# HUMAN FACTORS CONTROL ROOM DESIGN REVIEW
# OF
# COMANCHE PEAK STEAM ELECTRIC STATION

DECEMBER 1982

## TABLE OF CONTENTS

# 1.0 INTRODUCTION

## 1.1 OVERVIEW

The purpose of this report is to document the results of the Comanche Peak Steam Electric Station (CPSES) human factors control room design review (CRDR). The CPSES CRDR team included representatives of Texas Utilities Services, Inc. (TUSI); Texas Utilities Generating Company (TUGCO); Gibbs & Hill, Inc., architect-engineer for CPSES; and Essex Corporation, a human factors consulting firm.

The CRDR was performed on the Unit 1 control boards. A detailed component-by-component comparison of the Unit 1 and Unit 2 control boards was performed, however, and a design change package for Unit 2 has been developed to make the configuration of Unit 2 identical to the configuration of Unit 1. All analysis, Human Engineering Discrepancies (HEDs), and backfits discussed in this report are therefore applicable to both the Unit 1 and the Unit 2 control boards at CPSES.

## 1.2 OBJECTIVES OF THE CRDR

a. The primary objective of the CPSES CRDR was to identify potential human factors design concerns so that corrective actions could be implemented in a timely manner.

b. The specific objectives of the CRDR were to:

   o Identify characteristics of the control room instrumentation, including controls, displays, other equipment, and physical arrangements that may detract from operator performance

   o Analyze and evaluate the problems that could arise from the identified discrepancies, and to analyze the means of correcting those discrepancies which could lead to substantial problems

   o Define and put into effect a plan of action to improve the control room design and enhance operator performance.

## 1.3 SCOPE OF THE CRDR

a. The initial scope of the CRDR was to perform an evaluation using the NUREG/CR-1580 (Draft) guidelines. After the issuance of NUREG-0700, the CRDR was restructured to follow NUREG-0700 guidelines.

b. Certain areas of a complete NUREG-0700 CRDR have not been addressed due to the current state of plant construction. The specific areas not addressed, with the relevant reasons, are listed below. These areas will be addressed in a timely manner, as discussed in Section 6.0.

1) Environmental aspects (light, noise and HVAC), and emergency garments could not be evaluated due to the state of plant construction.

2) The system function and task analysis (SFTA) was not conducted since it will use the Westinghouse Owners Group SFTA guidelines which were not yet available.

## 1.4 BACKGROUND

### 1.4.1 NRC Initiatives

In May 1980, the NRC published NUREG-0660 which stated a requirement to conduct a control room review to identify and correct design deficiencies. Following 0660, NUREG/CR-1580 was issued for review in July 1980, and then in draft in September 1980. NUREG-0659, a supplement to CR-1580 was provided in March 1981. NUREG-0700, Guidelines for Control Room Design Reviews, which contains the latest NRC guidelines for the CRDR was provided in September 1981.

### 1.4.2 CPSES Response to the Initiatives

a. In October 1980, the NRC advised TUGCO management that it planned to perform a preliminary audit of the CPSES control room in December 1980. As a result of this notification TUGCO selected Essex Corporation, an HF consulting firm, to assist in a preliminary human factors review. The review was completed November 17, 1980. After receiving the results, the NRC conducted an on-site control room review and audit in December 1980. The NRC issued an audit report in May 1981.

b. After receipt of the NRC preliminary audit report, CPSES began a detailed CRDR based upon CR-1580. In September 1981, NUREG-0700 was issued and the evaluation team restructured the review to follow 0700. From November 1981 to present, the review team has worked to rearrange the control boards and to enhance them by topical treatments such as mimics and demarcation. TUGCO/TUSI rearranged the CPSES control boards by moving approximately 1600 unit one/unit two components in order to correct arrangement and grouping problems. Additionally, labeling and engraving enhancements are being incorporated to ensure adequate readability, consistency, and durability in all control board labeling. As part of this effort, a constrained language dictionary was developed for specific application to the CPSES control room. TUGCO/TUSI are currently involved in an ongoing project to implement as many HED resolutions as possible without impacting the fuel load schedule.

## 1.5 EXCEPTIONS TO NUREG-0700 GUIDELINES

### 1.5.1 Program Plan

NUREG-0700, Section 2.1 recommends the submittal of a program plan to the NRC prior to commencement of the assessment process. CPSES did not submit a program plan since the CPSES detailed CRDR assessment process was already well underway by the time NUREG-0700 was issued. In lieu of this program plan, CPSES met with the NRC Human Factors Branch on April 7, 1982, to outline the CRDR progress to date. The minutes from the meeting are contained in the NRC letter of May 27, 1982, from S. B. Burwell to Texas Utilities Generating Company.

# 2.0 PROJECT MANAGEMENT

## 2.1 INTRODUCTION

The purpose of this chapter is to document the human factors review team background and experience and the CRDR documentation processes.

## 2.2 MANAGEMENT AND STAFFING

The human factors CRDR team (also referred to as the "review team") was comprised of utility personnel and human factors analysts directed by the CRDR team leader. Some personnel were dedicated to the entirety of the review and others participated in individual tasks. The roles performed by the review team personnel and their professional and academic background are presented in Table 1. One role performed by several of the CRDR team members was that of HED Review Committee member. The HED Review Committee was charged with evaluation and selection of methods for resolving discrepancies identified in the CRDR. Resumes of the CRDR team personnel can be found in Appendix F.

## 2.3 DOCUMENTATION AND DOCUMENT CONTROL

### 2.3.1 Introduction

Four types of documentation were included: 1) the input or reference documentation, 2) the component and discrepancy level HED documentation, 3) the CPSES preliminary CRDR audit report, and 4) the NRC preliminary audit report.

### 2.3.2 Input or Reference Documentation

A project library was established at the start of the review, and was expanded through a continual process of acquiring more materials as the needs arose during the review. The following documents, materials, etc., were used to support all aspects of the CRDR:

- o FSAR
- o Technical specifications and system descriptions
- o P&IDs
- o ICDs
- o Panel drawings

- o Control room layout drawings
- o Photomosaic
- o SPDS software descriptions
- o Procedures (ERGs)
- o CPSES preliminary CRDR audit report and the NRC preliminary audit report
- o Various NRC and industry documents bearing on control room design (0700, 1580, HF texts, etc.)

### 2.3.3 Component and Discrepancy Level HED Documentation

a. **Component Level HED Documentation — Human Engineering Component Evaluation Report ("Component Sheet").** A comprehensive filing system was developed to store all data collected in the CRDR. A component sheet was prepared for every component in the control room. Component sheets, used in conjunction with the checklists, were the forms on which identified discrepancies were recorded. In the filing system, component sheets served to quickly access and identify all Human Engineering Discrepancies (HEDs) related to any particular component.

b. **Discrepancy Level HED Documentation — Human Engineering Discrepancy Reports (HED).** An HED was written for each discrepancy cited in the CPSES preliminary CRDR audit report and the NRC preliminary audit report. HEDs were also written for all discrepancies identified during the detailed CRDR. In the filing system, HEDs served as a way to quickly access and identify all components having a particular discrepancy.

c. **CRDR Output Findings Report.** This report was prepared at the conclusion of the CRDR and consists of a summarization of each HED in the following format:

   A. HED Description

   B. Guideline Reference

   C. Location

   D. Potential Safety Consequences

   E. Assessment Process

   F. Backfit

**TABLE I**
**COMANCHE PEAK STEAM ELECTRIC STATION UNIT-1**
**HUMAN FACTORS CONTROL ROOM DESIGN REVIEW TEAM**

| Organization | Name | Role | Years Experience | Education |
|---|---|---|---|---|
| TUSI | Ron Estes | CRDR Team Leader; HED Review Committee Member | 23 | |
| | Dale Walling | CRDR Team and HED Review Committee Member | 7 | B.S. Electrical Engineering, Univ. of Mo.-Rolla |
| TUGCO | Bobby Bird | CRDR Team and HED Review Committee Member | 6 | B.S. Electrical Engineering, Texas Tech University |
| Gibbs & Hill, Inc | Don Castro | CRDR Team and HED Review Committee Member | | |
| | Joe Calamito | CRDR Team and HED Review Committee Member | | |
| Essex Corporation | Ken Mallory | Project Director, May-Sept. 1981 | 19 | M.S. Experimental psychology, Tufts University<br>B.S. Experimental Psychology and Mathematics, Lynchburg College. |
| | Allen Elliff | Project Manager, Sept. 1981-present | 10 | Ph.D. Industrial Engineering/Operations Research, Texas A&M University<br>M.S. Industrial Engineering/Operations Research, Texas A&M University<br>B.S. Industrial Engineering, Texas A&M University |

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**COMANCHE PEAK STEAM ELECTRIC STATION UNIT-1**
**HUMAN FACTORS CONTROL ROOM DESIGN REVIEW TEAM**

| Organization | Name | Role | Years Experience | Education |
|---|---|---|---|---|
| | Tim O'Donoghue | Data Collection Manager; H.F. Analyst; HED Review Committee Member | 2.5 | M.A. Candidate, Industrial/Organizational Psychology, George Mason University<br>B.A. Psychology, George Mason University |
| | Walter Talley | Technical Quality Review; HED Review Committee Member | 20 | M.S. Applied Psychology, Stevens Institute of Technology<br>B.A. General Experimental Psychology, New Mexico State University<br>A.A. Arts & Sciences, New Mexico State University |
| | Terence J. Voss | Technical Quality Review; HED Review Committee Member | 2 | ABD Experimental Psychology/Learning, University of Montana<br>M.A. General Experimental Psychology, Florida Atlantic University<br>B.A. Sociology/Psychology, State University of New York |
| | Elliott Steele | H.F. Analyst, May-Sept. 1981 | | |
| | Diane Jeorling | H.F. Analyst; Task Manager for Annunciator Study; HED Review Committee Member | 2 | B.S. Mathematics, St. Louis University |
| | Larry Avery | Senior Technical H.F. Analyst; Task Manager for Rearrangement Analysis | 4 | M.A. (ABT) Industrial Psychology, George Mason University<br>B.A. Business Administration, George Mason University |

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**HUMAN FACTORS CONTROL ROOM DESIGN REVIEW TEAM**

| Organization | Name | Role | Years Experience | Education |
|---|---|---|---|---|
| | Cliff Baker | Participant in Preliminary Review | 5.5 | M.A. Candidate, Experimental Psychology, George Mason University<br>B.S. Psychology, University of Maryland |
| | Danna Beith | Task Leader for Checklisting; H.F. Analyst | 5 | B.A. Psychology, University of California, Santa Barbara |
| | Dale Pilsitz | Provided ongoing nuclear power plant operation expertise to ensure pragmatism of analysis and recommendations | 12 | 1976-1981 Senior Reactor Operator License, Three Mile Island Nuclear Power Station Unit 1<br>1974-1976 Reactor Operator License, Three Mile Island Nuclear Power Station Unit 1<br>1973 Pressurizered Water Reactor Training Program, Babcock and Wilcox Simulator, Lynchburg, Virginia<br>1971 Reactor Familiarization Program, Penn State University Reactor Facility<br>1969 Reactor Operator Training Course, Metropolitan Edison Company |
| | Tom Harding | Provided ongoing nuclear power plant operation expertise to ensure pragmatism of analysis and recommendations; HED Review Committee Member | 11 | 1980 Senior Reactor Operator Permit, USNRC North Anna Nuclear Power Station Unit 1 and Unit 2<br>1978 Reactor Operator License, USNRC North Anna Nuclear Power Station Unit 1<br>1975 Retraining Qualifications, Westinghouse Zion Power Station, Simulator<br>1973 Reactor Operator License, USAEC Surry Power Station, Unit 1 and Unit 2 |

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**COMANCHE PEAK STEAM ELECTRIC STATION UNIT-1**
**HUMAN FACTORS CONTROL ROOM DESIGN REVIEW TEAM**

| Organization | Name | Role | Years Experience | Education |
|---|---|---|---|---|
| | Donald Seibert, Jr. | H.F. Analysis and Data Gathering | 1 | B.S. Engineering Technology (Power Plant System Major), University of Maryland<br>Certificate in HVAC, Lincoln Technical Institute<br>Boiler Technician, Class A School, U.S. Navy |
| | Candace Weiss | H.F. Analysis and Data Gathering | 2 | B.A. Political Science, The George Washington University |
| | Trudy Justice | H.F. Analysis and Data Gathering | 1.5 | B.A. Psychology, North Carolina State University |
| | Everett Boyd | H.F. Analysis and Data Gathering | 2 | B.A. Psychology, The College of William and Mary |

# 3.0 METHODOLOGY AND SCOPE

## 3.1 INTRODUCTION

This chapter describes the methodology and scope of the CRDR. Paragraph 3.2 describes the general scope of the CRDR, while paragraph 3.3 describes methodology that was generally employed for all phases of the review process. All subsequent paragraphs describe each survey that was conducted and document any additional methodologies or definitions of scope particular to that survey.

## 3.2 SCOPE

The overall scope of the CRDR was as follows:

a. Review the Unit 1 control boards to assess compliance with NUREG/CR-1580 guidelines

b. Reassess control boards for compliance with NUREG-0700 guidelines

c. Evaluate applicable SERs and LERs

d. Develop corrections for all Unit 1 discrepancies

e. Compare Unit 2 to Unit 1 to assess design differences

f. Develop and implement design change packages such that Unit 2 will be identical to the corrected Unit 1.

The review was limited to those primary control panels with which the operator normally interfaces, including the Hot Shutdown Panel. Each survey had various levels of depth and limitations imposed due to the state of plant construction and equipment availability. These are documented in the subsequent paragraphs.

## 3.3. REVIEW METHODS AND PROCEDURES

### 3.3.1 General

Evaluation procedures consisted of a data collection phase, analysis and review phase, and a documentation phase.

### 3.3.2 Data Collection

For each survey, a team of human factors analysts and utility personnel, directed by the CRDR team leader, reviewed the control room. The data collected were recorded on checklists and data collection forms for subsequent analysis and review.

### 3.3.3 Analysis

Data were analyzed by comparing them to the applicable criteria contained in NUREG/CR-1580 and subsequently in Section 6 of NUREG-0700. Where data did not agree with the recommended criteria, Human Engineering Discrepancy (HED) reports were completed for review by the HED Review Committee.

### 3.3.4 Assessment

a. **General Description.** All HEDs were given an iterative review. Initially, HEDs were reviewed to validate each potential discrepancy, estimate the significance of the problem, and determine a tentative backfit. Upon completion of this preliminary review, HEDs were assigned to TUGCO/TUSI operational support staff for final validation, review, and disposition.

b. **Detailed Description.** The procedure used to assess human engineering discrepancies and select backfits consists of three sequential steps, each composed of one or more substeps:

- o Performance of Surveys by the CRDR Team to identify human engineering discrepancies based on the criteria of NUREG-0700 and NUREG/CR-1580
- o Meeting of CRDR Team members with the Data Collection Manager to
  - clarify and agree on source of discrepancy
  - develop alternatives for backfits
- o Meeting of the HED Review Committee to
  - Review discrepancies
  - Identify potential safety consequences
  - Discuss and decide on backfits.

#### 3.3.4.1 Performance of Surveys by the CRDR Team

This step involved identifying discrepancies in the control room through the use of various surveys based on the criteria of NUREG-0700 and NUREG/CR-1580. An HED was written for each discrepancy found. A list of the discrepant components and potential operator error was included in each HED.

HEDs identified by the NRC preliminary audit and the Essex preliminary review report were updated to include the potential operator error.

#### 3.3.4.2 Meeting of the CRDR Team Members with the Data Collection Manager

This step essentially consisted of the Data Collection Manager and an operations representative (for specific individuals see Table 1) reviewing the identified HEDs. They would "walk through" each HED in the control room and establish a mutual understanding of the source of the discrepancy (i.e., the "what" and "why").

Once this understanding was established, backfit options were developed for discussion. Each backfit option was researched for its feasibility of implementation and effectiveness in resolving the discrepancy.

#### 3.3.4.3 Meeting of the HED Review Committee

Next, the HED Review Committee (for specific members see Table 1), which included representatives from TUSI (Technical Support), TUGCO (Operations), Gibbs & Hill (A&E), and Essex (Human Engineering) met to discuss each HED. Each HED was reviewed and its potential effects on plant safety were identified (if any). The Committee then made a decision on the corrective actions to be taken. Responses were developed for those HEDs in which no corrective action would be taken. Any HEDs which required further research and/or review were assigned to one of the Committee members for further investigation and subsequent resolution at a later HED Review Committee meeting.

## 3.4 SURVEYS

### 3.4.1 Control Room Workspace

#### 3.4.1.1 Introduction

The control room workspace design evaluation addressed the physical and the environmental effects on human performance.

#### 3.4.1.2 Objectives

The objectives of this review were to determine the extent to which good human factors engineering design criteria were incorporated into the control room workspace design.

#### 3.4.1.3 Scope

The scope of this review addressed four areas: general layout, workstation design, emergency equipment, and control room environment. Certain features in each of these areas could not be evaluated due to the state of plant construction at the time of the evaluation. The features evaluated are described in the following paragraphs.

#### 3.4.1.3.1 General Layout

Six design characteristics of the general control room layout and equipment arrangement were evaluated. These were:

- o Accessibility of instrumentation and equipment
- o Furniture and equipment layout
- o Document organization and storage
- o Spare parts, operating expendables, and tools
- o Supervisor access
- o Non-essential personnel access.

#### 3.4.1.3.2 Workstation Design

Three workstation design characteristics were evaluated. These were the:

- o Anthropometric dimensions of installed equipment and consoles
- o Use of procedures and other materials at workstations
- o Desk and chair anthropometric dimensions.

#### 3.4.1.3.3 Emergency Equipment

Emergency equipment storage facilities were evaluated based upon engineering design drawings. Actual facilities were not complete during the evaluation. Fire, radiation, rescue and operator protective equipment were not available for evaluation.

#### 3.4.1.3.4 Environment

With the exception of engineering drawings for the personal storage areas and emergency lighting control designs, environmental factors could not be evaluated due to the state of plant construction.

#### 3.4.1.4 Procedures

Procedures used for the workspace evaluation were those outlined in Section 3.3.

### 3.4.2 Communications Survey

#### 3.4.2.1 Introduction

The communications survey studied the ability of the existing and proposed communications systems to provide adequate means for communication of messages and signals to and from the control room.

#### 3.4.2.2 Objectives

The objectives of this survey were to determine the extent to which communication systems were planned and incorporated into the control room design based on human factors engineering design criteria. Human factors design criteria were also used to evaluate the operation of the communication equipment.

#### 3.4.2.3 Scope

a. This survey addressed voice communication systems in the control room such as, conventional-powered telephones, sound-powered telephones, announcing systems, point-to-point intercom systems, and wireless transceivers (e.g., walkie-talkies).

b. The following aspects of the communication system were evaluated:

   - Procedures for handling communications during an emergency
   - Availability of communication to and from strategic work areas
   - Dedication of communication systems for specific purposes
   - Adequate and strategic provisions for communications equipment in the control room.

c. The following communications systems could not be evaluated because they were either not installed or were not complete at the time of the survey:

   - Walkie-talkie radio transceivers
   - Sound-powered telephones
   - Fixed-band VHF transceivers.

#### 3.4.2.4 Procedures

Procedures used for this survey were those outlined in Section 3.3.

### 3.4.3 Annunciator Survey

#### 3.4.3.1 Introduction

The annunciator survey studied the capability of the visual and audible annunciator alarm subsystems to immediately and effectively alert the operator to out-of-tolerance changes in plant conditions.

#### 3.4.3.2 Objectives

The objectives of the survey were to determine the extent to which the annunciator warning system incorporated appropriate human factors engineering criteria to enhance its effectiveness.

### 3.4.3.3 Scope

There were three major subsystems of the annunciator warning system in the CPSES control room: auditory alert, visual alarm, and operator response. The following paragraphs describe the review of these subsystems, both separately and integrally.

#### 3.4.3.3.1 The Auditory Alert Subsystem

This subsystem was evaluated for its auditory characteristics, to ascertain that signals were adequately audible and directional to alert operator attention to the annunciated alarm.

#### 3.4.3.3.2 The Visual Alarm Subsystem

The capability of the visual alarm subsystem to present a clear indication of an out-of-tolerance change was evaluated according to the following factors:

- o Speed and accuracy of locating and identifying annunciated alarm tiles
- o Legibility of annunciator tile message (e.g. character size, consistency of abbreviations and acronyms, and clarity of message)
- o Placement and location of annunciator tiles to enhance visibility and prioritization.

#### 3.4.3.3.3 The Operator Response Subsystem

This subsystem was evaluated to determine its effectiveness as an interface between the operator and the annunciator alarms. The following factors were considered:

- o Response effectiveness (e.g. master silence capability)
- o Procedures to ensure the operability of the response system.

### 3.4.3.4 Procedures

The procedures for the annunciator survey were those outlined in Section 3.3.

## 3.4.4 Controls Survey

### 3.4.4.1 Introduction

The controls survey studied the characteristics of controls for ease of operation and minimization of probability for operator error.

#### 3.4.4.2 Objectives

The objective of the controls survey was to determine the extent to which manually operated controls were designed for adequacy, economy, human suitability, and durability.

#### 3.4.4.3 Scope

The survey covered a variety of controls found in the control room such as, pushbuttons, J-handles, key-operated switches, continuous adjustment rotary controls, rotary selector switches, thumbwheels, slide switches, toggle switches, and rocker switches. The scope of the survey was to evaluate how each control type was suited for its function, how each control type was suited for manipulation by the individuals using them, whether or not controls were identifiable by type and function, and whether or not controls were designed and installed to promote safe and easy operation.

#### 3.4.4.4 Procedures

Procedures for the controls survey were those outlined in Section 3.3.

### 3.4.5 Visual Displays

#### 3.4.5.1 Introduction

The survey of visual displays and coding methods determined if data was presented to the operator in a clear fashion.

#### 3.4.5.2 Objective

The objective of the survey was to determine if visually displayed data was clearly presented so that the operator action elicited would be appropriate and timely.

#### 3.4.5.3 Scope

Each visual display and coding method in the CPSES control room was evaluated.

#### 3.4.5.4 Procedures

Procedures used for surveying visual displays and coding methods were those outlined in Section 3.3.

### 3.4.6 Labels and Location Aids Survey

#### 3.4.6.1 Introduction

The labels and location aids survey studied label readability, location, and consistency in format and abbreviations.

#### 3.4.6.2 Objective

The objective of this survey was to determine the extent to which labels and location aids promoted effective and reliable operations in the control room.

#### 3.4.6.3 Scope

Samples of a variety of labels, and all mimics and demarcation occurring in the control room were evaluated.

#### 3.4.6.4 Procedures

Procedures used for the labels and location aids survey were those outlined in Section 3.3.

### 3.4.7 Panel Layout Survey

#### 3.4.7.1 Introduction

The panel layout survey studied the control/visual display layout on the CPSES control boards.

#### 3.4.7.2 Objective

The objective of this survey was to determine the extent to which controls and visual displays followed the layout conventions established for the CPSES control boards.

#### 3.4.7.3 Scope

This survey addressed each layout on a system-by-system basis for all control boards within the horseshoe, the switchyard panel, the HVAC panels, and the Hot Shutdown Panel. Layouts were evaluated against established CPSES layout conventions including the following:

a. Placement of components by train designation
b. Placement of components by system function
c. Placement of components by sequence of operation.

#### 3.4.7.4 Procedures

Procedures used for the panel layout survey were those outlined in Section 3.3.

### 3.4.8 Control/Display Integration Survey

#### 3.4.8.1 Introduction

The control/display integration survey studied the integration of controls and displays into the panel layout.

#### 3.4.8.2 Objective

The objective of this survey was to evaluate the operational effectiveness of the control/display integration in the panel layout.

#### 3.4.8.3 Scope

This evaluation reviewed each control/display integration in every panel layout. Controls and displays used in the same operation were examined for the appropriateness of relative positioning of controls and displays, and the sufficiency in separation distances for avoiding obstruction or inadvertant activation.

#### 3.4.8.4 Procedures

Procedures used for the control/display integration survey were those outlined in Section 3.3.

# 4.0 RESULTS

## 4.1 INTRODUCTION

This chapter summarizes the results of the CRDR. The detailed results of the review are documented on the HED Summary Sheets in Appendix B. The remaining paragraphs of this section highlight the major discrepancies identified in each survey.

## 4.2 RESULTS

### 4.2.1 Control Room Workspace

#### 4.2.1.1 General

The control room workspace design met or exceeded the majority of the recommended guidelines of section 6.1, NUREG-0700. Planned locations for operators' desks were positioned for good line-of-sight and immediate access to all primary control room areas. General layout of all equipment within the primary operating area met HFE criteria for source requirements. Planned normal lighting appeared adequate for both console and desk activities. The double horseshoe configuration for Units 1 and 2, and the furniture arrangement between the two units appeared to adequately support the control of access to the primary operating area by non-essential personnel. Potential discrepancies were divided into four categories: general layout, work station design, emergency equipment, and environment. These categories are summarized in the following paragraphs and have been recorded on HED Summary Sheets (located in Appendix B, Section 2.0).

#### 4.2.1.2 General Layout

a. The location of the HVAC panels required an operator to leave the primary control area.

b. Page phone cords were non-retractable and lay on the floor during storage and use of the handset.

c. The latest design did not provide storage space for spare parts, operating expendables, or tools.

#### 4.2.1.3 Workstation Design

a. The latest design did not provide storage or use areas at the workstation for procedures and other reference materials.

b. Some displays were located above and below the recommended anthropometric heights for ideal viewing.

c. Some parallax problems were found on the top row of vertical meters.

d. Controls on the transition portion of the control board exceeded recommended maximum reach distances.

e. Some controls were below the minimum recommended height.

#### 4.2.1.4 Emergency Equipment

The latest design did not provide storage areas in the control room for emergency equipment.

#### 4.2.1.5 Environment

The emergency lighting design did not have manual activation/test capability in the control room.

### 4.2.2 Communications Survey

#### 4.2.2.1 General

Results of this survey are based upon the existing communications system at the time of evaluation. Because the system was incomplete, these results may not be representative of discrepancies in an on-line plant. However, these findings may help to reveal potential problems and provide solutions for the existing and projected communications scheme. All identified discrepancies are contained on HED Summary Sheets in Appendix B, Section 3.0.

#### 4.2.2.2 Emergency Procedures

There were no procedures for handling commmunications during an emergency.

#### 4.2.2.3 Dedicated Phone Lines

There was no dedicated phone for emergency calls.

#### 4.2.2.4 Inadequate Communications

a. No communication system existed between the control room and the Technical Support Center.

b. There was no loudspeaker at the Hot Shutdown Panel.

### 4.2.3 Annunciator Survey

#### 4.2.3.1 General

The annunciator warning systems survey determined that there was some potential for masking of auditory alarms by ambient noise, and confusion of responses due to multiple inputs, lack of prioritization, inconsistencies in abbreviations and acronyms, ambigious tile legends, and other problems. Discrepancies were divided into three categories: auditory alert subsystem, visual alarm subsystem, and operator response subsystem. These categories are summarized in the following paragraphs. All identified discrepancies are contained on HED Summary Sheets in Appendix B, Section 4.0.

#### 4.2.3.2 Auditory Alert Subsystem

a. Audible alarms were not discernible over ambient control room noise.

b. Auditory sources were not localized to the specific panel or area which was in the alarm state.

#### 4.2.3.3 Visual Alarm Subsystem

a. No column/row numbering codes were used for identification of individual tiles.

b. Blank annunciators were illuminated.

c. Annunciator tile legends were ambiguous and general.

d. Annunciator tile legends contained inconsistent abbreviations and acronyms.

e. Approximately 1/3 of the viewing distances between the control station and the annunciator tile did not meet recommended guidelines.

f. Failure of annunciator circuitry or bulbs was not immediately apparent.

g. High priority alarms were not distinguishable from low priority alarms.

h. A first out alarm panel did not exist in the control room.

#### 4.2.3.4 Operator Response Subsystem

a. Approximately 1/3 of the alarms in the control room were multiple input alarms.

b. A master silence capability did not exist.

### 4.2.4 Controls Survey

#### 4.2.4.1 General

The majority of the controls were found to be suitable for their applied functions. Discrepancies were divided into three categories: suitability for human manipulation, identifiability, and safety and ease of operation. These categories are summarized in the following paragraphs and have been recorded on HED Summary Sheets located in Appendix B, Section 5.0.

#### 4.2.4.2 Suitability for Human Manipulation

Pushbuttons on process controllers, on counters, on the miniature turbine panel, and on the safety system inoperative indicators were smaller than the required dimensions for best operation.

#### 4.2.4.3 Identifiability

a. J-handle and star-handle pointers did not adequately contrast with their background.

b. Not all controls were labeled.

