HEDs which can be corrected by enhancement. The remaining HEDs were analyzed to identify design improvement alternatives and to select solutions. In addition, some HEDs will be corrected through training. An integral part of this step was the reapplication of the control room review process, as appropriate, to ensure that:

1. Other guidelines were not violated
2. Other corrections were not invalidated
3. Any resulting increase in significance of other findings was identified and accommodated

Solutions which do not bring the discrepancies into full compliance with the guidelines have been identified and justified herein.

The Project Review Team has processed their recommendations through the management team for approval.

3.1 ASSESSMENT RESULTS

The following summarizes the status of the forty-five (45) Category "A" HEDs identified in this program. Appendix A contains the detailed disposition of the Category "A" HEDs:

1. Relayout of panels for functional grouping of associated system or subsystem devices, or relocation on an appropriate panel to minimize operator movement or to facilitate task sequence, or to accommodate frequency of usage.

   Sheet Numbers* - 511, 526, 530, 568, 569, 570, 572, 573, 574, 575, 576, 577, 578, 593, 594, 598, 599, 600, 603, 604, 605, 875

2. Include needed information on a panel CRT or plasma display

   Sheet Number - 875

3. Add equipment to the main panels, modify equipment, or replace with equipment that meets NUREG-0700 guidelines

   Sheet Numbers - 510, 517, 518, 549

* See Appendix D for master list of numerically sequenced sheet numbers vs. the Control Room Survey Report Book number and page number.

4. Provide easily distinguishable coding system

   Sheet Numbers - 517

5. Upgrade engraving, label or annunciator rewording or application of hierarchial labeling.

   Sheet Numbers - 054, 068, 322, 498, 511, 530, 566, 567, 774

6. Engineering is in progress at this time.

   Sheet Numbers - 367, 484, 679, 725, 726, 727, 731, 732, 748, 749, 750, 767, 768

The following summarizes the disposition of the 323 Category "B" HEDs identified in this program. Appendix B contains the detailed disposition of a representative sampling of the Category "B" HEDs as reported in the Control Room Survey Validation Report for the main panels.

1. Relayout of panels for functional grouping of associated system or subsystem devices, or reposition label, or relocation on an appropriate panel to minimize operator movement or to facilitate task sequence, or to accommodate frequency of usage or reposition or relocation of displayed or alarmed information.

   Sheet Numbers - 001, 002, 003, 004, 021, 022, 023, 024, 026, 027, 028, 029, 031, 032, 033, 037, 039, 040, 041, 043, 044, 045, 046, 065, 066, 067, 069, 076, 077, 078, 079, 110, 112, 114, 115, 319, 320, 321, 323, 382, 383, 393, 398, 400, 410, 411, 412, 419, 421, 454, 494, 495, 496, 497, 499, 503, 504, 505, 506, 520, 525, 571, 579, 597, 606, 656, 688, 708, 797, 798

2. Require detailed engineering for implementation.

   Sheet Numbers - 054, 328, 332, 356, 469, 646, 665, 715, 738, 754, 777

3. Add equipment to the main panels, adjust or modify equipment, or replace with criteria report or NUREG-0700 guidelines equipment.

   Sheet Numbers - 329, 330, 331, 334, 335, 359, 360, 361, 362, 374, 376, 391, 392, 408, 422, 423, 459, 460, 461, 470, 475, 476, 477, 479, 649, 650, 651, 655, 660, 661, 666, 670, 671, 672, 673, 675, 695, 696, 699, 701, 705, 706, 711, 712, 713, 716, 719, 720, 721, 724, 734, 735, 736, 739, 742, 743, 744, 745, 747, 759, 760, 761, 763, 771, 776, 781, 782, 783, 784, 786, 796, 799, 800, 801, 803, 804, 805, 807, 808, 809, 870, 872, 873, 874, 876, 878, 879, 880, 881, 882, 883, 884, 885

4. Provide easily distinguishable coding system

   Sheet Numbers - 006, 060, 288, 299, 310, 364, 364, 480, 676, 764, 787

5. Upgrade engraving, label or annunciator rewording or application of hierarchial labeling.

   Sheet Numbers - 013, 014, 015, 019, 026, 030, 051, 052, 053, 057, 196, 197, 198, 199, 204, 209, 210, 211, 215, 216, 294, 305, 316, 322, 342, 343, 344, 345, 346, 347, 348, 354, 371, 372, 404, 406, 415, 424, 429, 430, 431, 432, 436, 437, 440, 441, 442, 446, 447, 448, 449, 451, 452, 453,

458, 463, 471, 486, 492, 493, 498, 527, 528, 529, 581, 584, 585, 589, 591, 592, 595, 596, 601, 602, 607, 608, 609, 610, 614, 615, 618, 619, 620, 623, 624, 625, 626, 629, 630, 631, 632, 633, 636, 637, 639, 640, 642, 643, 644, 648, 668, 683, 691, 692, 693, 694, 718, 741, 757, 769, 778

6. Provide panel enhancement, e.g. demarcation, or modify current enhancement.

Sheet Numbers - 035, 036, 042, 413, 417, 420, 514, 703, 802

7. Not accepted by the PRT

Sheet Numbers - 011, 016, 025, 038, 059, 074, 109, 111, 113, 116, 117, 118, 119, 120, 121, 200, 212, 286, 295, 306, 317, 336, 337, 338, 339, 340, 341, 349, 353, 355, 363, 373, 377, 378, 379, 381, 384, 388, 389, 394, 399, 409, 414, 416, 418, 433, 455, 465, 466, 467, 473, 474, 483, 487, 489, 490, 491, 515, 580, 588, 611, 622, 634, 641, 653, 657, 658, 659, 662, 664, 684, 686, 687, 689, 698, 700, 704, 710, 714, 722, 729, 730, 733, 751, 752, 753, 772, 773, 775, 790, 791, 792, 794, 795, 806, 811, 818, 821, 855, 886.

3.2 SUMMARY OF REMAINING WORK

The following is a list of CRDR Human Factors work that is in progress or cannot be completed until the control room and/or simulator becomes operational:

1. The final engineering solution to the problem of non-distinguishable Rotatellite green color will be checked.

2. The final engineering solution to the problem of poor readability of the Bypass/Inoperable status lights will be checked.

3. The methodology for zone coding meters is completed, see figure 3-6. Temporary zone coding of meters will be performed by operating personnel during startup testing. The permanent zone coding will be completed after startup verification.

4. Sample checks will be made of approximately 100 labels taken at random to verify that the panel fabricator complied with the recommendations made in the labeling study. Note that this may not be necessary if the quality control report verifies compliance.

5. Many meters were removed from the panels and the parameters transferred to the QDPS plasma display. In addition, the walk-through/talk-through exercises identified a variety of recommended displays. These displays will be checked.

6. The effectiveness of the five annunciator horns designated to correct a reported discrepancy will be checked.

7. Sample checks will be made of approximately 50 random annunciator tiles to verify compliance with the recommendations of the annunciator study.

8. Sample checks will be made of the demarcation painting to verify compliance with the recommendations of the demarcation study.

9. A check will be made to verify that the recommended change of switch handles corrects the readability of switch positions.

10. The final engineering solution for the need for meters to fail off-scale will be checked.

11. Sample checks will be made of approximately fifty meter scales to verify compliance with recommended meter scale markings.

12. Sample checks will be made of approximately fifty legend light engravings to verify compliance with the labeling study and criteria report recommendations.

13. Sample checks will be made of recorder paper for correction of reported discrepancies and accessibility of supplies.

14. Sample checks will be made that vertical meter pointers have been changed from black to red.

15. A check will be made to determine if operators are trained to interpret the status of legend lights. See sheet number 792 for a description of this HED.

16. The following summarizes the Category E criteria that will be checked for compliance to the guidelines.

- o Full view of controls and displays from the normal desk position.
- o All communications guidelines.
- o Operator access guidelines for equipment in work stations.
- o Compliance with guidelines for all work space and furniture dimensional and design features.
- o Storage, coding, portability, ease of useage, protection of and organization of control room documents.
- o Availability, quantity, storage, and identification of expendable supplies and tools.
- o Supervisor access guidelines to the control room.
- o Accessibility to controls (anthropometrics).
- o Accessibility, storage identification, instructions, training and useage of protective clothing and gear in plant operations and maintenance thereof.
- o Control room environment for comfort temperature, humidity, air velocity, normal and emergency illumination, and sound levels (noise).
- o Inclusion of annunciation on the auxiliary shut down panel.

- Compliance with guidelines for systems related annunciator arrangement, annunciator facilities, and console annunciator facilities.

- Compliance with guidelines for the process computer and ERF annunciator facilities.

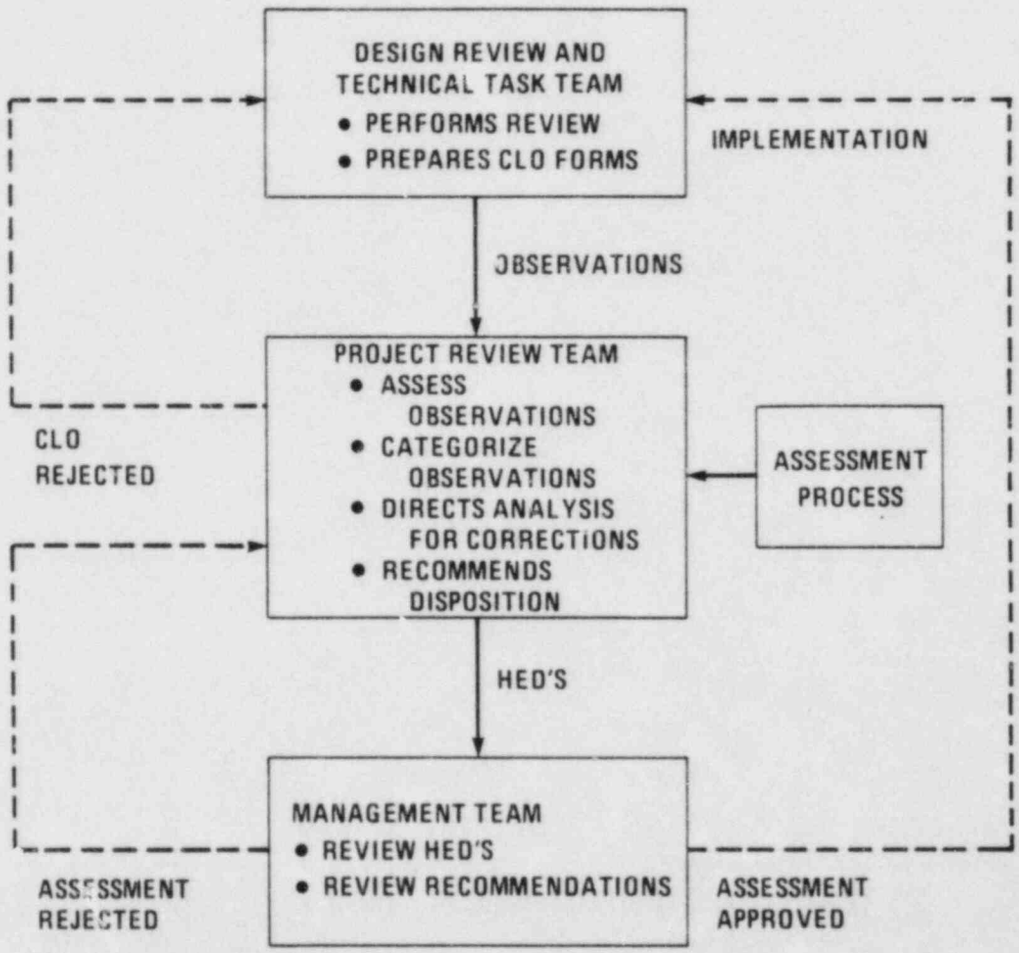
- Compliance with the human factors features of meters.

- Recognition of intended information via indicator lights (transmitted light intensity).

- Effectiveness of the methodology used to prevent the interchanging of indicator lenses.

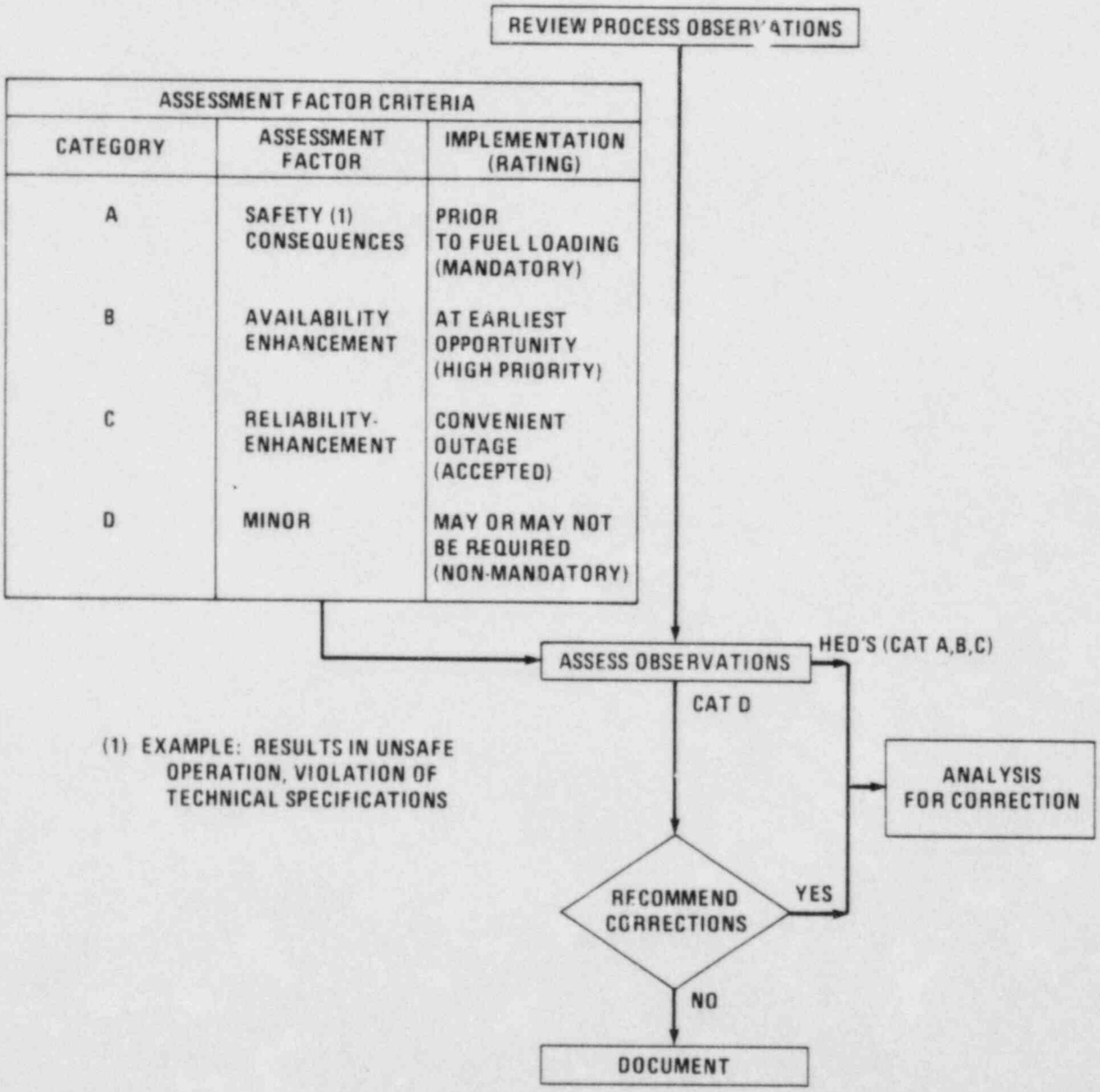
- Ability of displays to accurately track plant conditions.

- Ability of controls to perfom their criteria report guideline functions.



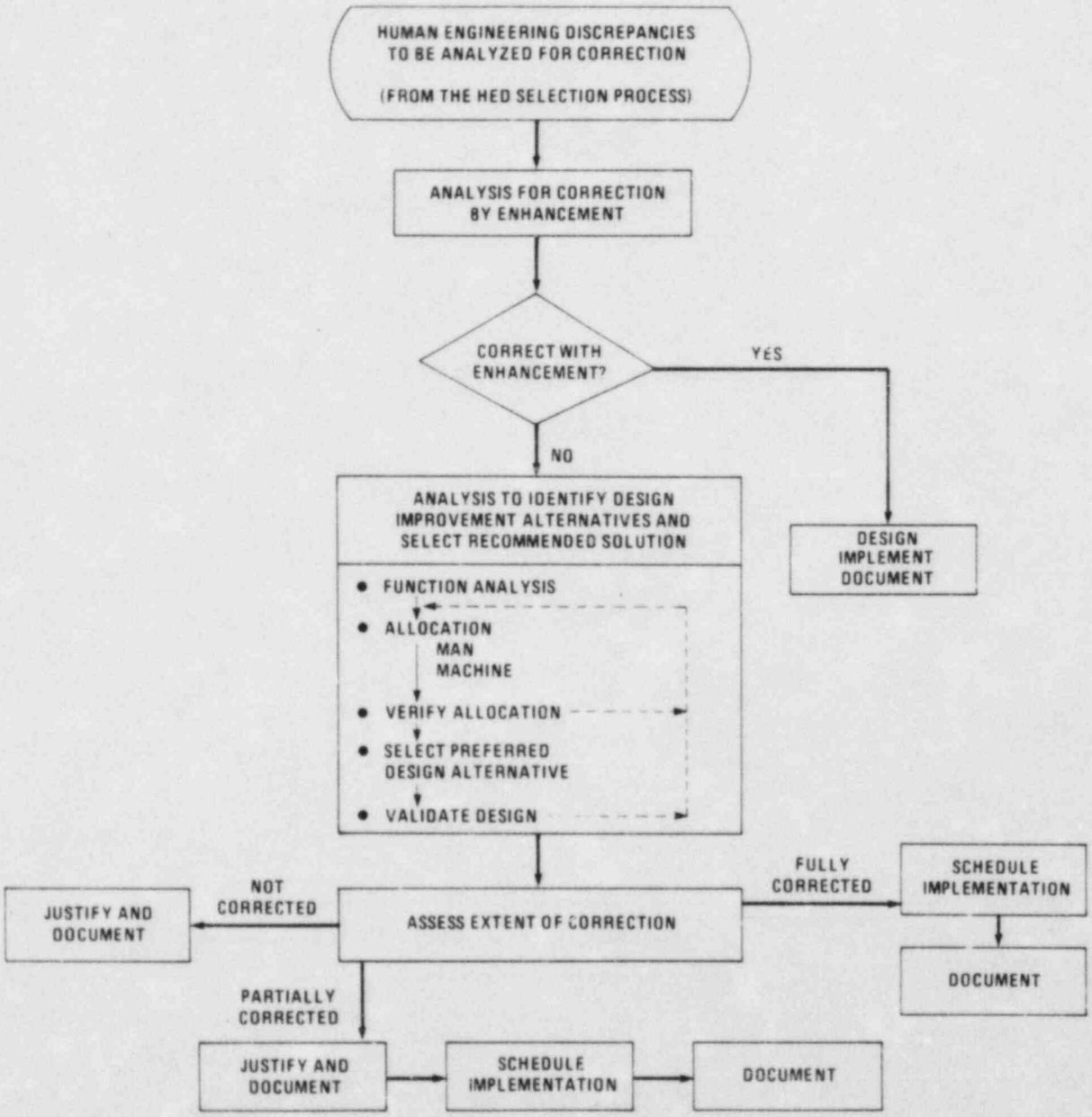
LEGEND:
CLO – CHECKLIST OBSERVATIONS
HED – HUMAN ENGINEERING DISCREPANCY

ASSESSMENT AND IMPLEMENTATION METHODOLOGY
Figure 3-1

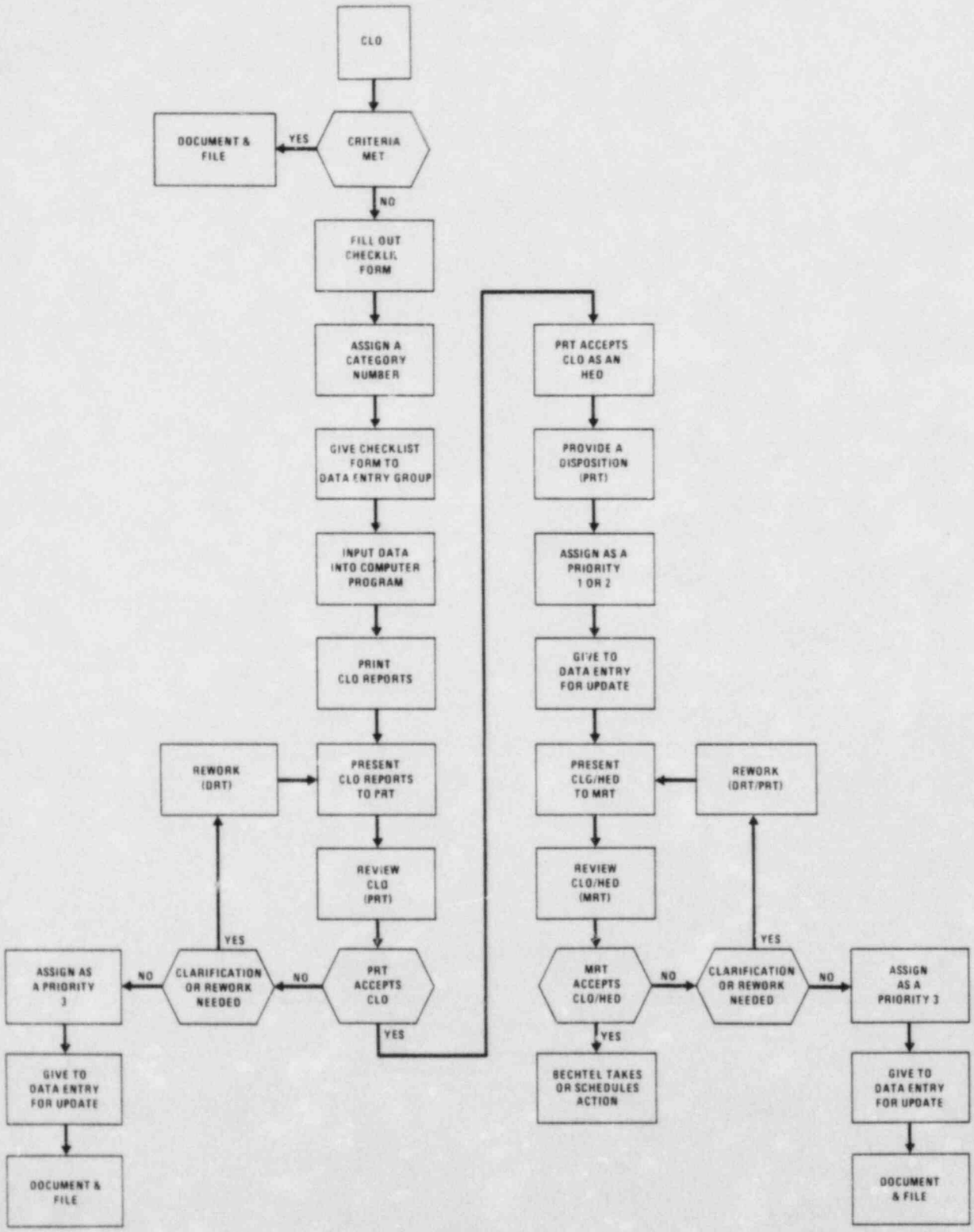


NOTE: CATEGORY E REFERS TO CRITERIA DEFERRED FOR EVALUATION IN THE ACTUAL CONTROL ROOM.

SELECTION OF HED'S
TO BE ANALYZED FOR CORRECTION
Figure 3-2

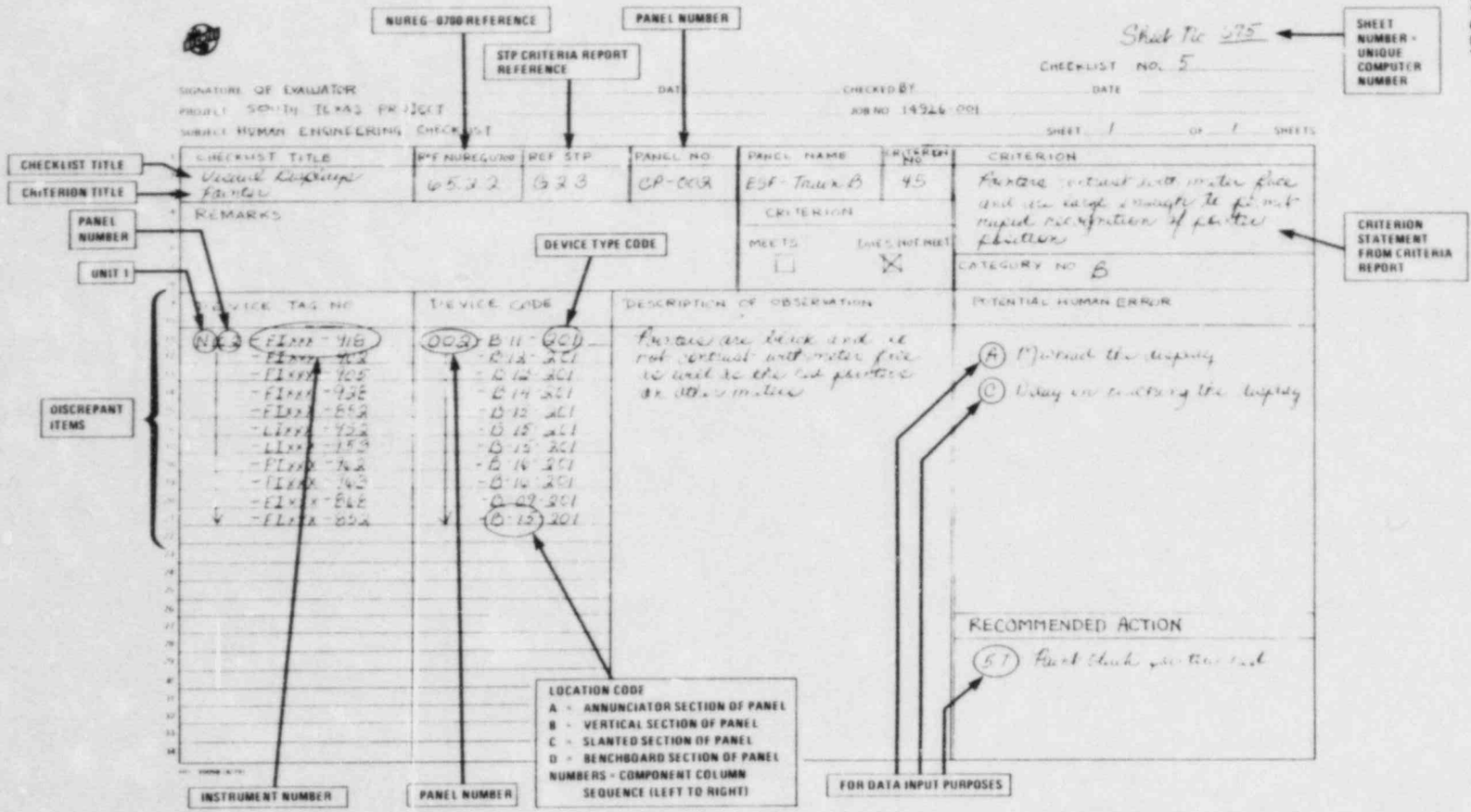


SELECTION OF DESIGN IMPROVEMENTS
Figure 3-3

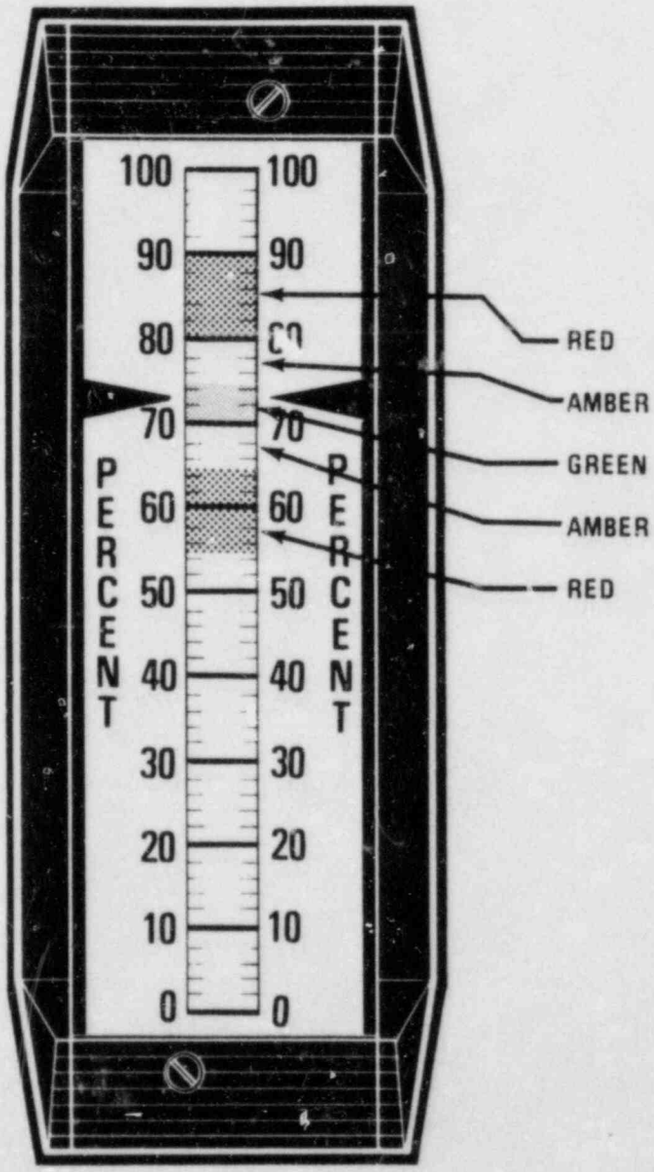


CHECKLIST OBSERVATION PROCESS

Figure 3-4



CHECKLIST OBSERVATION
Figure 3-5
3-14



ZONE MARKING EXAMPLE
Figure 3-6

4.0 CRDR NRC IN-PROGRESS AUDIT REVIEW

4.1 BACKGROUND

HL&P requested an NRC in-progress audit of the STP CRDR in April 1983. The prime purpose for the audit was to receive NRC review comments of the redesigned main panel layouts prior to issuing a release to manufacture panels 001 through 010. The audit was conducted from May 2 through May 6, 1983 at the mock-up facility in Bechtel's Houston engineering facilities. The NRC was assisted by its consultants from Lawrence Livermore National Laboratory. Figure 4-1 shows many of the audit participants at the mock-up. The following was available at the mock-up to facilitate the audit:

1. A full-size control room mock-up.

2. A half-size color photo mosaic of the control room simulator.

3. A scale model showing control room layout.

4. Sample controls and displays.

5. A full scale panel section showing demarcation and hierarchial labeling techniques being developed to assist control room operators.

HL&P also provided a number of documents by mail and at the audit site to support the in-progress audit. Finally, HL&P, Bechtel Energy Corporation, and Torrey Pines Technology (human factors consultant) personnel involved in the CRDR were available on a daily basis during the audit.

The in-progress audit consisted of walk-throughs, document reviews, briefings, and discussions. Major emphasis was placed on evaluation of the organization and process of the CRDR. CRDR results, particularly in areas which could affect main control board layout, were also evaluated.

The results of this audit are reported in a letter from Knighton to Goldberg dated October 31, 1983 (Docket Nos.: 50-498 and 50-499).

4.2 AUDIT COMMENTS AND HL&P RESPONSES

For clarity this section extracts the NRC comments from the audit results and puts them in quotes. The HL&P response follows the quotes.

4.2.1 Background

A Summary Report is to be submitted at the end of the CRDR. As a minimum it shall:

"1. Outline proposed control room changes."

This CRDR has resulted in the following significant changes that are reflected on the released panel layout drawings:

- The original train-oriented layout of the Engineered Safety Features (ESF) panels (CP-001, 002, and 003) was totally revised to a system-oriented layout. In this redesign effort auxiliary feedwater controls were moved to CP-006 as recommended by the Operating Experience Review and SFTA. This effort permitted the correction of indicators on CP-002 that were located too high for accurate viewing. The auxiliary feedwater controls were moved from CP-001, 002 and 003 to 006. Figure 4-2 shows the functional allocation of systems for the ESF panels.

- The controls, CRT and associated keyboard for radiation monitoring have been relocated on the operators console and recorder panel. Figure 4-3 shows the revised functional allocation for CP-004, CP-005 and CP-006. Major layout changes were made to satisfy the apparent discrepancies noted by the OER, CRS and SFTA.

- Figure 4-4 shows the revised functional allocation for CP-007 through 010. The HVAC controls were relocated to the HVAC back panel. The PORV and MSIV controls were grouped with the steam generator controls on CP-006. The full-flow deaerator equipment was added to panel 008.

- Figures 4-5 and 4-6 show the configuration of the operator console and the auxiliary console that were added to the control room. These consoles were mocked up and used during the walk-through-talk-through exercises.

- Over 30 percent of all panel switches were changed to different types in order to comply with the switch conventions noted in the Criteria Report.

- The hierarchial labeling study resulted in gross label changes for all panels. The study techniques were extended to rototellites, annunciator, and status light engravings.

- An extensive annunciator review resulted in a reduction of active windows, addition of zone alarm horns, a revision of window boxes to match the revised panel layouts, prioritization of alarms, reworking of tile messages, reduction of window box tiles from 96 to 48 and enlarged tile lettering.

- o The demarcation study resulted in the addition of color patching and mimics to distinguish systems and subsystems.

- o The addition of panel equipment to satisfy Req. Guide 1.97 requirements.

- o Figures 4-7, 4-8 and 4-9 show the mock-up of the HVAC and Recorder back panels and auxiliary shutdown panels added in the CRDR process.

- o See Appendix A for a listing of all changes made or to be made to correct Category "A" HEDs and Appendix B for a listing of typical changes made or to be made to correct Category "B" HEDs.

- o Gross changes were made to meter scales in order to bring them in line with the NUREG-0700 guidelines. Provisions were also made for adding zone coding to meters. Vertical meter pointers will be painted red instead of black.

- o Switch handles that obscured switch position markings were corrected with new type switches or with revised handles as recommended by Van Cott and Kinkade.

- o Legend pushbuttons will be distinguished from legend lights with "closed corner octagon" markings on the lenses.

"2. Outline proposed schedules for implementation"

See Section 5.0.

"3. Provide summary justification for HEDs with safety significance to be left uncorrected or partially corrected."

There are no known HEDs in these categories. Some deficiencies are in the process of being corrected.

4.2.2 Planning Phase

1. "Milestones for other important CRDR activities (e.g. those related to the remote shutdown panel and environmental surveys) were not available and could not be evaluated."

Section 5.0 lists all known significant activity required to complete the DCRDR and the currently projected completion dates.

4.2.3 Review Phase

1. "Some plan for keeping both the document [LERs etc.] review and operator survey current is recommended. It is expected that such a plan would be useful throughout plant life."

The document reviews will be included as part of the Operating Experience Review Program for both internal and external events with HF considerations included as part of the review.

The operator's survey will be covered by the design change request program. If changes to the Control Room are involved, it will be evaluated for HFE, i.e., Criteria Report, Appendix T.

2. "One concern was that the SFTA was not based on finalized emergency operating procedures .... The staff recommends that HL&P confirm, after EOPs are finalized, that information (parameter type, dynamic range, accuracy frequency, feedback, etc.) and control functions (discrete/analog, precision, duration, criticality, etc.) have been adequately identified and are satisfied by available instrumentation and controls."

The program plan stated the WOG ERGs would be used and acceptable as a basis for the SFTA.

The finalized EOPs are required to be validated in accordance with NUREG-0737 and deficiencies will be resolved accordingly.

4.2.4 Assessment and Implementation Phase

1. "The basic plan for scheduling implementation appears adequate, however, a more definitive implementation schedule will be needed as part of the summary report."

See Section 5.0 for this scheduling.

2. "There are certainly advantages to early conduct of the CRDR. However, care should be taken that future operating procedures and training efforts are coordinated with the CRDR effort. Establishment of a means to assure proper consideration of control room improvements to resolve human factors problems identified during operator training and development of procedures is recommended."

As noted in Section 4.2.3, each EOP will be validated using a staff that will provide continuity with the present CRDR Design Review Team. Methodology has been developed to assure the application of good human factors principles to all future changes (see Appendix T of the Criteria Report).

3. "... however, there is some concern about the reporting of CRDR issues that cannot be addressed fully by the Summary Report date. For example, the environmental surveys may not be adequately completed until the plant is actually operating, and other activities may continue past the Summary Report date (e.g., coordination of emergency procedure and training efforts with the CRDR)."

Section 5.0 clearly identifies all open items for completing the tasks identified in the program plan and known open items. HL&P is committed to continue to apply the benefits of the CRDR program in the appropriate plant activities on a continuing basis.

4.2.5 NRC Audit Conclusions

A. "Several recommendations resulted from the NRC evaluation of the STP CRDR. They were:

1. Keep the operating experience review current through document review and periodic updates of the operator survey."

See above 4.2.3, Item 1

"2. During verification and validation, use the control room mock-up to assess the integrated effect of the fullest range of design improvements possible (to include labeling and demarcation)."

See above 4.2.3, Item 2

"3. Update the simulator as soon as possible and use it for operator training and confirmation of the integrated effect of design improvements (verification and validation of procedures might also be done conveniently on an updated simulator)."

A plan to modify the simulator is currently in the development stage. Completion of the modification is targeted to support the scheduled operator training activities in the fall of 1985.

"4. Continue to assure participation of an adequate mix of personnel (including operators and human factors professionals) throughout the development and evaluation of design improvements."

The CRDR effort following the May audit placed great emphasis on the participation of operators and human factors professionals. This is evidenced in our post-review validation effort. See the Operating Experience Review Validation Report and Control Room Survey Validation Report.

"5. Include human factors review of the remote shutdown panel, any control room modification or additions made as a result of post-TMI actions, as well as lessons learned from operating reactor events."

This report includes the results of our review of the auxiliary (remote) shutdown panel. HL&P plans to continue to monitor industry produced LERs and internal plant produced documents as applicable to future control room modifications.

3. "Several information needs remain to be filled in order to complete NRC evaluation of the STP CRDR. They are:

1. A schedule reflecting all activities associated with the CRDP (including more detailed implementation schedules and schedules for any activities which might extend beyond licensing)."