#### 4.2.4.4 Safety and Ease of Operation

a. Controls lacked mechanisms for prevention against accidental activation.

b. Pushbuttons lacked frictionalized surfaces.

c. Not all controls conformed to established guidelines for direction of movement.

d. Some CMC switches, thumb rotary switches, and vernier controllers lacked pointers.

e. Some J-handle, star-handle, and thumb rotary switches had extraneous switch positions.

### 4.2.5 Visual Displays Survey

#### 4.2.5.1 General

It was found that the majority of visual displays did not pose any significant problems in their presentation of data. Discrepancies were divided into three categories: readability, maintainability, and visual coding. These categories are summarized in the following paragraphs and have been recorded on HED Summary Sheets located in Appendix B, Section 6.0.

#### 4.2.5.2 Readability

The following problems were found in reading displays:

a. Pointers overlapped and obscured meter scales.

b. Pens and scales overlapped and obsured pen traces on some trend recorders.

c. Some vertical meters had elevated zeros.

d. Vertical meters had unequal distances between intermediate marks.

e. Scale gradations did not progress by increments of 1, 2 or 5.

f. Vertical meters had either more than nine gradation marks or no gradation marks between major scale markings, causing precise reading to be difficult.

g. Indicator light luminance was low on process controllers and rotary switches.

h. Ambient lighting caused indicator lights to appear illuminated when they are not.

#### 4.2.5.3 Maintainability

The following problems were found in the maintenance of displays:

a. Special tools were needed to remove and change all indicator lamp holders, transilluminated labels of controls, and annunciator lamps.

b. Lamp failure was not immediately apparent in indicator lights since there was no lamp test capability.

c. Indicator light lenses were interchangeable.

#### 4.2.5.4 Visual Coding

The following problems were found in visual coding methods:

a. Meter nameplates did not have corresponding color coded bezels.

b. Color target indicators on J-handle controls were difficult to differentiate.

c. Color coding in the control room was incomplete and inconsistently applied.

d. Color coding of component train designation was inconsistent.

e. Meter scales had no operating range coding and/or setpoint markings.

f. Coding of multiple scale meters to enhance label-scale associations was not employed.

g. Unfavorable plant equipment status indication was not easily differentiated from other indicator lights.

### 4.2.6 Labels and Location Aids Survey

#### 4.2.6.1 General

Labels and location aids were found to be discrepant in four categories: inconsistent and missing labels, readability, impermanence, and mimics. These categories are summarized in the following paragraphs. HED Summary Sheets for these discrepancies are contained in Appendix B, Section 7.0.

#### 4.2.6.2 Inconsistent and Missing Labels

a. Inconsistencies were found in the abbreviations and acronyms used in some labels.

b. Inconsistencies were found in legends (e.g., components were labeled differently for TRN A and TRN B).

c. Character sizes were not consistent for various hierarchical levels of labeling.

d. Some labeling was missing required information.

e. Label locations were not consistent with the general stereotypes.

#### 4.2.6.3 Readability

Some labeling was found to have poor readability characteristics due to letter crowding, small character sizes, and label orientation.

#### 4.2.6.4 Impermanence

a. Labels were not permanently attached to the component or the control board.

b. Temporary labels were used on controls that covered erroneous permanent labels.

#### 4.2.6.5 Mimics

a. Mimic lines did not terminate at a labeled component or a label.

b. Component symbols on mimics were not always labeled.

### 4.2.7 Process Computer Survey

#### 4.2.7.1 General

In general, the process computer was found to be adequate for its intended function. The identified discrepancies were grouped into three categories: hardware, software, and procedures. These categories are summarized in the following paragraphs. HED Summary Sheets are contained in Appendix B, Section 8.0.

#### 4.2.7.2 Hardware

a. Numeric interface keypad violated numeric sequence convention.

b. CRT lacked graphic display capability.

c. CRT lacked color coding.

d. Line length of CRT legends extended beyond CRT horizontal limits.

#### 4.2.7.3 Software

a. Computer audio alarm was inhibited when operator failed to acknowledge an alarm at printer console.

b. Process computer CRT used 5 x 7 dot matrix.

c. More than 25% of the process computer CRT was activated with information.

d. Backup software was not stored off-site.

#### 4.2.7.4 Procedures

a. Operators were not trained in the use of the process computer.

b. Procedures for loss of process computer did not exist.

### 4.2.8 Panel Layout Survey

#### 4.2.8.1 General

Component location discrepancies identified during this survey are summarized in the following paragraph. HEDs are identified in detail on the HED Summary Sheets in Appendix B, Section 9.0.

#### 4.2.8.2 Component Arrangement

a. Components were not consistently arranged in a sequential operating order such as bottom-to-top or left-to-right.

b. Trains were not arranged consistently.

c. Indicator lights were not arranged in a logically consistent manner.

d. Meters were clustered in numbers of greater than five.

### 4.2.9 Control/Display Integration Survey

#### 4.2.9.1 General

The majority of control/display associations in the control room were found to be well integrated in the panel layout. The distances between operationally related controls and displays was found to be quite sufficient in facilitating multicomponent operations and avoiding obstruction or potential inadvertant activations. The discrepancies identified during this survey are summarized in the following paragraph. HEDs are identified in detail on the HED Summary Sheets in Appendix B, Section 10.0.

#### 4.2.9.2 Component Relative Location

a. Indicator lights and MLBs/TSLBs were not always located directly over their related controls.

b. In some instances, meters were not located directly above their related controls.

c. Controls for one set of annunciators were located on a different panel.

d. The arrangement of meters did not always match the arrangement of associated controls.

e. Some indicator lights, related to controls on the main control board, were located outside of the main control board area.

# 5.0 BACKFITS

## 5.1 INTRODUCTION

The purpose of this chapter is to briefly summarize the significant backfits which were implemented to resolve the HEDs described in Chapter 4.0.

## 5.2 BACKFITS

### 5.2.1 Control Room Workspace

#### 5.2.1.1 General

A total of 34 HEDs were written against the control room workspace. Of these, 20 HEDs have been or will be resolved with backfits. The remaining 14 HEDs require no backfit action.

#### 5.2.1.2 Backfits

A summary of the significant backfits for the control room workspace HEDs is given below. Specific HED resolutions are contained on the HED Summary Sheets in Appendix B, Section 2.0.

a. Parallax and glare caused by poor viewing angle will be eliminated to the extent feasible given the existing control board physical constraints.

b. Unit 1 control board construction has been completed.

c. Page phone cords will be modified to eliminate a tripping hazard.

d. Storage areas will be provided for essential reference materials, emergency equipment, spare parts, operating expenditures, and tools.

### 5.2.2 Communications

#### 5.2.2.1 General

A total of 7 HEDs were written against the communications system. All 7 HEDs have been or will be resolved with backfits.

#### 5.2.2.2 Backfits

A summary of the significant backfits for the communications system HEDs is given below. Specific HED resolutions are contained on the HED Summary Sheets in Appendix B, Section 3.0.

a. The page phone system will be prioritized with a dedicated channel to handle emergency communications.

b. A procedure will be provided for handling communications during an emergency.

c. All required communication links to the control room will be provided.

d. A page phone has been installed at the HVAC panels.

### 5.2.3 Annunciator

#### 5.2.3.1 General

A total of 29 HEDs were written against the annunciator system. Of these, 22 HEDs have been or will be resolved with backfits. The remaining 7 HEDs require no backfit action.

#### 5.2.3.2 Backfits

The Annunciator Human Engineering Specification in Appendix C provided the guidelines which were used to resolve annunciator system HEDs. A summary of the significant backfits for these HEDs is given below. Specific HED resolutions are contained on the HED Summary Sheets in Appendix B, Section 4.0.

a. Alarms will be visually prioritized.

b. A first-out panel will be provided.

c. Legends will be modified to be clear and unambiguous.

d. Auditory alarms will be localized.

e. Master silence capability will be provided.

f. When required for timely operator response, some multiple input alarms will be broken up into single input alarms.

g. Alarms not presently above their related controls will be moved.

### 5.2.4 Controls

#### 5.2.4.1 General

A total of 42 HEDs were written against the control room controls. Of these, 29 have been or will be resolved with backfits. The remaining 13 HEDs require no backfit action.

#### 5.2.4.2 Backfits

A summary of the significant backfits for the control room controls HEDs is given below. Specific HED resolutions are contained in the HED Summary Sheets in Appendix B, Section 5.0.

a. Mechanisms will be provided to prevent accidental activation of critical function pushbuttons and controls located near the panel edge.

b. Emergency controls will be coded with red handles.

c. Some control switches will be modified to conform to established direction-of-movement conventions.

d. Extraneous switch positions will be eliminated.

e. Control switches will be coded to identify switch function and switch operation.

### 5.2.5 Visual Displays

#### 5.2.5.1 General

A total of 99 HEDs were written against visual displays in the control room. Of these, 63 HEDs have been or will be resolved with backfits. The remaining 36 HEDs require no backfit action.

#### 5.2.5.2 Backfits

The Vertical Indicator Human Engineering Specification in Appendix D provided the guidelines which were used to resolve vertical indicator HEDs. A summary of the significant backfits for these and for the rest of the visual display HEDs is given below. Specific HED resolutions are contained on the HED Summary Sheets in Appendix B, Section 6.0.

a. Vertical indicator scales will be modified to improve readability.

b. Vertical indicator scale numbering will be made consistent.

### 5.2.7 Process Computer

#### 5.2.7.1 General

A total of 12 HEDs were written against the process computer used in the control room. Of these, 6 HEDs will be resolved with backfits. The remaining 6 HEDs require no backfit action.

#### 5.2.7.2 Backfits

A summary of the significant backfits for the process computer HEDs is given below. Specific HED resolutions are contained on the HED Summary Sheets in Appendix B, Section 8.0.

a. An ERF/SPDS computer will be installed for use in the control room. This computer will provide expanded analytical and display capabilities to complement the existing process computer.

b. Operators will be trained in the use of the process computer.

c. Backup software will be stored off-site.

### 5.2.8 Panel Layout and Control/Display Integration

#### 5.2.8.1 General

A total of 45 HEDs were written against the control room panel layout and control/display integration. Of these, 39 HEDs have been or will be resolved with backfits. The remaining 6 HEDs require no backfit action.

#### 5.2.8.2 Backfits

The control boards were redesigned by the CRDR team to correct panel layout and control/display integration problems. Each system layout was assessed for logical, operationally useful component arrangements. Discrepant arrangements were corrected to achieve a more suitable human factors design. A total of approximately 1600 components were moved in this redesign effort. Specific HED resolutions are contained in the HED Summary Sheets in Appendix B, Sections 9.0 and 10.0.

# 6.0 INCOMPLETE TASKS

## 6.1 INTRODUCTION

Certain portions of the CPSES detailed CRDR could not be performed due to the state of control room construction or procedure development. These portions are itemized below and explained in the subsequent paragraphs.

a. Noise, lighting, and environmental surveys.

b. System function/task analysis.

## 6.2 NOISE, LIGHTING, AND ENVIRONMENTAL SURVEYS

As stated in Chapter 1.0, the CPSES control room houses the control boards for both units. Until such time as control room construction is complete, the results of any noise, lighting, and environmental surveys would be inconclusive due to the effects of construction on control room noise, lighting, and environment. Control room construction is scheduled for completion after Unit 1 fuel load. At that time, noise, lighting, and environmental surveys will be performed for the control room.

## 6.3 SYSTEM ANALYSIS

Verification of CPSES emergency procedures developed from the Westinghouse Owners' Group Emergency Response Guidelines (ERGs) is the basis by which the system analysis will be conducted for the CRDR. The emergency procedures will be verified by flow chart review, table-top review, and control room walk-throughs. The control room walk-throughs will be structured to assure tasks defined in the procedures can be accomplished with the minimum shift complement at the main control board. Documentation of this verification will be filed with the emergency procedures generation package.

# APPENDIX A

## HED ORGANIZATION
## AND
## CROSS REFERENCES

## HED ORGANIZATION

A total of 334 HEDs were identified as a result of the preliminary Control Room Design Review, the NRC preliminary audit, and the detailed Control Room Design Review, forming the basis for this report. Documentation control of HEDs was accomplished by assigning a sequential control number to each HED.

The HEDs were organized in sections according to the sections set forth in the Control Room Human Engineering Guidelines in NUREG-0700. To assist in accessing a particular HED within this organization, two types of cross references have been created. As shown in Table A-1, a HED can be located by cross-referencing to its section. Table A-2 provides the information needed to locate any or all HEDs produced from any of the surveys, to access all HEDs assigned to a given prioritization category, and to identify any or all HEDs that have, will or will not be backfitted. In addition, each HED section in Appendix B has a cross reference giving the same information as Table A-2.

## TABLE A-1. HED CROSS REFERENCE BY SECTION

| HED CONTROL NO. | APPENDIX B SECTION: 2.0 WORKSPACE | 3.0 COMMUNI-CATIONS | 4.0 ANNUNCIATORS | 5.0 CONTROLS | 6.0 VISUAL DISPLAYS | 7.0 LABELING & LOCATION AIDS | 8.0 PROCESS COMPUTER | 9.0 PANEL LAYOUT | 10.0 CONTROL/DISPLAY INTEGRATION |
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| 258 | | | | | | | | | 25 |
| 259 | | | | | 259 | | | | |
| 260 | | | | | 260 | | | | |
| 261 | | | | | 261 | | | | |
| 262 | | | | | 262 | | | | |
| 263 | | | | | 263 | | | | |
| 264 | | | | | | | | | 26 |
| 265 | | | | | 265 | | | | |
| 266 | | | | | 266 | | | | |
| 267 | | | | | 267 | | | | |
| 268 | | | | | 268 | | | | |
| 269 | | | | | 269 | | | | |
| 270 | | | | | 270 | | | | |
| 271 | | | | 271 | | | | | |
| 272 | | | | 272 | | | | | |
| 273 | | | | 273 | | | | | |
| 274 | | | | 274 | | | | | |
| 275 | | | | 275 | | | | | |
| 276 | | | | | | | | 276 | |
| 277 | | | | 277 | | | | | |
| 278 | 278 | | | | | | | | |
| 279 | 279 | | | | | | | | |
| 280 | 280 | | | | | | | | |
| 281 | 281 | | | | | | | | |
| 282 | | | | | | | | 282 | |
| 283 | | | | | | | | 283 | |
| 284 | | | | | | | | 284 | |
| 285 | | | | | | | | 285 | |
| 286 | | | | | | | | 286 | |
| 287 | | | | | | | | 287 | |
| 288 | | | | | | | | | 288 |

| HED CONTROL NO. | APPENDIX B SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2.0 WORKSPACE | 3.0 COMMUNI-CATIONS | 4.0 ANNUNCIATORS | 5.0 CONTROLS | 6.0 VISUAL DISPLAYS | 7.0 LABELING & LOCATION AIDS | 8.0 PROCESS COMPUTER | 9.0 PANEL LAYOUT | 10.0 CONTROL/ DISPLAY INTEGRATION |
| 289 | | | | 289 | | | | | |
| 290 | | | | 290 | | | | | |
| 291 | | | | | 291 | | | | |
| 292 | | | | | 292 | | | | |
| 293 | | | | | 293 | | | | |
| 294 | | | | | 294 | | | | |
| 295 | | | | | 295 | | | | |
| 296 | 296 | | | | | | | | |
| 297 | | | | | | | | | 297 |
| 298 | | | | | 298 | | | | |
| 299 | | | | | | 299 | | | |
| 300 | | | | | | 300 | | | |
| 301 | | | | | | 301 | | | |
| 302 | | | | | 302 | | | | |
| 303 | | | | 303 | | | | | |
| 304 | | | | | | 304 | | | |
| 305 | | | | | | 305 | | | |
| 306 | | | 306 | | | | | | |
| 307 | | | 307 | | | | | | |
| 308 | | | 308 | | | | | | |
| 309 | | | 309 | | | | | | |
| 310 | | | 310 | | | | | | |
| 311 | | | 311 | | | | | | |
| 312 | | | 312 | | | | | | |
| 313 | | | 313 | | | | | | |
| 314 | | | 314 | | | | | | |
| 315 | | | 315 | | | | | | |
| 316 | | | 316 | | | | | | |
| 317 | | | 317 | | | | | | |
| 318 | | | 318 | | | | | | |
| 319 | | | 319 | | | | | | |
| 320 | | | 320 | | | | | | |
| 321 | | | 321 | | | | | | |
| 322 | | | 322 | | | | | | |
| 323 | | | 323 | | | | | | |
| 324 | | | 324 | | | | | | |

| HED CONTROL NO. | APPENDIX B SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2.0 WORKSPACE | 3.0 COMMUNI-CATIONS | 4.0 ANNUNCIATORS | 5.0 CONTROLS | 6.0 VISUAL DISPLAYS | 7.0 LABELING & LOCATION AIDS | 8.0 PROCESS COMPUTER | 9.0 PANEL LAYOUT | 10.0 CONTROL DISPLAY INTEGRATI |
| 325 | | | | | 325 | | | | |
| 326 | | | | | 326 | | | | |
| 327 | | | | | 327 | | | | |
| 328 | | | | | | 328 | | | |
| 329 | | | 329 | | | | | | |
| 330 | | | 330 | | | | | | |
| 331 | | | | | | 331 | | | |
| 332 | | | | | | | 332 | | |
| 333 | | | | | | | 333 | | |
| 334 | | | | | | | 334 | | |

## TABLE A-2. HED CROSS REFERENCE BY SURVEY AND DISPOSITION

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 1 | 1 | | | | X |
| 2 | 1 | | | X | |
| 3 | 1 | | | X | |
| 4 | 1 | | | X | |
| 5 | 1 | | | X | |
| 6 | 1 | | | X | |
| 7 | 1 | | | X | |
| 8 | 1 | | | | X |
| 9 | 1 | | | X | |
| 10 | 1 | | | X | |
| 11 | 1 | | | X | |
| 12 | 1 | | | X | |
| 13 | 1 | | | | X |
| 14 | 1 | | | X | |
| 15 | 1 | | | X | |
| 16 | 1 | | | X | |
| 17 | 1 | | | | X |
| 18 | 1 | | | X | |
| 19 | 2 | | | X | |
| 20 | 2 | | | X | |
| 21 | 2 | | | X | |
| 23 | 2 | | | X | |
| 24 | 2 | | | X | |
| 25 | 2 | | | X | |
| 26 | 2 | | | X | |
| 27 | 2 | | | X | |
| 28 | 2 | | | X | |
| 29 | 2 | | | X | |
| 30 | 2 | | | X | |
| 31 | 2 | | | X | |
| 32 | 2 | | | | X |
| 33 | 2 | | | X | |
| 34 | 2 | | | X | |
| 35 | 2 | | | | X |
| 36 | 2 | | | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 37 | 2 | | | | X |
| 38 | 3 | | | X | |
| 39 | 3 | | | | X |
| 40 | 3 | | | | X |
| 41 | 3 | | | | X |
| 42 | 3 | | | X | |
| 43 | 3 | | | | X |
| 44 | 3 | | | | X |
| 45 | 3 | | | | X |
| 46 | 3 | | | | X |
| 47 | 3 | | | | X |
| 48 | 3 | | | X | |
| 49 | 3 | | | X | |
| 50 | 3 | | | | X |
| 51 | 3 | | | | X |
| 52 | 3 | | | | X |
| 53 | 3 | | | | X |
| 54 | 4 | | | X | |
| 55 | 4 | | | | X |
| 56 | 4 | | | X | |
| 57 | 4 | | | X | |
| 58 | 4 | | | X | |
| 59 | 4 | | | X | |
| 60 | 4 | | | X | |
| 61 | 4 | | | X | |
| 62 | 4 | | | X | |
| 63 | 4 | | | | X |
| 64 | 1 | 1 | | X | |
| 65 | 1 | 1 | | X | |
| 66 | 1 | 1 | | X | |
| 67 | 1 | 1 | | X | |
| 68 | 1 | 1 | | X | |
| 69 | 1 | 1 | | X | |
| 70 | 1 | 1 | | X | |
| 71 | 1 | 1 | | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 72 | 1 | 1 | | X | |
| 73 | 1 | 2 | | | X |
| 74 | 1 | 2 | | X | |
| 75 | 1 | 2 | | X | |
| 76 | 1 | 2 | | X | |
| 77 | 1 | 2 | | X | |
| 78 | 1 | 2 | | | X |
| 79 | 1 | 2 | | X | |
| 80 | 2 | 1 | | X | |
| 81 | 2 | 2 | | | X |
| 82 | 2 | 2 | | X | |
| 83 | 2 | 2 | | X | X |
| 84 | 2 | 2 | | X | |
| 85 | 2 | 2 | | X | |
| 86 | 2 | 2 | | X | |
| 87 | 2 | 3 | | X | |
| 88 | 3 | 1 | | X | |
| 89 | 3 | 1 | | | X |
| 90 | 3 | 3 | | X | |
| 91 | 3 | 3 | | X | |
| 92 | 4 | 1 | | X | |
| 93 | | 1 | | X | |
| 94 | | 1 | | X | |
| 95 | | 1 | | X | |
| 96 | | 1 | | X | |
| 97 | | 1 | | X | |
| 98 | | 1 | | X | |
| 99 | | 1 | | X | |
| 100 | | 1 | | X | |
| 101 | | 1 | | X | |
| 102 | | 1 | | X | |
| 103 | | 1 | | X | |
| 104 | | 1 | | X | |
| 105 | | 1 | | X | |
| 106 | | 1 | | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 107 | | 1 | | | X |
| 108 | | 1 | | X | |
| 109 | | 1 | | | X |
| 110 | | 1 | | | X |
| 111 | | 1 | | | X |
| 112 | | 1 | | X | |
| 113 | | 1 | | X | |
| 114 | | 1 | | X | |
| 115 | | 1 | | X | |
| 116 | | 1 | | | X |
| 117 | | 1 | | X | |
| 118 | | 1 | | X | |
| 119 | | 1 | | X | |
| 120 | | 1 | | | |
| 121 | | 1 | | X | |
| 122 | | 1 | | X | |
| 123 | | 1 | | X | |
| 124 | | 1 | | X | |
| 125 | | 1 | | X | |
| 126 | | 1 | | | X |
| 127 | | 1 | | X | |
| 128 | | 1 | | X | |
| 129 | | 1 | | X | |
| 130 | | 1 | | X | |
| 131 | | 1 | | X | |
| 132 | | 1 | | X | |
| 133 | | 1 | | X | |
| 134 | | 2 | | X | |
| 135 | | 2 | | | X |
| 136 | | 2 | | X | |
| 137 | | 2 | | X | |
| 138 | | 2 | | X | |
| 139 | | 2 | | X | |
| 140 | | 2 | | | X |
| 141 | | 2 | | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 142 | | 2 | | X | |
| 143 | | 2 | | | X |
| 144 | | 2 | | | X |
| 145 | | 2 | | X | |
| 146 | | 2 | | | X |
| 147 | | 2 | | X | |
| 148 | | 2 | | X | |
| 149 | | 2 | | | X |
| 150 | | 2 | | X | |
| 151 | | 2 | | | X |
| 152 | | 2 | | X | |
| 153 | | 2 | | X | |
| 154 | | 2 | | X | |
| 155 | | 2 | | X | |
| 156 | | 2 | | | X |
| 157 | | 2 | | | X |
| 158 | | 2 | | X | |
| 159 | | 2 | | X | |
| 160 | | 2 | | X | |
| 161 | | 2 | | | X |
| 162 | | 2 | | | X |
| 163 | | 3 | | X | |
| 164 | | 3 | | X | |
| 165 | | 3 | | | X |
| 166 | | 3 | | X | |
| 167 | | 3 | | | X |
| 168 | | 3 | | | X |
| 169 | | 3 | | | X |
| 170 | | 3 | | X | |
| 171 | | 3 | | X | |
| 172 | | 3 | | X | |
| 173 | | 3 | | X | |
| 174 | | 3 | | | X |
| 175 | | 3 | | X | |
| 176 | | 3 | | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 177 | | 3 | | | X |
| 178 | | | X | X | |
| 179 | | | X | X | |
| 180 | | | X | X | |
| 181 | | | X | X | |
| 182 | | | X | X | |
| 183 | | | X | | X |
| 184 | | | X | X | |
| 185 | | | X | | X |
| 186 | | | X | X | |
| 187 | | | X | X | |
| 188 | | | X | X | |
| 189 | | | X | | X |
| 190 | | | X | X | |
| 191 | | | X | X | |
| 192 | | | X | X | |
| 193 | | | X | | X |
| 194 | | | X | X | |
| 195 | | | X | X | |
| 196 | | | X | X | |
| 197 | | | X | X | |
| 198 | | | X | X | |
| 199 | | | X | X | |
| 200 | | | X | X | |
| 201 | | | X | X | |
| 202 | | | X | X | |
| 203 | | | X | X | |
| 204 | | | X | X | |
| 205 | | | X | X | |
| 206 | | | X | X | |
| 207 | | | X | | X |
| 208 | | | X | | X |
| 209 | | | X | | X |
| 210 | | | X | | X |
| 211 | | | X | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 212 | | | X | X | |
| 213 | | | X | X | |
| 214 | | | X | | X |
| 215 | | | X | X | |
| 216 | | | X | X | |
| 217 | | | X | X | |
| 218 | | | X | X | |
| 219 | | | X | X | |
| 220 | | | X | X | |
| 221 | | | X | X | |
| 222 | | | X | X | |
| 223 | | | X | X | |
| 224 | | | X | | X |
| 225 | | | X | X | |
| 226 | | | X | X | |
| 227 | | | X | X | |
| 228 | | | X | | X |
| 229 | | | X | | X |
| 230 | | | X | X | |
| 231 | | | X | X | |
| 232 | | | X | X | |
| 233 | | | X | X | |
| 234 | | | X | | X |
| 235 | | | X | X | |
| 236 | | | X | X | |
| 237 | | | X | X | |
| 238 | | | X | | X |
| 239 | | | X | X | |
| 240 | | | X | X | |
| 241 | | | X | | X |
| 242 | | | X | | X |
| 243 | | | X | | X |
| 244 | | | X | X | |
| 245 | | | X | | X |
| 246 | | | X | | X |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 247 | | | X | | X |
| 248 | | | X | X | |
| 249 | | | X | | X |
| 250 | | | X | X | |
| 251 | | | X | | X |
| 252 | | | X | X | |
| 253 | | | X | X | |
| 254 | | | X | X | |
| 255 | | | X | X | |
| 256 | | | X | X | |
| 257 | | | X | X | |
| 258 | | | X | X | |
| 259 | | | X | X | |
| 260 | | | X | X | |
| 261 | | | X | X | |
| 262 | | | X | X | |
| 263 | | | X | X | |
| 264 | | | X | | X |
| 265 | | | X | | X |
| 266 | | | X | | X |
| 267 | | | X | | X |
| 268 | | | X | X | |
| 269 | | | X | X | |
| 270 | | | X | X | |
| 271 | | | X | X | |
| 272 | | | X | | X |
| 273 | | | X | | X |
| 274 | | | X | X | |
| 275 | | | X | | X |
| 276 | | | X | X | |
| 277 | | | X | | X |
| 278 | | | X | X | |
| 279 | | | X | X | |
| 280 | | | X | | X |
| 281 | | | X | | X |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 282 | | | X | X | |
| 283 | | | X | X | |
| 284 | | | X | X | |
| 285 | | | X | X | |
| 286 | | | X | X | |
| 287 | | | X | X | |
| 288 | | | X | | X |
| 289 | | | X | X | |
| 290 | | | X | X | |
| 291 | | | X | | X |
| 292 | | | X | X | |
| 293 | | | X | X | |
| 294 | | | X | X | |
| 295 | | | X | | X |
| 296 | | | X | | X |
| 297 | | | X | X | |
| 298 | | | X | X | |
| 299 | | | X | X | |
| 300 | | | X | X | |
| 301 | | | X | X | |
| 302 | | | X | | X |
| 303 | | | X | X | |
| 304 | | | X | X | |
| 305 | | | X | X | |
| 306 | | | X | X | |
| 307 | | | X | X | |
| 308 | | | X | | X |
| 309 | | | X | X | |
| 310 | | | X | | X |
| 311 | | | X | | X |
| 312 | | | X | X | |
| 313 | | | X | X | |
| 314 | | | X | | X |
| 315 | | | X | X | |
| 316 | | | X | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 317 | | | X | X | |
| 318 | | | X | X | |
| 319 | | | X | X | |
| 320 | | | X | X | |
| 321 | | | X | X | |
| 322 | | | X | X | |
| 323 | | | X | X | |
| 324 | | | X | X | |
| 325 | | | X | | X |
| 326 | | | X | X | |
| 327 | | | X | X | |
| 328 | | | X | X | |
| 329 | | | X | | X |
| 330 | | | X | | X |
| 331 | | | X | X | |
| 332 | | | X | | X |
| 333 | | | X | | X |
| 334 | | | X | X | |

# APPENDIX B

# HED SUMMARIES

TABLE OF CONTENTS

# 1.0 INTRODUCTION

This section summarizes each HED identified in the preliminary Control Room Design Review (CRDR), NRC preliminary audit, and the detailed Control Room Design Review (CRDR). This section does not describe in detail the discrepant components or their backfits, which can be found in the HED filing system located at the plant.