See Section 5.0.

"2. Description of any document review accomplished as part of the operating experience review process."

The Operating Review Team reviewed INPO's Significant Operating Experience Reports (SOERs) issued as of May 19, 1982. This review included SOERs 80-1 through 80-6, 81-2 through 81-17 and 82-1 through 82-4.

"3. Description of the completed control room inventory and its use."

Figures 4-10, 4-11 and 4-12 show typical printout sheets from the computer-based main control panel equipment list. The initial layout of the mock-up was made from this type of listing. The CRDR resulted in extensive changes to both the make-up (layout of equipment) of each panel and the type of equipment on each panel. There were significant changes made to switch types, meters and recorders. This inventory is a basic Bechtel engineering document and is in a continuous process of change. Changes will undoubtedly be made during the installation and plant startup stages. The application of human factors considerations is provided for by the Criteria Document; specifically Appendix T, which defines a review methodology to incorporate human factors concerns. Figure 4-13 shows a typical switch development and wiring scheme which is referenced on the inventory sheet Figure 4-11 (see item no. 001S054). The inventory sheets were also used during the control room survey and in the verification of the equipment and equipment characteristics defined by the Task Analysis process.

"4. Description of the completed verification process and results."

In the verification of task performance capabilities (NUREG 0700 Section 3.7) the verification of availability was performed by the task analysis specialists using the mock-up and completing the formated information shown in Figure 4-14 (see SFTA Report and SFTA Validation Report)."

The verification of human engineering suitability was also performed by the task analysis specialists. The principal tool used to evaluate the practicality of the inventoried displays and controls was the spatial operational sequence study. Figure 4-15 is a typical diagram. The diagrams are contained in the SFTA and SFTA Validation Reports. In addition, NUREG-0700 recommends the use of CRS check lists. This concept was implemented by the execution of the CRS panel layout and control display integration check lists assisted by the human factors specialist after most of the task analysis work was completed. In this check list review emphasis was placed on the task application for the panel hardware.

HL&P also plans to supplement this effort with the results of the verification efforts associated with its production of Emergency Operating Procedures.

"5. Description of the completed validation process and results."

The validation effort for the CRDR consisted of three efforts as follows:

- The use of walk and talk through procedures following NUREG 0700 Section 3.8.2 approach.

  One operating crew performed this function for the steam generator tube rupture selected operational event (SOE) and a second operating crew performed the plant startup SOE. These exercises were conducted at the mock-up using advanced developed EOPs. These exercises were video taped.

The STP Emergency Procedures are prepared with a system that involves the shift supervisor (SRO) to direct the actions of two licensed operators. The SRO is responsible for performing diagnostics as the procedures progress. This validation effort resulted in the follow up study of 112 meters associated with the control and protection channels of 53 parameters. This study resulted in the recommendation to eliminate 61 meters while adding 10 meters primarily through the use of the Qualified Display Processing System (QDPS). The validation also uncovered a few procedural problems and identified QPDS display needs. See the evaluation of specified parameters in the Special Studies Report, and the SFTA Validation Report.

- An Operating Experience Review (OER) Validation was conducted as suggested in the May 83 NRC audit meeting. Essentially 33 percent of the operators who provided the basic data for the OER report reviewed the redesigned main panel layout with a human factors specialist to determine if the concerns they had identified were corrected and to determine if the corrections generated any new problems or discrepancies. Figure 4-16 shows a few of the 82 concerns covered in this validation effort. See the Operating Experience Review Validation Report for details.

- o A Control Room Survey (CRS) Validation was conducted as suggested in the May 83 NRC audit meeting. This effort covered the review of all Category "A" HEDs and five Category "B" HEDs of each checklist identified through the review of the main control panels. A human factors specialist compared each of the above discrepancies on the half scale mosaic with the reviewed panel layout on the mock-up to validate that the discrepancy was resolved and that the corrective action did not create any new problems or discrepancies. See the CRS Validation Report for details.

"6. Confirmation, after EOPs are finalized, that information (parameter type, dynamic range, accuracy, frequency, feedback, etc.) and control functions (discrete/analog, precision, duration, criticality, etc.) have been adequately identified and are satisfied by available instrumentation and controls.

See Section 4.2.3 above for response.

"7. Identification of deviations from information already received."

These are identified throughout each report with a revision log and change bars.

"8. Resolution of concerns raised during the NRC audit of HEDs and independent control room survey."

These are reviewed throughout this report.

"9. An outline of proposed control room changes."

See Section 4.2.1, Item 1 above.

"10. Justification for leaving safety significant HEDs uncorrected or partially corrected."

There are no known safety significant HEDs uncorrected or partially corrected. Some deficiencies are in the process of correction (see Appendix A). See Appendix C for a list of deviations from the Criteria Report guidelines.

4.2.6 Appendix Part A

"The audit of the HL&P identified HEDs and the NRC's independent control room survey were limited. No representation of the following panels was available for audit of HL&P identified HEDs or independent NRC survey:

"1. CP011 through CP015"

These panels are not utilized during emergency operations and are not a part of the CRDR. They are titled as follows:

CP-011- Nuclear Instrumentation
CP-012- Flux Mapping
CP-013- Seismic Monitoring
CP-014- Vibration Monitoring
CP-015- Loose Parts Monitoring

"2. CP018 (Recorder Panel)"

This panel has been mocked-up (See Figure 4-8) and the review results integrated in this report and pertinent support reports referenced herein.

"3. CP019 (Fire Protection Panel)"

This panel is not utilized during emergency operations and is not a part of the CRDR.

"4. CP022 (HVAC Panel)"

This panel has been mocked-up (See Figure 4-7) and the review results integrated in this report and pertinent support reports referenced herein.

"5. Auxiliary (Remote) Shutdown Panel"

This panel has been mocked-up (See Figure 4-9) and the review results integrated in this report and pertinent support reports referenced herein.

"In addition, facilities at the audit site did not permit audit of HL&P identified HEDs or an independent survey against the following guidelines sections in NUREG-0700:

CONTROL ROOM WORKSPACE

6.1.1.4	General Layout -- Document Organization and Storage
6.1.1.5	General Layout -- Spare Parts, Operating Expendables, and Tools
6.1.1.6	General Layout -- Supervisor Access
6.1.1.7	General Layout -- Non-essential Personnel Access
6.1.3	Multi-Unit Control Rooms (does not apply to STP)
6.1.4	Emergency Equipment
6.1.5	Environment

COMMUNICATIONS

6.2.1 Voice Communication Systems

6.2.2 Auditory Signal Systems

ANNUNCIATOR WARNING SYSTEMS

6.3.1 General System Characteristics

6.3.2 Auditory Alert Subsystem

6.3.3 Visual Alarm Subsystem

6.3.4 Operator Response Subsystem

VISUAL DISPLAYS

6.5.5 Miscellaneous Display Types

LABEL AND LOCATION AIDS

6.6.1 Labeling Principles

6.6.2 Label Location

6.6.3 Label Content

6.6.4 Label Lettering

6.6.5 Use and Control of Temporary Labels

PROCESS COMPUTERS

6.7.1 Computer Access

6.7.2 Cathode Ray Tube (CRT) Displays

6.7.3 Printers"

The guidelines will be evaluated in the Unit 1 control room when it becomes operational.

4.2.7 Appendix Part B

"A limited audit of the HL&P control room survey and the NRC's independent control survey resulted in no NRC concerns with DCRDR results associated with the following NUREG-0700 guidelines sections:

CONTROL ROOM WORKSPACE

6.1.1.1 General Layout — Accessibility of Instrumentation/Equipment
6.1.1.2 General Layout — Consistency of Manning with Equipment Layout
6.1.1.3 General Layout — Furniture and Equipment Layout

CONTROLS

6.4.4 Rotary Control Specifications
6.4.5 Other Control Specifications

CONTROL-DISPLAY INTEGRATION

6.9.1 Basic Control-Display Relationships
6.9.2 Layout Arrangement Factors
6.9.3 Specific Panel Layout Design"

The STP CRDR work indicates no change in status for the above guidelines.

4.2.8 Appendix Part C

1. "The following general concerns about HL&P's control room survey and special studies were identified:

Deviations from Criteria

Deviations from HL&P criteria were observed in the mock-up (e.g., J-handles instead of selector switches). It is not known whether the deviations were errors in the mock-up or intentional. Assurance that the final control room configuration will follow conventions developed during the DCRDR is necessary. Intentional deviations should be treated as uncorrected or partially corrected HEDs to be justified in the Summary Report."

See Appendix C for a listing of all known deviations from HL&P criteria with justifications.

2. "Disposition of HEDs

The final disposition of many HL&P observations (HEDs) is not known. Included are those in Category "E" (items which could not be assessed using the mock-up or simulator) and those whose proposed corrections has not passed through the full review hierarchy."

See Control Room Survey Report for disposition of all category A, B, C and D HEDs. Category E HEDs will be reported after they are reviewed and assessed after the Unit 1 control room becomes operational.

3. "Workstation Design

The bulk of the workstation design guidelines in NUREG-0700 are based on anthropometric data. HL&P conducted a comprehensive anthropometric survey in response to this item. The present main control boards do not accommodate the full range of functional reach (5th percentile female to 95th percentile male) used in developing NUREG-0700 guidelines. HL&P has proposed rearrangement of controls on the boards to reduce the magnitude of the problem. That rearrangement and use of extended functional reach (i.e., leaning over the control boards to operate controls) will allow the main control boards to accommodate 5th percentile male/20th percentile female and larger operators. The proposed rearrangement is an acceptable resolution to the discrepancy provided HL&P acts to ensure:

1. That controls are operable by (not just accessible to) all control room operators, and that no inadvertent activation of controls would result from allowing operators to lean over the main control board to operate controls. HL&P will demonstrate that the controls are accessible to all operators."

   This will be demonstrated by a written procedure using operators that range from the 5th percentile male/20 percentile female and larger operators.

4. "Location Aids

The use of color padding as a demarcation technique is being explored by HL&P. The purpose of location aid techniques (including color padding) is to facilitate rapid, reliable operator orientation and search on complex panels. As a general observation, color padding appears to be most effective when a small number of colors are used (i.e., 2-3 including background). Use of a larger number tends to result in visual clutter and degradation rather than improvement of operator orientation and search.

Attempts to convey information by manipulating color pad size, shape, location, or interconnection may also result in overextension of the technique. Although color padding can be a useful technique for entering operator performance on complex panels, it should be carefully developed and evaluated.

Other location aid techniques (e.g., labeling, demarcation lines, mimics) appear to be limited in a way similar to color padding. On complex panels, integrated use of several techniques may result in the most effective location aids. Again, careful development and evaluation are needed.

Considerable effort has gone into relayout of the STP panels. Development of labels and location aids should enhance orientation to and search of those panels. Given the advantage of a full-scale mock-up, operator evaluation of the label and location aid schemes integrated with other improvements would help to assure that enhancement."

HL&P has expended an extensive effort to perform an integrated demarcation and labeling study. These studies were conducted by a special team using a systems engineer, a human factors specialist and senior level operators for review. The review included the use of full scale mock-up panel sections that were patch painted and hierarchially labeled. This effort was consistent with the above NRC guidance. See the Special Studies Report for details.

5. "General Panel Layout

Considerations of factors such as structural bracing of the main control boards and electrical separation had not been completed at the time of the in-progress audit. Care should be taken to assure that any layout changes due to these factors (especially on heavily instrumented panels such as CP006) do not degrade the operator interface. In addition, the impact of effective hierarchical labeling on layout should be considered (e.g., on CP006 and above the reactor coolant pump seal recorders)."

Main control panels CP-001 thru 010 have been completed and meet current seismic requirements. The final structural design did not affect the basic layout recommended in the CRDR process.

HL&P emphasizes again that prior to and following the NRC audit extensive use was made of operators in the review of label and location aid developments. The continuation of such reviews is provided for in the Criteria Report, Appendix T.

4.2.9 Appendix Part D

"On the basis of a limited audit of the HL&P control room survey, concerns typified by the following examples were raised:

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
1.	0459	6.4.1.1	HL&P OBSERVATION The following switches are not knurled handle selector switches. (NRC NOTE: list of switches has been omitted from this report.) HL&P RECOMMENDED ACTION Change switch type to knurled handle.

HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
1. (Cont'd)		NRC CONCERNS Shape coding of controls is reasonable, however knurled handle knobs used in the STP control room were observed to obscure the shaft pointer."

As a result of the NRC concern expressed in the May 1983 audit, the DRT conducted a study of this problem. This study is reviewed in the Special Studies Report. The DRT recommended using lever handles which elminates this problem. The Criteria Report is revised accordingly. This correction will be validated on the installed control panels.

HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
2.	"0662	6.4.1.1 HL&P OBSERVATION Pushbutton is used for DG emergency start. HL&P RECOMMENDED ACTION Change switch type. NRC CONCERN Recommended action was rejected. Given that the STP control room will have a shape coding convention, more than a "special case" rationale for no change appears required. The consequence of not making the change needs to be assessed in terms of operators' overall concept of the control room, the potential for errors due to an exception of convention, and the acceptableness of such errors."

DG emergency start is presently a pushbutton, it is located directly above the Emergency Trip Reset pushbutton. The two of them are demarcated to show the safety implication of their use. The use of these switches was reviewed and accepted by the STP operators assigned to this review.

HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
3. "0710	6.4.1.1	HL&P OBSERVATION CR-2940s that are spring return to center are very hard to turn with some being hard to turn to the full right or full left position. Also pull-to-lock SBMs are hard to put in the locked position. HL&P RECOMMENDATION Reduce spring tension within switches. NRC CONCERNS Recommended action was rejected. A large number of switches are involved, and their amount of use will probably vary a great deal. Thus a "reduction of spring tension with use" rationale for no change will apply to some switches more than others. Assessment should assure that the involved switches (particularly any which must be held in an active position) are operable by all operators. If operability problems exist, the recommended action or alternative actions (e.g., extender handles) should be reconsidered.

HL&P will assess all CR-2940 switches to assure that they are operable by all licensed operators.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
4.	"0708	6.4.1.2	HL&P OBSERVATION Trip switches are above the rod control lever, which are subject to inadvertent activation because of the amount of time the operator has to hold the lever during start-up. HL&P RECOMMENDED ACTION Reposition controls. NRC CONCERN Recommended action was rejected. The observation appeared valid and recommended action appropriate. No rationale, in terms of safety concerns, for not following the recommended action was provided. Alternative actions do not appear to have been considered."

The trip switches and rod control lever have been repositioned on the revised panel layout, correcting this concern.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
5.	"0463	6.4.2.1	HL&P OBSERVATION The "AUTO" position is not located at the center position. HL&P RECOMMENDED ACTION Move "AUTO" position to the center position. NRC CONCERN 1. Will the "AUTO" position of the first three devices (listed in HL&P's Observation Report) conform to control room convention? 2. The recommended action was rejected for a fourth device. More than a "unique device" rationale for no change appears required. The consequence of not making the change needs to be assessed in terms of the operator's overall concept of the control room, the potential for errors due to an exception to convention, and the acceptableness of such errors."

Hardware for items 1, 2 and 3 below is not available. An error due to misoperation has been evaluated and does not result in adverse system operation. Item 4 has been revised to conform to Off-Auto-Manual.

1.	XXXX-028-07-C04-307	STEAM DUMP LINE DN VLVS (AUTO, OPEN)
2.	LVXX-7916-07-C07-301	LH STM CHEST DRN VLV (AUTO, OPEN)
3.	LVXX-7918-07-C08-301	RH STM CHEST DRN VLV (AUTO, OPEN)
4.	XXX-0018-07-D09-302	TURNING GEAR (OFF, MANUAL, AUTO)

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
6.	"0465	6.4.3.3	HL&P OBSERVATION Lamp replacement for pushbuttons on the E.H. turbine operator control panel can not be done without activating pushbuttons on either side of the pushbuttons. HL&P RECOMMENDED ACTION Provide greater spacing between pushbuttons. NRC CONCERN Recommended action was rejected. More than the "inadvertent activation of operating pushbuttons can be defeated" rationale for not following the recommended action appears required. The consequence of the inadvertent activation of controls, including the time to recognize and correct the situation, needs to be assessed."

Inadvertant activation of controls, including the time to recognize and correct the situation, has been assessed. HL&P will provide a special tool for relamping these pushbuttons.

HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
7. "0466	6.4.3.3	HL&P OBSERVATION Legend covers are not keyed to prevent possiblity of interchanging covers for pushbuttons and lights. HL&P RECOMMENDED ACTION Key legend covers to identify correct position. NRC CONCERN Recommended action was rejected. "Normal operating practice of only changing one lamp at a time" does not appear to provide as adequate correction as keying. Keying and other alternatives (e.g., provision of a legend panel map) reduce the probability of error even when there is a breakdown in procedures."

HL&P will provide in the control room template type legend panel maps. These maps will be stored near the replacement bulbs.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
8.	"0473	6.5.1.3	HL&P OBSERVATION Character separation on legend pushbuttons and legend lights is not one stroke width.
	0474	6.5.1.3	HL&P OBSERVATION Space between lines of text is not one-half character height.
	0790	6.5.3.3	HL&P OBSERVATION Lettering on pushbuttons and legend lights on the SGFP turbine control panels do not meet criteria. Character separation on some lights/pushbuttons is not one stroke width and line separation is not one-half the character height, and stroke width is not consistent. HL&P RECOMMENDED ACTION Engrave legends according to specification. NRC CONCERN Recommended actions for 0473, 0474, and 0790 above were rejected on the basis of the legend pushbuttons and lights being on a vendor supplied panel. The readability of legend pushbuttons and lights from a reasonable distance needs to be assured. If readability is poor, some corrective action should be taken regardless of the panel's source."

HL&P will check legend engraving readability from appropriate operating positions using representative operators when the control room becomes operable.

HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
9. "0075	6.5.1.6	HL&P OBSERVATION The color amber is used to indicate a test position and white is used to indicate a simulate position, which does not follow control room color conventions. HL&P RECOMMENDED ACTION Change indicator color from amber to white and change indicator to red. NRC CONCERN Project and Management Review Team concurrences indicate white as appropriate for a test light and "any other color....for simulate." The use of "any other color" suggests limited control of color use in the control room."

A check of the control schematic for the generator ground detector shows that the colors are correct for the applications. A control room color convention has been added to the Criteria Report. This action removes the uncertainty noted by the NRC.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
10.	"0289	6.5.3.1	HL&P OBSERVATION A bulb-test capability or dual bulb/dual filament bulb is not provided. HL&P RECOMMENDED ACTION Provide lamp test capability. NRC CONCERN The "Category D (minor)" designation of this observation is questioned. Human errors such as those noted with the HL&P observation, i.e., (1) "failure to detect equipment failure," (2) "failure to detect equipment malfunction," and (3) "misinterpretation of equipment status" would appear to affect plant safety, availability, and reliability. Some corrective action appears necessary."

The HL&P decision to classify this item a Category D is based on the redundancy provided by associated equipment, particularly the ESF status monitoring system. HL&P recognizes this is a generic industry problem and will continue to monitor the industry for appropriate application of proven techniques.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
11.	"0483	6.5.3.1	HL&P OBSERVATION Legend lights/legend pushbuttons are located too high for easy replacement of burned out bulbs. HL&P RECOMMENDED ACTION Resposition control and displays. NRC CONCERN The recommended action was rejected on the basis that "frequency of this operation does not warrant relocation." Some action does appear necessary based on the possibility of inadvertent activation of controls. Although relocation may not be warranted, alternatives should be considered (e.g., provision of a portable platform which eases access and reduces the probability of inadvertent activation)."

HL&P plans to use a specially designed ladder platform for working with this equipment. The acceptability at this platform will be validated in the control room.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
12.	"0792	6.5.3.3	HL&P OBSERVATION Some legends are not worded to tell status indicated by glowing of the light. HL&P RECOMMENDED ACTION Changing wording to indicate the presence of the light. NRC CONCERN Recommended action was rejected in favor of training. Human errors associated with this observation would be more reliably reduced, over the life of the plant, by the originally recommended action. It should be noted that, even if the human error reduction were equal, the originally recommended action would have a time and cost benefit over the life of the plant due to reduced need for training."

This problem will be corrected by the addition of labels with engravings to define the meaning of the lighted legends.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
13.	"0491 and 0688	6.5.4.1	HL&P OBSERVATION Viewing of the channel being plotted can only be done after a period of time when the paper has moved down. HL&P RECOMMENDED ACTION Relocate recorders to a lower position for easier viewing. NRC CONCERN The recommended action was rejected for 0491 on the basis that the pointer could be used until the paper rolls down. There is concern that the rejection did not take into account factors such as the specific information needs being satisfied by the recorder (e.g., point data or trend data) and the consequence of the lag in data availability on operator action. The recommended action does not resolve the problem for the Hagan Optimac 3-pen recorder referred to in 0688."

The recorders from Sheet 0491 are:

1. Main Steam Pressure SG 1 & 2
2. Main Steam Pressure SG 3 & 4
3. Main Steam Temperature
4. Main Steam Temperature

The Main Steam Pressure recorders are located on the recorder panel and provide a historical trend only. All operating evolutions are performed using meters on the main control panels.

The Main Steam Temperature recorders have been deleted.

The recorders from Sheet 0688 are:

1. RHR 1B HX1B inlet & outlet Temperature (accepted recommended action)
2. RWST Levels
3. Containment H_2 Level
4. Containment Building Pressure

The RHR HX recorder is located on the main control panels, they are used to determine the relative amount of cooling being performed in the reactor coolant system when shutdown, cooled down and depressurized. When the plant is in this condition a very large lag in information can be tolerated. The indication on the recorder is information only, the purpose of the system is to maintain primary coolant temperature which is indicated on the plasma display located adjacent to the RHR system on the control panels.

The RWST level recorder is located on the main control panel adjacent to the SI and RHR systems. It provides a trend, and historical trend. There are two meters for RWST level, and three separate instrument loops indicating RWST level in the QDPS. Operating evolutions are performed using the meters or the QDPS.

The containment H_2 and Building Pressure recorders are located on the recorder panel. They are for historical trends only. All operating evolutions are performed using the indication on the QDPS.

The above discussion clarifies the usage of these recorders and should resolve the concerns noted by the NRC.

	HL&P SHEET NUMBER	NUREG-0700 REFERENCE	OBSERVATION/RECOMMENDED ACTION/NRC CONCERN
14.	"0380	6.5.4.1	HL&P OBSERVATION Number printing on recorder is crowded because numbers are printed on top of each other. HL&P RECOMMENDED ACTION Adjust recorder printing. NRC CONCERN It is not clear that adjustment of recorder printing will resolve the problem identified in the observation."

The recorders referenced in sheet number 0380 were reviewed with experienced plant operators. They concurred with the engineering concept for these recorders. The intent of the printing is to produce multi-point groupings. Deviations from these grouped zones provide the quick recognition for out-of-tolerance parameter(s) required for proper plant operations.

4.2.10 Appendix Part E

On the basis of the NRC's limited independent control room survey, the following HEDs were identified:

	HED NUMBER	NUREG-0700 REFERENCE	HED
1.	"B303	6.4.1.1	Pressurizer Heater control types are inconsistent. One type may violate STP established convention."

Differentation by type and by demarcation will emphasize the separate function of the control vs. backup heaters.

2. "B10[illegible] 6.4.1.1.b There appear to be controls and displays on the main control panels which are unnecessary for emergency operations and are used very infrequently during normal operations. Examples of this are:

1. Chiller controls and displays on CP004.
2. Spray Valve Supp Temp Loop 4 "T1605/T1604" and surge Line Temp "T1605" vertical meters."

The chiller controls and displays on CP0004 and the Spray Valve Supp Temp Loop 4 "T1605/T1604" and Surge Line Temp "T1605" vertical meters have been reviewed with plant operations and it was concluded that although this equipment is not used frequently their location on the main control panels is very important to the planned overall plant control scheme.

3. "B301 6.4.2.2.a STP pushbutton criterion does not cover all uses of pushbuttons. Examples are:

1. D.G. EMERGENCY START pushbutton.
2. Intermediate Range BLOCK pushbutton.
3. Source Range BLOCK and RESET on rotating switch."

The Criteria Report has been revised to cover the use of the above pushbuttons and others as required.

4. "B305 6.4.2.2.a Use of "J handles" for Reactor Trip Switches does not conform to STP criterion to use Pushbuttons for Trip functions."

An extensive effort has been made to find pushbuttons that meet all regulatory and design criteria. There are no such pushbuttons available; consequently, the present J handled switches will be used but will be distinguished in a unique way.

5. "B401 6.4.3.3.a There are several cases on panels where it is not possible to distinguish a status light from a control pushbutton. An example of this is the panel pushbuttons and legend status indicators on CP006."

See special studies for the use of the octogon closed corner solution to this problem.

6. "B201 6.5.1.1.b There are two "zero" positions on the same scale for the same variable indication. No "Plus, Minus" indications on meter face. This applies to E.H. Turbine Control, TV and GV Tracking meters."

This is an error in the mock-up. The actual equipment will be verified.

7. "B304 6.5.4.1.b Recorders have different scales and scale markings on the recorder chart paper as compared to the meter scaling portion."

HL&P will purchase paper with scale markings to match the recorder scales.

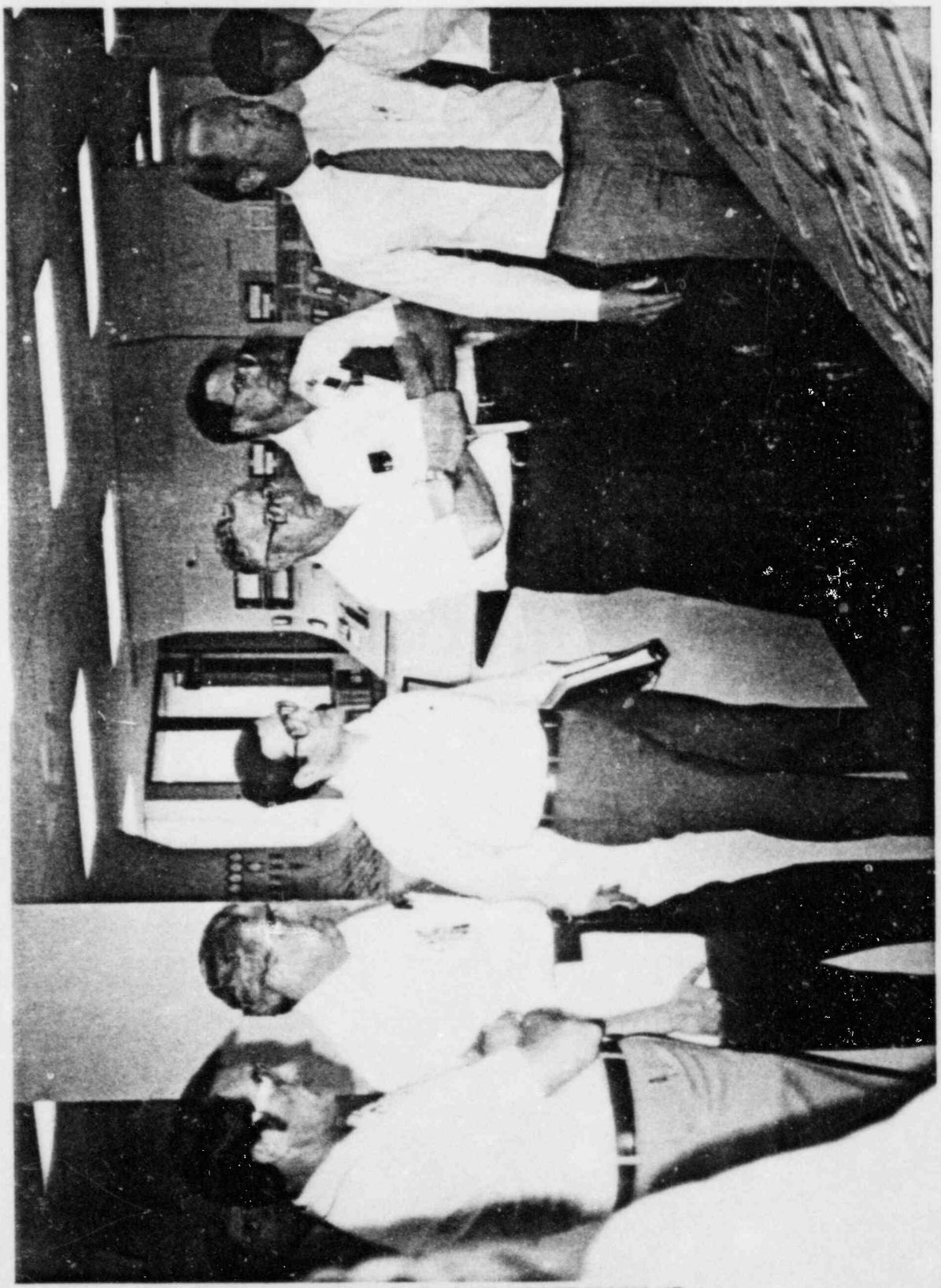
8. "B102 6.8.2.4.a Panel-to-panel standardization is not followed for some groups of controls which appear on more than one panel. Examples are:

1. BYPASS AND INOPERABLE status test buttons on CP001 and CP002.
2. Annunciator control buttons.
3. Plasma display control buttons."

The final control room layout has standarized the panel-to-panel grouping of controls.

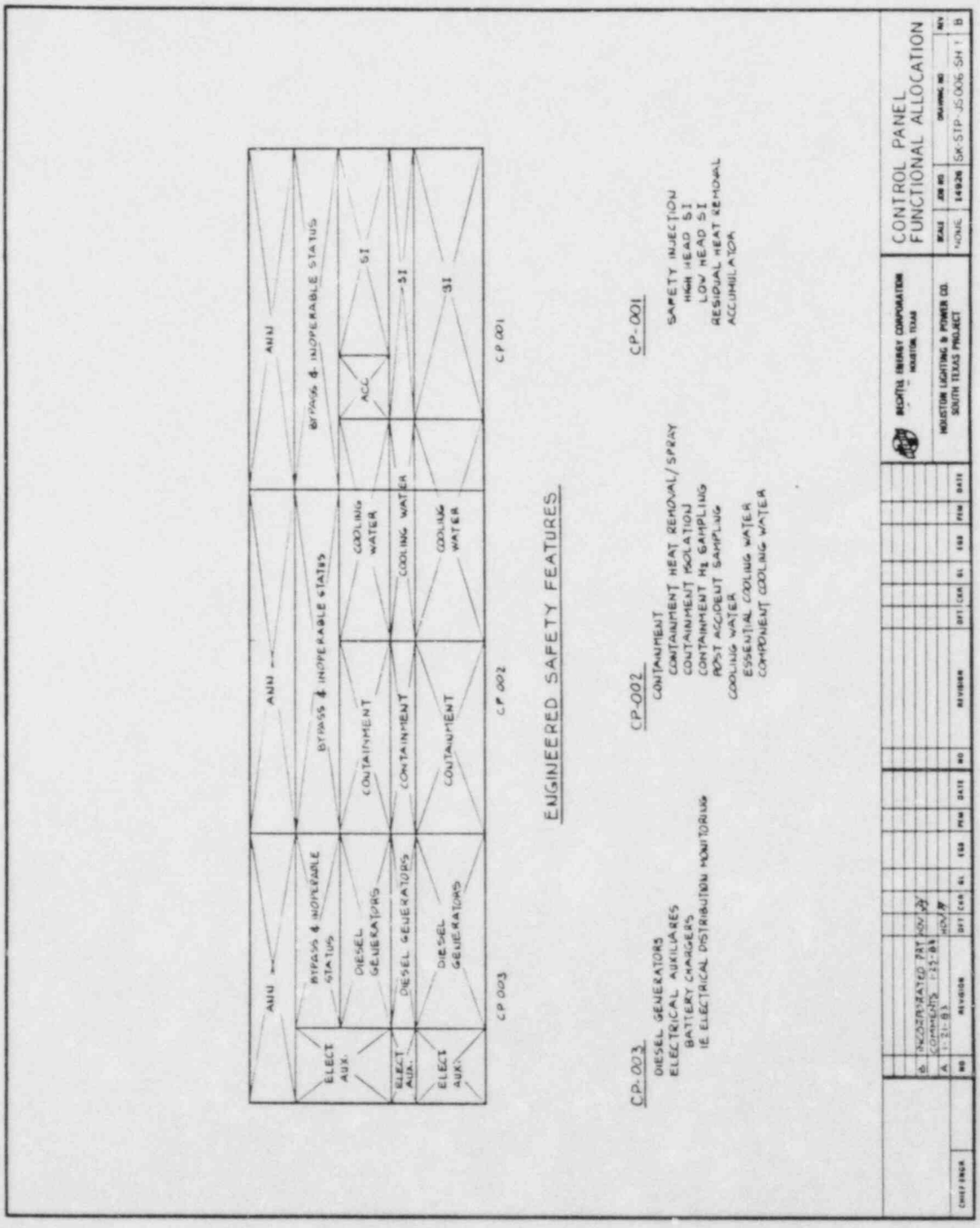
9. "B103 6.8.3.1.b Annunciator controls and BYPASS AND INOPERABLE status test buttons on CP002 are located near each other. They are similar and the operator may inadvertently operate one when the other is intended.

This item was resolved in the final panel layouts utilizing different test button arrangements and distinct demarcation.



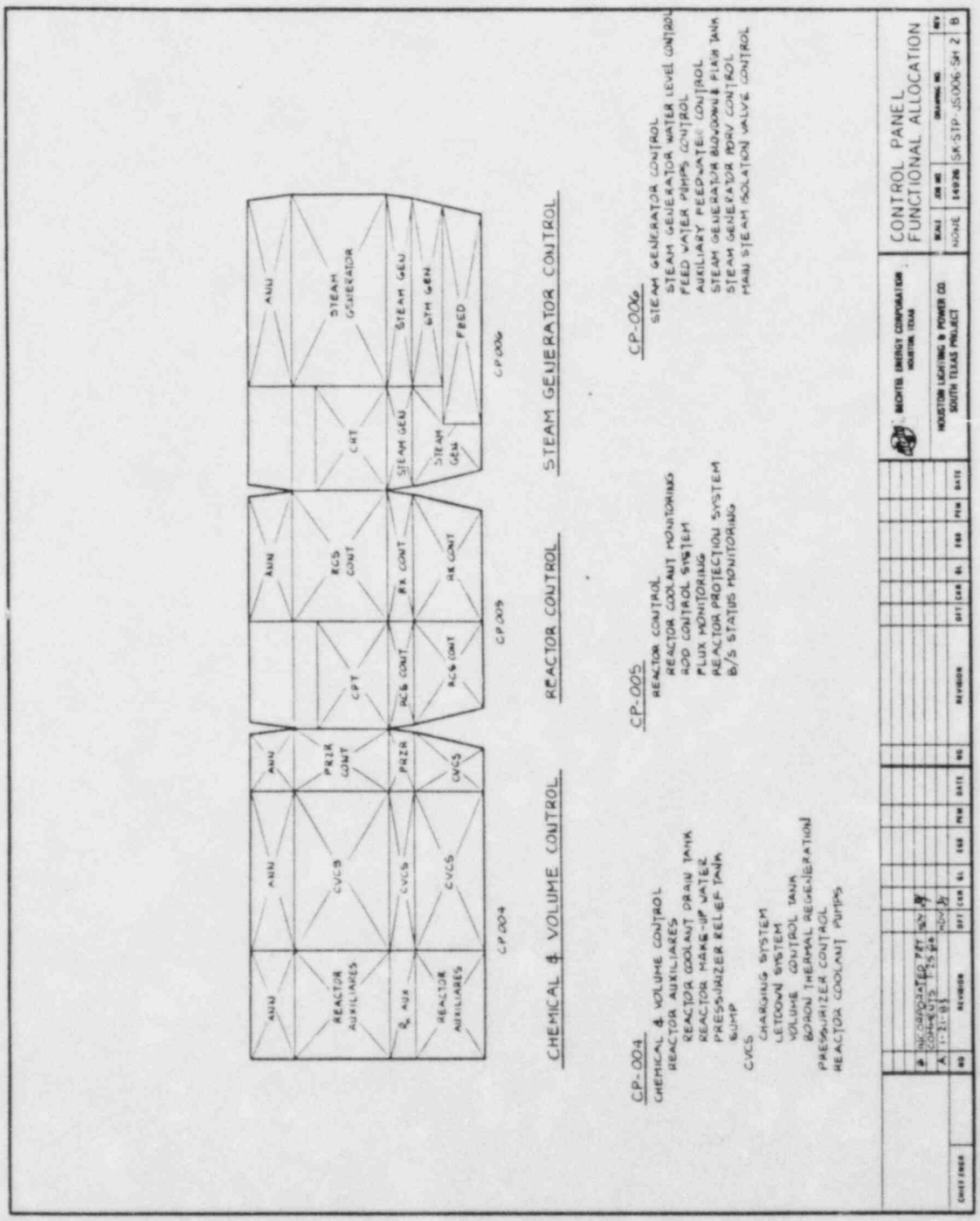
NRC AUDIT TEAM AT STP MOCK-UP

Figure 4-1



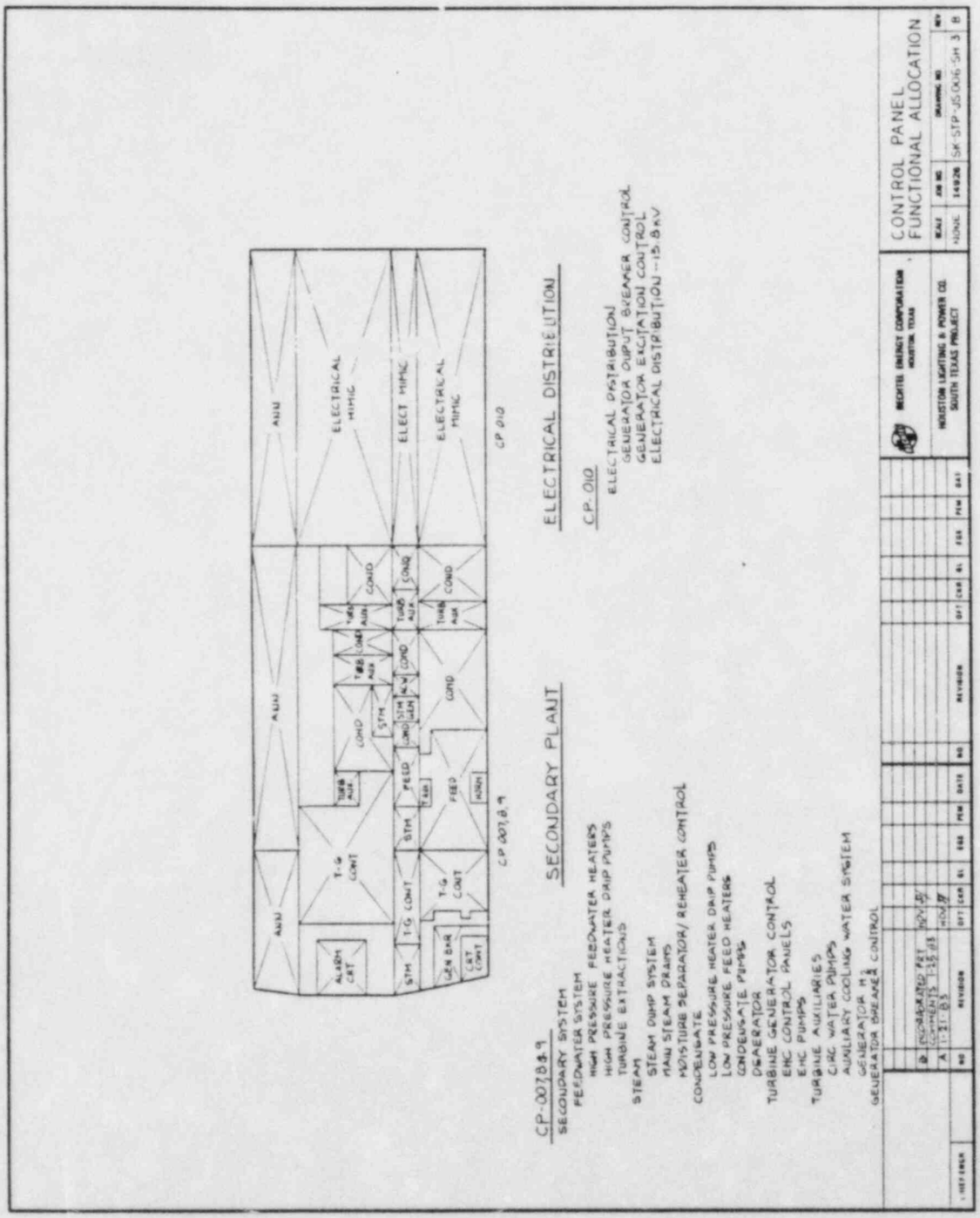
FUNCTIONAL ALLOCATION FOR PANELS CP 001, 002, AND 003