# 2.0 WORKSPACE HEDS

## WORKSPACE HED CROSS REFERENCE

| HED CONTROL No. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 1 | 1 | | | | X |
| 9 | 1 | | | X | |
| 42 | 3 | | | X | |
| 44 | 3 | | | | X |
| 45 | 3 | | | | X |
| 46 | 3 | | | | X |
| 59 | 4 | | | X | |
| 68 | 1 | 1 | | X | |
| 70 | 1 | 1 | | X | |
| 73 | 1 | 2 | | | X |
| 77 | 1 | 2 | | X | |
| 78 | 1 | 2 | | | X |
| 87 | 2 | 3 | | X | |
| 108 | | 1 | | X | |
| 109 | | 1 | | | X |
| 110 | | 1 | | | X |
| 111 | | 1 | | | X |
| 112 | | 1 | | X | |
| 122 | | 1 | | X | |
| 131 | | 1 | | X | |
| 153 | | 2 | | X | |
| 154 | | 2 | | X | |
| 155 | | 2 | | X | |
| 156 | | 2 | | | X |
| 166 | | 3 | | X | |
| 167 | | 3 | | | X |
| 170 | | 3 | | X | |
| 171 | | 3 | | X | |
| 175 | | 3 | | X | |
| 278 | | | X | X | |
| 279 | | | X | X | |
| 280 | | | X | | X |
| 281 | | | X | | X |
| 296 | | | X | | X |

A. HED DESCRIPTION

MLB lamp tests are not accessible to 50th percentile operators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.b.(1).

C. LOCATION

CB-01, CB-02, and CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Inability to detect MLB failures.

E. ASSESSMENT PROCESS

1. Feasibility of relocating lamp tests was examined.
2. Alternative locations were evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   CPSES realizes the need to be able to test the MLB lamps from a location accessible to the fifth percentile operator, however, in view of the possibility to compromise plant safety with such an extensive change, we do not feel it is justified.

A. HED DESCRIPTION

Distance between HVAC panels is too small.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.3.f.2.

C. LOCATION

CV-01 and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Measurements were taken.

F. BACKFIT

None.

1. JUSTIFICATION

Partial administrative control will be established to restrict casual traffic in this area.

A. HED DESCRIPTION

The location of semi-circular turbine meters and rod counters results in excessive amounts of glare.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.f.

C. LOCATION

CB-07 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Improper turbine control-unit shutdown.

E. ASSESSMENT PROCESS

Glare was assessed to determine its impact on display readability.

F. BACKFIT

Glare on the semi-circular turbine meters and the rod counters will be reduced to improve readability of the displayed information.

A. HED DESCRIPTION

An operator must exit the main control room horseshoe to access the HVAC panels. Positive monitoring and status checking would become erratic and tenuous.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.1.b.

C. LOCATION

CV-01 and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Improper HVAC operation.

E. ASSESSMENT PROCESS

Situations when an RO or SRO must exit the main control area were identified.

F. BACKFIT

None.

1. JUSTIFICATION

The minimum staffing requirements, as outlined in the CPSES Operations Department Administrative procedures (ODAs), provide for adequate operating personnel to operate the HVAC panels when the reactor is in manual control.

A. HED DESCRIPTION

The control room has several traffic obstructions (the PRODAC and drawing layout table) which obstruct traffic flow between portions of the control boards.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.3.c.1.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

   The drawing layout table is temporary and will be replaced with permanent furniture. The PRODAC is essential to the operator for information retrieval and as such is located with similar readout devices. Location of the PRODAC does not significantly impede operator mobility.

A. HED DESCRIPTION

The Shift Supervisor's desk does not permit visual access to main control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.6.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Reviewed applicable FSAR commitment.

F. BACKFIT

None.

1. JUSTIFICATION

As stated in Operating Procedure ODA-102, Step 4.3, the control room will have an SRO and RO to monitor activities.

A. HED DESCRIPTION

Temporary control room ventilation presents white noise, which could degrade communications as well as mask alarms and communications signals.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.5.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The effects of noise on control room operations could not be evaluated due to the state of control room construction. Noise surveys will be conducted and appropriate backfits made after control room construction is complete.

A. HED DESCRIPTION

No storage space has been allocated for essential material.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.4.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Loss or delay in acquiring supplies or procedures.

E. ASSESSMENT PROCESS

Original control room floor plans were reviewed.

F. BACKFIT

Essential material and documentation is stored in the file and chart supply rooms as indicated on the control room layout drawing. A movable cart has been provided for storage of emergency procedures.

A. HED DESCRIPTION

Protective equipment for operating personnel is not provided.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.4.1.d.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Personal injury.

E. ASSESSMENT PROCESS

Present available protective equipment was assessed.

F. BACKFIT

Protective equipment will be provided.

A. HED DESCRIPTION

Controls located on the transition section of the control boards are not easily accessible to the 5th percentile operator.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.b.(1).

C. LOCATION

CB-01 through CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in operating controls.

E. ASSESSMENT PROCESS

Examined effect on operability.

F. BACKFIT

None.

1. JUSTIFICATION

   The controls are located in the most operationally useful and effective layout on the control boards.

A. HED DESCRIPTION

A conduit protrudes through the control room floor near PRODAC, posing a tripping hazard.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.3.c.(1).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Personnel injury.

E. ASSESSMENT PROCESS

Original plans for conduit penetrations were reviewed.

F. BACKFIT

A CRT will be installed over these protrusions.

A. HED DESCRIPTION

Readability is hampered by poor viewing angle and by position of numerals with respect to the display surface. This problem occurs on the rod step counters and on some circular meters.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.e.

C. LOCATION

CB-07 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper plant parameter control.
2. Possible shutdown.

E. ASSESSMENT PROCESS

Alternative solutions to improving the readability of the counters were evaluated for their feasibility of implementation.

F. BACKFIT

None.

1. JUSTIFICATION

   Parallax that exists on these circular meters caused by poor viewing angle is not significant due to the nature of the displays.

A. HED DESCRIPTION

Parallax effect is created by top row of vertical meters on the control board.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.b.(1).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Misreading various indicators.

E. ASSESSMENT PROCESS

Examined effect upon operability.

F. BACKFIT

The displays requiring improved readability were moved to minimize the effect of parallax on operations.

A. HED DESCRIPTION

HVAC panel not installed.

B. GUIDELINE REFERENCE

None.

C. LOCATION

CV-01 and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

N/A

E. ASSESSMENT PROCESS

None.

F. BACKFIT

HVAC panel has been installed.

A. HED DESCRIPTION

Incomplete evaluation of control room maintenance/housekeeping.

B. GUIDELINE REFERENCE

None.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

None.

1. JUSTIFICATION

Control room maintenance/housekeeping is not an evaluation criterion of NUREG-0700.

A. HED DESCRIPTION

Emergency AC and DC lighting systems are not operable. Lighting for some areas is not installed and lighting surveys were not completed.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.4.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

None.

1. JUSTIFICATION

The emergency AC/DC lighting systems will be evaluated when construction has been completed. Backfits will be made as necessary.

A. HED DESCRIPTION

Conclusive NRC sound level surveys were not performed.

B. GUIDELINE REFERENCE

None.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

None.

1. JUSTIFICATION

The effects of noise on control room operators could not be evaluated due to the state of control room construction. Noise surveys will be conducted and appropriate backfits made after control room construction is complete.

A. HED DESCRIPTION

The HVAC, Radiation Monitoring, Meteorological, and Nuclear Instrumentation System Panels were not completed at the time of the NRC audit.

B. GUIDELINE REFERENCE

None.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A

E. ASSESSMENT PROCESS

None.

F. BACKFIT

These panels have been installed.

A. HED DESCRIPTION

The Hot Shutdown Panel is in the process of complete redesign.

B. GUIDELINE REFERENCE

None.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Construction on the Hot Shutdown Panel has been completed. The HFE evaluation has been performed and backfits implemented as necessary.

A. HED DESCRIPTION

Operators serve as switchboard operators during night shift hours.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.2.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Security department will handle incoming phone calls to the plant at night when the plant becomes operational. Only pertinent calls will be transferred to the control room.

HED CONTROL NO. 153

A. HED DESCRIPTION

Page phone cords present tripping hazard.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.3.c.(1).

C. LOCATION

CB-02, CB-04, CB-07, CB-10, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

Personal injury.

E. ASSESSMENT PROCESS

Researched the design of page phones used in other plants.

F. BACKFIT

Page phone cords will be modified so that they no longer present a tripping hazard.

A. HED DESCRIPTION

Recorder glass causes glare, thereby hampering readability of scale indicators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.f.

C. LOCATION

All panels except CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed in or incorrect data interpretation.

E. ASSESSMENT PROCESS

Various alternatives to reduce or eliminate glare were evaluated.

F. BACKFIT

Glare on the recorder glass will be reduced to improve the readability of displayed information.

A. HED DESCRIPTION

Toggle switches located below recommended 34-inch minimum height.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.a.(1).

C. LOCATION

In-core instrumentation panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Situations requiring operator interface with these switches were reviewed.

F. BACKFIT

These toggle switches were used to select an InCore thermocouple for monitoring on the P2500 computer. With the new Core Cooling Monitoring (CCM) design, these toggle switches are bypassed. The CCM selects the highest thermocouple reading and displays it automatically on the Core Exit Temperature meter located on CB-05.

A. HED DESCRIPTION

Infrequently operated controls located above 70-inches maximum height from floor.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.a.(1).

C. LOCATION

In-core instrumentation panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Situations involving requiring interface with these switches were reviewed.

F. BACKFIT

None.

1. JUSTIFICATION

CPSES realizes the advantages of having these controls located lower than 70 inches above the floor. However, the extensive modifications that would be needed to move these controls to a more accessible location does not, in CPSES opinion, warrant the convenience on a panel that is infrequently operated.

A. HED DESCRIPTION

Controls are too high (above 74 inches) and too low (24 inches) for easy access. Recorders are too low (below 41 inches) for easy visibility.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.a.(1) and b.(1).

C. LOCATION

Radiation Monitoring Panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The Radiation Monitoring Panel has been redesigned to correct control & display location problems.

A. HED DESCRIPTION

Frequently operated controls are located too high.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.a.(1).

C. LOCATION

CV-01 and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Reviewed operational requirements.
2. Reviewed feasibility of moving controls.

F. BACKFı

None.

1. JUSTIFICATION

CV-01: These controls are operated only during normal, nonemergency conditions and are, therefore, required to be less than 70 inches from the floor, which they are.

CV-03: Even though these controls are located above the recommended maximum height for emergency controls, they are located in the best possible arrangement for the existing panel configuration. The operability of these controls by the operating staff is not hindered.

A. HED DESCRIPTION

Controllers/rod step counter lenses reflect undiffused light from ceiling grid, thereby causing glare.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.f.

C. LOCATION

CB-04, CB-05, CB-06, CB-07, CB-08, CB-09, and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper rod control or power relief operation
2. Causing possible Reactor shutdown.

E. ASSESSMENT PROCESS

Various alternatives to reduce or eliminate glare were evaluated.

F. BACKFIT

Glare on the controllers/rod step counter lenses will be reduced to improve readability of displayed information.

A. HED DESCRIPTION

Glare hampers readability of PRODAC.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.f.

C. LOCATION

Printer console.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect or delayed data interpretation.

E. ASSESSMENT PROCESS

Various alternatives to reduce or eliminate glare were evaluated.

F. BACKFIT

Glare on PRODAC will be reduced to improve readability of displayed information.

A. HED DESCRIPTION

The top row of annunciator tiles is above the recommended 84-inch maximum height above floor.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.e.(1) (a).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to identify annunciators.

E. ASSESSMENT PROCESS

The readability of the top row of tiles was evaluated and situations requiring operator interface reviewed.

F. BACKFIT

The top row of annunciators can be easily read in the normal operating/viewing positions. A stepladder will be provided for maintenance. The ladder will be designed so that an operator cannot place his foot on the control board without a strained effort.

A. HED DESCRIPTION

Displays are located above the maximum allowable height (70 inches) for displays used in normal operation.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.b.(1).

C. LOCATION

CB-01, CB-02, CB-03, CB-04, CB-05, CB-06, CB-08, CB-09, CB-11, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Inability to read displays to the desired accuracy.

E. ASSESSMENT PROCESS

1. Reviewed feasibility of moving displays.
2. Reviewed potential consequences of being unable to read displays to the desired accuracy.

F. BACKFIT

Those displays requiring improved readability were moved to where the readability is sufficient for normal operations.

A. HED DESCRIPTION

Displays are located above maximum allowable height (66 inches) for displays that are read precisely and frequently and are safety related.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.b.(2).

C. LOCATION

CB-02, CB-03, and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Inability to read displays to the desired accuracy.
2. Delay in reading displays.

E. ASSESSMENT PROCESS

1. Reviewed feasibility of moving displays.
2. Reviewed potential consequences of being unable to read displays to the desired accuracy.

F. BACKFIT

The displays have been placed where the readability is sufficient for precise and frequent readings.

A. HED DESCRIPTION

Displays are located below required minimum allowable height (41 inches) for displays used in normal operation.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.b.(1).

C. LOCATION

CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

Inability or delay in reading displays.

E. ASSESSMENT PROCESS

Reviewed operation requirements.

F. BACKFIT

None.

1. JUSTIFICATION

   Information on these trend recorders and indicator lights is used infrequently and is not critical to safe operation.

A. HED DESCRIPTION

Controls are below minimum allowable height (34 inches) for controls used in normal operation.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.b.(1).

C. LOCATION

CV-03 and CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect operation of controls.
2. Failure to operate controls.

E. ASSESSMENT PROCESS

1. Reviewed feasibility of moving controls.
2. Evaluated potential long-term continuous or frequent operational requirements.

F. BACKFIT

None.

1. JUSTIFICATION

   The controls have no long-term continuous or frequent operational requirements.

A. HED DESCRIPTION

Controls violate anthropometric maximum and minimum requirements of distance from the control board edge.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.d.(1) and (2).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Inadvertent control actuation.

E. ASSESSMENT PROCESS

Potential backfits were investigated.

F. BACKFIT

None.

1. JUSTIFICATION

   The controls are located in the most operationally useful and effective layout on the control boards.

# 3.0 COMMUNICATIONS HEDS

## COMMUNICATIONS HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 10 | 1 | | | X | |
| 71 | 1 | 1 | | X | |
| 117 | | 1 | | X | |
| 118 | | 1 | | X | |
| 119 | | 1 | | X | |
| 120 | | 1 | | X | |
| 121 | | 1 | | X | |

A. HED DESCRIPTION

Page phone channels are shared, leading to potential competition for communication.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.6.f.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Lost communiques.
2. Possible failure to avert problems.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The page phone system will be prioritized with a dedicated channel to handle emergency communications.

A. HED DESCRIPTION

Inadequate provisions for communication between HVAC panel and main control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.8.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in or incorrect HVAC operation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A page phone has been installed at the HVAC panels.

A. HED DESCRIPTION

Lack of emergency communications procedure.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.1.c.

C. LOCATION

Procedures.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A procedure will be provided for handling communications during an emergency.

A. HED DESCRIPTION

Presently, there is only one outside phone in the control room. There is no dedicated phone for NRC hotline, state or local authorities, or NRC operations center.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.8.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

Requirements for communications in the control room were assessed.

F. BACKFIT

All required communication links to the control room will be provided.

A. HED DESCRIPTION

No communication link between control room and Technical Support Center.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.7.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A communication link will be added.

A. HED DESCRIPTION

Sound-powered jack communications are incomplete.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.3.b.(6).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

The sound-powered jack communications were re-evaluated.

F. BACKFIT

Sound-powered jack communications have been completed.

A. HED DESCRIPTION

There is no loudspeaker at the Hot Shutdown Panel.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.6.a.(2).

C. LOCATION

Remote Shutdown Cabinet.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

The layout design of the Remote Shutdown Panel was reviewed to incorporate a Gaitronics.

F. BACKFIT

A speaker will be provided for communications at the Hot Shutdown Panel.

# 4.0 ANNUNCIATORS HEDS

## ANNUNCIATORS HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 2 | 1 | | | X | |
| 3 | 1 | | | X | |
| 15 | 1 | | | X | |
| 58 | 4 | | | X | |
| 74 | 1 | 2 | | X | |
| 79 | 1 | 2 | | X | |
| 91 | 3 | 3 | | X | |
| 144 | | 2 | | | X |
| 306 | | | X | X | |
| 307 | | | X | X | |
| 308 | | | X | | X |
| 309 | | | X | X | |
| 310 | | | X | | X |
| 311 | | | X | | X |
| 312 | | | X | X | |
| 313 | | | X | X | |
| 314 | | | X | | X |
| 315 | | | X | X | |
| 316 | | | X | X | |
| 317 | | | X | X | |
| 318 | | | X | X | |
| 319 | | | X | X | |
| 320 | | | X | X | |
| 321 | | | X | X | |
| 322 | | | X | X | |
| 323 | | | X | X | |
| 324 | | | X | X | |
| 329 | | | X | | X |
| 330 | | | X | | X |

A. HED DESCRIPTION

Due to annunciator nomenclature not being abbreviated, the acceptable number of characters within the space provided is exceeded. Visual angle is also below acceptable standards, due to the small character size.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.1.b.(2).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to respond to alarm.
2. Plant shutdown or equipment damage.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Annunciator legends will be abbreviated to provide more space and, therefore, allow larger characters.

A. HED DESCRIPTION

Annunciator alarms are not visually prioritized.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.1.4.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delay in responding to alarms.
2. Failure to respond to more serious alarms.

E. ASSESSMENT PROCESS

Visual prioritization of alarms was examined in a specialized study.

F. BACKFIT

The annunciator alarms will be visually prioritized.

A. HED DESCRIPTION

Auditory alarms are not localized.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.2.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to locate alarms.

E. ASSESSMENT PROCESS

Alternative solutions were evaluated.

F. BACKFIT

Auditory alarms will be localized as specified in the Annunciator Guidelines (Appendix C).

A. HED DESCRIPTION

There is no master silence control for annunciators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.4.1.a.(2).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Failure or delay in silencing audible results in making additional alarms.

E. ASSESSMENT PROCESS

1. Alternative solutions were generated.
2. Alternative solutions and system capability were assessed.

F. BACKFIT

Annunciator logic will modified such that any alarm within the horseshoe will be able to be silenced at any annunciator silence pushbutton within the horseshoe. The HVAC and switchyard alarms will be silenced at their respective locations.

A. HED DESCRIPTION

Annunciators are not located above related controls/displays.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.1.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in responding to alarms.

E. ASSESSMENT PROCESS

The relocation of annunciators in the control room was examined in a specialized study.

F. BACKFIT

Annunciators will be rearranged so that they are located above their related systems and components.

A. HED DESCRIPTION

No first out panel is located in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.1.3.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in accident response.

E. ASSESSMENT PROCESS

1. Alarms to be incorporated in a first out annunciator panel were determined.
2. The location for the first out annunciator panel was determined.

F. BACKFIT

A first out panel has been installed on CB-07 in the position of annunciator matrix 1-ALB-6C.

A. HED DESCRIPTION

Inconsistent annunciator pushbutton arrangements across panels.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.4.2.

C. LOCATION

CB-12 and CV-01.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to observe alarm.
2. Possible plant shutdown.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Annunciator pushbutton configurations on the CV-01 and CB-12 will be changed to match the configurations on other panels.

A. HED DESCRIPTION

The CONTAINMENT HI PRESSURE annunciator tile is located on CB-02 rather than above its related meter on CB-03.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.1.a.

C. LOCATION

CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to detect high containment pressure.

E. ASSESSMENT PROCESS

Feasibility of relocating annunciator was examined.

F. BACKFIT

None.

1. JUSTIFICATION

Due to the number of alarms associated with systems whose controls/displays are on CB-03, it was necessary to "spill over" into annunciator boxes on adjacent panels. In doing so, alarms were kept as close as practicable to their associated controls/displays. Since the indications for CNTMT PRESS are at the far left of CB-03, the CNTMT PRESS HI annunciator tile ended up on the right of CB-02. To move it would mean displacing another annunciator tile to a position even more remote from its associated control/display. The location of the CNTMT PRESS HI annunciator tile on CB-02 is in close proximity to the related display on CB-03.

A. HED DESCRIPTION

Multiple input alarms exist.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.1.2.c.(1) and 6.3.3.4.a.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in locating problems.

E. ASSESSMENT PROCESS

1. Examined each multiple input alarm to assure that sufficient information existed to determine which input was in alarm state.
2. Analyzed effect of delayed response caused by multiple input alarm.

F. BACKFIT

Where necessary for expedient operator response, multiple input alarms will be separated into individual alarms.

A. HED DESCRIPTION

Shared alarms are duplicated in each control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.1.2.d.(1) and (2)

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to react to alarm.

E. ASSESSMENT PROCESS

Alternatives were assessed to improve operator response to alarms.

F. BACKFIT

Alarm response procedures will address how the operator will respond to these shared alarms.

A. HED DESCRIPTION

Audible alarms are not discernible over ambient control room noise.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.1.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

Cannot be evaluated due to the incomplete nature of the control room.

F. BACKFIT

None.

1. JUSTIFICATION

The effects of noise on control room operations could not be evaluated due to the state of control room construction. Noise surveys will be conducted and appropriate backfits made after control room construction is complete.

A. HED DESCRIPTION

Alarm signal intensity, frequency, and tone is easily adjusted.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.1.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to detect or recognize audible alarms.

E. ASSESSMENT PROCESS

Preventive measures are being examined.

F. BACKFIT

Administrative controls have been implement d to prevent unauthorized adjustment of audible alarm signals.

A. HED DESCRIPTION

The ability of an alarm to capture the operator's attention could not be evaluated.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.1.c.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

Cannot be evaluated due to the incomplete nature of the control room.

F. BACKFIT

None.

1. JUSTIFICATION

The effects of noise on control room operations could not be evaluated due to the state of control room construction. Noise surveys will be conducted and appropriate backfits made after control room construction is complete.

A. HED DESCRIPTION

Alarm detection levels could not be evaluated.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.1.d.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

Cannot be evaluated at this time due to the incomplete state of the control room.

F. BACKFIT

None.

1. JUSTIFICATION

The effects of noise on control room operations could not be evaluated due to the state of control room construction. Noise surveys will be conducted and appropriate backfits made after control room construction is complete.

A. HED DESCRIPTION

No provision for auditory coding.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.2.a.(1) and (2).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

1. Auditory signal capability was assessed.
2. Auditory coding schemes were generated and examined.

F. BACKFIT

Auditory coding will be implemented as described in the Annunciator Guidelines (Appendix C).

A. HED DESCRIPTION

Columns and rows of annunciator matrices are not labeled for identification of individual tiles.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.3.c.(1) and (2).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

Alternative solutions were evaluated.

F. BACKFIT

Numbers will be added to black borders of matrix for coding.

A. HED DESCRIPTION

There are more than fifty alarm tiles per matrix.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.3.d.(1).

C. LOCATION

CB-03, CB-06, CB-07, CB-08, CB-09, CB-10, and CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Difficulty in finding, identifying, and responding to alarms.

E. ASSESSMENT PROCESS

Alternative solutions were examined for feasibility and effectiveness.

F. BACKFIT

None.

1. JUSTIFICATION

   Engineering constraints dictate the use of more than fifty tiles in these matrices. Prioritization and rearrangement will decrease the visual search time required for response to a particular alarm.

A. HED DESCRIPTION

When the lamp drive transistor fails on the cards, the lamp box fails OFF. If there is a failure in the control card (which controls the flash rate for individual alarms), it will also fail OFF.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.2.c.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to identify problems.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A full functional annunciator test will be performed daily.

HED CONTROL NO. 316

A. HED DESCRIPTION

Extended duration of annunciator illumination.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.2.f.(1) and (2).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Administrative procedures will be implemented to control this problem.

A. HED DESCRIPTION

Blank annunciator tiles are illuminated.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.3.f.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Unused tiles will be de-energized, but will be illuminated during testing.

A. HED DESCRIPTION

Annunciator tile legends are not specific.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.4.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to understand or correct problem.

E. ASSESSMENT PROCESS

A readability survey was performed.

F. BACKFIT

The legends have been reviewed and will be rewritten, as necessary, to make the message clear and understandable.

A. HED DESCRIPTION

Inconsistent use of abbreviations on annunciator tile legends.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.4.d.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to understand or correct problem.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Abbreviations in annunciator tile legends have been made consistent through the use of a dictionary of standard abbreviations and acronyms.

A. HED DESCRIPTION

Present character height does not subtend a visual angle of 15 minutes of arc.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.5.a.(1).

C. LOCATION

All annunciators.

D. POTENTIAL SAFETY CONSEQUENCES

Inability to read message.

E. ASSESSMENT PROCESS

1. Defined constraints.
2. Analyzed character heights mathematically.

F. BACKFIT

Annunciator legend character height will be modified as specified in the Annunciator Guidelines (Appendix C).

A. HED DESCRIPTION

Annunciator character sizes are inconsistent.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.5.a.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Misreading alarm messages.

E. ASSESSMENT PROCESS

1. Defined constraints.
2. Analyzed character heights mathematically.

F. BACKFIT

Annunciator legend character height will be modified as specified in the Annunciator Guidelines (Appendix C).

A. HED DESCRIPTION

Annunciator character width-to-height ratios vary.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.5.a.(1), 6.3.3.5.d.(2), (3), (4), (5) and (6)

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Misreading alarm messages.

E. ASSESSMENT PROCESS

1. Defined constraints.
2. Analyzed character heights mathematically.

F. BACKFIT

Annunciator legend character height will be modified as specified in the Annunciator Guidelines (Appendix C).

A. HED DESCRIPTION

Lack of strong administrative procedures governing testing of annunciators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.4.1.d.(2) and 6.3.4.2.c.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to detect alarm failure.

E. ASSESSMENT PROCESS

1. The need to test annunciators was assessed.
2. The methods by which annunciators could be tested were assessed.

F. BACKFIT

Administrative procedures will be implemented for the testing of annunciators.

HED CONTROL NO. 324

A. HED DESCRIPTION

Failure of annunciator circuitry or bulbs is not immediately apparent.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-2.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to receive alarm message.

E. ASSESSMENT PROCESS

Methods by which annunciator bulbs and circuitry could be tested were assessed.

F. BACKFIT

Periodic testing procedures will be implemented to ensure that annunciator bulbs and circuitry are always functioning properly.

A. HED DESCRIPTION

Nuisance alarms.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.1.2.a.1.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

Due to the incomplete state of the control room this HED cannot be evaluated at this time.

F. BACKFIT

None.

1. JUSTIFICATION

   If any alarms prove to be unnecessary or nuisance alarms during normal operations, then procedures will be implemented to ensure the overriding of such alarms by an operator initiated action.

A. HED DESCRIPTION

Setpoints are such that operators have enough time to respond to a condition before it could result in serious problems.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.1.2.a.(2).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

Due to the incomplete state of the control room this HED cannot be evaluated at this time.

F. BACKFIT

None.

1. JUSTIFICATION

If setpoints prove to be inadequate for timely operator response during normal operations, then procedures will be implemented to ensure readjustment of setpoints to proper levels.

# 5.0 CONTROLS HEDS

# CONTROLS HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 12 | 1 | | | X | |
| 16 | 1 | | | X | |
| 26 | 2 | | | X | |
| 27 | 2 | | | X | |
| 28 | 2 | | | X | |
| 38 | 3 | | | X | |
| 50 | 3 | | | | X |
| 51 | 3 | | | | X |
| 82 | 2 | 2 | | X | |
| 93 | | 1 | | X | |
| 124 | | 1 | | X | |
| 127 | | 1 | | X | |
| 157 | | 2 | | | X |
| 161 | | 2 | | | X |
| 162 | | 2 | | | X |
| 169 | | 3 | | | X |
| 172 | | 3 | | X | |
| 174 | | 3 | | | X |
| 180 | | | X | X | |
| 183 | | | X | X | |
| 212 | | | X | X | |
| 213 | | | X | X | |
| 214 | | | X | | X |
| 217 | | | X | X | |
| 218 | | | X | X | |
| 219 | | | X | X | |
| 220 | | | X | X | |
| 221 | | | X | X | |
| 222 | | | X | X | |
| 223 | | | X | X | |
| 224 | | | X | | X |
| 226 | | | X | X | |
| 244 | | | X | X | |
| 271 | | | X | X | |
| 272 | | | X | | X |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 273 | | | X | | X |
| 274 | | | X | X | |
| 275 | | | X | | X |
| 277 | | | X | | X |
| 289 | | | X | X | |
| 290 | | | X | X | |
| 303 | | | X | X | |

A. HED DESCRIPTION

J-handle switches located near panel edge are not provided with protection against accidental activiation.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.2.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Inadvertent control actuation.