Figure 4-2



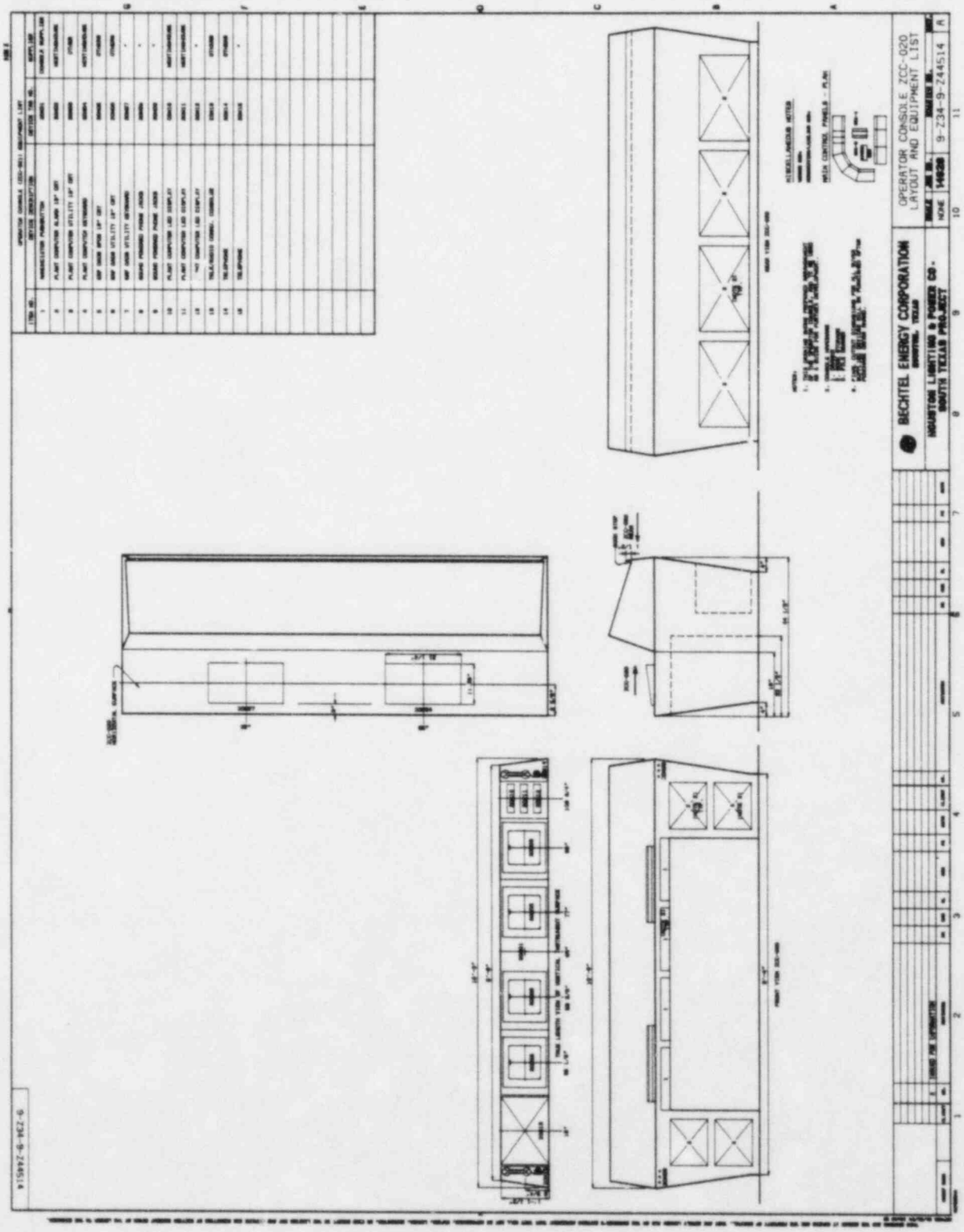
FUNCTIONAL ALLOCATION FOR PANELS CP004, 005 AND 006

Figure 4-3

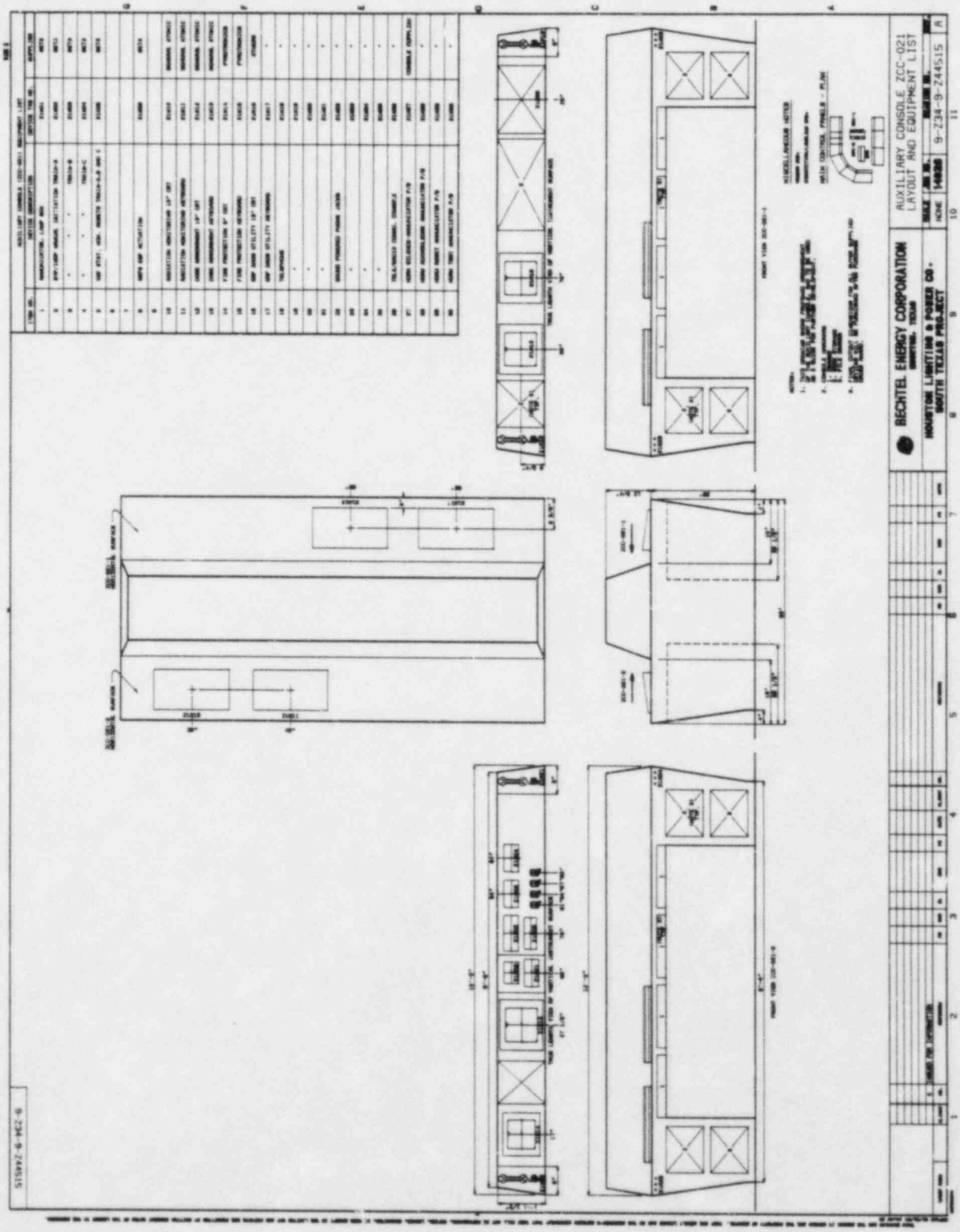


FUNCTIONAL ALLOCATION FOR PANELS CP007-CP010

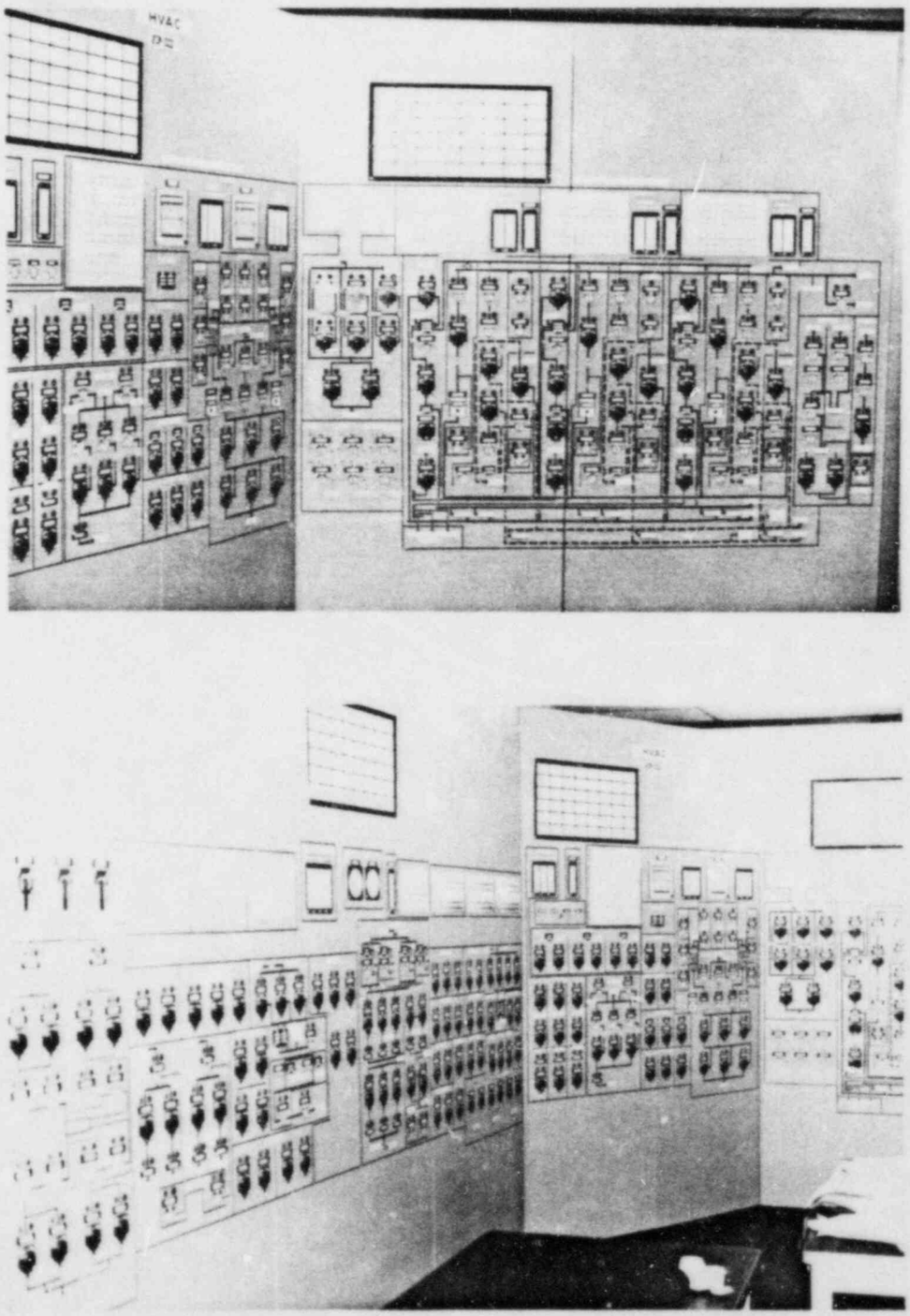
Figure 4-4



OPERATOR CONSOLE
Figure 4-5

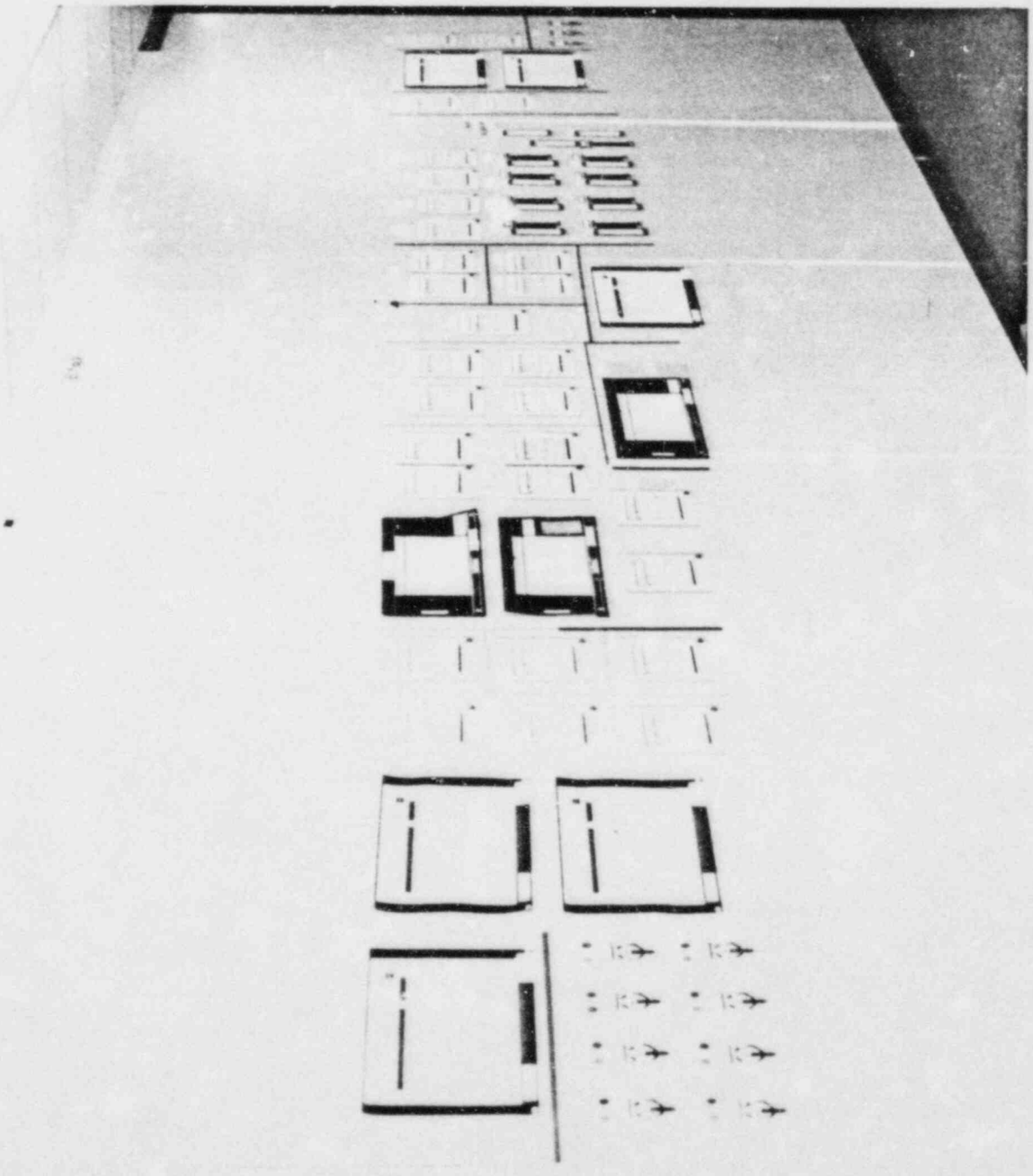


AUXILIARY CONSOLE
Figure 4-6



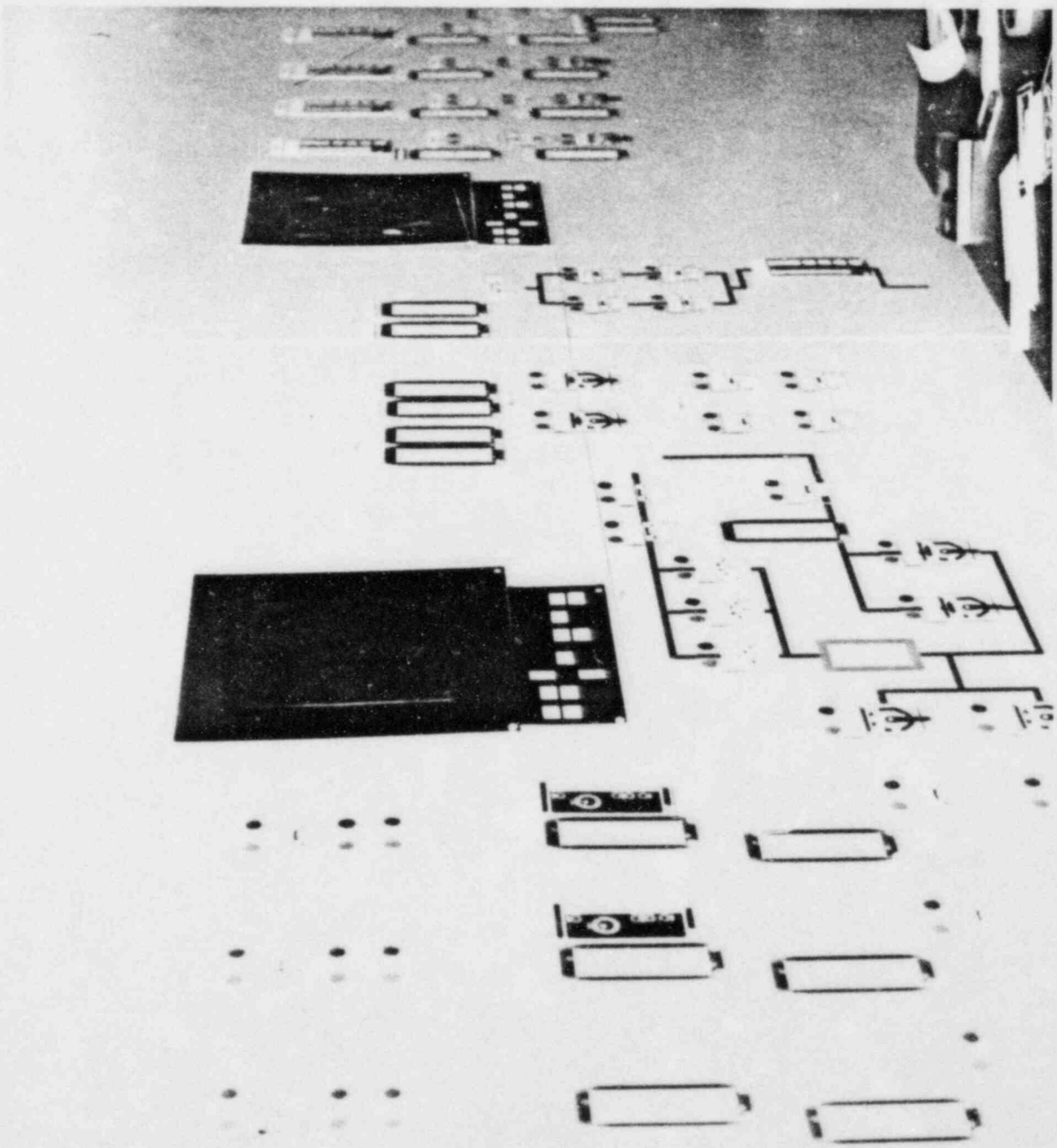
HVAC PANEL MOCK-UP

Figure 4-7



RECORDER PANEL MOCK-UP

Figure 4-8



AUXILIARY SHUTDOWN PANEL MOCK-UP

Figure 4-9

SOUTH TEXAS PROJECT
JOB 14925-001
REPORT EQL06
SORT:PANEL NUMBER(*)

MAIN CONTROL PANEL EQUIPMENT SYSTEM

EQUIPMENT LIST
52011247511 REV 07

DATE 11/10/83
TIME 22:52:55
PAGE 8

ITEM NO.	DEVICE DESCRIPTION	INSTR TAG NO. / SCALE UNITS MJ MIN	POS/ESCUTCHEON ENGRAVING	SUPPLIER / P.O. / MFG / MODEL / TYPE/CAT.NO	LIGHTS / LIGHT TYPE / HANDLE / HANDLE TYPE	LOGIC DWG. / LOOP DIA. / VENDOR WIR / ELEC(ELEM) / PLG/SLT #	SEP. STAGES REQD. / SYS. CONNECTOR NO. / PWR. CONN TYP/TERM / Q CLASSIF.
	HFE REMARKS / REMARKS						
001R002	RHR HX 13 INLET/OUTL TEMP TR-875 PEN 1-RED INLET TE-858 PEN 2-GRN OUTLET TE-875 WAS 002R001 (5/83)	N1RH-TR-0875		WEST 4000 HAGAN OPTI-100 SH.7-19	N/A --- N/A ---	N/A N/A 1T1/N-1T51	N N/A RH RC1105 AC 28-15
001R005	RWST LEVEL LR-931 PEN 1-RED LT-931, WAS 002R002 (5/83) PEN 2-GRN LT-932, RED NAMEPLATE	N1SI-LR-0931		WEST 4000 HAGAN OPTI-100 SH.7-21&22	N/A --- N/A ---	N/A 1T1/N-1T51	N N/A SI RC1107&8 AC 28-15
001R006	RHR HX 1C INLET/OUTLET TEMP IR-675 PEN 1 RED INLET TE-859 PEN 2 GRN OUTLET TE-876, WAS 003R001 (5/83)	N1RH-TR-0576		WEST 4000 HAGAN OPTI-100 SH.7-20	N/A --- N/A ---	N/A 1T1/N-1T51	N N/A RH RC1106 AC 28-15
001S009	CCW DISCH FROM RHR HX 1A FV-4531	A1CC-HS-4531	1CLOSE 2AUTO 3OPEN	MAGNETICS 4304 GE CR-2940 SH. 1-6	GRN RED ET-16 STAN SR-L	Z3182-3 1E6918 E13944N-501 1B16/A-1B22	A ---- CC RC1S09 DC 32A-13
001S015	RHR PUMP 1A INLET ISOL VLV MOV-0060A	A1RH-HS-0060A	1CLOSE 2AUTO 3OPEN	MAGNETICS 4304 GE CR-2940 SH. 1-4	GRN RED ET-16 STAN SR-L.R.	Z42182 1E6716 E13944N-502 1B17/A-1B22	A ---- RH RC1S15 AC 32A-13
001S016	RWST TO SFPPS FV-3936	A1SI-HS-3936	1CLOSE 2AUTO 3OPEN	MAGNETICS 4304 GE CR-2940 SH. 1-5	GRN RED ET-16 STAN SR-R	Z42008 1E6683 E13944N-501 1B14/A-1B22	A ---- SI RC1S16 DC 32A-13
001S017	RHR PUMP 1A INLET ISOL VLV MOV-0061A	B1RH-HS-0061A	1CLOSE 2AUTO 3OPEN	MAGNETICS 4304 GE CR-2940 SH. 1-4	GRN RED ET-16 STAN SR-L.R.	Z42182 1E6719 E13944N-501 1T6/S-1T34	B ---- RH RC1S17 AC 32A-13

EQUIPMENT LIST
CP-001, PAGE 8
Figure 4-10

SOUTH TEXAS PROJECT
JOB 14925-001
REPORT EQL06
SORT:PANEL NUMBER(*)

MAIN CONTROL PANEL EQUIPMENT SYSTEM

EQUIPMENT LIST
52011247511 REV 07

DATE 11/10/83
TIME 22:52:55
PAGE 13

ITEM NO.	DEVICE DESCRIPTION / HFE REMARKS / REMARKS	INSTR TAG NO. / SCALE / UNITS MJ MIN	POS/ESCUTCHEON ENGRAVING	SUPPLIER / P.O. / MFG / MODEL / TYPE/CAT.NO	LIGHTS / LIGHT TYPE / HANDLE / HANDLE TYPE	LOGIC DWG. / LOOP DIA. / VENDOR WIR / ELEC(ELEM) / PLG/SLT #	SEP. STAGES REQD. / SYS. CONNECTOR NO. / PWR. CONN TYP/TERM / Q CLASSIF.
001S054	LHSI PUMP 1A	A1SI-HS-0967	1PULL TO LK 2STOP 3AUTO 4START	MAGNETICS 4304 GE SBM SH.2-41	GRN RED ET-16 PISTOL GRIP SR-L.R	Z3390-1 1E6530 E13944N-528 1B16/A-1B22	A 5 SI RC1S84 DC 36A-22
001S104	BYP/INOP 4-CONTACT BLOCKS/WIRE TO T.B.		TEST	MAGNETICS 4304 GE CR-2940 SH. 1-8	N/A --- STAN PB	N/A E13944N-534 N-1B19	N ---- SM --- DC TB
001S105	ESF STATUS 4-CONTACT BLOCKS/WIRE TO T.B.		TEST	MAGNETICS 4304 GE CR-2940 SH. 1-8	N/A --- STAN PB	N/A E13944N-534 N-1B19	N ---- SM --- DC TB
001S106	LHSI PUMP 1A TO HOT LEG RECIRC MOV-0019A	A1SI-HS-0019A	1CLOSE 2(BLANK) 3OPEN	MAGNETICS 4304 GE CR-2940 SH.1-13	GRN RED ET-16 STAN SR-L.R.	Z42005 1E6710 E13944N-502 1B16/A-1B22	A ---- SI RC1S106 AC 32A-13
001S106A	LHSI PUMP 1A TO HOT LEG RECIRC VPI FOR MOV-0019A LIGHTS ONLY NEW (6/83)			MAGNETICS 4304 GE N/A SH.1-13	GRN RED ET-16 N/A N/A	 1B16/A-1B22	A N/A SI RC1S106 AC ---
001S108	ACC 1A CHECK VLV LEAK TEST FV-3972	N1SI-HS-3972	CLOSE OPEN	MAGNETICS 4304 GE CK-2940 S. 1-1	GRN RED ET-16 STAN MT	Z42010 1E6685/7 E13944N-501 1B15/N-1B19	N ---- SI RC1S108 DC 32A-13
001S109	ACC 1A NITROGEN SUPPLY / VENT PV-3930	B1SI-HS-3930	1CLOSE 2(BLANK) 3OPEN	MAGNETICS 4304 GE CR-2940 SH. 1-4	GRN RED ET-16 STAN CR-L.R	Z42025 1E6685/9 E13944N-501 1T6/B-1T34	B ---- SI RC1S109 DC 324-13

EQUIPMENT LIST
CP-002, PAGE 13
Figure 4-11

SOUTH TEXAS PROJECT
JOB 14925-001
REPORT EQL06
SORT:PANEL NUMBER(*)

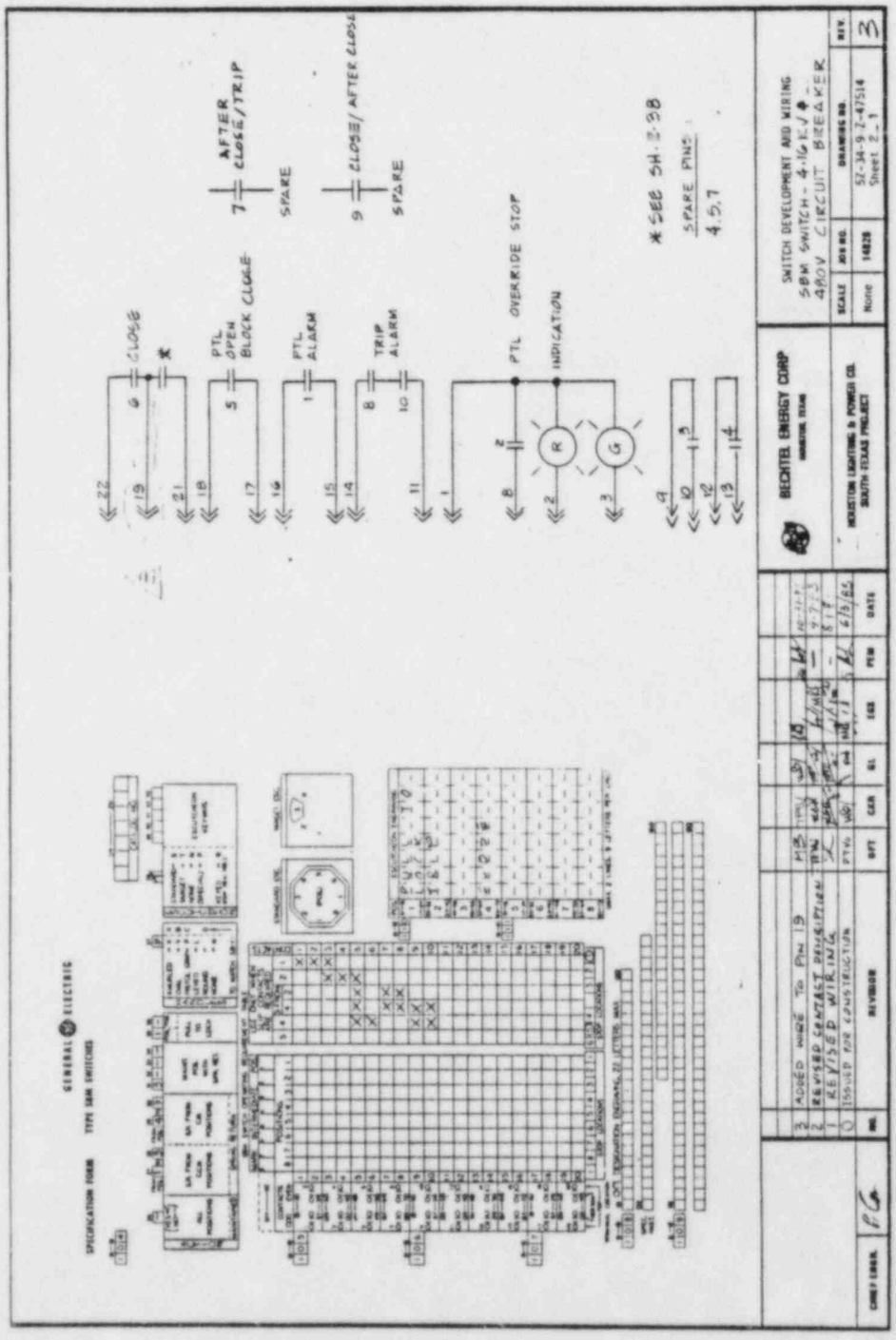
MAIN CONTROL PANEL EQUIPMENT SYSTEM

EQUIPMENT LIST
52011247511 REV 07

DATE 11/10/83
TIME 22:52:55
PAGE 145

ITEM NO.	DEVICE DESCRIPTION	INSTR TAG NO. / SCALE UNITS MJ MIN	POS/ESCUTCHEON ENGRAVING	SUPPLIER / P.O. / MFG / MODEL / TYPE/CAT.NO	LIGHTS / LIGHT TYPE / HANDLE / HANDLE TYPE	LOGIC DWG. / LOOP DIA. / VENDOR WIR / ELEC(ELEM) / PLG/SLT #	SEP. STAGES REQD. / SYS. CONNECTOR NO. / PWR. CONN TYP/TERM / Q CLASSIF.
	HFE REMARKS						
	REMARKS						
0061110	AFW PUMP 14	REVISED (9/83)		MAGNETICS	N/A	N/A	D N/A
	TURB STM PRESS	D1AF-PI-7547		4304	N/A		AF ---
	PE-7547	0 2000 PSIG 8 80		WEST	N/A		-- TB
	INPUT 0-10 VDC			VX-252	N/A	N/A	
	WAS 0011071 (6/83)			VERT		D-6350	
0061111	AFW PUMP 14	REVISED (9/83)		MAGNETICS	N/A	N/A	D N/A
	DISCH PRESS	D1AF-PI-7529		4304	N/A		AF ---
	P1-7529	0 3000 PSIG 6 60		WEST	N/A		-- TB
	INPUT 0-10 VDC			VX-252	N/A	N/A	
	WAS 0011072 (6/83)			VERT		D-6350	
0061112	AFW PMP FLOW	REVISED (9/83)		MAGNETICS	N/A	N/A	D N/A
	TO SG 10	D1AF-FI-7526		4304	N/A		AF ---
	FI-7526	0 700 GPM 7 70		WEST	N/A		-- TB
	INPUT 0-10 VDC			VX-252	N/A	N/A	
	WAS 0011073 (8/83)			VERT		D-6850	
0061113	SG 1C FW FLOW			WEST	N/A	N/A	N N/A
	FI-0530/FI-0531	N1FW-FI-0530/0531		4000	N/A		FW REMARKS
		0 4.8 5 48		SIGMA	N/A		-- 28-15
	RC6107/RC6110, INPUT	0-10 VDC X 10 6 LBS/HR		1251	N/A	N/A	
	WAS 0061015 & 0061014 (9/83)			SH.7-26&28			
0061114	SG 1C STEAM FLOW			WEST	N/A	N/A	N N/A
	FI-0532/FI-0533	N1MS-FI-0532/0533		4000	N/A		MS REMARKS
		0 4.8 5 48		SIGMA	N/A		-- 28-15
	RC6109/RC6112, INPUT	0-10 VDC X 10 6 LBS/HR		1251	N/A	N/A	
	WAS 0061015 & 0061014 (9/83)			SH.7-30&32			
0061115	AFW TURB SPEED			MAGNETICS	N/A	N/A	D N/A
	SI-7538	D1AF-SI-7538		4304	N/A		AF ---
		0 5000 RPM 10 50		WEST	N/A		-- TB
				VX-252	N/A	N/A	
	WAS-0011069 (6/83)			VERT		D-6350	
0061120	SG 1A PROG LVL			WEST	N/A	N/A	N N/A
	LI-0551	N1FW-LI-0551		4000	N/A		FW RC6109
		0 100 PCT 10 100		SIGMA	N/A		-- 29-15
				1151	N/A	N/A	
	INPUT 0-10 VDC			SH.7-30			

EQUIPMENT LIST
CP-006, PAGE 145
Figure 4-12



SWITCH DEVELOPMENT
Figure 4-13

TASK/STEP NUMBER	TASK OBJECTIVE DESCRIPTION (LIST IN SEQUENCE)	REFERENCE	PERFORMED BY	MONITORED BY	PANEL NOS.	LIST EQUIPMENT REQUIRED TO COMPLETE TASK
		ERG REF. SEQ NO.				
7.5.1	Read SG Pressures The faulted SG should indicate a pressure significantly lower	15	2		6B	PI-514, 24, 34, & 44
7.6	Isolate faulted SG	E-2 6				
7.6.1	Main steam is already isolated					
7.6.2	Isolate AFW to faulted SG	16	2		6D	Example: SG A MOV-0048
	Note: After the faulted SG has dried out, RCS pressure would begin to recover.					
8.0	Recovery of RCS to stable conditions					
8.1	Check Non-Faulted SG Levels	E-2 7				
8.1.1	Read Level Indicator	17	2		6B	SG A LI-519 SG B LI-529 SG C LI-539 SG D LI-549
8.1.2	Adjust Throttle valves to maintain SG level at approx. 50% NR	18 19 20	2 2 2		6D 6D 6D	Valves SG A FV-7525 SG B FV-7524 SG C FV-7522 SG D FV-7526