E. ASSESSMENT PROCESS

1. All panels with controls near edges were identified.
2. Various guard designs were evaluated for their impact on the operability of the controls.

F. BACKFIT

Guards will be installed on all J-handle switches located near the panel edge.

A. HED DESCRIPTION

Reactor trip switches are not coded to stand out from other components.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.

C. LOCATION

CB-07 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in Reactor trip.

E. ASSESSMENT PROCESS

The use of color coding for controls in the control room was reviewed.

F. BACKFIT

The Reactor Trip and the Reactor Trip/Close switches will be provided with red handles and red background.

A. HED DESCRIPTION

Rod control startup pushbutton has no protection against accidental activitation.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.2.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper rod control.
2. Possible Reactor shutdown could occur.

E. ASSESSMENT PROCESS

1. Safety consequences of accidential activation were identified.
2. Various guarding devices were reviewed.

F. BACKFIT

A guard will be provided.

A. HED DESCRIPTION

Control switches violate direction of movement convention (e.g., AUTO is counter-clockwise and CLOSE is clockwise) and control positions are inconsistent across controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-03 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper control operation.
2. Loss of sampling capacity.
3. Loss of main steam relief heating steam.

E. ASSESSMENT PROCESS

Feasibility of modifying switch positions was assessed.

F. BACKFIT

Control positions will be changed to CLOSE-AUTO and CLOSE-NEUTRAL.

A. HED DESCRIPTION

Different switch types are used for valve controls - different plant equipment (i.e., pumps, valves) operated by J-handles.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.d.

C. LOCATION

CB-08 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect system operation.
2. Loss of feedwater could result in possible plant shutdown.

E. ASSESSMENT PROCESS

1. Reviewed feasibility of shape coding.
2. Reviewed feasibility of symbol coding.

F. BACKFIT

J-handles valve controls will be coded to differentiate them from J-handle pump controls.

A. HED DESCRIPTION

Key-operated controls do not have OFF at "12 o'clock" position and key teeth do not point up when inserting key.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.3.b.

C. LOCATION

CB-02, CB-04, and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper valve alignment.
2. Loss of SI flow.

E. ASSESSMENT PROCESS

Feasibility of equipment modification was investigated.

F. BACKFIT

The switch will be rotated so the OFF position is at "12 o'clock." Although "teeth down" is contrary to guidelines, it is more important to satisfy the requirement of consistency of teeth direction.

A. HED DESCRIPTION

Distances between star-handle switch positions do not meet minimum separation requirements.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.5.d.(2).

C. LOCATION

CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Potential consequences of selection error were evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   Ammeter selector switches have no safety significance if any inadvertent error is made; therefore, star-handled controls will remain in present configuration.

A. HED DESCRIPTION

Continuous adjustment rotary controls on Hagan controllers do not meet recommended size specifications causing obstruction of vernier scales on knob skirts when adjustments are being made.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.4.e.

C. LOCATION

CB-04, CB-06, CB-08, and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Information sources for operation were identified.

F. BACKFIT

None.

1. JUSTIFICATION

   Vernier scales are not used. Feedback is provided through the process variable indication.

A. HED DESCRIPTION

Violation of control direction of movement convention. Control setting is increased with counter-clockwise movement instead of clockwise movement of switch.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-04, CB-06, CB-08, and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect control operation.
2. Loss of Residual Heat Removal, Auxiliary Feedwater, charging.

E. ASSESSMENT PROCESS

The feasibility of modifying equipment electronics was reviewed.

F. BACKFIT

Controller electronics will be modified so that a clockwise adjustment of the controller setting will open the valve. Position indication has been modified to display 0-100% open.

A. HED DESCRIPTION

No control coding is currently being used for:

a. Mechanical valves, pumps, breakers, motors, etc.

b. Throttle valves.

c. Emergency or critical controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.

C. LOCATION

CB-08 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

Improper control actuation.

E. ASSESSMENT PROCESS

1. Reviewed various forms of coding, including shape, size, and symbology coding.
2. Estimated effectiveness of using labeling to contain information, differentiating types of components.
3. Assessed symbology coding as the most effective and feasible means of denoting various types of components.

F. BACKFIT

Control switches will be coded.

A. HED DESCRIPTION

Emergency or critical controls not guarded.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.2.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Inadvertent control actuation.

E. ASSESSMENT PROCESS

1. All emergency or critical controls were identified.
2. Various guard designs were evaluated for their impact on the operability of the controls.

F. BACKFIT

1. Guards will be installed on all critical-function pushbuttons.
2. Emergency J-handle controls will not be guarded since the implementation of guards would mean that these controls would require two hands to operate. Two-handed operation of emergency J-handle controls located on the transition section of the control boards would be awkward. Furthermore, all emergency J-handle controls are located in a position on the control boards that would make inadvertent actuation highly unlikely in view of the amount of torque required to operate them.

A. HED DESCRIPTION

A "reverse convention" is used for the thermal regeneration system bypass flow controller.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of equipment modification was evaluated.

F. BACKFIT

The "reverse convention" of the BTRS will be corrected.

A. HED DESCRIPTION

Violation of control direction of movement; i.e., control direction of movement is reversed.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect rod movement.
2. Possible shutdown.

E. ASSESSMENT PROCESS

1. The upward motion of the control rods was compared to the downward motion of the control rod movement lever.
2. The feasibility of reversing the lever direction of motion for the outward control rod movement out was ascertained.

F. BACKFIT

None.

1. JUSTIFICATION

   The present configuration of the Full Length Rod Motion (FLRM) control switch is acceptable from the standpoint that when the operator uses the switch, he is thinking in terms of the motion of the control rods. Although the NUREG-0700 guidelines do not address a population stereotype for the control movements associated with insertion and withdrawal, it stands to reason that "forward" is best for insertion (IN) and "backward" is best for withdrawal (OUT).

A. HED DESCRIPTION

Continuous adjustment rotary control knobs are uncomfortable and fatiguing if held in the contact position for a long time.

B. GUIDELINE REFERENCE

NUREG/CR-1580: CON-37.

C. LOCATION

CB-02 and CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Function of switches were reviewed.
2. Electrical schematic drawings were reviewed to verify seal-in circuits.

F. BACKFIT

None.

1. JUSTIFICATION

Momentary position CMC switches need not be held in the contact position for the duration of valve travel. Momentary contacts are designed to seal-in until the valve has travelled to the position selected.

A. HED DESCRIPTION

Reactor trip J-handles move counterclockwise fcr trip, whereas other J-handle controls move clockwise for actuation.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-10 and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Reviewed control room "TRIP" direction of actuation.

F. BACKFIT

None.

1. JUSTIFICATION

   Reactor trip control switches are so designed to be consistent with all other "TRIP" controls in the control room which move CCW to trip.

A. HED DESCRIPTION

CMC switches stop between detented positions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.5.b.2.

C. LOCATION

CB-02 and CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect SI valve alignment.
2. Loss of SI flow.

E. ASSESSMENT PROCESS

Incorrect positioning of these switches was investigated.

F. BACKFIT

None.

1. JUSTIFICATION

These CMC switches can only be stopped between positions with a concentrated effort to do so. It is very unlikely to occur accidentally.

A. HED DESCRIPTION

There is no coding or visual enhancement for controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect control/display association.
2. Improper control actuation.

E. ASSESSMENT PROCESS

The applicability of various types of visual enhancements were examined.

F. BACKFIT

Controls will be coded and visually enhanced.

A. HED DESCRIPTION

The Reactor trip J-handle is not a single function, momentary contact switch to perform the unique trip function.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to trip Reactor.

E. ASSESSMENT PROCESS

1. Reviewed design considerations.
2. Investigated feasibility of equipment modification.

F. BACKFIT

None.

1. JUSTIFICATION

   The Reactor Trip switch is so designed to preclude the use of interposing auxiliary relays which are prone to failure. All contacts required for reactor trip interlocks are contained within the mechanical "gangs" of the Reactor Trip switch. Because of the number of contacts required (and hence the number of gangs), a J-handle switch was implemented. A pushbutton is not suitable in this application since a pushbutton cannot be obtained with the required amount of contacts. Furthermore, in view of the amount of interlocks contained on the Reactor Trip switch in its present configuration, redesign of this function to a pushbutton actuation has the potential to compromise safety.

A. HED DESCRIPTION

Thumb rotary switches are missing the red dot, indicating the switch position.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.5.d.2.

C. LOCATION

CB-01, CB-03, CB-06, and CV-01.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Red dots will be provided.

A. HED DESCRIPTION

The color coding of pushbuttons on the miniature turbine control panel and on the process controllers is indiscriminant.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.f.

C. LOCATION

CB-01, CB-04, CB-05, CB-06, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Color coding of process controller pushbuttons is consistently red. The function of the pushbutton color coding on the miniature turbine control panel is clear and unambiguous.

A. HED DESCRIPTION

J-handle switches are used for a single function, momentary contact switch.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.b.

C. LOCATION

CB-07 and CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in safety actuation.

E. ASSESSMENT PROCESS

1. The functions of the switches were reviewed.
2. The labeling necessary to convey these functions was determined.

F. BACKFIT

The center position will be labeled "NORMAL" and the left switch position mark will be removed.

A. HED DESCRIPTION

Four J-handles have the "TRIP" position on the right side instead of the left.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.b.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. The function of the "TRIP" position was determined.
2. The appropriateness of the "TRIP" label was evaluated.

F. BACKFIT

The word "TRIP" does not convey the actual function of the switch position. "TRIP" will be changed to a more appropriate word.

A. HED DESCRIPTION

A rotary control with clockwise-counterclockwise movement is used to control a "lower" and "raise" function.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1 a. or 6.4.2.1.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Diesel Generator shutdown from incorrect voltage control.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

A design convention for J-handles has been established with "raise" on left and "lower" on right for volt adjustment controls on the electrical distribution panel.

A. HED DESCRIPTION

The "OFF" and "CLOSE" switch positions do not follow placement conventions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1. a. and b.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Appropriate locations of these switch positions for the switch functions have been reviewed.

F. BACKFIT

Switches will be replaced with 2-position switches with "CLOSE" in the center position and "OPEN" in the clockwise position.

A. HED DESCRIPTION

The J-handle "AUTO" position is mislabeled as "CONTROL." The "CLOSE" position violates the position location convention; i.e., is incorrectly placed on the right, instead of the left.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

Isolation of feedwater resulting in Reactor shutdown.

E. ASSESSMENT PROCESS

1. Analyze function of switch.
2. Analyze hardware limitations.

F. BACKFIT

These switches will be replaced with switches that have "CLOSE" in the counterclockwise position and "AUTO" in the center position.

A. HED DESCRIPTION

The "OFF" position of synchronizing switches is inconsistent with the location of other "OFF" positions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The function of the unmarked position was determined.

F. BACKFIT

The switches are two-position; the center and clockwise positions are active. The counterclockwise position is inactive and will be removed from the switch escutcheon.

A. HED DESCRIPTION

The Condenser Exhaust Vacuum pumps have unconventional locations for the "STANDBY" and "OFF" switch positions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Improper operation of vacuum pumps.

E. ASSESSMENT PROCESS

Switches were reviewed to see if the "STANDBY" position can be moved to the center switch position and if more appropriate labeling should be used.

F. BACKFIT

Switch configurations will be changed to OFF-STANDBY-ON maintained positions to conform to the established control room convention.

A. HED DESCRIPTION

OPEN and CLOSE pushbuttons on the Cutler-Hammer pushbutton modules are in unconventional locations. The OPEN pushbutton should be on the right under the red indicator light and the CLOSE pushbutton should be on the left under the GREEN indicator light.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to operate valves correctly.

E. ASSESSMENT PROCESS

Pushbuttons were examined to determine if positions could be altered without adverse consequence to their intended operation.

F. BACKFIT

These pushbutton modules will be changed to match other Cutler-Hammer pushbutton configurations.

A. HED DESCRIPTION

Use of diverse pushbutton configurations for similar valve control applications.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.3.1.a. and c. or 6.4.1.2.a. or 6.4.2.2.a. and b.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect or improper control operation.

E. ASSESSMENT PROCESS

Pushbuttons were examined to determine if positions could be altered without adverse consequence to their intended operation.

F. BACKFIT

These pushbutton configurations will be changed to match other Cutler-Hammer pushbutton configurations.

A. HED DESCRIPTION

Pushbuttons that are unlabeled and not functional are identical in appearance to other, functional pushbuttons on Cutler-Hammer pushbutton modules.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.b.(1) or 6.5.1.1.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control operation.

E. ASSESSMENT PROCESS

Methods to identify functional and nonfunctional pushbuttons were assessed.

F. BACKFIT

These pushbutton modules will be replaced with modules that have no non-functional pushbuttons.

A. HED DESCRIPTION

Pushbuttons/indicators on process controllers are not readily identifiable as controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.d.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The pushbuttons have the same function on each process controller, and are manipulated in a similar manner. Therefore, the existence, operation, and function of the pushbuttons should be learned rapidly.

A. HED DESCRIPTION

Setpoint knob covers on process controllers can be easily removed.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.e.(3).

C. LOCATION

CB-04, CB-05, CB-06, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Damage to equipment.

E. ASSESSMENT PROCESS

The "removability" of the knob covers was evaluated.

F. BACKFIT

Setpoint knob covers will be permanently attached.

A. HED DESCRIPTION

The association between control and related display is not immediately apparent, i.e., the meaning of coding of selector switch and pointer on trend recorder is not obvious.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.f.(2).

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of color coding was reviewed.

F. BACKFIT

Color coding will be added to the recorder selector switch positions on switch escutcheon.

A. HED DESCRIPTION

There are no switch plates or escutcheons on two star-handles.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.c.1.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect breaker operation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Switch escutcheons will be provided for these switches.

A. HED DESCRIPTION

Pushbutton surfaces are not highly frictionalized and concave.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.3.1.c.

C. LOCATION

CB-01 through CB-12, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Consequences of delayed operation were evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

Any delays in operation of pushbuttons resulting from non-frictionalized or non-concave pushbuttons are minimal. Operators have encountered no problems with slippage to date.

A. HED DESCRIPTION

Pushbuttons on process controllers, trend recorders, LED counters, the miniature turbine control panel, and the safety system inoperative indicators are smaller than the required dimensions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.3.2.

C. LOCATION

CB-02, CB-03, CB-04, CB-05, CB-06, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

There are no consequences if the pushbuttons are missed and immediate feedback is given if an operator fails to operate them. The pushbuttons on the miniature turbine panel measure approximately .25 inches in diameter (.125 inches undersized). This is not considered to be significantly undersized for this particular arrangement and application.

A. HED DESCRIPTION

J-handles are shorter than the minimum 3.75 inches required in the guidelines.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.2.a.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay or failure to trip Reactor.

E. ASSESSMENT PROCESS

Torque requirements of J-handles were determined.

F. BACKFIT

Requirements have been established to ensure that high torque J-handles, will conform to optimum size required by 0700, which is 4 inches in length, although the minimum required length of 3.75 inches could be used. The only identified J-handles with high torque requirements are the Reactor trip switch. All other J-handles are medium to low torque, which allows for the presently smaller sized handles.

A. HED DESCRIPTION

The thumbwheels on the BA BLDR Counter and the TOTAL MU Counter are below the required minimum depth dimension of .125 inches.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.5.1.d.(2).

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The operational requirements for speed and accuracy were determined.

F. BACKFIT

None.

1. JUSTIFICATION

These thumbwheels are sufficient for their intended functions. No consequences of misoperation result since feedback exists through the adjacent counters.

A. HED DESCRIPTION

Reactor trip-close switch has two positions or functions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to trip Reactor when required.
2. Inadvertent Reactor Trip.

E. ASSESSMENT PROCESS

1. Identified consequences of selecting wrong function.
2. Reviewed feasibility of creating two switches, each with one of the functions.
3. Reviewed cost-effectiveness of creating two switches.

F. BACKFIT

None.

1. JUSTIFICATION

The "Reactor Trip/Close" switch is provided with two positions to allow the operator to trip or reclose the reactor trip breaker. If the operator fails to trip the reactor by operating the "Reactor Trip/Close" switch to the "CLOSE" position, feedback will be immediate through the indications provided in close proximity (e.g., the rod bottom lights).

A. HED DESCRIPTION

Pushbuttons have the same design as annunciator pushbuttons, rather than the conventional design employed elsewhere in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Pushbuttons were examined to determine methods to identify their functions and to distinguish them from annunciator pushbuttons.

F. BACKFIT

Annunciator control stations will be painted yellow to distinguish them from other pushbutton controls.

A. HED DESCRIPTION

Different switch designs are used for select functions rather than one common design.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.c.(1) and (2).

C. LOCATION

CB-05 and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delay in selection.
2. Poss. Pressurizer Control Problem.

E. ASSESSMENT PROCESS

1. Reviewed consequences of delay in selection.
2. Examined feasibility of changing all select switches to star-handled configurations.

F. BACKFIT

J-handle and star handle switches used for select functions will be changed to T-handle switches. Thumb rotary switches used for select functions are identifiable through their associated demarcation and/or labeling. Delays in selection that may occur with these switches do not have any safety-related consequences.

A. HED DESCRIPTION

The PR SMPL SYS TRA and TRB ISOL MSTR VLV switches have "AUTO" and "CLOSE" positions located on the left and right, respectively. This is unconventional for the design of switch positions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.3.

C. LOCATION

CB-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The switch design was examined for possible solutions that would maintain the integrity of its function.

F. BACKFIT

Control positions on these switches will be changed to CLOSE-LOCAL with CLOSE to the left of center and LOCAL to the right of center.

# 6.0 VISUAL DISPLAYS HEDS

## VISUAL DISPLAYS HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 8 | 1 | | | | X |
| 11 | 1 | | | X | |
| 13 | 1 | | | | X |
| 14 | 1 | | | X | |
| 17 | 1 | | | | X |
| 29 | 2 | | | X | |
| 30 | 2 | | | X | |
| 31 | 2 | | | X | |
| 32 | 2 | | | | X |
| 39 | 3 | | | | X |
| 40 | 3 | | | | X |
| 41 | 3 | | | | X |
| 43 | 3 | | | | X |
| 47 | 3 | | | | X |
| 48 | 3 | | | X | |
| 52 | 3 | | | | X |
| 53 | 3 | | | | X |
| 57 | 4 | | | X | |
| 60 | 4 | | | X | |
| 61 | 4 | | | X | |
| 62 | 4 | | | X | |
| 63 | 4 | | | | X |
| 72 | 1 | 1 | | X | |
| 80 | 2 | 1 | | X | |
| 81 | 2 | 2 | | | X |
| 83 | 2 | 2 | | X | |
| 85 | 2 | 2 | | X | |
| 88 | 3 | 1 | | X | |
| 89 | 3 | 1 | | | X |
| 94 | | 1 | | | X |
| 96 | | 1 | | | X |
| 102 | | 1 | | | X |
| 113 | | 1 | | X | |
| 114 | | 1 | | X | |
| 123 | | 1 | | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 126 | | 1 | | | X |
| 128 | | 1 | | X | |
| 129 | | 1 | | X | |
| 132 | | 1 | | X | |
| 133 | | 1 | | X | |
| 158 | | 2 | | X | |
| 173 | | 3 | | X | |
| 176 | | 3 | | X | |
| 178 | | | X | X | |
| 179 | | | X | X | |
| 181 | | | X | X | |
| 184 | | | X | X | |
| 185 | | | X | | X |
| 195 | | | X | X | |
| 197 | | | X | X | |
| 198 | | | X | X | |
| 199 | | | X | X | |
| 201 | | | X | X | |
| 202 | | | X | X | |
| 203 | | | X | X | |
| 227 | | | X | X | |
| 229 | | | X | | X |
| 230 | | | X | X | |
| 231 | | | X | X | |
| 232 | | | X | X | |
| 233 | | | X | X | |
| 234 | | | X | | X |
| 235 | | | X | X | |
| 236 | | | X | X | |
| 237 | | | X | X | |
| 238 | | | X | | X |
| 240 | | | X | X | |
| 241 | | | X | | X |
| 242 | | | X | | X |
| 243 | | | X | | X |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 245 | | | X | | X |
| 246 | | | X | | X |
| 247 | | | X | | X |
| 248 | | | X | X | |
| 249 | | | X | | X |
| 250 | | | X | X | |
| 251 | | | X | | X |
| 259 | | | X | X | |
| 260 | | | X | X | |
| 261 | | | X | X | |
| 262 | | | X | X | |
| 263 | | | X | X | |
| 265 | | | X | | X |
| 266 | | | X | | X |
| 267 | | | X | | X |
| 268 | | | X | X | |
| 269 | | | X | X | |
| 270 | | | X | X | |
| 291 | | | X | | X |
| 292 | | | X | X | |
| 293 | | | X | X | |
| 294 | | | X | X | |
| 295 | | | X | | X |
| 298 | | | X | X | |
| 302 | | | X | | X |
| 325 | | | X | | X |
| 326 | | | X | X | |
| 327 | | | X | X | |

A. HED DESCRIPTION

If rod control lever is held down, the step counters will continue to advance beyond 228 steps after the control rods are entirely out.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.e.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Only applicable in bank control with no safety consequences.

E. ASSESSMENT PROCESS

CPSES reviewed with Westinghouse, the supplier of this equipment, the criteria for control board interface as it relates to reactor operation and control rod manipulation.

F. BACKFIT

None.

1. JUSTIFICATION

   The Westinghouse design for control rod control requires that these step counters continue to count past 228 steps if the operator inadvertently advances the control rods after they are entirely out.

A. HED DESCRIPTION

Process controllers and counters present immediate control setting feedback in terms of percent signal sent to systems/components, rather than actual system response.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.e.(1).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect control actuation.
2. Misinterpretation of display.

E. ASSESSMENT PROCESS

1. Forms of feedback were determined.
2. Criticality of feedback was determined.

F. BACKFIT

Where knowledge of plant response is critical or needed immediately, measures have been taken to furnish appropriate feedback.

A. HED DESCRIPTION

Reactor Coolant Pump vibration levels are not displayed in startup area.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.

C. LOCATION

CV-07.

D. POTENTIAL SAFETY CONSEQUENCES

Possible Reactor Coolant Pump damage.

E. ASSESSMENT PROCESS

The operational requirements to successful performance in situations involving this indication were reviewed.

F. BACKFIT

None.

1. JUSTIFICATION

Reactor Coolant Pump vibration is monitored on the Reactor Coolant Pump Vibration Monitoring Panel which is in close proximity to the main horseshoe. Excessive Reactor Coolant Pump vibration will be annunciated over the Reactor Coolant Pump controls on CB-05.

A. HED DESCRIPTION

Lamp test pushbutton is occupied by another status legend.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-91.

C. LOCATION

CB-01 and CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

Undetected safety system problems if MLBs are not properly tested.

E. ASSESSMENT PROCESS

1. MLB legend organization/layout was reviewed.
2. Alternative legend locations were assessed.

F. BACKFIT

MLB test pushbuttons will be identified by appropriately placed labels.

A. HED DESCRIPTION

Legend plates of CMC switches are subject to accidental interchange during maintenance.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.c.2.

C. LOCATION

CB-02 and CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

Loss of SI flow.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Legend plates are keyed to their respective modules by identical engineering numbers located on CMC legend plates and on corresponding key-operated switches.

A. HED DESCRIPTION

Reactor coolant drain tank level indication is not displayed in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Reactor coolant drain tank level is monitored by the plant computer and can be accessed as required.

A. HED DESCRIPTION

Chilled water surge tank level information is not displayed in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Loss of chilled water system.
2. Inability to observe changes to prevent serious problems.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

High-high and low-low chilled water surge tank level alarms are provided in the control room. Alarm procedures will be written to require an auxiliary operator to determine tank level locally prior to initiating control room action.

A. HED DESCRIPTION

Turbine Plant Cooling Water Head Tank level information is not displayed in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Inability to observe changes.
2. Possible loss of cooling system.
3. Possible turbine damage.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Turbine Plant Cooling Water Head Tank level indication will be installed on CB-10.

A. HED DESCRIPTION

Condensate pump motor current is not displayed in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Inability to observe rapid change in condensate suction supply.
2. Possible loss of condensate and feedwater.
3. Plant shutdown.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

   Each condensate pump is provided with three stator winding RTD's, monitored by the plant computer, which provides sufficient information to evaluate motor performance.

A. HED DESCRIPTION

Inconsistent pointer position in de-energized circular meters.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect display interpretation.

E. ASSESSMENT PROCESS

Each meter was examined to determine its proper pointer position when de-energized.

F. BACKFIT

None.

1. JUSTIFICATION

   Redundant information exists to determine whether a meter has failed or whether it is reading zero.

A. HED DESCRIPTION

Circular meters on CB-11, which have positive and negative values, do not have zero at either the 9 or 12 o'clock position, but rather at the 10 o'clock position. The vertical meter on CB-06 has positive and negative values, but does not have zero at the center of the scale.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.4.b.2.

C. LOCATION

CB-06 and CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The current location of zero is the most appropriate to cover the necessary range of measurement and display it with the necessary resolution.

A. HED DESCRIPTION

There is no test function for some LED displays.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-91.

C. LOCATION

CB-06, CB-08, and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Improper boron control.

E. ASSESSMENT PROCESS

Assessed life span of LEDs.

F. BACKFIT

None.

1. JUSTIFICATION

LEDs are highly reliable and typically long-lived displays.

A. HED DESCRIPTION

Scale numbers are positioned between graduation marks and pointers. Pointers are also wider than the intermediate graduation marks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.a.2.

C. LOCATION

CB-10 and CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of scales was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   Scales can be read to the degree of accuracy required with no significant delays in determining values.

A. HED DESCRIPTION

Turbine stress trending information is not displayed in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Possible turbine damage.

E. ASSESSMENT PROCESS

Assessed the required data needed to support the operator and the operating conditions when using this data.

F. BACKFIT

None.

1. JUSTIFICATION

A TSE recorder is provided on CV-04. This trend is required infrequently during normal operation. The TSE located on CB-10 provides the operator with the information required during startup and normal operation.

A. HED DESCRIPTION

Bulbs in annunciators, MLBs, and other displays with transilluminated labels require special tools for replacement.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.a.(3).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to replace bulbs, causing inability to receive information.
2. Damage to displays.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Special tools will be provided for bulb maintenance if available from the manufacturer.

A. HED DESCRIPTION

The annunciator windows cannot be opened sufficiently to enable bulb replacement unless the adjacent window below each one is opened first.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.a.(3).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

   Since annunciator windows are only opened during maintenance, changing the annunciator design is unwarranted. Procedures will address the proper method to change annunciator light bulbs.

A. HED DESCRIPTION

Recorder's door opens partially due to the nearness of the adjacent recorder.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-78.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of moving adjacent recorder was examined.

F. BACKFIT

None.

1. JUSTIFICATION

This recorder door can be opened fully by opening the door to the adjacent recorder. This is acceptable.

A. HED DESCRIPTION

Scales on meters are nonlinear.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.a.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect display interpretation.

E. ASSESSMENT PROCESS

Each nonlinear meter was checked for its appropriateness.

F. BACKFIT

Where necessary for comparison, nonlinear scales on meters will be replaced with linear scales. Otherwise, scales have been left as is since the normal operating range of the parameter lies in the expanded portion of the scale providing greater resolution for determining the values.

A. HED DESCRIPTION

No direct indication of turbine percent of power or wide range turbine megawatt in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect turbine, feedwater, or rod control.
2. Possible plant shutdown.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A digital percent power meter will be installed on CB-10 next to the TSE.

A. HED DESCRIPTION

The scales of generator meters show only positive values; however, negative values are also required.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.(7).

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

1. Damage or loss of generator.
2. Possible loss of power or emergency functions.

E. ASSESSMENT PROCESS

Evaluated applicability of scale to operator needs.

F. BACKFIT

The meters will be changed to display KVAR "IN" and KVAR "OUT".

A. HED DESCRIPTION

The scales of two related meters do not have compatible numerical progression and scale range. Scale increments are different and number of graduations are different.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.d.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to identify causes for loss of feedwater.
2. Inability to control feedwater.
3. Plant shutdown.

E. ASSESSMENT PROCESS

The meters' functions and their relationships were evaluated.

F. BACKFIT

Meters will be changed to 0-1300 PSIG linear displays.

A. HED DESCRIPTION

Brightness of indicator lights is variable, due to the use of different light covers.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Extent/magnitude of the variability was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

The existence of different intensities of red and green indicator lights does not, in CPSES's opinion, affect discrimination between priorities or the operator's color sensitivity. Therefore, no action is required to make indicating light colors uniform.