Figure 4-14

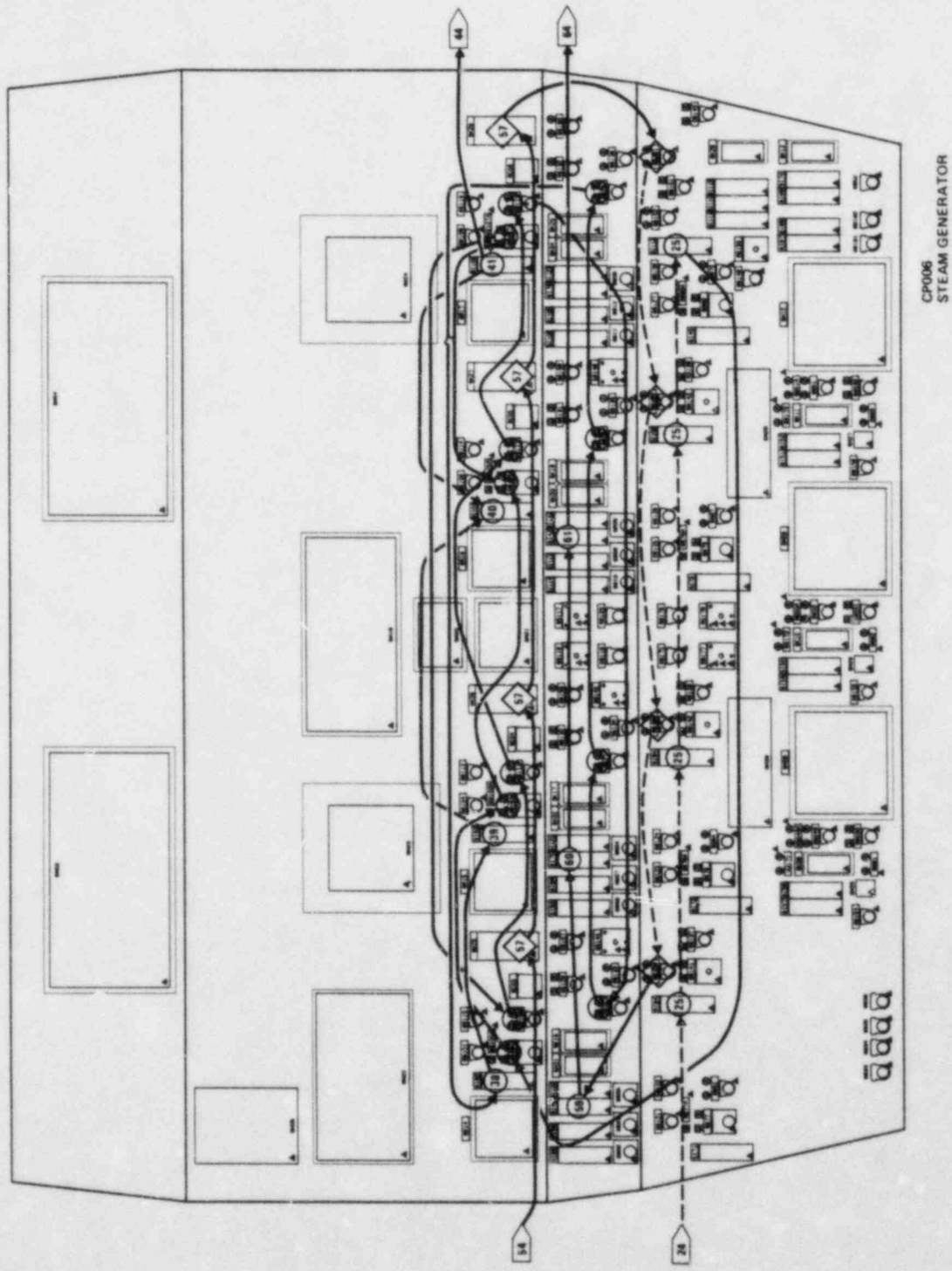


Figure 4-15

OPERATIONAL SEQUENCE DIAGRAM – LOSS OF OFFSITE POWER

PROBLEM REPORTED IN OER REPORT

B. CONTROLS

	PROBLEM CORRECTED	PROBLEM NOT CORRECTED	NO NEW PROBLEM	CREATES NEW PROBLEM
1. TURBINE CONTROLS AND GENERATOR VOLTAGE AND BREAKER CONTROLS ARE TOO FAR APART				
2. AUXILIARY FEEDWATER CONTROLS ARE SCATTERED				
3. CONTROLS ARE NOT MIMICED AND HARD TO IDENTIFY				
4. VCT CONTROLS ARE POORLY ARRANGED				
5. MAIN FEEDWATER SYSTEM CONTROLS NOT GROUPED PROPERLY				

REMARKS: _____

Figure 4-16

5.0 SCHEDULE

This section lists all the activities planned for completion as part of this CRDR. This planning is tied to completion prior to the following four major plant milestones:

- o Cold Hydro
- o Energization
- o Hot Functional
- o Fuel Load

All items will be completed prior to fuel loading. HL&P will submit a supplementary executive summary report to conclude the CRDR reporting within a period of three months following the completion of fuel loading.

5.1 COLD HYDRO

- o Random label checkout (including readability from normal control room positions).
- o Check of vertical meter pointer painted red.
- o Check if demarcation painting complies with the recommendations of the Demarcation Study.
- o Verify the implementation of the use and control of temporary labels.
- o Validate the correct usage of lamp replacement legend maps.
- o Check of labels to correct identifying meaning of some status lights when lit (sheet No. 0792).

5.2 ENERGIZATION

- o Check of annunciator tiles for compliance with the annunciator study results.
- o Check of switch handles vs. readability of switch position.
- o Check for compliance of meter scale markings.
- o Random check of legend light engraving and "closed corner" markings.

5.3 HOT FUNCTIONAL

- o Resolve and validate correction of Rototellite color problem, and sample check of their engraving.
- o Resolve and validate correction of poor readability of the BYPASS/INOPERABLE status lights.
- o Check out the QDPS plasma displays.
- o Check out the effectiveness of annunciator horns.
- o Resolve and validate correction of the problem for some meters to fail off-scale.
- o Complete the review of the Human Engineering suitability and arrangement of panel devices.
- o Resolve and validate correction for the problem for those switches that are difficult to turn.
- o Check of the inadvertant actuation and accessibility of controls to operators.
- o Check of recorder paper and accessibility of supplies.

5.4 FUEL LOAD

- Review and assessment of all Category E criteria (see Item 16 of Section 3.2).
- Complete validation of EOPs.
- Control Room Survey check of control room desk type stations used during plant operations.

APPENDIX A

CATEGORY A HEDs DISPOSITIONS

HF AREA Workspace HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-875 P-6.1.1.1	1. Need AFW Flow Indication related to flow controller 2. Need ECW pump disch. flow indication	1. AFW flow controller was relocated on panel 006 near indicator 2. ECW Flow Data was included in data base for display on QDPS plasma display

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Annunciator HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-510 P-6.2.2.1	System specification provides for only one D.C. buzzer.	Five horns will be installed in the control room.
S-511 P-6.3.3.4	Specific problems or deviation are not given in some tiles.	The annunciator study group reviewed each window engraving and modified them considering this problem. See annunciator report.
S-517 P-6.3.1.4	Annunciator windows lack prioritization.	The annunciator system design was changed to include three window colors to display priorities.
S-518 P-6.3.1.3	System specification does not include "First-Out" Annunciation.	iator system design was nclude "First-Out" of all reactor and
S-526 P-8.5.1.1	Annunciators are not functionally grouped, not logical, and not consistent.	nuncia study group rearranged each window box to correct this problem. See annunciator report.
S-530 P_1 None P_2- 8.5.1.2	ESF status lights difficult to read.	All status light boxes were placed significantly lower on the panels and the window messages were reduced from four lines to three lines.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Annunciator HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-549 P_1- 6.3.3.3	Window boxes have 96 windows which exceeds the maximum of 50 criteria.	The annunciator system design was changed to limit size of window box to 48 windows. The window size was increased by 60%
S-566 P_1- 6.3.3.4	Tile messages are not clear.	The annunciator study group developed new text for each window that is unambiguous and addresses alert conditions.
S-567 P_1- 6.3.3.4	Annunciator and status window engravings are inconsistent.	The annunciator study group considered this problem in their detailed review and incorporated criteria report abbreviations in the totally revised annunciator and status engravings.
S-774 P_1- 6.3.3.5	Letter height are not adequate; tiles cannot be read from controls position.	The annunciator specified lettering height was changed from 0.1875 to 0.269 which provides a subtended angle of 15 minutes.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Visual Displays HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-367 P_1- 6.5.3.1 & S-484 S-679 S-725 S-748	Rotatellite green light color is not distinguishable.	Design implementation
S-726 P_1- 6.5.3.3 & S-732 S-749 S-767	Bypass inoperable status lights are not readable due to narrow stroke width, character separation and line spacing.	Design implementation
S-727 P_1- 6.5.3.3 & S-731 S-750 S-768	Legend messages contain more than three lines of text.	Design implementation

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Visual Displays (Continued) HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-0075 P_1- 6.5.1.6	Two indicating lights do not follow control room color conventions.	A check of the control schematic for the generator ground detector shows that the colors are correct for the applications.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Labels HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-054 P_1- 6.6.1.2	Some components are unlabeled. CP-002	All components are now labeled as part of the labeling study.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Panel Layout HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-568 P_1- 6.8.8.1 & S-576 S-603	Excess travel is required for ESF operational tasks among panels 001, 002 & 003.	The ESF systems have been relayed out to minimize travel among panels 001, 002, & 003 for operational tasks.
S-569 P_1- 6.8.8.1	Related ESF displays and controls are spread over three separate panels (001, 002 & 003).	These displays and controls have been relocated on panel 001, consistent with the SFTA evaluation.
S-577 P_1- 6.8.8.1	Related ESF displays and controls are spread over three separate panels (001, 002 & 003).	These displays and controls have been relocated on panel 002 consistent with the SFTA evaluation.
S-604 P_1- 6.8.8.1	Related ESF displays and controls are spread over three separate panels (001, 002 & 003).	These displays and controls have been relocated on panel 003 consistent with the SFTA evaluation.
S-570 P_1- 6.8.8.1	Controls and displays are not grouped by importance and frequency of use. CP-001	Panel CP-001 has been redesigned to group controls and displays by importance and frequency of use.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Panel Layout HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-578 P_1- 6.8.8.1	Controls and displays are not grouped by importance and frequency of use. CP-002	Panel CP-002 has been redesigned to group controls and displays by importance and frequency of use.
S-605 P_1- 6.8.8.1	Controls and displays are not grouped by importance and frequency of use. CP-003	Panel CP-003 has been redesigned to group controls and displays by importance and frequency of use.
S-572 P_1- 6.8.8.1	AFW related controls and displays for AFW pumps are widely separated.	The AFW related controls and displays for AFW pumps have been relayed out to accommodate operational task sequences.
S-573 P_1- 6.8.2.3	Identical groups of sub-system displays are not arranged consistently from panel to panel.	Panel CP-001 has been relayed out with with consistent sub-system grouping.
S-598 P_1- 6.8.8.1	Same as S-573.	Panel CP-002 has been relayed out with consistent sub-system grouping.
S-593	Same as 573.	Panel CP-003 has been relayed out with consistent sub-system grouping.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Panel Layout HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-574 P_1- 6.8.2.4	Arrangement and location of controls and displays are not maintained from panel to panel. CP-001	Panel CP-001 has been redesigned and controls and displays repositioned for standardization from panel to panel.
S-599 P_1- 6.8.2.4	Arrangement and location of controls and displays are not maintained from panel to panel (MSIV; PURGE, VENT & H2). CP-002	Panel CP-002 has been redesigned and controls and displays repositioned standardization from panel to panel.
S-575 P_1- 6.8.3.1	Separation between adjacent switches is less than minimum allowed. CP-001	Panel relay out work corrected problem.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Panel Layout HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-600 P_1- 6.8.3.1	Separation between adjacent switches is less than minimum allowed. CP-002	Panel relay out work corrected problem. There are a few switches on on CP-002 that still do not meet criteria. A review of their switch position versus function indicates there is no problem with switch handle interference or accidental actuation. The following switches are cited: Traveling SCRN - Start/Stop SCRN Wash Pump - Start/Stop (Train's A, B, & C)
S-0594 P.6.8.3.1	Separation between adjacent switches is less than minimum allowed. CP-003	Panel relay out work corrected the problem.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Control/Display Integration HED CATEGORY A

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-068 5.7.2.2	Labeling of control and associated displays do not Contain the same wording. CP-003	Consistent labels for controls and displays have been provided to conform with the labeling design guide.
S-322 5.7.2.2	Labeling of controls and associated displays do not contain the same wording. CP-001	Consistent labels for controls and displays have been provided to conform with the labeling design guide.
S-498 5.7.2.2	Labeling of controls and associated displays do not contain the same wording. CP-002	Consistent labels for controls and displays have been provided to conform with the labeling design guide.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

APPENDIX B

CATEGORY B HEDs DISPOSITIONS

(Representative Samples)

HF AREA Workspace HED CATECORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-109 P_1-6.1.2.2	Switches and pushbuttons are less than two inches from the front edge of the board CP-001	A handrail is provided to the fronts of panels CP-001 thru CP-010
S-111	Ditto for CP 002	
S-113	Ditto for CP 003	
S-118	Ditto for CP 007	
S-110 P_1-6.1.2.2	Controls are greater than 25 inches from edge of board CP-001	The controls were relocated as part of the redesign and meet the extended functional reach criteria recommended in the Anthropometry Study.
S-112	Ditto for CP-002	
S-114	Ditto for CP-003	
S-115	Ditto for CP-004	
S-116	Ditto for CP-005	
S-117	Ditto for CP-006	
S-118	Ditto for CP-007	
S-119	Ditto for CP-007	
S-120	Ditto for CP-008	
S-121	Ditto for CP-009	
S-122	Ditto for CP-010	

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Annunciator HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-514 P[1]-6.3.4.2	Annunciator controls are not coded for easy recognition	The annunciator controls have been designed to include a unique demarcation color patch.
S-520 P2-8.4.9	Alarm conditions are not combined into multiple input windows	The Annunciator Study Group reviewed the total annunciator - ESF and optimized message combinations. The number of tiles was reduced from 1055 to 642. See Annunciator Report.
S-525 P2-8.5.1.1	RCP tiles on 1LB005A should be located on CP004. Condenser tiles on 1LB007 should be located on CP 008 and CP 009	The combined effect of the major panel redesign and the annunciator study have resulted in locating these tiles with their associated system equipment.
S-527 P1-6.3.3.5	Stroke-width-to-character-height ratio is not between 1:6 & 1:8 and stroke width is not consistent across all tiles	The character height was increased from 3/16" to 1/4" and the stroke width was increased to .04" providing a 1:6.25 ratio.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Annunciator HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-528 P1-6.3.3.5	Space between characters is not consistently one stroke width	The labeling guide which is now part of the Criteria Report specifies in Table 1-1 a character spacing equal to the letter stroke width. The labeling guidelines are being imposed on the annunciator supplier for the STP.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Controls HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-354 P_1-6.4.2.1	The auto position on fourteen rotary selector switches on panel CP 008 are on the left position	These switches were changed to open/ auto/close.
S-460 P_1-6.4.1.1	Eight selector switches are not rotary selector switches on panel CP 007	These switches were changed to rotary selector switches and are now located on CP 006.
S-461 P_1-6.4.1.1	The following reset actuation or trip switches are not pushbutton switches: 7S-0022 STM LN ISOL 7S-0023 STM LN ISOL 7S-0017 TURB. TRIP 7S-0011 STM LN ISOL ACT 7S-0012 STM LN ISOL ACT	Changed to pushbuttons: 7S-0022 and moved to CP 006 7S-0023 and moved to CP 006 7S-0017 and moved to CP 006 Not changed since there is no pushbutton capable of matching the switch development of the pistol grip switch.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Controls HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-703 P1-6.4.3.3	Legend pushbuttons are not readily distinguishable from legend lights.	Special study recommended the "Close Corner Octogon" for marking the controls. Bechtel Engineering will implement this recommendation.
S-712	Twenty-Seven switches used for pump or fan operations or for breaker control are rotary selector type switches instead of J-handled switches.	These switches have been changed to J-handled switches. A few of these switches were eliminated.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Visual Displays HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-006 P1-6.5.2.3	Meter zone markings are not used to denote operational implications	Meter zone marking technique recommended as part of special studies will be used to mark meters in the field on a plant evaluated need basis. See special studies report for meter marking technique.
S-335	The following meter scales on CP 009 are not graduated in 1's, 2's, 5's or 10's. PI - 8509 STA AIR PRESS PI - 8563 INST OUT. AIR PRESS INST AIR DRYER XI - 8225 WIND DIRECTION LI - 6670 RESERVOIR LEVEL	Meters markings specified to comply. Meter marking specified as follows: Major div. 25 minor div. 5 Major div. 25 minor div. 5 Major div. _ minor div. _ (later) Major div. 10 minor div. 1
S-371	Space between lines of text on legend lights/pushbuttons is not one-half the character height. N1-0002M Reheat Temp. Cont. CP 008	

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Visual Displays HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-376 P_1-6.5.4.1	Scale on recording Paper is not the same as the scales on the recorder XR 6008	Paper will be purchased with scales to match the recorder scales.
S-486 P_1-6.5.3.3	Standard abbreviation is not used on legend lights. Drain should be DRN	The labeling study reviewed the messages of all labels in relation to the addition of hierarchial labels. The instructions to the panel fabricator show this item to be corrected per the iterative human factors/operator review process to optimize labeling.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Labels HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-013 P1-6.6.1.2	No hierarchial labeling scheme is provided.	An extensive study corrected this HED. See labeling report in Special Studies Report.
S-019 P1-6.6.3.2	Standard abbreviations are not used for the following words: Temperature, pressure. T1 - 8227 P1 - 8509 P1 - 6059	General problem corrected as above These meters have been deleted through design evolution.
S-584 P1-6.6.4.1	One hundred and seventy three labels on CP003 use 0.125 inch letter which allows a viewing distance of only 21 inches	The label study changed the letter height to 0.75 inches which doubles the viewing distance (42 inches).
S-591 P1-6.6.4.1	Stroke - width-to-character height ratio is not between 1:6 and 1:8 on the service engravings and engraving is inconsistent.	This general problem was resolved by the results and implementation of the labeling study results.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Labels HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-619 P1-6.6.4.1	Space between characters on the service engraving is not at least one stroke width.	The labeling guide which is now part of the Criteria Report specifies in Table 1-1 a spacing equal to the lettering width.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Panel Layouts HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-003 P_1-6.8.3.2	More than five similar components are in an unbroken row on CP 004	CP004 has been total redesign with extensive use of mimics. The problem no longer exists.
S-412 P_1-6.8.8.1	Steam Dump Selector Switches are separated from the Steam Dump Controllers.	A review of the rearranged Steam Dump Subsystem shows this problem is corrected.
S-413 P_1-6.8.1.3	Enhancement techniques are not used to separate turbine controls from main steam control.	A major panel redesign resulted in excellent separation (on two separate panels), each demarcated and hierarchial labeled.
S-571	The controls and displays at the system level are not arranged according to frequency of use or importance CP-006.	CP 006 has been rearranged and this problem no longer exists.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Panel Layouts HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-797 P_1-6.8.2.1	1. PORV's & related block valves are not arranged in left to right configuration. (PCV-0655A, 0656A, RC-0001A, RC-0001B. 2. Pressurizer heaters not arranged in L-T-R or T-T-B order of use. 3. Pressurizer spray and pressurizer controls are not in a L-T-R or T-T-B order of use (PK 0655A, B, C) 4. PRT valves are not arranged in a L-T-R or T-T-B order of use. (FV 3653, 3652, 3650, 3651, LV 3655.	The major panels redesign has corrected these observations.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Control/Display Integration HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-001 P1-6.9.2.2	Corresponding controls and displays do not occupy the same relative position (switches - 0010S, -0009S, - 0012S, - 0011S, meters F1-0530, F1-0531, FI-0540 and F1-0541, CP-006.	These devices have been rearranged and integrated. The switch transmitter position is now directly below the indicator (new switch type).
S-065 P1-6.9.1.1	Displays separated by a non-related display. (P1-0830, L1-0832A) CP-003.	These devices have been rearranged and integrated. They are now located on CP 002
S-494 P1-6.9.1.1	Related controls are not grouped (switches - 0040, 0052 and 0050). Labels do not identify control & display the same (letdown HX, etc., PI-0135, Proc. Controller 0006 & switch 0001). CP-004.	These devices have been rearranged in mimic format.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

HF AREA Control/Display Integration HED CATEGORY B

SHEET NUMBER / REFERENCE PARAGRAPH	OBSERVATION OR CRITERIA TITLE	DISPOSITION
S-0495 P1-6.9.1.1	The following displays are not directly above their associated controls T1-9732 P1-0862 TR-0875 L1-0952 CP-002	These devices have been rearranged and are now located in close proximity to their associated controls with each subsystem. These are further enhanced by color demarcation patches and hierarchial labels.
S-503 P1-6.9.1.1	Six displays are located above eye level T1-0451 T1-0461 T1-0471 T1-0452 T1-04762 T1-0472 TR-0612 CP-005	The meters were integrated with the QDPS. All parameters are still available and located in the prime eye level area of the panels. The recorder is at eye level.

Note: Reference P_1 is NUREG-0700 Section 6 number
P_2 is STP criteria report number

APPENDIX C

LIST OF DEVIATIONS FROM THE
CRITERIA REPORT GUIDELINES
WITH JUSTIFICATION

CRDR CRITERIA REPORT
DEVIATIONS

PARAGRAPH NUMBER	CRITERIA/ DESIGNED TO	JUSTIFICATION
	CRITERIA:	
6.2.1.3.F	Each control shall be recognizable in terms of its function, and shall conform to operator expectations, such as: F. Pushbuttons, CR-2940 - trips, reset functions, lamp test or annunciator control	Although pushbuttons have been used for single function control i.e., trip, reset, etc. the contact configuration and separation requirements precluded the use of pushbuttons for these actuate and reset applications.
	DESIGNED TO: J-type handles were chosen for Engineered Safety Features Actuate and Reset applications and the Reactor Trip actuation for ease of operation and to differentiate the spring return action from maintained action selector switches where lever type handles were used.	
	CRITERIA:	
6.3.1.4	Display Failure (Ref.: NUREG-0700, Sec. 6.5.1.1) When panel instruments, such as meters, fail or become inoperative, the failure shall be apparent to the operator (e.g., through off-scale indication).	For protection system displays, the operator can discern instrument failure through cross-channel checking with redundant meters or via the QDPS. The QDPS performs cross-channel checking and provides the operator with a quality tag for each input.
	DESIGNED TO: Standard W NSSS output signals to panel meters are 0-10 Vdc and as such do not provide off-scale indication.	

CRDR CRITERIA REPORT
DEVIATIONS

PARAGRAPH NUMBER	CRITERIA/ DESIGNED TO	JUSTIFICATION
	CRITERIA:	
App. A A.2.4	Foot room allowances of 4 inches both horizontally and vertically or greater should be incorporated in the stand up control panel.	Based on information received from the Main Control Panel supplier and seismic consultant, the 4-inch vertical by 4-inch horizontal toe space originally provided within the design of the HVAC and Miscellaneous Recorder panels was eliminated, due to anticipated concern regarding seismic qualification. Center of gravity and weight displacement incurred by cantilevering the face plate or instrument bearing surface outward over the base would require extreme modification to the panel structure in order to achieve seismic stability. Upon evaluating the vertical panel design, equipment layout and equipment use, seismic stability is considered more important than the toe space.

APPENDIX D

LIST OF CLO/HEDs VS. CRS REPORT
VOLUME AND PAGE NO.

LIST OF CLO/HEDS VS. CRS REPORT

SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
001	III	I40	050	IV	Q34
002	III	I22	051	III	F7
003	III	H129	052	III	F49
004	III	H128	053	III	F91
005	II	E241	054	III	F127
006	II	E220	055	IV	0-3
007			056	IV	0-12
008			057	III	F152
009	IV	M11	058	IV	F230
010			059	II	E177
011	II	D34	060	II	E218
012	IV	M10	061	II	E239
013	III	F37	062	IV	N32
014	III	F79	063	IV	N43
015	III	F121	064	IV	N50
016	III	F142	065	III	I9
017	IV	0-9	066	III	I28
018	IV	0-18	067	III	I38
019	III	F171	068	III	I44
020	III	F260	069	III	I69
021	III	H21	070	IV	Q4
022	III	H46	071	IV	Q14
023	III	H67	072	IV	Q24
024	III	H98	073	IV	Q33
025	III	H112	074	II	E176
026	III	H118	075	II	E178
027	III	H124	076	III	H18
028	III	H20	077	III	H66
029	III	H43	078	III	H71
030	III	H101	079	III	H94
031	III	H116	080	IV	N13
032	III	H123	081	IV	N33
033	III	H131	082	IV	N34
034	III	H134	083	IV	N44
035	III	H135	084	IV	N51
036	III	H144	085	IV	Q7
037	III	H99	086	IV	Q17
038	III	H102	087	IV	Q27
039	III	H120	088	IV	J1
040	III	H126	089	IV	J2
041	III	H133	090	IV	J3
042	III	H145	091		
043	III	I5	092		
044	III	I25	093	IV	J5
045	III	I30	094	IV	J6
046	III	I52	095	IV	J7
047	IV	Q5	096	IV	J8
048	IV	Q15	097	IV	J9
049	IV	Q25	098	IV	J10
			099	IV	J11

LIST OF CLO/HEDS VS. CRS REPORT

SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
100	IV	J12	150	IV	J42
101	IV	J13	151	IV	J43
102	IV	J14	152	IV	J44
103	IV	J15	153		
104	IV	J16	154		
105	IV	J17	155	IV	J45
106	IV	J18	156	IV	J46
107			157	IV	J47
108	IV	J19	158	IV	J48
109	II	3B	159	IV	J49
110	II	10B	160	IV	J50
111	II	5B	161	IV	J51
112	II	12B	162	IV	J52
113	II	7B	163	IV	J53
114	II	14B	164	IV	J54
115	II	16B	165	IV	J55
116	II	18B	166	IV	J56
117	II	20B	167	IV	J57
118	II	9B	168	IV	J58
119	II	22B	169	IV	J59
120	II	24B	170	IV	J60
121	II	26B	171	IV	J61
122	II	27B	172	IV	J62
123	IV	J25	173	IV	J63
124	IV	J26	174	IV	J64
125			175	IV	J65
126			176	IV	J66
127			177	IV	J67
128			178	IV	J68
129			179	IV	J69
130			180	IV	J70
131	IV	J27	181	IV	J71
132	IV	J28	182	IV	J72
133			183	IV	J83
134			184	IV	J84
135			185	IV	J85
136			186	IV	J86
137	IV	J29	187	IV	J87
138	IV	J30	188	IV	J88
139	IV	J31	189	IV	J89
140	IV	J32	190	IV	J90
141	IV	J33	191		
142	IV	J34	192		
143	IV	J35	193	IV	J81
144	IV	J36	194	IV	J82
145	IV	J38	195		
146			196	III	F97
147	IV	J39	197	III	F39
148	IV	J40	198	III	F81
149	IV	J41	199	III	F123

LIST OF CLO/HEDS VS. CRS REPORT

SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
200	III	F143	250	IV	K22
201	IV	0-10	251		
202	IV	0-19	252	IV	K23
203	III	F262	253	IV	K24
204	III	F172	254		
205	III	F368	255	IV	K25
206	III	F369	256	IV	K26
207	III	F370	257	IV	K27
208	III	F371	258		
209	III	F1	259	IV	K28
210	III	F43	260	IV	K29
211	III	F85	261		
212	III	F134	262		
213	IV	0-1	263	IV	K30
214	IV	0-11	264	IV	K31
215	III	F150	265	IV	K32
216	III	F174	266	IV	K33
217	III	F224	267	IV	K34
218			268	IV	K35
219			269	IV	K36
220			270	IV	K37
221			271	IV	K38
222			272	IV	K39
223	IV	K1	273	IV	K40
224			274	IV	K41
225			275		
226	IV	K2	276	IV	K42
227	IV	K3	277	IV	K43
228			278	IV	K44
229	IV	K5	279	IV	K45
230	IV	K6	280	IV	K46
231	IV	K7	281		
232			282	IV	K47
233	IV	K8	283	IV	K48
234	IV	K9	284	IV	K49
235	IV	K10	285	IV	N4
236			286	II	E175
237	IV	K11	287		
238	IV	K12	288	II	E200
239	IV	K13	289	II	E222
240	IV	K14	290	IV	N26
241	IV	K15	291	IV	N35
242	IV	K16	292	IV	N45
243	IV	K17	293	IV	N52
244	IV	K18	294	II	E266
245	IV	K19	295	II	E276
246	IV	K20	296	IV	N57
247			297	IV	N5
248			298		
249	IV	K21	299	II	E204

LIST OF CLO/HEDS VS. CRS REPORT

SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
300	II	E226	350	IV	M9
301	IV	N28	351	II	D55
302	IV	N37	352		
303	IV	N47	353	II	D58
304	IV	N54	354	II	D51
305	II	E270	355	II	E18
306	II	E280	356	II	E37
307	IV	N59	357	II	E92
308	IV	N7	358	IV	N11
309			359	II	E123
310	II	E206	360	II	E131
311	II	E229	361	II	E149
312	IV	N29	362	II	E167
313	IV	N38	363	II	E183
314	IV	N48	364	II	E216
315	IV	N55	365	IV	N31
316	II	E271	366	II	E236
317			367	II	E249
318	IV	N60	368	IV	N42
319	III	I7	369	IV	N49
320	III	I26	370	IV	N56
321	III	I36	371	II	E258
322	III	I42	372	II	E275
323	III	I46	373	II	E284
324	IV	Q2	374	II	E286
325	IV	Q12	375	IV	N64
326	IV	Q22	376	II	E289
327	IV	Q32	377	II	E298
328	II	E41	378	II	E309
329	II	E129	379	II	E313
330	II	E153	380	II	E315
331	II	E170	381	II	E317
332	II	E39	382	III	I13
333	IV	N12	383	III	I18
334	II	E124	384	III	I57
335	II	E169	385	IV	Q9
336	II	E184	386	IV	Q19
337	II	E314	387	IV	Q29
338	II	E316	388	II	E299
339	II	E318	389	II	E310
340	II	D20	390	II	E94
341	III	F133	391	II	E151
342	III	F210	392	II	E133
343	III	F302	393	III	I24
344	III	F362	394	III	I59
345	III	F212	395	IV	Q10
346	III	F304	396	IV	Q20
347	III	F323	397	IV	Q30
348	III	F364	398	III	I16
349	II	D17	399	III	I21

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SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
400	III	I55	450	III	F253
401	IV	Q8	451	III	F355
402	IV	Q18	452	III	F31
403	IV	Q28	453	III	F319
404	II	E111	454	III	F131
405	IV	N22	455	III	F140
406	II	E113	456	IV	0-7
407	IV	N24	457	IV	0-16
408	II	E199	458	III	F166
409	II	D19	459	II	D29
410	III	H23	460	II	D33
411	III	H48	461	II	D48
412	III	H73	462	IV	M8
413	III	H136	463	II	D50
414	III	H50	464	II	D54
415	III	H74	465	II	D56
416	III	H122	466	II	D57
417	III	H138	467	II	E16
418	III	H52	468	II	E90
419	III	H103	469	II	E35
420	III	H142	470	II	E61
421	III	H25	471	II	E109
422	III	H92	472	IV	N10
423	III	I3	473	II	E96
424	III	I15	474	II	E97
425	IV	Q31	475	II	E122
426	IV	Q21	476	II	E147
427	IV	QII	477	II	E166
428	III	F428	478	IV	N20
429	III	F33	479	II	E193
430	III	F75	480	II	E214
431	III	F117	481	II	E234
432	III	F132	482	IV	N30
433	III	F141	483	II	E245
434	IV	0-8	484	II	E248
435	IV	0-17	485	IV	N41
436	III	F168	486	II	E274
437	III	F206	487	II	E283
438	III	F222	488	IV	N63
439	III	F256	489	II	E297
440	III	F298	490	II	E308
441	III	F321	491	II	E312
442	III	F358	492	III	F146
443	III	F223	493	III	F149
444	III	F148	494	III	I10
445			495	III	I8
446	III	F114	496	III	I27
447	III	F295	497	III	I37
448	III	F72	498	III	I43
449	III	F203	499	III	I48

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SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
500	IV	Q3	550		
501	IV	Q13	551	II	C41
502	IV	Q23	552	II	C42
503	III	I1	553	II	C43
504	III	I12	554		
505	III	I20	555	II	C44
506	III	I54	556	II	C45
507	IV	Q6	557	IV	L14
508	IV	Q16	558		
509	IV	Q26	559		
510	II	C1	560	II	C46
511	II	C3	561		
512			562	II	C47
513	II	C5	563	IV	L15
514	II	C6	564		
515	II	C8	565		
516	II	C10	566	II	C49
517	II	C11	567	II	C51
518	II	C12	568	III	H1
519	II	C13	569	III	H27
520	II	C14	570	III	H53
521	II	C16	571	III	H76
522	II	C17	572	III	H69
523	II	C18	573	III	H105
524	IV	L1	574	III	H108
525	II	C20	575	III	H113
526	II	C21	576	III	H8
527	II	C24	577	III	H33
528	II	C26	578	III	H56
529	II	C28	579	III	H82
530	II	C30	580	II	E7
531	IV	L3	581	III	F312
532	IV	L4	582	III	F236
533	IV	L5	583	III	F218
534	IV	L6	584	III	F186
535	IV	L7	585	III	F154
536	II	C32	586	IV	0-13
537	II	C33	587	IV	0-4
538	II	C34	588		
539	II	C35	589	III	F55
540	II	C36	590		
541	II	C37	591	III	F266
542	II	C38	592	III	F326
543	IV	L8	593	III	H107
544	IV	L9	594	III	H115
545	IV	L10	595	III	308
546	IV	L11	596	III	F216
547	IV	L12	597	III	F130
548	IV	L13	598	III	H106
549	II	C39	599	III	H110

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SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
600	III	H114	650	II	E128
601	III	F13	651	II	E140
602	III	F278	652	II	E161
603	III	H14	653	II	E181
604	III	H39	654	IV	N17
605	III	H62	655	II	E191
606	III	H88	656	II	E287
607	III	F338	657	II	E293
608	III	F22	658	II	E303
609	III	F64	659	II	D5
610	III	F106	660	II	D30
611	III	F138	661	II	D37
612	IV	0-6	662	II	D44
613	IV	0-14	663	IV	M3
614	III	F161	664	II	E4
615	III	F195	665	II	E22
616	III	F220	666	II	E57
617	III	F245	667	II	E78
618	III	F287	668	II	E100
619	III	F316	669	IV	N6
620	III	F347	670		
621	IV	0-15	671	II	E126
622	III	F139	672	II	E136
623	III	F110	673	II	E157
624	III	F68	674	IV	N15
625	III	F26	675	II	E187
626	III	F199	676	II	E202
627	III	F221	677	II	E223
628	III	F249	678	IV	N27
629	III	F319	679	II	E246
630	III	F291	680	IV	N36
631	III	F351	681	IV	N53
632	III	F59	682	IV	N46
633	III	F101	683	II	E268
634	III	F137	684	II	E278
635	IV	0-5	685	IV	N58
636	III	F156	686	II	E291
637	III	F190	687	II	E301
638	III	F219	688	II	E311
639	III	F282	689	III	F136
640	III	F342	690	III	F217
641	II	E9	691	III	F310
642	III	F17	692	III	F180
643	III	F314	693	III	F272
644	III	F162	694	III	F332
645	III	F240	695	II	D24
646	II	E27	696	II	D41
647	II	E82	697	IV	M5
648	III	F144	698	II	D11
649	II	E118	699	II	D27

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SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
700	II	D15	750	II	E263
701	II	D32	751	II	E292
702	IV	M7	752	II	E302
703	II	D53	753	II	E12
704	II	D13	754	II	E29
705	II	D25	755	IV	N1
706	II	D46	756	II	E84
707	IV	M6	757	II	E104
708	II	D49	758	IV	N8
709	IV	M1	759	II	E119
710	II	D1	760	II	E142
711	II	D22	761	II	E163
712	II	D35	762	IV	N18
713	II	D43	763	II	E193
714	II	E1	764	II	E208
715	II	E20	765	II	E232
716	II	E56	766	IV	N39
717	II	E76	767	II	E256
718	II	E98	768	II	E265
719	II	E114	769	II	E272
720	II	E134	770	IV	N61
721	II	E155	771	II	E288
722	II	E180	772	II	E294
723	IV	N14	773	II	E305
724	II	E185	774	II	C23
725	II	E244	775	II	E14
726	II	E250	776	II	E59
727	II	E259	777	II	E32
728	II	E285	778	II	E107
729	II	E290	779	II	E87
730	II	E300	780	IV	N9
731	II	E261	781	II	E121
732	II	E252	782	II	E129
733	II	D8	783	II	E145
734	II	D23	784	II	E165
735	II	D39	785	IV	N12
736	II	D45	786	II	E196
737	IV	M4	787	II	E211
738	II	E25	788		
739	II	E58	789	IV	N40
740	II	E80	790	II	E257
741	II	E102	791	II	E273
742	II	E117	792	II	E282
743	II	E127	793	IV	N62
744	II	E138	794	II	E296
745	II	E159	795	II	E307
746	IV	N16	796	III	F128
747	II	E189	797	III	H96
748	II	E247	798	III	I32
749	II	E254	799	II	E52

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SHEET NO.	VOLUME	PAGE NO.	SHEET NO.	VOLUME	PAGE NO.
800	II	E72	850	IV	P26
801	III	I61	851		
802	III	I64	852	III	G8
803	II	E53	853	IV	P27
804	II	E73	854	IV	P28
805	III	I62	855	III	G9
806	III	I65	856		
807	II	E55	857	IV	P29
808	II	E75	858	III	G10
809	III	I63	859	IV	P30
810	IV	P2	860	IV	P31
811	IV	P3	861	IV	P32
812	IV	P4	862	IV	P33
813	IV	P5	863	IV	P34
814	III	G1	864	IV	P35
815	IV	P6	865		
816	III	G3	866	IV	P36
817	III	G4	867	IV	P37
818	III	G5	868	IV	P38
819	IV	P7	869	VI	J20
820	IV	P8	870	II	E46
821	III	G6	871	II	E172
822	IV	P9	872	II	E67
823	III	G7	873	II	E69
824	IV	P10	874	II	E48
825	IV	P11	875	II	B1
826	IV	P12	876	III	I66
827	IV	P13	877	II	E62
828	IV	P14	878	II	E43
829	IV	P15	879	II	E44
830	IV	P16	880	II	E64
831	IV	P17	881	II	E45
832			882	II	E66
833	IV	P18	883	II	E50
834	IV	P19	884	II	E70
835	IV	P20	885	II	E173
836	IV	P21	886	III	I34
837	IV	P22	887		
838	IV	P23	888		
839	IV	P24	889		
840	IV	P25	890		
841			891		
842			892		
843			893		
844			894		
845			895		
846			896		
847			897		
848			898		
849			899		
			900		

Control Room Design Review

Control Room Survey Validation Report

The South Texas Project

HOUSTON LIGHTING & POWER COMPANY