A. HED DESCRIPTION

Meters have no range or setpoint markings.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.3.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to identify impending problems.
2. Reactor shutdown.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Range and setpoint markings will be added to meters, as they are determined, during plant start-up activities.

A. HED DESCRIPTION

Pointers on J-handle/Star-handle switches contrast poorly with handle color.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Operating switch to wrong position.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Pointers will be filled with white epoxy paint to improve contrast.

A. HED DESCRIPTION

Scales on trend recorders obscure pen traces and other scales.

B. GUIDELINE REFERENCE

NUREG/CR 1580: VD-10 and VD-78.

C. LOCATION

CB-05 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delayed or incorrect reading.
2. Reactor trip.
3. Loss of seal flow.

E. ASSESSMENT PROCESS

Alternative solutions were generated and evaluated.

F. BACKFIT

None.

1. Justification

   These recorders are used to trend non-safety related parameters. They are not used for indication. As such the visibility of the pen traces and scales from the normal operating position is not critical.

A. HED DESCRIPTION

Related meters do not have compatible scales.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.d.

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The relationship among these meters was reviewed and the requirements for proper display of were identified.

F. BACKFIT

These meters will have compatible scales.

A. HED DESCRIPTION

J-handle "target" colors are difficult to differentiate from each other.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.e.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in control operation.

E. ASSESSMENT PROCESS

Cause of poor differentiation between colored flag indicators was determined.

F. BACKFIT

Targets will be cleaned to make colors easy to differentiate.

A. HED DESCRIPTION

Trend recorder scale differs from chart paper scale.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.b.

C. LOCATION

CB-01, CB-02, CB-03, and CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Chart paper will be changed to agree with the appropriate scales.

A. HED DESCRIPTION

There is no lamp test provided to test indicator lights associated with control switches.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.a.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in response to component failure.

E. ASSESSMENT PROCESS

Functional modes of indicator lights were investigated.

F. BACKFIT

None.

1. JUSTIFICATION

   Sufficient feedback exists for the operator to determine a lamp failure without the use of a lamp test feature.

A. HED DESCRIPTION

Incomplete color coding of indicators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A

E. ASSESSMENT PROCESS

Effort to complete indicator color coding was assessed.

F. BACKFIT

RG 1.97, Rev. 2 Category 1 indications will be color-coded.

A. HED DESCRIPTION

Post-Accident Monitoring System displays are not distinctly coded.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in assessment of condition.

E. ASSESSMENT PROCESS

Reviewed all types of coding currently being planned for use in the control room.

F. BACKFIT

As a minimum, all RG 1.97, Rev. 2 Category 1 indications will be color-coded. PAMs coding has been deleted.

A. HED DESCRIPTION

Overlapping pens on trend recorders cause other pens to be obscured.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.2.b.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Possible incorrect FW operation
2. Delay in operation of control.
3. Reactor trip.

E. ASSESSMENT PROCESS

Alternative solutions were generated and evaluated.

F. BACKFIT

None.

1. Justification

   These recorders are used to trend non-safety related parameters. They are not used for indication. As such, the visibility of the pen traces and scales from the normal operating position is not critical.

A. HED DESCRIPTION

Core subcooling system design and integration into the Safety Parameter Display System were not decided at the time of the NRC audit.

B. GUIDELINE REFERENCE

NUREG-0700: 1.3.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

Design and procurement of the core subcooling system has been completed. Delivery and installation is anticipated before fuel load.

A. HED DESCRIPTION

The type of reactor vessel level indication system to be purchased was not decided at the time of the NRC audit.

B. GUIDELINE REFERENCE

NUREG-0700: 1.3.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

Design and procurement of the Reactor Vessel Level indication system has been completed. Installation is scheduled for after fuel load.

A. HED DESCRIPTION

The incore thermocouple readout is limited to 700°F.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Incore Thermocouple Readout Display.

D. POTENTIAL SAFETY CONSEQUENCES

1. Inability to correctly analyze situation.
2. Possible failure to limit Reactor core damage.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The incore thermocouple design has been modified to meet the requirements of NUREG-0737.

A. HED DESCRIPTION

There is no direct indication of percent flow bypassed. It must be determined by comparing letdown flow to CVCS return flow. These two indicators have different scales and are not adjacent to each other.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.8.

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of equipment modification was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   Flow indicator FI-385 displays flow through the BTRS in gallons-per-minute. Charging and letdown flow is compared by the operator for additional indication of stable/unstable pressurizer level. Therefore, comparing charging and letdown flows is independent of BTRS demineralizer flow or BTRS bypass flow.

A. HED DESCRIPTION

Inconsistent color coding of status indicator; i.e., white for "OPEN" instead of red.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.

C. LOCATION

CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control actuation.

E. ASSESSMENT PROCESS

1. The use of color coding for indicators was reviewed.
2. A neutral color not previously used in the control room was selected.

F. BACKFIT

The status indicator color will be changed to blue to denote that this valve OPEN permissive has been satisfied.

A. HED DESCRIPTION

Trend recorders lack chart paper, pens, and scales. Some have handwritten scales.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.

C. LOCATION

CB-01, CB-02, CB-03, and CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

All recorder deficiencies will be corrected.

A. HED DESCRIPTION

All 50 incore thermocouples monitored by the process computer. The computer can provide long-and short-term map and data on the trend typewriter and line printer.

B. GUIDELINE REFERENCE

NUREG-0700: 1.3.

C. LOCATION

Incore Thermocouples

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Incore thermocouple design will be modified to comply with NUREG-0737.

A. HED DESCRIPTION

Incore thermocouple readings are displayed in three locations: incore thermocouple panel, control board CRT, and the process computer CRT.

B. GUIDELINE REFERENCE

NUREG-0700: 1.3.

C. LOCATION

Incore Thermocouples.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Incore thermocouple design will be modified to comply with NUREG-0737.

HED CONTROL NO. 158

A. HED DESCRIPTION

A special tool is required to remove status indicator lampholders.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.a.(3).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Broken indicator and loss of information.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Special tools will be provided for lamp maintenance if available from the manufacturer.

A. HED DESCRIPTION

There is no coding or visual enhancements for displays.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect control/display association.
2. Improper control actuation.

E. ASSESSMENT PROCESS

The applicability of various types of visual enhancements were examined.

F. BACKFIT

Displays will be coded and visually enhanced.

A. HED DESCRIPTION

Meters with color-coded nameplates do not have color coded bezels; resulting in coding inconsistency.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.

C. LOCATION

CB-01, CB-02, CB-03, CB-08, and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in locating information.

E. ASSESSMENT PROCESS

Usefulness of color coding train designation was reviewed.

F. BACKFIT

Color coding of Post Accident Monitoring Displays will be eliminated.
REG GUIDE 1.97, REV. 2, Category 1 indications will be coded.

A. HED DESCRIPTION

Multiple scales are not coded so as to enhance scale-label and scale-trend associations.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-69.

C. LOCATION

CB-05, CB-06, CB-07, CB-08, CB-10, and CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Analyzed methods for improving scale-label/scale-trend associations.

F. BACKFIT

A color coding scheme has been developed to enhance scale-label and scale-trend associations.

A. HED DESCRIPTION

Red numbers with black graduation marks and vice versa are used for color coding purposes, making scales difficult to read.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.e.2.

C. LOCATION

CB-06 and CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in reading meters.

E. ASSESSMENT PROCESS

Readability of scales was evaluated.

F. BACKFIT

Scales with black numbers and black graduation marks will be incorporated.

A. HED DESCRIPTION

**The Nuclear Instrumentation System recorder lacks a scale for differential power.**

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-8.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A scale for differential power will be provided.

A. HED DESCRIPTION

Counters require calculations by operator when displayed values run past 60 minutes. Other counters require the operator to convert displayed values by multiplication factors other than multiplies of ten.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.2.b.

C. LOCATION

CB-01, CB-11, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Counters were examined to determine if they were best suited for their respective quantitative tasks.

2. Methods to best present displayed information were assessed.

F. BACKFIT

Where calculations or interpolations of displayed information must be made, labels and other enhancements will be added to aid operators in display interpretation.

A. HED DESCRIPTION

Visual displays have markings (i.e., manufacturer's trademark/name) that are unrelated to control function.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.4.b.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Determined impact on operations.

F. BACKFIT

None.

1. JUSTIFICATION

   Manufacturer's trademarks/names do not pose problems that interfere with operations.

A. HED DESCRIPTION

A zero is missing from the number "300" on the scale.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.2.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Existing scale will be replaced with new scale that meets the Vertical Indicator Guidelines outlined in Appendix D.

A. HED DESCRIPTION

Engineering unit labels are placed in various locations on similar displays.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

CB-01 CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in locating display.

E. ASSESSMENT PROCESS

Analyzed backfit alternatives.

F. BACKFIT

Engineering unit label placement will be made consistent for all similar displays.

A. HED DESCRIPTION

1. Engineering unit labels are located too close to the scale, causing a cluttered appearance.
2. Engineering unit labels on scales are obscured by labels on trend recorder doors.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.

C. LOCATION

CB-07, CB-08, and CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in obtaining information.

E. ASSESSMENT PROCESS

Analyzed backfit alternatives.

F. BACKFIT

Engineering unit label placement on trend recorders will be made consistent and will not obscure or add clutter to the trend recorder scale.

A. HED DESCRIPTION

Engineering units are not present on the label.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

CB-01, CB-04, CB-06, CB-07, CB-08, CB-09, CB-10, CB-11, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in obtaining information.

E. ASSESSMENT PROCESS

1. Determined engineering units.
2. Analyzed applicability of engineering units in labels.

F. BACKFIT

Enginering units will be added to labels or scale faces.

A. HED DESCRIPTION

Negative values are not indicated as such on vertical meter scales.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

CB-06, CB-07, CB-08, CB-11, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Negative signs (-) will be added to negative values on vertical meter scales.

A. HED DESCRIPTION

Location of positive and negative signs on scales does not clearly indicate which numbers are positive and which numbers are negative.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Negative signs (-) will be added to the left of numbers below zero.

A. HED DESCRIPTION

Decimals are used on scale numbers.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-63.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Decimals will be eliminated on these scales by using a smaller scale multiplier (i.e., $10^3$ rather than $10^6$).

A. HED DESCRIPTION

Backplates on process controllers are not permanently attached.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.e.(3).

C. LOCATION

CB-04, CB-05, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Failure of component.

E. ASSESSMENT PROCESS

The "removability" of process controller backplates was evaluated.

F. BACKFIT

The backplates will be permanently attached.

A. HED DESCRIPTION

Trend recorder pointers overlap scale graduation marks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.b.1.

C. LOCATION

CB-01B, CB-02, CB-03, CB-05, CB-06B, CB-07, CB-09, and CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of scales was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

Recorders can be read without difficulty.

A. HED DESCRIPTION

Pointers on meters are bent which causes parallax between the scale and the pointer.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.b.

C. LOCATION

CB-05, CB-06, CB-09, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The pointers will be repaired.

A. HED DESCRIPTION

The first and last graduation marks on the EX LTDN HX TEMP meter are unnumbered.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.d.

C. LOCATION

CB-06B.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

These scales were examined.

F. BACKFIT

The first and last graduation marks will be numbered.

A. HED DESCRIPTION

The meter scale range of SG-1 FW flow and SG-4 FW flow is incompatible with the scale ranges of other SG FW flow meters.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.d.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper FW Flow control.
2. Plant Shutdown.

E. ASSESSMENT PROCESS

The function of the meters was reviewed.

F. BACKFIT

The scale ranges will be made compatible.

A. HED DESCRIPTION

Scales do not have the same numerical progression as their associated recorders.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.d.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Function of meters was evaluated.
2. Correct numerical progression was determined.

F. BACKFIT

The scales will be made compatible with the associated recorder scales.

A. HED DESCRIPTION

Square root and logarithmic scales are used.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.e.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Scales were examined to determine the requirement for square root/logarithmic scales.

F. BACKFIT

None.

1. JUSTIFICATION

   Square root and logarithmic scales were found to be adequate for their intended functions.

A. HED DESCRIPTION

Scale graduations do not progress by 1, 2, or 5 or decimal multiples thereof.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.c.

C. LOCATION

CB-05, CB-08, CB-10, CB-12, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed or misread information.

E. ASSESSMENT PROCESS

Scales with unconventional graduations were examined to determine the significance of the scalar progression to the task being peformed.

F. BACKFIT

Whenever possible, scales will be changed such that graduations progress by 1, 2, or 5 or decimal multiples thereof.

A. HED DESCRIPTION

The BA BLDR FLOW trend recorder has one scale that progresses by 10 and one scale that progresses by 40. The association of scale to trend will be confused by the use of two, nonseparately coded scales.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.c.

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. The function and correct scaling of both trend recorders was determined.
2. Coding methods were evaluated.

F. BACKFIT

The association of scale to trend will be enhanced by coding. The scale that progresses by 40 will be changed to progress by 20.

A. HED DESCRIPTION

The pressurizer pressure meters and trend recorders do not have the same scalar numerical progression. The Tref/Tave recorder and the Tave loop meters do not have the same scalar numerical progression.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.d.

C. LOCATION

CB-05 and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The function and correct scaling of these meters was determined.

F. BACKFIT

The scale ranges will be made compatible.

A. HED DESCRIPTION

Scale graduation marks are not permanent in the CCW SUR TK LVL meters and the CCW TRAIN A and TRAIN B SUR TK LVL/HX OUT FLOW trend recorders.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.

C. LOCATION

CB-03 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect display reading.
2. Loss of display reading.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The temporary scales will be replaced with appropriate permanent scales.

HED CONTROL NO. 240

A. HED DESCRIPTION

Scale is obscured by sticker glue on window.

B. GUIDELINE REFERENCE

None.

C. LOCATION

CB-03 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

Sticker glue will be removed.

A. HED DESCRIPTION

Scale numbers are obscured by pointer.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.a.2.

C. LOCATION

CB-03, CB-04, CB-05, CB-06, CB-07, CB-08, CB-09, CB-11, CB-12, CV-01, CV-03, and CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of the scales was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

Scales can be read easily to the degree of accuracy required without significant delays.

A. HED DESCRIPTION

Dual scale meters have a raised metal strip between the two scales which causes the scale numbers to be obscured when viewing from the side. This is especially true when the right scale has three digit numbers whose last digit is obscured.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-22.

C. LOCATION

CB-09 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The readability of the meters was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   The angle of view has to be fairly acute for the scale value to be obscured. Since readings are taken from in front of the meters, no significant delay occurs.

A. HED DESCRIPTION

The pointers on the FWP 1-A and 1-B TURB VIBRATION trend recorders cover scale numbers and marks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.a.2.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of scales was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   The trend recorders can be read to the degree of accuracy required.

A. HED DESCRIPTION

Pointers are located on left of vertical meters instead of on the right; pointers are located on the top of the horizontal scales instead of on the bottom.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-67.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of meters was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

The readability of the scale is not degraded significantly.

A. HED DESCRIPTION

Pointers obscure shortest graduation marks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.a.2.

C. LOCATION

CB-01 through CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of scales was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

The readability of the scales is not degraded significantly.

A. HED DESCRIPTION

The width of the end of the pointer exceeds the width of intermediate graduation marks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.2.2.a.2.

C. LOCATION

CB-01, CB-03 through CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of scale was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

The width of the pointer does not prevent reading the scale to the degree of accuracy required.

A. HED DESCRIPTION

Scales have more than nine graduations between numbered major marks or do not have any intermediate graduation marks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.a.(1), (2), and (3).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in reading display.

E. ASSESSMENT PROCESS

1. Scales were assessed for their content and significance of information.
2. Recommendations were made for improving the significance of the scale to the operator.

F. BACKFIT

Scales with an inordinate amount of graduations were identified and will be changed if scale markings are inadequate or excessive for their intended functions.

A. HED DESCRIPTION

Because graduation marks on scales are located too close together, discrimination is difficult.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Consequences of misreading scale were evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   The scales can be read to the degree of accuracy required. Consequences of misreading the scales are not serious.

A. HED DESCRIPTION

Insufficient distance between major graduation marks on Hagan controller valve position scales and vertical meter scales.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.

C. LOCATION

CB-01, CB-04, CB-06, CB-07, CB-08, and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed or incorrect reading of display.

E. ASSESSMENT PROCESS

Scales were examined for feasibility of backfitting.

F. BACKFIT

1. Scales on vertical meters with less than .5 inches between major graduation marks will be corrected.
2. Distance between major graduation marks on Hagan controller valve pos[illegible] indicator scales is constrained by the size of the meters. Meters can be [illegible] to the degree of accuracy required.

A. HED DESCRIPTION

Triangular graduation marks on the circular meters do not conform to the recommended format of scale markings.

B. GUIDELINE REFERENCE

NUREG/CR- 1580: VD-73.

C. LOCATION

CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

Possible loss of electrical power.

E. ASSESSMENT PROCESS

Readability of scales was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

Triangular graduation marks do not detract from the readability of the scales.

A. HED DESCRIPTION

Indicator lights for fan and damper controls are not split.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect operation of system.

E. ASSESSMENT PROCESS

Examined ICDs to determine requirements for split lens lights.

F. BACKFIT

Single indicator lights will be replaced with appropriately labeled split lens lights.

A. HED DESCRIPTION

Indicator light lenses are subject to accidental interchange.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.c.(2).

C. LOC TION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay or improper equipment operation.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

Administrative procedures will be implemented to control the maintenance of indicator lights, therefore ensuring that interchange is averted.

A. HED DESCRIPTION

Indicator lights reflect light from adjacent lights causing them to appear illuminated when they are not.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.b.(1).

C. LOCATION

CB-01, CB-03, CB-05, CB-06, CB-08, CB-09, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect display interpretation.

E. ASSESSMENT PROCESS

1. Indicator lights were examined to determined criticality of problem.
2. Bulb lenses were examined to determine if change was necessary.

F. BACKFIT

Reflected light will be eliminated.

A. HED DESCRIPTION

The indicator lights on process controllers and switch modules have low luminance.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.2.b.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect display interpretation.

E. ASSESSMENT PROCESS

Indicator lights were examined to determine cause of problem.

F. BACKFIT

All red bulbs in process controllers have been replaced with white bulbs. White diffuser lenses have been removed from indicator lights on switch modules.

A. HED DESCRIPTION

Scale of AUX FW to SG-3 TEMP is a faded white, poorly contrasting to the panel background color.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.3.c.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper Auxiliary Feedwater control.
2. Loss of level.

E. ASSESSMENT PROCESS

Readability of the scale was examined.

F. BACKFIT

The scale will be replaced.

A. HED DESCRIPTION

Drum-type counters are not mounted perpendicular to the line of sight.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.5.1.b.1.

C. LOCATION

CB-1, CB-07, CB-10, CB-11, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of counters was evaluated.

F. BACKFIT

1. JUSTIFICATION

Counters are readable from the normal operating position.

A. HED DESCRIPTION

Numbers in counter windows increase with a downward movement of the counter drum.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.5.1.c.2.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Operational situations were reviewed.
2. Consequences of incorrect operation were evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

The counter is only moved manually when picking up a dropped rod; there are no consequences from moving it in the wrong direction. The counter reading itself presents immediate feedback if an error is made during manual operations. Furthermore, redundant rod position information is contained in the Digital Rod Position Information display located directly above the drum counters.

A. HED DESCRIPTION

Trend recorders use frosted glass.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.k.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Possible turbine shutdown or damage.

E. ASSESSMENT PROCESS

1. Trend recorder glass was examined to determine effect on readability.
2. Replacement glass was examined.

F. BACKFIT

None.

1. JUSTIFICATION

The original glass was selected to decrease glare from ambient lighting and has proven to be effective. The glass does not prevent the operator from reading the recorder to the required degree of accuracy. However, replacement glass that eliminates glare and provides improved readability is still being investigated.

A. HED DESCRIPTION

The large impact-type recorders have doors with unnecessary key locks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.f.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The doors will be left unlocked at all times.

A. HED DESCRIPTION

Trend recorder doors in the control room could swing down when unlatched and strike and obscure components located below them.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Inadvertent control actuation.

E. ASSESSMENT PROCESS

1. Effect on operations was evaluated.
2. Potential consequences of plant safety were examined.

F. BACKFIT

Administrative controls will be used to prevent doors from remaining open unnecessarily for long periods of time. Inadvertent control actuation resulting from a trend recorder door striking a control switch handle is highly unlikely.

A. HED DESCRIPTION

Magnets used as a latching mechanism on trend recorder doors detach easily.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.

C. LOCATION

CB-02, CB-04, CB-05, CB-06, and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Inadvertent control actuation.

E. ASSESSMENT PROCESS

Magnets were examined.

F. BACKFIT

Magnets will be glued to all trend recorder doors.

A. HED DESCRIPTION

Trend recorders lack high-low speed capability.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.i.

C. LOCATION

CB-01 through CB-08, and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Single speed recorders are adequate for their intended operational functions.

A. HED DESCRIPTION

J-handle switches are missing targets.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-112.

C. LOCATION

CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Examined J-handle switch functions to determine if targets are required.

F. BACKFIT

Targets will be provided for these J-handle switches.

A. HED DESCRIPTION

The lenses for indicator lights 1-ZL-2407B, 1YL-2112H and 1-YL-2111H are missing.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.2.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in display interpretation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Lenses have been provided.

A. HED DESCRIPTION

The windows for counters X-FQI-5354, 5345, and 5099 are scratched and marred.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-84.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of numbers was assessed.

F. BACKFIT

These windows will be replaced.

A. HED DESCRIPTION

Containment and reactor activity sump pump run time counters only count up to 60 minutes.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-6 and VD-10.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Consulted operations.

F. BACKFIT

None.

1. JUSTIFICATION

Operators will be required to periodically log run time counter readings as part of their daily routine. The probability of a counter "turning over" more than once during a logging period is very remote since leak rates of more than one gpm per hour (Technical Specification limit) will be alarmed.

A. HED DESCRIPTION

Indicator lights are used to indicate unfavorable status.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.d.

C. LOCATION

CB-08, CB-09, CB-10, and CV-01.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to detect problem.

E. ASSESSMENT PROCESS

Examined enhancements to improve operator awareness.

F. BACKFIT

These lights indicate which parameter in a multiple input annunciator window is out of limits. Specific alarm response procedures will be written to define the operator interface with these indicator lights.

A. HED DESCRIPTION

Dual meters have graduation marks that are smaller in height than the required heights for major, intermediate, and minor marks.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.b.

C. LOCATION

CB-08 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of meters was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   Meters can be read to the required degree of accuracy.

A. HED DESCRIPTION

Pointers on impact recorders extend across all scales, obscuring numbers and some scales.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-68, VD-64, and VD-6.

C. LOCATION

CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Accuracy and timeliness of readings were evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   These recorders do not display critical information and are readable to the degree of accuracy required.

A. HED DESCRIPTION

Some of the major graduation marks on the COOLT TEMP meters are unnumbered, which is inconsistent with the associated recorders.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.5.d.

C. LOCATION

CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The scales of the recorders were compared.

F. BACKFIT

The unnumbered major graduation marks will be numbered to be consistent with the scales on the associated recorders.

A. HED DESCRIPTION

Extinguished indicator lights indicate a nonoperable condition.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.c(1)

C. LOCATION

CV-04.

D. POTENTIAL SAFETY CONSEQUENCES

Possible plant shutdown.

E. ASSESSMENT PROCESS

1. The applicability of control room operations to this panel was examined.
2. Possible enhancements were studied.

F. BACKFIT

Positive indication of operable and nonoperable conditions will be provided.

# 7.0 LABELING & LOCATION AIDS HEDS

## LABELING & LOCATION AIDS HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 4 | 1 | | | X | |
| 5 | 1 | | | X | |
| 6 | 1 | | | X | |
| 7 | 1 | | | X | |
| 24 | 2 | | | X | |
| 33 | 2 | | | X | |
| 34 | 2 | | | X | |
| 56 | 4 | | | X | |
| 65 | 1 | 1 | | X | |
| 66 | 1 | 1 | | X | |
| 67 | 1 | 1 | | X | |
| 75 | 1 | 2 | | X | |
| 76 | 1 | 2 | | X | |
| 86 | 2 | 2 | | X | |
| 95 | | 1 | | X | |
| 97 | | 1 | | X | |
| 98 | | 1 | | X | |
| 99 | | 1 | | X | |
| 100 | | 1 | | X | |
| 101 | | 1 | | X | |
| 103 | | 1 | | X | |
| 104 | | 1 | | X | |
| 105 | | 1 | | X | |
| 106 | | 1 | | X | |
| 107 | | 1 | | | X |
| 130 | | 1 | | X | |
| 134 | | 2 | | X | |
| 146 | | 2 | | | X |
| 147 | | 2 | | X | |
| 148 | | 2 | | X | |
| 149 | | 2 | | | X |
| 150 | | 2 | | X | |
| 151 | | 2 | | | X |
| 152 | | 2 | | X | |
| 159 | | 2 | | X | |

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 168 | | 3 | | | X |
| 182 | | | X | X | |
| 186 | | | X | X | |
| 187 | | | X | X | |
| 189 | | | X | | X |
| 190 | | | X | X | |
| 191 | | | X | X | |
| 192 | | | X | X | |
| 193 | | | X | | X |
| 196 | | | X | X | |
| 200 | | | X | X | |
| 204 | | | X | X | |
| 205 | | | X | X | |
| 206 | | | X | X | |
| 207 | | | X | | X |
| 208 | | | X | | X |
| 209 | | | X | | X |
| 210 | | | X | | X |
| 211 | | | X | X | |
| 215 | | | X | X | |
| 216 | | | X | X | |
| 225 | | | X | X | |
| 228 | | | X | | X |
| 239 | | | X | X | |
| 253 | | | X | X | |
| 299 | | | X | X | |
| 300 | | | X | X | |
| 301 | | | X | X | |
| 304 | | | X | X | |
| 305 | | | X | X | |
| 328 | | | X | X | |
| 331 | | | X | X | |

A. HED DESCRIPTION

Labels contain excessive and inconsistent terminology.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.5. and 6.6.3.3.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delay in reading indicators.
2. Delay in operating controls.

E. ASSESSMENT PROCESS

A labeling study has been performed and a dictionary of standardized terms and abbreviations has been produced.

F. BACKFIT

Consistent labeling will be implemented throughout the control room.

A. HED DESCRIPTION

Star handles on switches obscure position labeling during operation.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.8.

C. LOCATION

CB-07, CB-11, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

1. Controls improperly operated.
2. Incorrect information displayed.

E. ASSESSMENT PROCESS

Alternative handle shapes were examined.

F. BACKFIT

Star handles will be replaced with T-handles to improve postion label readability during switch operation.

A. HED DESCRIPTION

The labels provide ambiguous or insufficient functional description of controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed or incorrect control operation.

E. ASSESSMENT PROCESS

Determine control switch functions.

F. BACKFIT

Labels will be modified to more clearly convey the functions of these control switches.

A. HED DESCRIPTION

The dual scales of vertical meters are not clearly labeled. It is not immediately apparent which part of the label is associated with each scale.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delayed or incorrect display reading.
2. Incorrect or delayed response.

E. ASSESSMENT PROCESS

Methods of scale-label association were examined.

F. BACKFIT

Dual scale meters will be relabeled to clarify scale-label associations.

A. HED DESCRIPTION

Labels describe engineering maintenance features rather than functional or operational features.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSFQUENCES

Incorrect or delayed control operation.

E. ASSESSMENT PROCESS

Determine control switch functions.

F. BACKFIT

Labels will be modified to more clearly convey the functions of these control switches.

A. HED DESCRIPTION

Inconsistent color coding is applied to the labeling of trains. Some trains are color coded with two colors.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.3.

C. LOCATION

CB-02 and CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delay or failure in location of displays.
2. Misinterpretation of system status.

E. ASSESSMENT PROCESS

Use of color coding train designation was assessed.

F. BACKFIT

Train color coding will be modified in the relabeling effort for the control room. See Labeling Guidelines, Appendix E.

A. HED DESCRIPTION

Labels on trend recorders are placed on the inside of windows where they obscure trend graphs.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.1.

C. LOCATION

CB-03 and CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to observe trends or receive data.

E. ASSESSMENT PROCESS

Alternative locations for labels were evaluated.

F. BACKFIT

Labels on the trend recorder will be relocated such that they do not obscure displayed information.

A. HED DESCRIPTION

Miniature turbine control panel organization could cause label-meter misassociations.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.1.a.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper turbine operation.
2. Plant shutdown.

E. ASSESSMENT PROCESS

Potential backfits were reviewed during the labeling study.

F. BACKFIT

The miniature turbine control panel will be enhanced to improve label-meter associations.

A. HED DESCRIPTION

Process controllers have dual labels with inconsistent nomenclature.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.3.b.

C. LOCATION

CB-04, CB-05, CB-06, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Possible Reactor trip.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Vendor labels have been removed.

A. HED DESCRIPTION

Lack of summary or functional group labels in control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.7.a. or 6.6.1.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in display assessment and control actuation.

E. ASSESSMENT PROCESS

1. Assessed need for summary/group labels on the control boards.
2. Determined locations in which summary/group labels were needed.

F. BACKFIT

Summary or functional group labels have been applied to the control boards in conjunction with demarcation.

A. HED DESCRIPTION

Inconsistent positioning of labels in relation to their associated components.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.1.a.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect display or control selection.

E. ASSESSMENT PROCESS

Evaluated magnitude of problem.

F. BACKFIT

Positioning of labels with respect to their associated components will be made consistent within component types and is in accordance with NUREG-0700.

A. HED DESCRIPTION

Location of labels under trend recorders precludes easy readability.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.4.b.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Readability was assessed.
2. Alternate locations for labels were reviewed.

F. BACKFIT

Labels will be relocated where they can be read easily.

A. HED DESCRIPTION

Momentary and continuous contact CMC switches are not differentiated.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.8.a.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control actuation.

E. ASSESSMENT PROCESS

Alternative methods of coding switch types were examined.

F. BACKFIT

Momentary contact CMC switches will be coded to differentiate them from maintained contact CMC switches.

A. HED DESCRIPTION

Meaning of symbols on Allis-Chalmers controllers is not immediately obvious.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.4.a.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper turbine operation.
2. Plant shutdown.

E. ASSESSMENT PROCESS

Meaning of symbols was clarified.

F. BACKFIT

Pictorial symbols will be replaced with conventional labels.

A. HED DESCRIPTION

Some switches have two labels with identical nomenclature.

B. GUIDELINE REFERENCE

NUREG/CR-1580: PA-55.

C. LOCATION

Control Room.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Accuracy and appropriateness of nomenclature of these switches was evaluated.

F. BACKFIT

Redundant switch labels will be eliminated.

A. HED DESCRIPTION

Labeling of auxiliary feedwater pump turbine trip pushbutton is not specific.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to trip main turbine.
2. Inadvertent tripping of feedwater turbine.
3. Loss of feedwater.

E. ASSESSMENT PROCESS

Actual switch function and operational requirements were compared against label description of function.

F. BACKFIT

Pushbutton will be relabeled "AFWPT TRIP".

A. HED DESCRIPTION

Multiple abbreviations for single words cause labels to be ambiguous.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.3.b.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect or delayed control.
2. Activation of display assessment.

E. ASSESSMENT PROCESS

Magnitude of discrepancy was assessed by a survey of the use of multiple abbreviations.

F. BACKFIT

A list of standard terms, acronyms, and abbreviations has been generated. Consistent labeling will be implemented throughout the control room.

A. HED DESCRIPTION

Labeling of pressurizer selector switch and of selector switch position is confusing and incomplete.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect control operation.
2. Possible Reactor trip.

E. ASSESSMENT PROCESS

1. Errors in operability were estimated.
2. Actual function of the switches was assessed.

F. BACKFIT

Switches will be relabeled to identify the association between switch positions and controls/displays.

A. HED DESCRIPTION

Incorrect position label on switch; i.e., "CHRG PMP RCS ISOL VLV" has "RESET-BLOCK" position label.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

1. Loss of charging flow-possible.
2. Reactor trip.

E. ASSESSMENT PROCESS

Actual switch function was determined through the use of ICDs.

F. BACKFIT

Switch will be relabeled to read "CLOSE-AUTO-OPEN".

A. HED DESCRIPTION

Labels are illegible due to dirt accumulation, causing poor contrast between white letters on orange background.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.4.1.b.(1).

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in control actuation or display assessment.

E. ASSESSMENT PROCESS

Usefulness of color coding train designation was assessed.

F. BACKFIT

Labels will be revised such that contrast is not a problem.

A. HED DESCRIPTION

Use of a temporary label on "sequence of events" recorder.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.5.1.a.

C. LOCATION

BETA 120 SER, control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in display and plant condition assessment.

E. ASSESSMENT PROCESS

Assessed ease of replacement with an engraved label.

F. BACKFIT

Temporary label will be replaced with a permanent label.

A. HED DESCRIPTION

Control switch split lens indicating lights are not engraved.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Indicator light meanings were determined.

F. BACKFIT

The split lens w... engraved to convey indicator light meaning.

A. HED DESCRIPTION

Illuminated legends integrated with controls have not been engraved or had color filters added.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Assessed ease of labeling and color filter implementation.

F. BACKFIT

Split indicator light lenses will be labeled and color filters added.

A. HED DESCRIPTION

Labels are missing.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in control actuation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Labels will be provided for all unlabeled components on the control boards.

A. HED DESCRIPTION

Train A and Train B color coding is not applied consistently and/or correctly.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Improper control actuation.

E. ASSESSMENT PROCESS

1. Usefulness of color coding train designation was assessed.
2. Examined conspicuous train label inconsistencies.

F. BACKFIT

None.

1. JUSTIFICATION

   Conspicuous train label inconsistencies were examined. All apparent errors were found to be correct as is.

A. HED DESCRIPTION

Controls have unlabeled switch positions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.8.a.

C. LOCATION

CB-02, CB-07, CB-08, CB-09, CB-10, CB-11, CB-12, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper control actuation.
2. Plant shutdown.
3. Safety injection.

E. ASSESSMENT PROCESS

Function of unlabeled switch positions was evaluated.

F. BACKFIT

Unused switch position labels will be painted over. Switch positions that are used will be labeled.

A. HED DESCRIPTION

No mimicking exists on the control panels.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.1.

C. LOCATION

CB-01, CB-02, CB-03, CB-04, CB-05, CB-06, CB-07, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed or incorrect operation of controls.

E. ASSESSMENT PROCESS

Reviewed the applicability of mimicking, demarcation, and group/summary labeling to the panels.

F. BACKFIT

Mimicking, demarcation, and/or group/summary labeling have been applied to every panel.

A. HED DESCRIPTION

Incorrect label color.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.3.

C. LOCATION

CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect equipment operation.
2. Damage to SI pump.

E. ASSESSMENT PROCESS

Examined engineering documents to ascertain correct label colors.

F. BACKFIT

None.

1. JUSTIFICATION

   Label colors are correct as is. 1/1-8814B is Train A (orange). 1/1-CIPBA2A is dual-train (orange and green).

A. HED DESCRIPTION

Labeling does not clearly indicate control function or identification.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.1.a.

C. LOCATION

CB-02 and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control activation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The operational differences between these switches will be identified by more descriptive labeling.

A. HED DESCRIPTION

Justification for irregular numbering sequence not apparent.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The applicability of the numbering sequence within the functional context was examined.

F. BACKFIT

The switch will be relabeled to justify the irregular numbering sequence.

A. HED DESCRIPTION

Inconsistent switch position labels for control switches with similar functions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.8.a.

C. LOCATION

CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The position labeling is correct for these switches. Valve 1-8843 has an automatic function (closes upon the receipt of a Containment Isolation signal) and, therefore, switch 1/1-8843 has an AUTO position. Valve 1-8882 has no automatic function and, therefore, switch 1/1-8882 has no AUTO position.

A. HED DESCRIPTION

Meter scale labels are inconsistent with each other and with annunciator tiles.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.3.b.

C. LOCATION

CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in display assessment.

E. ASSESSMENT PROCESS

Magnitude of problem in the control room was determined.

F. BACKFIT

A list of standard terms, acronyms, and abbreviations has been generated. Consistent labeling will be implemented throughout the control room.

A. HED DESCRIPTION

Control switch indicating lights, for controls with three indicating lights, are not labeled.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

1. Loss of instrument air.
2. Unit shutdown.

E. ASSESSMENT PROCESS

The functional meaning of indicator lights were determined.

F. BACKFIT

None.

1. JUSTIFICATION

Control switch indicating lights, for controls with three indicating lights, conform to the following standard convention throughout the control room:

| | |
|---|---|
| RED: | pump running, breaker closed |
| GREEN: | pump stopped, breaker open |
| AMBER: | mismatch |
| WHITE: | trip |

This standard is well known to the operators making labeling unnecessary.

A. HED DESCRIPTION

Association of labeling with indicator light groups is unclear due to the ambiguous placement of labels.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.1.

C. LOCATION

CB-01, CB-03, CB-08, CB-09, and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control actuation.

E. ASSESSMENT PROCESS

Alternative locations were examined.

F. BACKFIT

The design and placement of labels will be modified to clearly convey the association of labels with indicator light groups.

A. HED DESCRIPTION

Top row of MLB legends is partially obscured.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.1.c.

C. LOCATION

CB-01 and CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect or delay in reading legends.

E. ASSESSMENT PROCESS

Cause of problem was determined.

F. BACKFIT

Existing MLB lenses will be replaced with new lenses engraved on the front face rather than the back face.

A. HED DESCRIPTION

Equipment number label placed below J-handle control is obscured by operator's hand when operating control.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.4.c or 6.6.3.8.c.

C. LOCATION

CB-08 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Assessed importance of knowledge of equipment number during operation as compared to descriptive/functional label.

F. BACKFIT

None.

1. JUSTIFICATION

These labels are not required to be visible during switch operation.

A. HED DESCRIPTION

The methods used to code the trend recorder channel to the label are inconsistent.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.3.

C. LOCATION

CB-05 and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

RCP seal failure, and pump damage, resulting in plant shutdown.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A consistent method will be used to code the trend recorder channel to the label.

A. HED DESCRIPTION

Labels on control switch modules are obscured by indicating lights when viewed from the normal operating position.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.1.a.

C. LOCATION

CV-01 and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control operation.

E. ASSESSMENT PROCESS

Analyzed methods for improving readability.

F. BACKFIT

As a result of that analysis, a Labeling Guideline (Appendix E) was developed to improve the clarity, consistency, and readability of all control room labels. Existing control room labels will be replaced with labels that conform to this specification.

A. HED DESCRIPTION

Small character size makes trend recorder labels unreadable. Some are also located in extreme positions making them difficult to read.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1 or 6.6.4.1.a.(1).

C. LOCATION

CB-01, CB-03, CB-07, CB-09, and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in control operation.

E. ASSESSMENT PROCESS

Analyzed methods for improving readability.

F. BACKFIT

As a result of that analysis, a Labeling Guideline (Appendix E) was developed to improve the clarity, consistency, and readability of all control room labels. Existing control room labels will be replaced with labels that conform to this specification.

A. HED DESCRIPTION

Curved labeling and/or improper orientation of label.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.3.

C. LOCATION

CB-04, CB-07, CB-10, CB-11, and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Curved labels are used to identify party line numbers on page phone selector switches. Labels are clear and legible.

A. HED DESCRIPTION

Labels are not permanently attached to the panel.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.2.a.

C. LOCATION

CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Existing control room labels will be replaced with labels that conform to the Labeling Guidelines in Appendix E.

A. HED DESCRIPTION

Rotary switch position marked AUTO is not functional and is covered by white tape. The tape can be accidentally removed, thereby exposing the irrelevant position label.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.8.a.

C. LOCATION

CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Improper equipment operation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

"AUTO" position label will be permanently removed.

A. HED DESCRIPTION

Indicator lights are not labeled and their meaning is unclear.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Determined meaning of indicator lights.

F. BACKFIT

Labels will be added to these indicator lights per the Labeling Guideines in Appendix E.

A. HED DESCRIPTION

Pushbutton labels violate hierarchical label sizing convention by being larger than the descriptive labels associated with them.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.2.b.(3) and (4).

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Analyzed alternatives.

F. BACKFIT

None.

1. JUSTIFICATION

Descriptive labels and pushbutton labels are easily read and distinguishable from one another. Furthermore, no operational consequences could result from confusing the two labels.

A. HED DESCRIPTION

Label only addresses one of two parameters displayed on dual scale.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Existing label will be replaced with a new label that meets the Labeling Guidelines outlined in Appendix E.

A. HED DESCRIPTION

Absence of engineering units on process controller meter labels.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

CB-09 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in obtaining information.

E. ASSESSMENT PROCESS

1. Determine engineering units.
2. Analyze backfit alternatives.

F. BACKFIT

Engineering units will be added to these process controller scales.

A. HED DESCRIPTION

Roman numerals are used on selector switch escutcheons.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.4.e.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Roman numerals used on these selector switch escutcheons will be replaced with Arabic numerals.

A. HED DESCRIPTION

Disconnect switches and generator symbols are not labeled on mimics.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.4.b.(6).

C. LOCATION

CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Disconnect switch and generator symbols on mimics will be labeled.

A. HED DESCRIPTION

Mimic lines do not terminate at a labeled component or at labels specifying the line destinations.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.4.b.(4) and (5).

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in electrical system operation.

E. ASSESSMENT PROCESS

Determine meaning of discrepant mimic lines.

F. BACKFIT

Mimic lines that do not terminate at a labeled component or symbol are bus mimic. Bus mimic will be labeled to enhance clarity.

HED CONTROL NO. 207

A. HED DESCRIPTION

Mimic lines depicting flow of electrical distribution are not color coded consistently.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.4.a.4.

C. LOCATION

CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The existing convention is to color code trains within the electrical mimic and to pattern code voltage levels. This is consistent, reasonable, and relatively easy to learn in its application to the boards.

A. HED DESCRIPTION

More than four mimic lines of the same color run in parallel.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.4.a.5.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

   The five mimic lines do not constitute a substantial operational burden over four mimic lines.

A. HED DESCRIPTION

Mimic lines overlap.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.4.b.2.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Crossing of mimic lines has been minimized and agrees with industry standards for unconnected cross-overs.

A. HED DESCRIPTION

Not all directions of flow are identified by arrowheads.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.4.b.3.

C. LOCATION

CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

   Concept does not readily apply to electrical mimics.

A. HED DESCRIPTION

The TURBINE IMP PRESS select switch has an unlabeled third position.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.5.b.(2).

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

1. Loss of impulse signal.
2. Plant shutdown.

E. ASSESSMENT PROCESS

An assessment was made to determine if the unlabeled third position is active.

F. BACKFIT

The unlabeled third position will be labeled to convey the intended function.

A. HED DESCRIPTION

The Emergency Start-Stop Diesel Generator switches have "STOP" and "OFF" positions, which could be confused operationally.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in diesel operation or failure to operate equipment.

E. ASSESSMENT PROCESS

More appropriate labeling has been reviewed for the switch functions.

F. BACKFIT

The "OFF" position will be changed to "NORMAL."

A. HED DESCRIPTION

Switches have "AFT" and "OFF", labeling the center switch position. This label is ambiguous and could possibly cause the meaning of that position function to be misinterpreted.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.2.d or 6.6.1.1.

C. LOCATION

CB-08 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delayed or improper operation.
2. Loss of feedwater or isolation of mainsteam.
3. Plant shutdown.

E. ASSESSMENT PROCESS

1. Referred to the ICDs.
2. Determined function of center switch position.

F. BACKFIT

The center switch position label will be changed to read "AUTO."

A. HED DESCRIPTION

The locking position or function of the vernier controllers is not clearly indicated.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-04, CB-06, CB-08, and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in controller operation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The locking position will be labeled "LOCK."

A. HED DESCRIPTION

The demand labels on process controllers are difficult to see from the right side.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.4.b.

C. LOCATION

CB-04, CB-05, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Process controllers are usually operated from directly in front of the meter, since the operator reads the scale while adjusting flow or rate of speed. There is also a position stereotype that the top button increases, while the lower button decreases.

A. HED DESCRIPTION

Labels on trend recorder windows are not permanently attached. If loosened, these labels may interfere with recorder action.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.2.a.

C. LOCATION

CB-05, CB-06, and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Trend recorder labels will be permanently attached.

A. HED DESCRIPTION

Labels indicate that vertical meters 5460-2 and 5460-3 are arranged in increasing order from right-to-left.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

These meters are incorrectly labelled. No rearrangement is required. New labels that more accurately describe the metered process are contained in the nameplate engraving list.

A. HED DESCRIPTION

Meter labels are not descriptive. The right-hand scale of each meter measures flow, but is unclear as to what flow is being measured.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Determined what flow is being measured.

F. BACKFIT

The existing label will be replaced with a new label that more accurately describes the metered process.

A. HED DESCRIPTION

Pull-to-lock J-handles are not identified as such.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.1.a.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to lock out equipment.
2. Damage to handles if not equipped with pull-to-lock and attempt is made to lockout.

E. ASSESSMENT PROCESS

Verify that all have pull-to-lock positions.

F. BACKFIT

Labels will be provided to identify pull-to-lock J-handle switches as such.

A. HED DESCRIPTION

The abbreviation "LVL" is used instead of "VLV."

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.2.f.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The control switch label will be corrected.

A. HED DESCRIPTION

Insufficient distance between position labels on switch escutcheon causes separate position labels to appear to be continuous.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.2.1.f.

C. LOCATION

CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in operating SI Block Reset switch.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Position labels on switch escutcheons will be modified such that they are far enough apart to be distinguishable from one another.

A. HED DESCRIPTION

The "AUTO" position on the J-handle switch for SER AIR CMPR 1 is worn away.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.8.c.

C. LOCATION

CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The "AUTO" position will be removed completely since the SER AIR CMPR has no automatic function.

A. HED DESCRIPTION

Corresponding controls of different trains do not have the same position labels.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.8.a.

C. LOCATION

CV-01.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed control operation.

E. ASSESSMENT PROCESS

Determine correct position label.

F. BACKFIT

Both control switch labels should be STOP-AUTO-START. Incorrect label will be replaced.

A. HED DESCRIPTION

Bezels are painted black which causes demarcation lines and mimic lines to become embedded in the visual field since they are dark also. Black bezels negate the effectiveness of demarcation lines and mimic lines.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.6.2.b.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in locating controls.

E. ASSESSMENT PROCESS

Alternative colors were evaluated for acceptable contrast.

F. BACKFIT

The bezels have been painted the same color as the panels.

# 8.0 PROCESS COMPUTER HEDS

## PROCESS COMPUTER HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 25 | 2 | | | X | |
| 35 | 2 | | | | X |
| 36 | 2 | | | X | |
| 37 | 2 | | | | X |
| 90 | 3 | 3 | | X | |
| 115 | | 1 | | X | |
| 116 | | 1 | | | X |
| 177 | | 3 | | | X |
| 188 | | | X | X | |
| 332 | | | X | | X |
| 333 | | | X | | X |
| 334 | | | X | X | |

A. HED DESCRIPTION

If operator fails to acknowledge a process computer alarm at printer console, subsequent process computer audio alarms will be inhibited when the main CRT flashes an alarm.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.3.2.

C. LOCATION

Printer console.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to receive CRT alarm message.

E. ASSESSMENT PROCESS

Feasibility of reprogramming computer was evaluated.

F. BACKFIT

Computer will be reprogrammed so that subsequent computer audio alarms are inhibited.

A. HED DESCRIPTION

The numeric key pad violates numeric sequence convention. It is numbered in calculator style sequence (7-8-9 as top row) instead of telephone style (1-2-3 as top row).

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.4.

C. LOCATION

Printer console.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The numeric keypads used to interface with the computer are arranged in a "calculator" configuration rather than a "telephone" configuration because that is the standard of the computer industry. All numeric keypads (except the telephones) are arranged in this manner. Furthermore, misoperation of any keypad does not have any operational consequences.

A. HED DESCRIPTION

There is no readily available index listing information contained in the process computer groups. Thus, the operator must search for desired information or memorize the information contained in each group.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.8.b.(2).

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in finding information.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

An index listing the information contained in each group will be provided for the operator.

A. HED DESCRIPTION

Output of SER must be interpreted through the use of a code book.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.3.1.c.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in analysis after events.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The process computer duplicates the SER messages in sentence format.

A. HED DESCRIPTION

CRT lacks graphic display capability.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.2.4.h.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

No assessment necessary since future implementation of a Safety Parameter Display System with graphics capability has been included.

F. BACKFIT

A Safety Parameter Display System is being installed in the control room. It is designed to provide the operator with graphic displays.

A. HED DESCRIPTION

Operators have not received formal training on the use of the process computer.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.1.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A.

E. ASSESSMENT PROCESS

None.

F. BACKFIT

Provisions will be made to train the operators in the use of the process computer.

A. HED DESCRIPTION

There are no operating procedures for operator actions if total loss of the process computer system should occur.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.8.a.(5)(b).

C. LOCATION

Process computer system.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in receiving and assessing information.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

   The process computer is not required for safe shutdown of the plant. Therefore, no operating procedure is necessary for loss of the process computer system.

A. HED DESCRIPTION

There is no color coding on the process computer CRT.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-52.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The process computer CRT is only used for alarm summary and therefore color coding provides no advantage.

A. HED DESCRIPTION

The information displayed on the CRT extends beyond the range capacity of the screen; displayed material is cut off at either end.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.2.1.a.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in reading information.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The line length will be adjusted to display all message characters.

A. HED DESCRIPTION

The utility CRT for P2500 process computer uses 5x7 dot matrix characters.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.2.2.

C. LOCATION

Process Computer.

D. POTENTIAL SAFETY CONSEQUENCES

Possible message misreadings.

E. ASSESSMENT PROCESS

The functional requirements of character design were examined.

F. BACKFIT

None.

1. JUSTIFICATION

   5x7 dot matrix characters are sufficient for the intended function.

A. HED DESCRIPTION

More than 25% of the P2500 process computer monitor screen is activated with information.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.2.5.m.

C. LOCATION

Process computer.

D. POTENTIAL SAFETY CONSEQUENCES

Possible vital information unnoticed.

E. ASSESSMENT PROCESS

The screen area requirements for displayed information were examined.

F. BACKFIT

None.

1. JUSTIFICATION

The nature of the displayed information on the process computer CRT (that is, alarm summary data) dictates the use of more than 25% of the CRT screen area.

A. HED DESCRIPTION

A copy of operating software is not currently stored off-site.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.1.

C. LOCATION

Not applicable.

D. POTENTIAL SAFETY CONSEQUENCES

Possible delay to reprogram process computer in the event of system crash.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Backup copies of the operating software for the process computer will be stored off-site (most likely in the EOF).

# 9.0 PANEL LAYOUT HEDS

## PANEL LAYOUT HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 18 | 1 | | | X | |
| 19 | 2 | | | X | |
| 20 | 2 | | | X | |
| 21 | 2 | | | X | |
| 22 | 2 | | | X | |
| 23 | 2 | | | X | |
| 49 | 3 | | | X | |
| 54 | 4 | | | X | |
| 55 | 4 | | | X | |
| 64 | 1 | 1 | | X | |
| 84 | 2 | 2 | | X | |
| 92 | 4 | 1 | | X | |
| 135 | | 2 | | | X |
| 136 | | 2 | | X | |
| 137 | | 2 | | X | |
| 138 | | 2 | | X | |
| 139 | | 2 | | X | |
| 141 | | 2 | | X | |
| 142 | | 2 | | X | |
| 143 | | 2 | | | X |
| 163 | | 3 | | X | |
| 164 | | 3 | | X | |
| 165 | | 3 | | | X |
| 194 | | | X | X | |
| 254 | | | X | X | |
| 255 | | | X | X | |
| 256 | | | X | X | |
| 257 | | | X | X | |
| 276 | | | X | X | |
| 282 | | | X | X | |
| 283 | | | X | X | |
| 284 | | | X | X | |
| 285 | | | X | X | |
| 286 | | | X | X | |
| 287 | | | X | X | |

A. HED DESCRIPTION

Layout of rod counters does not match operational sequence.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.a.(3)

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Possible delay in operation (startup).

E. ASSESSMENT PROCESS

Alternative solutions were examined for effectiveness and feasibility.

F. BACKFIT

Demarcation has been applied to make the organization of counters clearer.

A. HED DESCRIPTION

Trend recorders are located in the middle of MU and CHRG meters.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.1.2.

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The effectiveness of demarcation and group/summary labeling was evaluated.

F. BACKFIT

Demarcation and group/summary labeling have been applied to demonstrate functional groups.

A. HED DESCRIPTION

Related PRZR and PRT displays need to be grouped together.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.

C. LOCATION

CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delay in recognizing PRZR Leaks.
2. Reactor Shutdown.
3. Safety Injection.

E. ASSESSMENT PROCESS

The feasibility of rearranging the displays and the effectiveness of demarcation and group/summary labeling was reviewed

F. BACKFIT

The PRZR and PRT displays have been rearranged so that related displays are grouped together. Demarcation and group labeling have been added to enhance visual grouping.

A. HED DESCRIPTION

·itch for discharge valve is positioned on suction side of system.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.3.

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

Loss of charging.

E. ASSESSMENT PROCESS

Feasibility of relocating the switch was reviewed.

F. BACKFIT

This switch has been moved so that it is positioned on the discharge side of the system.

A. HED DESCRIPTION

Layout and grouping of components in the Auxiliary Feedwater System are poor.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect operation of Auxiliary Feedwater System.

Loss of heat removal from core.

E. ASSESSMENT PROCESS

Feasibility of rearrangement was reviewed.

F. BACKFIT

The components within the Auxiliary Feedwater System have been functionally grouped and demarcated.

A. HED DESCRIPTION

Related feedwater pump indications are on separate sides of the panel.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of relocating indicators was reviewed.

F. BACKFIT

Feedwater pump indicating lights have been relocated above their related controls.

A. HED DESCRIPTION

Distance between pushbuttons do not meet minimum separation requirements.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.3.1.b.

C. LOCATION

CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Potential consequences of selection error were evaluated.

F. BACKFIT

Annunciator pushbuttons similar to those on other panels will be installed.

A. HED DESCRIPTION

The sequential flow pattern of the controls is confusing.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.3.

C. LOCATION

CB-03.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect or delayed operation of equipment.

E. ASSESSMENT PROCESS

1. Reviewed operability of present arrangement to alternative arrangements.
2. Reviewed feasibility of rearranging controls.

F. BACKFIT

These controls have been rearranged so that functionally-related components are grouped together. Demarcation and group labeling have been added to visually enhance the functional grouping.

A. HED DESCRIPTION

MLBs are oriented vertically, which is inconsistent with the rest of the MLBs.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.4.a.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

These matrices are sequential status indicators for the four steam generators, rather than MLBs; therefore, they are appropriately designed for their intended function.

A. HED DESCRIPTION

Subsystems and components are not demarcated making control/display relationships difficult to identify.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.1.3.b.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed or incorrect operation.

E. ASSESSMENT PROCESS

Reviewed applicability of mimicking, demarcation, and group/summary labeling to the panels.

F. BACKFIT

Mimicking, demarcation, group/summary labeling or a combination of these have been applied to every panel.

A. HED DESCRIPTION

Related meters are not located together.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.

C. LOCATION

CB-06.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The relationship among these meters was reviewed.

F. BACKFIT

These meters have been arranged side-by-side.

A. HED DESCRIPTION

MLBs appear to generate abstract patterns, possibly due to poor grouping of functionally related indications.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.1.1.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to evaluate functioning of systems.

E. ASSESSMENT PROCESS

Reviewed alternative groupings of MLB indications.

F. BACKFIT

Indications in the MLBs will be functionally grouped into readily discernible patterns and labeled appropriately.

A. HED DESCRIPTION

Indication lights are arranged nonsequentially and inconsistent with other equipment.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.a.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Reviewed present arrangement for correctness.
2. Reviewed advantages and disadvantages of the present arrangement to alternative arrangements.

F. BACKFIT

None.

1. JUSTIFICATION

The indicator lights as they are presently arranged are functionally grouped by train.

A. HED DESCRIPTION

Indicator lights are nonsequentially and illogically ordered.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.a.

C. LOCATION

CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect or delayed evaluation of displays.

E. ASSESSMENT PROCESS

Reviewed feasibility of rearranging the indicators.

F. BACKFIT

The indicator lights have been rearranged so that the order is sequential and logical.

A. HED DESCRIPTION

The SI Pump Test Line valves lack a functional grouping pattern.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.

C. LOCATION

CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in SI Testing or Accumulator filling.

E. ASSESSMENT PROCESS

Reviewed alternative solutions and the feasibility and effectiveness of implementing each.

F. BACKFIT

Mimicking has been applied to illustrate the relationship between these valves.

A. HED DESCRIPTION

Containment sump controls and associated run-time meters are arranged nonsequentially.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.a.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Containment sump pump 3 & 4 controls and meters have been rearranged sequentially.

A. HED DESCRIPTION

Related pressure and flow indicators are not located side-by-side.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.(1).

C. LOCATION

CB-02.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to evaluate performance on problems in SI system.

E. ASSESSMENT PROCESS

Reviewed advantages and disadvantages to alternative arrangements.

F. BACKFIT

These indicators have been rearranged so that each pair of related pressure and flow indicators are side-by-side.

A. HED DESCRIPTION

Turbine driven Auxiliary Feedwater Pump status indicators should be grouped with related components.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect operation of Auxiliary Feedwater System.

E. ASSESSMENT PROCESS

Feasibility of relocating indicators was reviewed.

F. BACKFIT

These indicators have been relocated above related controls and adjacent to related meters.

A. HED DESCRIPTION

Cutler-Hammer switches are poorly arranged.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.(2).

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of moving Cutler-Hammer switches within module was examined.

F. BACKFIT

Cutler-Hammer switches have been rearranged to match related indicating light arrangements.

A. HED DESCRIPTION

The controls and displays on the Radiation Monitoring Panel are arranged by train and are mirror imaged.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.3.3.

C. LOCATION

Radiation Monitoring Panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Operational situations were reviewed.

F. BACKFIT

None.

1. JUSTIFICATION

All parameters on Radiation Monitoring Panel are available on the SPDS CRT. The indications on the Radiation Monitoring Panel are used as a backup to these CRT displays.

A. HED DESCRIPTION

Mid-string components are visually embedded in strings of more than five components.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.3.2.

C. LOCATION

CB-02, CB-03, CB-04, CB-06, CB-07, CB-08, CB-09, CB-10, CB-11, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed or/incorrect response.

E. ASSESSMENT PROCESS

Reviewed alternative solutions.

F. BACKFIT

Strings of more than five components have been demarcated into functional groups or broken up into smaller groups.

A. HED DESCRIPTION

MLBs on CB-01 should be located on CB-02.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.c.

C. LOCATION

CB-01.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in finding equipment problems.

E. ASSESSMENT PROCESS

Reviewed feasible locations on CB-02 for CB-01 MLBs.

F. BACKFIT

These MLBs have been relocated to CB-02.

A. HED DESCRIPTION

Digital clock should be located at the top of the control board.

B. GUIDELINE REFERENCE

None.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Impact on operational effectiveness was examined.
2. Potential safety consequences were reviewed.

F. BACKFIT

None.

1. JUSTIFICATION

The clock can be seen from all operating positions. Temporal visual blockage caused by another operator standing in the line of sight does not adversely impact operations.

A. HED DESCRIPTION

Switches appear to be out of position.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.1.1.b.

C. LOCATION

CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delayed or incorrect decision.
2. Possible failure of Residual Heat Removal System.

E. ASSESSMENT PROCESS

Investigated switch functions/train designations.

F. BACKFIT

Switch modules are located in the wrong place and have been corrected.

A. HED DESCRIPTION

Vertical meters 1-TI-5400 through 1-TI-5404 are not arranged in an increasing left-to-right order.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.

C. LOCATION

CB-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

These meters have been removed from the board.

A. HED DESCRIPTION

FUEL and AUX Building Elevation Exhaust Temperature meters X-TI-5734 through X-TI-5739 are not arranged in an ascending order.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.

C. LOCATION

CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

The feasibility of rearranging these meters was investigated.

F. BACKFIT

Meters have been arranged in ascending order from left-to-right.

A. HED DESCRIPTION

Indicator lights are not sequentially arranged.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.

C. LOCATION

CV-01 and CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in response.

E. ASSESSMENT PROCESS

The feasibility of rearranging these indicators was investigated.

F. BACKFIT

These indicators have been arranged in the proper order.

A. HED DESCRIPTION

Separation distance between pushbuttons on Cutler-Hammer pushbutton modules is too small.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.3.1.

C. LOCATION

CB-08.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control actuation.

E. ASSESSMENT PROCESS

The alternative solutions were determined and evaluated.

F. BACKFIT

These Cutler-Hammer pushbutton modules are being replaced by pushbutton modules that satisfy minimum separation distances between pushbuttons.

A. HED DESCRIPTION

Systems are not arranged operationally in the established bottom-to-top sequence.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.1.a.(1) and a.(2).

C. LOCATION

CB-03, CB-04, CB-06, CB-07, CB-08, CB-09, CB-10, and CV-01.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to operate equipment properly.

E. ASSESSMENT PROCESS

1. Correct sequential order was determined.
2. Feasibility of rearranging the systems was investigated.

F. BACKFIT

These systems have been rearranged in a bottom-to-top operational sequence where feasible. Where not feasible, demarcation, mimicking, and improved labels will be used to convey control inter-relationships.

A. HED DESCRIPTION

Orientation of the synchronization voltmeters (V-IN & V-RUN) and frequency meters (F-IN & F-RUN) is reversed between panels CB-11 and CB-12.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.3.

C. LOCATION

CB-11 and CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in breaker operation.

E. ASSESSMENT PROCESS

Reviewed feasibility of rearranging one pair of meters.

F. BACKFIT

The orientation of the meters has been changed such that the two panels match.

A. HED DESCRIPTION

Violation of left-to-right, top-to-bottom organization of ordered components.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.

C. LOCATION

CB-01, CB-03, CB-06, CB-08, CB-09, CB-10, CB-11, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Delayed or incorrect equipment operation.

E. ASSESSMENT PROCESS

1. Reviewed correctness of existing arrangements.
2. Reviewed feasibility of rearranging the comronents.

F. BACKFIT

Wherer appropriate, components were rearranged in left-to-right or top-to-bottom order.

A. HED DESCRIPTION

Train B components are located on the left side of their associated Train A components.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.3.

C. LOCATION

CB-06, CB-09, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect train operation.

E. ASSESSMENT PROCESS

Reviewed feasibility of relocating components.

F. BACKFIT

These systems have been rearranged to be consistent with the established train organization convention; that is, in a train A-left, train B-right order.

HED CONTROL NO. 285

A. HED DESCRIPTION

Layout of electrical distribution system controls/indicators is mirror-imaged.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.3

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

1. Reviewed feasibility of rearranging components.
2. Reviewed operability of panel in its present layout.

F. BACKFIT.

The electrical distribution system controls are best mimicked in a "mirror-image" layout. Demarcation and hierarchical labeling was added to the electrical distribution system indicators to enhance their layout and improve control/display integration.

A. HED DESCRIPTION

Controls seem to have no functional grouping pattern and have unexplainable gaps.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.1.1.b.

C. LOCATION

CB-02 and CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

Improper system equipment control.

E. ASSESSMENT PROCESS

Applicability of mimicking in conjunction with relocating components was examined.

F. BACKFIT

These systems have been mimicked and the displays functionally grouped and demarcated.

HED CONTROL NO. 287

A. HED DESCRIPTION

The location of the PCIP lamp cabinet is a privileged position established for annunciators. This location places the lamp cabinet further from the optimum viewing angle.

B. GUIDELINE REFERENCE

NUREG/CR-1580: WA-1 and VD-18.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in responding or recognizing status change.

E. ASSESSMENT PROCESS

Alternative solutions were viewed for feasibility of implementation and effectiveness in resolving the problem.

F. BACKFIT

The lamp cabinet will be made visually different from the surrounding annunciator matrices to avoid misinterpretation and to enhance visual search.

# 10.0 CONTROL/DISPLAY INTEGRATION HEDS

## CONTROL/DISPLAY INTEGRATION HED CROSS REFERENCE

| HED CONTROL NO. | SURVEY | | | DISPOSITION | |
|---|---|---|---|---|---|
| | PRELIM CRDR | NRC PRELIM | DETAILED CRDR | BACKFIT | NO BACKFIT |
| 69 | 1 | 1 | | X | |
| 125 | | 1 | | X | |
| 140 | | 2 | | | X |
| 145 | | 2 | | X | |
| 160 | | 2 | | X | |
| 252 | | | X | X | |
| 258 | | | X | X | |
| 264 | | | X | | X |
| 288 | | | X | | X |
| 297 | | | X | X | |

A. HED DESCRIPTION

Control rod permissive lights are not readable from control rod controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.2.a.(1).

C. LOCATION

CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect interpretation of permissives.
2. Improper rod control or plant shutdown.

E. ASSESSMENT PROCESS

The layout of CB-07 was reviewed for location of a control rod permissive TSLB.

F. BACKFIT

A control rod Permissive & Control Interlock Panel (PCIP) has been installed on CB-07.

A. HED DESCRIPTION

The vertical meters within the process controller assemblies are difficult to read while operating the reactor startup controls on CB-07.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.2.a.(1).

C. LOCATION

CB-05.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Reviewed content of SPDS and examined proposed location of SPDS CRT.

F. BACKFIT

Information displayed by the process controllers will also be displayed on the SPDS CRT, which is visible from the reactor startup controls on CB-07.

A. HED DESCRIPTION

Bistable (Reactor trip status) lights on CB-04 are remote from related Reactor control on CB-07.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.2.a.

C. LOCATION

CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in responding to Reactor protection problems or failures.

E. ASSESSMENT PROCESS

1. Reviewed the feasibility of moving the permissive indicators to CB-07.
2. Analyzed the operator interface with these trip status lights.

F. BACKFIT

None.

1. JUSTIFICATION

   There is insufficient space on CB-07 to relocate the Reactor trip status lights. Analysis of the operator interface with these status lights indicates that their absence from CB-07 would not degrade operator performance to such an extent that plant safety would be compromised.

A. HED DESCRIPTION

Controls for annunciators on CB-06 are located on CB-07.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.2.a.(1).

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to read annunciators properly.

E. ASSESSMENT PROCESS

Feasibility of moving annunciator controls and potential new locations were examined.

F. BACKFIT

These annunciator controls have been moved to CB-06.

A. HED DESCRIPTION

Ammeter switch escutcheon does not agree with ammeter scale markings.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.1.c.

C. LOCATION

CB-11.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect control actuation and display reading.

Possible artial loss of power.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Ammeter switch 1-AS-W3 escutcheon will be engraved to match the ammeter.

A. HED DESCRIPTION

Vertical meter arrangement on the panel does not match the associated thumb switch arrangement.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.2.2.a. and b.

C. LOCATION

CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Loss of feedwater.
2. Reactor trip.

E. ASSESSMENT PROCESS

The feasibility of relocating the vertical meters and thumb switches was investigated.

F. BACKFIT

The thumb switches have been rearranged to match the associated vertical meter arrangement.

A. HED DESCRIPTION

Indicator lights, vertical meters, and MLBs/TSLBs are not located directly above related controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.2.b.(1).

C. LOCATION

CB-01, CB-02, CB-04, CB-05, CB-08, CB-09, CB-11, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in equipment operation.

E. ASSESSMENT PROCESS

1. Related controls identified.
2. Feasibility of relocating indicators investigated.

F. BACKFIT

The indicator lights and vertical meters have been relocated above related controls where feasible. Where not feasible, indicating lights were rearranged to match arrangement of related controls and demarcated to enhance control/display relationship. MLBs/TSLBs were relocated and matrices rearranged as required to perform their intended function.

A. HED DESCRIPTION

Reset pushbutton obscures view of counter digits when viewed from the side.

B. CUIDELINE REFERENCE

NUREG-0700: 6.9.1.1.b.

C. LOCATION

CB-01, CB-06, and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Readability of counters was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

   Counters are readable from the normal operating position.

A. HED DESCRIPTION

The association of synchroscope switches with the synchroscope meters is not clear.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.1.c.

C. LOCATION

CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in breaker operation.

E. ASSESSMENT PROCESS

Alternative locations were examined.

F. BACKFIT

None.

1. JUSTIFICATION

   Both synchroscopes are energized by any synchroscope switch.

A. HED DESCRIPTION

The indications for plant response to operation of the PWR RANGE BLOCK TRAIN A and B pushbuttons on CB-07 are remotely located on the NIS panel, which is outside of the main control board area.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.1.

C. LOCATION

NIS panel and CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delay in plant operation.
2. Inability to detect a failure of block action, causing plant shutdown.

E. ASSESSMENT PROCESS

The operational requirements to assure successful performance in situations involving these indications were reviewed.

F. BACKFIT

The permissives to be provided with the installation of the Permissive Control Interlock Panel (PCIP) will supply the necessary indications.

# APPENDIX C

# ANNUNCIATOR SYSTEM
# HUMAN ENGINEERING GUIDELINES

HUMAN ENGINEERING GUIDELINES

1.0 PLANT: Comanche Peak Steam Electric Station

3.0 REV. NO. 0

REV. DATE ______

2.0 TITLE: ANNUNCIATOR SYSTEMS

4.0 GUIDELINES

4.1 INTRODUCTION

A major source of information in nuclear power plant control rooms is provided by the annunciator system. Plant annunciators should be used to do the following:

A. Alert operators to impending out-of-tolerance conditions

B. Inform operators of malfunctioning or out-of-tolerance systems

C. Bring attention to out-of-tolerance alarms which have returned-to-normal process conditions

D. Diagnose plant accidents and transients.

This document provides human engineering guidelines for the design and operation of the annunciator system in the Comanche Peak Steam Electric Station control room. Adherence to these criteria will provide a uniform, standardized scheme for the following:

A. General annunciator alarm indication

B. First-out annunciator alarm indication

C. Localization of annunciator auditory alarm signals and control stations

D. Annunciator matrix organization

E. Prioritization of annunciator auditory alarm signals and control stations

F. Labeling annunciator messages.

All of the above reduce human error related to the annunciator system.

4.2 GENERAL GUIDELINES

A. Annunciator warning systems should consist of three major subsystems:

1. auditory alert
2. visual alarm
3. operator response.

B. Illuminated tiles (steady on) should be distinguishable, from non-illuminated (steady off) annunciator tiles.

C. Annunciator tiles should illuminate in the case of flasher failure.

D. Out-of-service, or annunciators that are to remain ON for an extended period of time should be distinctively coded and controlled by administrative procedures.

E. Blank or unused annunciator tiles should not be illuminated.

F. Nuisance alarms should be avoided.

G. Setpoints should be established to give operators adequate time to respond to warning conditions.

H. Alarms which refer the operator to another more detailed panel should be minimized.

I. Alarms for shared plant systems and/or equipment should be duplicated on both units.

## 4.3 DETAILED GUIDELINES

A. GENERAL ANNUNCIATOR ALARM INDICATION - Annunciators are used to call the operator's attention to abnormal and returned-to-normal process conditions by means of audible signals and diacritical flash rates.

1. Flashing illumination should be used to indicate an alarming condition.
2. Annunciator flash rates should be between three (3) to five (5) flashes per second.
3. No more than three (3) flash rates should be used.
4. Flash rates should be distinguishable.
5. Annunciators should flash at a FAST-FLASH to indicate abnormal process conditions; and change to STEADY when alarms are ACKNOWLEDGED.
6. Annunciators should have ringback capability to denote when annunciator alarms have cleared and should be RESET. The visual signal for this capability should be SLOW FLASH rate.
7. For multiple input alarms, reflash capability should be provided to allow for subsequent alarms to be identified and ACKNOWLEDGED.
8. For multiple input alarms, alarm printout capability should be provided.

9. General annunciator alarm conditions as well as the recommended operator control action, and its associated annunciator alarm response should be illustrated in the matrix below:

BETA PRODUCTS INC. Sequence RFFM-Maintained Alarm

(Refer also to Figure I)

| ALARM CONDITION | CONTROL ACTION | ANNUNCIATOR ALARM RESPONSE |
|---|---|---|
| NORMAL | — | OFF |
| ABNORMAL | — | FAST-FLASH |
| ABNORMAL | ACKNOWLEDGE | STEADY |
| NORMAL | — | SLOW-FLASH |
| NORMAL | RESET | OFF |

B. FIRST-OUT ANNUNCIATOR INDICATION - First-Out annunciator indication allows for faster fault analysis by informing the operator of the annunciator trip alarm which initiated subsequent annunciator alarms. Knowing the initial cause of a trip the operator can more efficiently and quickly diagnose the problem and reduce temporal, interpretative and diagnostic errors.

1. A separate First-Out annunciator panel should be provided for the Reactor System and consist of alarms for each of the automatic reactor trip functions.
2. The First-Out annunciator panel should be set apart from other annunciator (e.g., red border).
3. The First-Out panel is located above the Reactor Control System - panel CB-07.
4. Annunciator information should not be redundant. The term REACTOR TRIP can be deleted from the message.
5. First-Out and subsequent annunciator alarm conditions as well as the recommended operator control action and its associated annunciator alarm response are illustrated in the matrix below:

BETA PRODUCTS INC.: Sequence SCFL-Maintained Alarm

(Refer also to Figure II)

| ALARM CONDITION | CONTROL ACTION | ANNUNCIATOR ALARM RESPONSE FIRSTOUT | SUBSEQUENT |
|---|---|---|---|
| NORMAL | — | OFF | OFF |
| ABNORMAL | — | RED FLASH | WHITE FLASH |
| ABNORMAL | ACKNOWLEDGE | STEADY RED | STEADY WHITE |
| NORMAL | — | STEADY RED | OFF |
| NORMAL | FIRST-OUT RESET | OFF | OFF |

C. LOCALIZATION OF ANNUNCIATOR ALARM SIGNALS AND CONTROL STATIONS - LOCALIZED - Annunciator auditory alarm signals and control stations minimize the possibility of error by reducing the confusion factor involved in trying to locate which annunciator panel is in alarm, and thereby also minimizing the control/display response time.

1. Annunciator Auditory Alarm Signals (Refer to Figure III)
   a. Two types of auditory alarm signals should exist:
      1) Alert - Auditory indication of an abnormal condition
      2) Ringback - Auditory indication of a return-to-normal condition.
   b. The main control board is divided into three sections:
      1) CB-01 through CB-04
      2) CB-05 through CB-08
      3) CB-09 through CB-11

      and is termed left, center and right respectively. Each section should contain both an Alert and Ringback horn specific to that section.
   c. In addition, a set of horns (Alert and Ringback) should also be located above the First-Out annunciator panel and pertain only to the First-Out alarms.
   d. Additional Alert and Ringback horns are located at the HVAC and Switchyard panel locations.
   e. Intensity levels should be 10dB (A) above average ambient noise and if adjustable, is regulated by administrative controls.
   f. For frequency coding, the First-Out signal should be 100 Hz above or below the general signal.

g. For frequency change coding, the center frequency should be between 500 and 1.000 Hz at a rate of 1 to 3 seconds per cycle.

h. For pulse coding, the signal should be turned on and off at a rate of approximately 1 second per cycle with a tone and silence duration of 0.5 second each.

i. No more than seven (7) coded frequencies should be used for each particular audible signal (e.g., horn, bell, siren).

2. Annunciator Control Stations

a. Fifteen control stations exist:

CB-01 through CB-06; 1 control station each,
CB-08 through CB-12; 1 control station each,
CB-07; 2 control stations,
CV-01; 1 control station,
CV-03; 1 control station.

b. Each annunciator control station should control the annunciator alarm box(es) located on that control panel.

c. Annunciator control stations should be distinct from nearby unassociated controls and displays.

d. All control stations should be placed such that:

1) All annunciators controlled are clearly readable from the point of operation of the controls,

2) Association between annunciators and controls is clear,

3) All controls necessary for annunciator operation are collocated.

e. Each annunciator control station should consist of the following controllable features:

1) SILENCE - Used to silence <u>any</u> auditory SIGNAL or RINGBACK signal,

2) ACKNOWLEDGE - Used to change the FAST FLASH to the STEADY state and "inform" the system that annunciators have been acknowledged,

3) RESET - Use to silence and clear annunciator when a system/ component problem has been corrected,

4) TEST - Used to test the operability of annunciator flash unit, bulbs, and audibles.

f. All annunciator control stations should have the same arrangement and relative location at different work stations.

g. Annunciator control stations should be coded (demarcated) to discriminate between other pushbutton controls.

D. ANNUNCIATOR MATRIX ORGANIZATION - All annunciators relating to a system should be grouped together for ease in locating and monitoring related systems and components. Lack of functional groups may reduce the alarm system's usefulness, and increase the probability of error.

1. Annunciator alarm tiles should be grouped by function or system within each annunciator matrix.
2. Annunciator alarm panels should be located above their related controls and displays.

E. PRIORITIZATION OF ANNUNCIATOR ALARMS - Annunciator prioritization enhances the operator's ability to diagnose problems quickly, and reduces erroneous assumptions about the importance of annunciator alarms.

1. Annunciators should be prioritized.
2. Three levels of priority should be used:

a. First Priority Alarms
- Plant shutdown (Reactor Trip, Turbine Trip)
- Radiation release
- Plant conditions which, if not corrected immediately, will result in automatic plant shutdown or radiation release, or will require manual plant shutdown

b. Second Priority Alarms,
- Technical specification violations which, if not corrected, will require plant shutdown
- Plant conditions which, if not corrected, may lead to plant shutdown or radiation release.

c. Third Priority Alarms,
- Plant conditions representing problems (e.g., system degradation) which affect plant operability but which should not lead to plant shutdown, radiation release, or violation of technical specifications.

3. If color is used to prioritize alarms, first priority alarms should be colored red; second priority alarms are colored amber; and third priority alarms are colored white.
4. In conjunction with the annunciator prioritization color coding scheme, the Permissive and Control Interlock Panel (PCIP) tiles should be color coded blue.

F. LABELING ANNUNCIATOR MESSAGES - Annunciator labels must communicate information rapidly, efficiently and clearly, with minimal likelihood of delays or errors in reading and interpretation. Unfortunately, labeling space is constrained by annunciator window size, and, as such, whole word messages cannot often be used. Abbreviations and acronyms are used to increase the amount of information presented within the compact space of annunciator windows. In order to relay information most effectively, this nomenclature must be consistent and clear. Variable or ambiguous nomenclature increases the time required for an operator to understand an alarm and increases the possibility of misreading or misinterpretation, followed by erroneous responses. In order to minimize the possibility of error, nomenclature was revised and standardized, a standard format for the layout of annunciator legends was established, and annunciator character size was determined.

1. Annunciator General Labeling Requirements
   a. Font style should be simple. Condensed block can be used, as this meets height/width requirements (see Section F-4).
   b. Font style should be consistent on all annunciator tiles in the main control room.
   c. Labeling should be in capital letters, without flourishes, embellishments or serifs.
   d. Legends should be engraved (black lettering on white translucent tiles) and readable without back lighting.
   e. Characteristic features such as breaks or openings should be readily apparent (e.g., S GA, not SGA).
   f. Symbols should be oriented vertically.
   g. Messages should be printed left to right, not top to bottom.
   h. Diagonal parts of letters, numerals and slashes should be approximately $30^{\circ}$.

2. Revised and Standardized Nomenclature

   Consistent use of abbreviations and acronyms reduces message length and permits wider margins and larger font engravings. Readability is improved because key terms are not buried in a margin-to-margin legend, but are noticeable in the open annunciator field.

   a. Annunciator legends should be specific and unambiguous.
   b. Abbreviations and acronyms are consistent with those used throughout the control room.
   c. Some symbols can be used on annunciator legends:
      / - indicating OR (e.g., SSWP 1/2 Station Service Water Pump 1 <u>or</u> 2)
      o - indicating THROUGH (e.g., ACCUM 1o4 Accumulators 1 THROUGH 4).
      & - indicating AND (e.g., CSP 1 & 3 Containment Spray Pump 1 AND 3).
      \ - used in some abbreviations to separate two words

   d. Where an abbreviation or acronym is used once, it should then be used continuously throughout the control room. This is done in order to maintain consistency and reduce the time required in transference of information.
   e. Abbreviations for system/components such as STEAM GENERATOR and FEEDWATER should always be standardized as SG and FW, respectively, whether spacing for a longer abbreviation is available or not (e.g., not STM GEN; FD WTR).

3. Format for Layout of Annunciator Legends

   Labeling density is reduced and readability improved by the use of a consistent format that provides the operator with information in a regular pattern.

   Examples of annunciator legend formats;

   a. Three line tier of information;
      1) First Line: System/Component
      2) Second Line: Subcomponent or Parameter Monitored
      3) Third Line: Alarm Status

e.g. SERV AIR

HDR PRESS

LO

b. Four line tier of information;

(This format should be used when legend length requires a deviation from the three line format. The four line format provides improved clarity and maintain consistency).

1) Two successive lines are compressed to provide the same pattern recognition as the three line format.

e.g. CCW HX
PIPE CHASE RM

SMP LVL

HI-HI

SSW TO
CCW HX 1 & 2

OUT FLO

LO

2) Where alphanumeric engineering numbers are required, they should appear on line 4.

e.g. SSW TRN A

AFWP SPLY VLV

NOT CLOSED

HS-4395

4. Annunciator Character Size and Related Information

a. Letter height should subtend a minimum visual angle of 15 minutes.

b. Stokewidth-to-character height ratio should be between 1:6 and 1:8.

c. Character width-to-height ratio should be between 1:1 and 3·5.

d. Numeral width-to-height radio should be 3:5.

e. Minimum space between characters should be one strokewidth.

f. Minimum space between words should be the width of one character.

g. Minimum space between lines should be one half the character height.

h. Recommended character heights and related information is listed below. Refer also to Figure IV.

1) Three line tier of information:

| | | | |
|---|---|---|---|
| a) | Character height | = | .22" |
| b) | Character width | = | .132" |
| c) | Strokewidth | = | .0275" |
| d) | Spacing between characters | = | .0275" |
| e) | Spacing between words | = | .132" |
| f) | Spacing between lines | = | .165" |
| g) | Top and bottom margins | = | .38" |
| h) | Characters per line | = | 14 (15 with I's). |

2) Four line tier of information

Compressed lines: Line 1 and Line 2

| | | | |
|---|---|---|---|
| a) | Character height | = | .22" |
| b) | Character width | = | .132" |
| c) | Strokewidth | = | .0275" |
| d) | Spacing between characters | = | .0257" |
| e) | Spacing between words | = | .132" |
| f) | Spacing between line 1 and line 2 | = | .11" |
| g) | Spacing between line 2 and line 3 | = | .165" |
| h) | Spacing between line 3 and line 4 | = | .165" |
| i) | Top and bottom margins | = | .215" |
| j) | Characters per line | = | 14 (15 with I's) |

3) Four line tier of information

Alphanumeric engineering number: Line 4

| | | | |
|---|---|---|---|
| a) | Character height | = | .22" |
| b) | Alphanumeric height | = | .11" |
| c) | Character width | = | .132" |
| d) | Alphanumeric width | = | .066" |
| e) | Character strokewidth | = | .0275" |
| f) | Alphanumeric strokewidth | = | .01375" |
| g) | Spacing between characters | = | .0275" |
| h) | Spacing between alphanumerics | = | .01375 |
| i) | Spacing between words | = | .132" |
| j) | Spacing between all lines | = | .165" |

k) Top and bottom margins = .2425"

l) Characters per line = 14 (15 with I's)

The above character specifications were derived from calculations based on pertinent human factors information. Realizing that engraving machines are not as specific (exact), the above figures are used as a guide.

# APPENDIX D

## VERTICAL INDICATORS
## HUMAN ENGINEERING GUIDELINES

# HUMAN ENGINEERING GUIDELINES

| | | | |
|---|---|---|---|
| 1.0 PLANT: Comanche Peak Steam Electric Station | 3.0 | SPEC. NO | |
| | | SPEC. DATE | 6/2/82 |
| | | REV. NO. | |
| | | REV. DATE | |

2.0 TITLE: **VERTICAL INDICATORS**

4.0 CONTACTS:

| | Name | Phone |
|---|---|---|
| o UTILITY: | Ron Estes | (817) 897-4032 |
| o A&E: | Gibbs & Hill | (212) 760-4400 |
| o ESSEX: | Allen Elliff | (703) 548-4500 |
| o OTHER: | | |

5.0 GUIDELINES

The requirements contained in the present document apply to single and dual vertical indicators in the Comanche Peak Steam Electric Station control room. The aim is to provide specific guidance and criteria for the labeling of vertical indicator scale faces. Adherence to these criteria will provide a uniform, standardized scheme for labeling vertical indicators which will enhance visual search while reducing control and display errors.

5.1 INFORMATION

A. Content — The information displayed to an operator should be limited to that which is necessary to perform specific actions or to make decisions.

B. Format — Information should be presented to the operator in a directly usable form (requirements for transposing, computing, interpolating, or mental translation into other units should be avoided whenever possible).

C. Precision — Information should be displayed only to the degree of specificity and precision required for a specific operator action or decision.

D. Redundancy — Redundancy in the display of information to a single operator should be avoided unless it is required to achieve specified reliability.

E. Display Failure Clarity — Displays should be so designed that failure of the display or display circuit will be immediately apparent to the operator.

F. Unrelated Markings — Trademarks and company names or other similar markings not related to the panel function should not be displayed on the panel face.

5.2 ARRANGEMENT

A. Accuracy — Displays should be located and designed so that they may be read to the degree of accuracy required by personnel in the normal operating or servicing positions.

B. Consistency — The arrangement of displays should be consistent in principle from application to application.

5.3 DESIGN REQUIREMENTS

A. Linearity — Except where system requirements clearly dictate nonlinearity to satisfy operator information requirements, linear scales should be used in preference to nonlinear scales.

B. Scale Markings

1. Graduations -
   a. Wherever possible, scale graduation shall progress by one, two, or five units or decimal multiples thereof.
   b. No more than nine minor and intermediate marks between numbered scale gradations.
   c. Major and minor gradation marks should be used if there are up to four gradation marks between numbered scale gradations.
   d. Major, intermediate, and minor gradation marks should be used if there are five of more gradations between numbered scale gradations.
2. Similar scales - When two or more similar scales appear on the same panel, they should have compatible numerical progression and scale organization.
3. Spacing - Minor graduation marks should be spaced no closer than .04 inch. If possible, major graduation marks should be spaced no closer than .50 inch. All major graduation marks should be numbered.

4. Length and Stroke Width

   Single indicators — see Attachment A

   Dual indicators — see Attachment B

C. Alphanumerics

1. Style - Labeling should be in all capital letters without flourishes, embellishments, or serifs. Diagonal parts of letters and numbers should be as close to $45^{\circ}$ as possible; characteristic features such as breaks or openings should be readily apparent, and critical details should be simple but prominent. An example of a recommended and acceptable font is Condensed Block or Futura Condensed (see Attachment C).
2. Character size - The width of the character should be determined by the height of the character, and is usually expressed in terms of width-to-height ratio. For numerals, the width-to-height ratio should be 3:5 except for four, which should be one strokewidth wider, and one, which should be one strokewidth wide. Stroke width-to-height ratio is between 1:6 and 1:8. In the case of letters, a width-to-height ratio of 3:5 is recommended, except for letters M and W, which should be one strokewidth wider, and the letter I, which should be one strokewidth wide. For specific recommendations concerning the size of alphanumerics to be used on single and dual indicators, see Attachments A and B respectively.
3. Spacing - The minimum acceptable spacing should be one strokewidth between characters, one char cter width between words, and one-half of the character height between lines (see Attachments A and B).
4. Numbering of scale graduation - Except for measurements that are normally expressed as decimals, whole numbers should be used for every major graduation mark. Display scales should start at zero, except where this would be inappropriate for the function involved. The end points of the scales should be numbered.

D. Scale Bands

1. Single indicator bands - Single indicators have two scale bands, one wider than the other (see Attachment A for specific dimensions). The wider band should retain both the scale markings and numerals. The narrow band should retain the units description (e.g., GPM, PSIG, FEET).

2. Dual indicator bands - Dual indicators are comprised of three scale bands, two of equal width and one narrower band located between the wider bands. The narrower band should contain both sets of scale markings as it does at present. The wider bands should contain only the numerals. The units description (GPM, PSIG, FEET, etc.) should be included in the labeling above the indicator. See Attachment B for the specific recommended dimensions of the scale bands. This type of scale organization will allow more digits to be displayed on the scale band, permitting simplification of the units' designation and less mental translation by the operator.

E. Other Markings

1. Minus signs - Minus signs should preceed any negative value, and should be dimensioned as any other character. See Attachments A and B for specific character sizes.
2. Plus signs - Plus signs should not be used except where clarity is enhanced (e.g., -2, 0, +2).
3. Size graduation - Subscripts and superscripts (e.g., $6_{10}$ in $10^6$) should be avoided on scales, but when necessary should be about 25 percent smaller than other numerals (see Attachments A and B for normal size recommendations).

F. Color — Vertical indicator scale faces should be white with black characters.

G. Coding — Both single and dual indicators may be color coded for normal operating range and set points (see Attachments D and E).

H. Pointers

1. Length - The display should be designed so that the control or display pointer will extend to, but not obscure, the shortest scale graduations.
2. Width - The width of the pointer, where it intercepts the graduation marks, should not exceed the width of the intermediate marks.
3. Mounting - The pointer should be mounted as close as possible to the face of the dial to minimize parallax.
4. Calibration Information - Provisions shall be made for placing calibration stickers on instruments without interfering with dial legibility.

## 6.0 CONSEQUENCES OF VIOLATION

Incorrect display reading and interpretation.

# APPENDIX E

# DEMARCATION, LABELING, AND MIMICS HUMAN ENGINEERING GUIDELINES

## HUMAN ENGINEERING GUIDELINES

| | | | |
|---|---|---|---|
| 1.0 PLANT: | Comanche Peak Steam Electric Station | 3.0 SPEC. NO. | ________ |
| | | SPEC. DATE | 6/2/82 |
| | | REV. NO. | ________ |
| | | REV. DATE | ________ |

2.0 TITLE: **DEMARCATION, LABELING, AND MIMICS**

4.0 CONTACTS:

| | Name | Phone |
|---|---|---|
| o UTILITY: | Ron Estes | (817) 897-4032 |
| o A&E: | Gibbs & Hill | (212) 760-4400 |
| o ESSEX: | Allen Elliff | (703) 548-4500 |
| o OTHER: | | |

5.0 GUIDELINES

A. Background — These guidelines have been prepared for the Comanche Peak Steam Electric Station (CPSES) located at Glen Rose, Texas. Specific design requirements and criteria have been selected and presented here based on the existing Comanche Peak Unit 1 control room design. These guidelines were developed as part of a detailed human engineering evaluation of the Comanche Peak Unit 1 control room. In several instances the constraints of the existing design preclude backfits which would be optimum in accordance with human engineering guidelines. Extending applicability of these guidelines to other nuclear power plant control rooms is therefore not recommended since these guidelines are intended for use by CPSES personnel to develop Unit 1 control room enhancements, as applicable.

The basis for these guidelines is NUREG-0700, Guidelines for Control Room Design Reviews; generally accepted and applied human engineering criteria; the conventions currently employed in the CPSES control room; and the constraints inherent in the existing CPSES control board design.

B. Purpose — The purpose of these guidelines is to provide specific human engineering guidance and criteria for developing uniform, standardized demarcation, labeling, and mimic schemes in the CPSES control room. Application of these guidelines to the development of demarcations, labeling, and mimics should result in the following:

1. Reduced visual search requirements in locating controls and displays.
2. Reduced probability for control and display substitution errors.
3. Reduced probability for control usage errors (missetting of controls).

C. Guideline Document Organization — Human engineering guidelines for demarcation, labeling, and mimics are highly inter-related. Implementation of these enhancements in the CPSES control room should therefore be integrated. For example, the demarcation design selected will define the opportunities for summary labeling, which will in turn impact the text of component labels.

To provide a somewhat orderly context to this document, the guideline topics will be discussed in the following general order:

- o Demarcation
- o Labeling
- o Mimics.

D. Demarcation Design Requirements

1. Purpose — The purpose of demarcation is to reduce operator workload by reducing the amount of information that must be processed to locate a specific component. Demarcation allows the operator to search through groups of components rather than looking at each individual component. This reduces response time and probability of error.

2. Simplicity of Design — Human factors engineering attempts to make things only as complex as is necessary to achieve the operator's ends. Demarcation in the CPSES control room should be only as complex as is necessary to visually separate components, systems, etc.

3. Hierarchical Demarcation — Hierarchical demarcation should be used whenever possible. This reduces visual search on a CR, panel, system, and subsystem level. An example is presented below.

4. Demarcation Shapes — The overall shape of a demarcated area should be even and regular whenever possible. The recommended demarcation shape for CPSES is presented below.

5. Adjacent Demarcated Areas — Adjacent areas should be demarcated as shown below.

6. Demarcation Line Size — With hierarchical demarcation, major system lines should be wider than subsystem lines. Lines of 1/4" width are recommended for the widest line width.

7. Demarcation Line Color — Lines should be easily discernible but not so compelling as to become distracting. A much deeper saturation of the panel surface color usually works well. For Comanche Peak with its beige panels, a dark brown is recommended. Nonglare material should be used.

8. Bezel Color — The CPSES control board has modular-type control switch housings that have raised black bezels which are dark in color. To implement a demarcation scheme that is beneficial to the operator, the color of all the control switch module bezel edges should be painted beige (to match the control board color).

E. Label Design Requirements

1. Standardization — Labels shall be located in a consistent manner throughout the control room. Label organization, content, wording and other characteristics shall be as consistent as possible across all labels.

2. Orientation — Labels and information thereon should be oriented horizontally so that they may be read quickly and easily from left to right. Vertical orientation shall be used only when labels are not critical for personnel safety or performance and where space is limited. When used, vertical labels shall read from top to bottom.

3. Location — Labels shall be placed on or very near the items which they identify, in order to eliminate confusion with other items and labels. Labels shall be located such that they do not obscure any other information needed by the operator. If possible, labels should be placed so that they are not obscured by controls.

   a. Summary Labels

      1) Where possible, summary labels shall be located above the system or functional group they identify. Exceptions include instances where space cannot accommodate summary labels or where label visibility is reduced by intervening components (e.g., control handles).

      2) Where possible, summary labels shall be located within or on associated demarcation lines.

b. Component Labels

1) Control and display labels should be located on the flattest, most uncluttered surface avaliable (preferably on the chassis, face plate, or bezel of the equipment itself) so that they may be read to the degree of accuracy required by personnel in normal operating positions.

2) Whenever possible, control labels should be placed above the controls they describe. Component labels for indicator lights, trend recorders, vertical indicators, and other displays on the vertical section of the panel should be located such that they are easily visible.

3) Curved labeling patterns should be avoided if possible.

4) Labels should appear upright at all times, even when the assembly changes from horizontal to vertical position.

5) Control position labels should be clear and horizontally oriented where practical. However, ease of control operation should be given priority over visibility of control position labels.

6) Labels should be located in a pattern or position such that they are not obscured by hardware, wherever possible.

7) Labels should be located so that the operator's hand does not obstruct any pertinent label, control, indicator or display during normal operation.

8) Two labels should not be placed so close together that they look like a continuation of one another. However, shared label plates are permissible if clearly delineated.

9) Labels on instrument faces should detract from neither the important figures of the scale nor the readibility of the instrument.

10) No manufacturer's labels or trademarks should be included on the instrument. If manufacturer's labels are present, they should be of a subordinate nature in style and location to all other labeling.

4. Label Qualities

   a. Visibility and Legibility — Labels shall be designed to be read easily and accurately at the anticipated operational reading distances and illumination levels, taking into consideration the following factors:

      1) Contrast between the lettering and its immediate background

      2) Height, width, strokewidth, spacing, and style of letters and numerals

      3) Method of application (e.g., etching, decal, and painting).

   b. Access — Labels shall not be covered or obscured by other units in the equipment assembly.

   c. Label Life — Labels shall have high contrast, and be mounted so as to minimize wear or obscurement by grease, grime, or dirt.

   d. Maintenance — Engraved labels on horizontal panels should be filled with a paint pigment, or covered with a clear plastic cover to prevent the etching from filling with dirt or grease which would cause a reduction in legibility. Caution should be used in covering labels with clear plastic in order to not introduce unacceptable levels of glare.

   e. Label and Background Colors — Colors of labels and backgrounds will be chosen to maximize contrast. Label plates should be a light color with black lettering. Summary labeling should be black lettering against the beige color of the control board.

   f. Train Indication — Train shall be indicated on labels for train-specific controls and displays by an orange (Train A) or green (Train B) designator. The design should be selected for ease of recognition at the anticipated viewing distance at which train identity is required.

F. Use of Summary Labels with Demarcation

1. Utilization of Summary Labels — Summary labels further reduce operator workload by reducing memory requirements and visual search times. They can be used without demarcation lines but are most effective with them. If used without demarcation, there should be some visually apparent separation between component groups.

2. Location — Summary labels should be located above the system/component group being labeled. If the label can't be placed above the components, strive for consistent placement on the control panel. Summary labels should be placed in a manner to minimize the possibility of associating the summary label with the wrong system or subsystem.

3. Size of Labels — The size of the summary labels will depend on the size of component labels. There is a hierarchy of labeling, with each hierarchical step at least 25% larger than the one below it. The hierarchy is:

   a. System/Work station (at least 25% larger than Major Subsystem)

   b. Major Subsystem (at least 25% larger than Small Subsystem/Component Group)

   c. Small Subsystem/Component group (at least 25% larger than component)

   d. Component (at least 25% larger than position)

   e. Position, both control and scale.

4. Content — The summary label terminology should be the same as that used on the annunciators and panels, and in the procedures. The use of abbreviation acronyms, and syntax should be consistent. If summary hierarchical labeling is enclosed within demarcation lines, repeating the major terms is not always necessary.

G. General Design Guidelines for Label Characters

1. Font of Alphanumeric Characters

   a. The same font should be used throughout the entire control room.

   b. Labels should be in all capital letters without flourishes, embellishments, or serifs. Lower case letters should only be used were industry or general stereotypes would interfere with correct interpretation of all capital letters.

   c. Diagonal parts of letters and numerals should be as close to 30° as possible. Characteristic features such as breaks or openings should be readily apparent. Critical details should be simple but prominent.

2. General Label Spacing and Size Requirements

   a. Character Spacing — The minimum space between characters shall be one strokewidth.

   b. Word Spacing — The minimum space between words shall be the width of one character (other than "I," "M," or "W").

   c. Line Spacing — The minimum space between lines shall be one-half character height.

   d. Label Size — Given the constraints on spacing covered in the preceding items, the physical size of component labels and the number of lines of text will cause an upper limit to the character size. Strict adherence to these guidelines will lead to maximum character heights for component labels as shown in Table 1.

   e. Minimum Character Size — Based on NUREG-0700 guidelines, minimum character height can be calculated based on viewing angles. Table 2 presents these minimum character heights.

   f. Recommended Character Heights — Table 3 presents recommended character heights for various label categories in the CPSES control room. These recommended heights were selected based on satisfying four constraints:

      - o Maximum height based on label height
      - o Minimum height based on human factors criteria in NUREG-0700
      - o Viewing distance based on control room anthropometrics
      - o At least 25 percent increase in character height as hierarchy level increases.

3. Recommended Font — The recommended font for CPSES is Regular Block or Futura Medium (regular width) for system and subsystem labels, and Condensed Block or Futura Medium condensed for component labels.

   a. For system and subsystem labeling, the width of the letters is determined by the font, and is within the character height-to-width ratio limits of 1:1 and 5:3. The character height-to-stroke width is also determined by the font and is between 6:1 and 8:1. To ensure permanence, the labeling should be sandwiched within two layers of clear mylar tape and then applied to the control board.

b. For component labeling, Futura condensed or condensed Block, lettering have an acceptable character height-to-width ratio of approximately 5:3. The stroke width is adjustable to some extent and should achieve an acceptable character height-to-stroke width ratio of between 6:1 and 8:1.

4. Size of Alphanumerics — The sizes listed in Table 3 represent recommendations which should be adhered to except in instances where space constraints exist. Where space is limited, somewhat smaller lettering is allowable, but in all instances lettering at a given level should be at least 25% larger than lettering at the next lower level.

5. Label Content and Syntax Requirements

a. Highly similar names for different controls and displays shall be avoided.

b. Labels should primarily describe the function of the control, and any secondary engineering characteristics.

c. Labels should be clear and concise, minimizing redundancy and avoiding lengthy or complex sentences.

d. Only required information written in language familiar to all operators should appear on labels. Unusual technical terms should be used only when absolutely necessary.

e. Instruments should be labeled in terms of what is being measured or controlled. Information should be displayed only to the degree of accuracy necessary for operator actions or decisions.

f. Standard sentence structure is "Component to Component." For example:

1) HX VLV TO RHR PUMP
2) RHR PUMP OUTLET VLV TO SPRAY HDRS.

g. Label nomenclature should be consistent with that in the procedures and technical specs (e.g., if a procedure mentions flow in gallons per minute, the display should not be in cubic feet per second).

h. Engineering designators (e.g., valve numbers, electrical buss, etc.) should not be used as the primary nomenclature.

i. Functional group and system labels should be utilized throughout the control room, where practical.

j. Abbreviations and acronyms should be standardized. The same abbreviation should be used for all tenses of the word, and for both singular and plural forms. No periods should appear after abbreviations except to preclude misinterpretation. Only commonly recognized abstract symbols (e.g., %) should be used. The CPSES Dictionary of Acronyms and Abbreviations should be used to determine the proper abbreviation or acronym to be used.

k. On all pump controls, a label indicating the electrical buss shall be placed on or near the control module. The label should be beige with black lettering and should be placed in the lower left corner of the module.

6. <u>System Summary Labeling Guidelines</u>

a. The character height for all system summary labeling is selected to be .72 inches which complies with the suggested recommendations.

b. The recommended relevant character and label wording dimensions are:

| | |
|---|---|
| Character height - .72" | Letter Separation - .125" (min) |
| Character width - .60" | Word Separation - .60" (min) |
| Strokewidth - .12" | Line Separation - .36" (min) |

7. <u>Subsystem/Component Group Labeling Guidelines</u>

a. Component labeling characters are centered vertically and horizontally on labeling plate, or where applicable on panel between controls and displays.

b. Human engineering criteria suggest that for viewing distances of between 39 and 79 inches, lettering height should be approximately .37 inch. Additionally, for System Summary labels to be 25% larger, component group labels should not exceed .60 in height.

c. The character height for the component group labeling is selected to be .375 inch, which complies with the suggested recommendations.

d. The relevant character and label wording dimensions are:

| | |
|---|---|
| Character height - .36" | Letter Separation .06" (min) |
| Character width - .30" | Word Separation - .30" (min) |
| Strokewidth - .06" (1/6 H) | Line Separation - .188" (min) |

The above measurements for character size are used for all component group labeling where space permits. The cases where this applies include:

1) Control labeling with one line of print
2) Control labeling with two lines of print
3) Control labeling for two or more displays

e. Where room does not permit, the following measurement criteria apply:

| | |
|---|---|
| Character height - .25" | Letter Separation - .042" (min) |
| Character width - .15" (3/5 Ht) | Word Separation - .15" (min) |
| Strokewidth - .042" (1/6 Ht) | Line Separation - .125" (min) |

8. Component Labeling Guidelines

a. Component labels and label characters should be centered above or below the component and oriented horizontally. Where label content requires overly long labels, labels may be located to the sides of vertical indicators.

b. Human engineering criteria suggest that for viewing distances between 20 and 39 inches, lettering height should be approximately .18 inch. Height should not exceed 0.30 inch in order for the small subsystem/component group labels to be 25% larger.

c. The recommended character height for component label characters is 0.200 inch. The following measurement criteria apply:

| | |
|---|---|
| Character height - 0.20" | Letter Separation - 0.033' (min) |
| Character width - 0.12" (3/5 Ht) | Word Separation - 0.12" (min) |
| Strokewidth - 0.033" (1/6 Ht) | Line Separation - 0.100" (min) |

H. Mimics

1. Purpose — Mimics aid the operator by providing a graphic representation of a system and the interrelationships within the system. This reduces

operator memory requirements, visual search times, and error rates. Mimics are especially effective on infrequently operated systems, and can reduce training time.

2. Simplicity of Design — Mimics should incorporate minimum complexity of design. The tendency in mimic design is to place the P&ID on the board, but this creates a very cluttered visual field. Mimic design should limit information to only that necessary for operator task performance.

3. Direction of Flow — A consistent direction of primary flow should be maintained (e.g., left to right and top to bottom) if possible. Mirror imaging should be avoided, whenever possible.

4. Direction-of-Flow-Arrows — Use direction-of-flow arrows when possible, preferably embedded in the lines. Arrows should be placed, at a minimum, at each exit and entry point (e.g., at each label or component), potential decision point, and in the middle of a long line.

   For valves where dual direction of flow is possible, arrows should be shown in both directions rather than two-headed arrows. The primary direction (e.g., the most frequent, most important, etc.) should have heavier arrows than the opposite direction.

5. Line Crossings — Minimize line crossings. When lines must cross, leave an easily discernible, unambiguous break on each side of the unbroken line. Establish the convention that no multiple connections will be shown on the mimic as a "tee." That is, the mimic should always offset one of the four lines converging on a "tee" connection.

6. Parallel Lines — Keep an easily discernible, unambiguous separation between parallel lines. Avoid more than 3 mimic lines (preferred) or 5 mimic lines (maximum) running in parallel with equal spaces between them. When it is necessary to run in excess of 5 lines in parallel, increase every third, fourth, or fifth space.

7. Line Size — Use line size to distinguish between primary and secondary lines, the primary being the larger of the two. Major (primary) lines are to be approximately 1/4" in width. Minor lines are to be approximately 1/8" in width.

8. Symbology — Symbols should be used in mimics to convey useful information to the operator. When symbols are used in the mimics, they should be consistent throughout the CR. It is preferable to use the same or similar symbols used on the P&IDs, or symbols that have the same meaning to all operators.

9. Color Coding — Color coding should be consistent throughout the control room. Mimic line color(s) should be different from demarcation line color. Different saturations of color can be used to indicate different meanings (e.g., light blue vs. dark blue). A lower saturation (lighter color) and/or a thinner line can also be used to indicate test lines from primary lines. This lessens the test lines' visual competition with the primary lines. It should be noted that NUREG-0700 (6.5.1.6 - c.2) recommends that ". . . Red should be reserved to indicate unsafe, danger, immediate action required, or an indication that a critical parameter is out of tolerance."

10. Start and End Points — All start and end points should be at a labeled component or a legend plate. Legend plates should be labeled consistently and in a manner that aids the operator in locating each point.

**Table 1**

**Maximum Character Height on CPSES Component Labels Under "Optimum" Spacing Guidelines[1]**

| Label Height[2] | Lines of Test on Label 1 | 2 | 3 | Examples |
|---|---|---|---|---|
| 0.5" | 0.25" | 0.142" | N/A | CB06 Trend Recorders; small labels in lower corners of control modules |
| 0.7" | 0.35" | 0[illegible] | 0.14" | Small control modules with tall position bezel |
| 1.0" | 0.5" | 0.286" | 0.2" | Most other labels |

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[1] Top and bottom borders each 1/2 character height, and 1/2 character height separation between lines.

[2] Based on actual size or available space, where appropriate.

**Table 2**

**Recommended Character Heig^ts as a Function of Viewing Distance[1]**

| Viewing Distance | Character Height: Minimum[2] Acceptable | Character Height: Preferred[3] |
|---|---|---|
| Up to 20" (0.5 m) | 0.080" | 0.120" |
| Up to 39" (1 m) | 0.156" | 0.234" |
| Up to 79" (2 m) | 0.316" | 0.474" |
| Up to 158" (4 m) | 0.632" | 0.948" |
| Up to 316" (8 m) | 1.264 | 1.896 |

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[1] NUREG-0700, Guideline 6.6.4.1.a.(1).

[2] 15' of visual arc at maximum viewing distance within category.

[3] 20' of visual arc at maximum viewing distance within category.

**Table 3**

**Recommended Character Heights For CPSES Unit 1 Labels**

| Label Type | Height (in.) |
|---|---|
| Position Indication | 0.160 |
| Component | 0.200[1] |
| Small Subsystem/Component Group | 0.360 |
| Large Subsystem | 0.480 |
| System | 0.720 |

[1] On 1/2 inch height labels with two lines of text, and on 0.7 inch height labels with three lines of text, it will be necessary to either use a smaller character height or reduce the top and bottom borders on the label.

APPENDIX F

PERSONNEL RESUMES

# RONALD L. ESTES

EDUCATION:

| | |
|---|---|
| 1969 - 1970 | Pre-Engineering, Central Virginia Community College; Lynchburg, Virginia |
| 1966 | Senior Reactor Operator (SRO) Liscense, Babcock & Wilcox Test Reactor; Lynchburg, Virginia |
| 1963 | Nuclear Power School, Westinghouse, Bettis Atomic Laboratory; Pittsburg, Pennsylvania |
| 1961 | Submarine Nuclear Power School, United States Navy; New London, Connecticut |
| 1960 | Submarine Systems School, United States Navy; New London, Connecticut |
| 1959 | Communications Electronics Technical School, United States Navy; San Diego, California |

EXPERIENCE:

April 1980 - present

TEXAS UTILITIES SERVICES INC.
Glen Rose, Texas

Supervising Instrumentation and Control Engineer - Responsible for TMI-2 retro-fit projects including Reactor Vessel Level, Containment Water Level, Core Sub-Cooling Monitor, Core Exit Thermocouple Upgrade, Containment Hydrogen Monitor, Control Room Design Review and ERF Computer Software development.

Served as Human Factors Engineering Review team leader, conducting the Comanche Peak preliminary and detailed control room design review. The team consisted of engineers and specialists from two architectural firms, utility operating company and HFE consultant firm.

Supervised a team of engineers and technicians in upgrading the Comanche Peak Control Room to conform to NUREG-0700 requirements. Represented the utility in all NRC meetings associated with the control room reviews.

Prepared and presented testimony to the Advisory Committee on Reactor Safeguards concerning the SPDS and Emergency Response Facility computer system to be implemented in the Comanche Peak Steam Electric Station. Also presented was the control room design review methodology and the potential for system interactions in instrument and control systems.

Served as a committee member on the Westinghouse Owners Group Ad-hoc Committee for instrumentation which developed the first nuclear accident identification software system. Chaired the subcommittee on Verification and Validation (V & V) for the Safety Assessment System software. This effort was the first to use the NSAC draft guidelines on SPDS V & V. It was also the first effort to test an SPDS on a full function PWR simulator.

Active on task analysis subcommittee of the Emergency Response Guidelines Committee of the Westinghouse Owners Group.

Analyzed the site specific impact of Reguide 1.97 Rev. 2 and formulated the utility position and implementation plan for compliance.

June 1976 - April 1980

BROWN & ROOT INC.
Glen Rose, Texas

Project Instrumentation Engineer - Responsible for managing field engineers and technicians in support of the instrumentation construction activities for the Comanche Peak Steam Electric Station. This support group was responsible for procuring field instruments and installation material, resolving construction problems, issuing design changes, scheduling construction activities, and budgeting resources.

June 1974 - June 1976

BROWN & ROOT INC.
Houston, Texas

Senior Instrumentation Engineer - Responsible for instrumentation and controls design, procurement and customer liaison on nuclear plant systems on the South Texas Nuclear Project.

1968 - 1974

BABCOCK & WILCOX CO.
Lynchburg, Virginia

Instrument Engineer - Developed instrument and controls procurement specifications and as vendor-customer liaison, administered the contracts for several nuclear power plants including: Oconee, Arkansas Nuclear 1, Crystal River, SMUD, Three Mile Island 1 & 2 and Midland. Handled qualification testing, system checkouts, and field pre-operational testing.

1966 - 1968

BABCOCK & WILCOX CO.
Lynchburg, Virginia

Senior Reactor Operator/Shift Supervisor: Held Senior Reactor Operator (SRO) liscense to operate a 6 Mwth test facility. Supervised an operating shift and was responsible for facility maintenance of mechanical and instrumentation systems.

1959 - 1966 UNITED STATES NAVY
Submarine Program

Electronics Technician - Served on several conventional and nuclear submarines. Responsible for operation and maintenance of shipboard electronic equipment.

Reactor Operator/Watch Officer - Served as Reactor Operator and enlisted Watch Officer on two nuclear submarines.

PROFESSIONAL RECOGNITION:

Member IEEE
Member IEEE - 381 Working Group 2.1, Equipment Qualification
Member ISA
Member ISA committee SP-67.05 Signal and Control Piping/ Tubing Standards for Nuclear Power Plants

## DALE L. WALLING

EDUCATION:

B. S. - Electrical Engineering, University of Missouri-Rolla.

EXPERIENCE:

June 1975 - present

BLACK & VEATCH

Control Engineer - TUSI/Comanche Peak Steam Electric Station - Responsible for coordinating long-term human factors evaluation of control panels for a large nuclear power generating facility in compliance with NUREG-0700.

ISU/Ottumwa Generating Station, I&C Start-up/Checkout Engineer - Responsibilities included electrical control system testing and checkout of major fossil power plant equipment and systems, including design and retrofit of field modifications as required.

PSO Black Fox Station - Prepared licensing responses to TMI Action Plan Requirements (NUREG-0660).

Orlando Utilities Commission, Curtis H. Stanton Plant Unit 1 - Estimated project control department man-day requirements. Preparing scope descriptions and commodity quantity estimates for control equipment procurement packages.

PSO Black Fox Station - Responsible for electrical schematic design for several BOP systems. Coordinated PGCC control panel design.

PSO - Black Fox Station - Responsible for writing system descriptions for several BOP systems. Responsible for writing and administrating the BFS annunciator system specification.

PSO - Black Fox Station - Responsible for logic diagram design for several BOP systems as well as panel layouts for simulator training facility.

ERDA-10MWe Solar Pilot Plant - Responsible for control design of NSP plant modification used by Honeywell to test solar boiler & thermal storage unit.

CPA-UPA Coal Creek Power Plant (2-550MW Units) - Responsible for accessory equipment lists; some control system design.

PROFESSIONAL RECOGNITION:

Registered Professional Engineer; Missouri - 1980
Member ISA

**ROBERT D. BIRD**

EDUCATION:

| | |
|---|---|
| 1982 | Simulator Accident Analysis Training |
| 1981 | Westinghouse Owners Group Seminar on the Emergency Response Guidelines |
| | EPRI/Honeywell Human Factors Engineering Seminar |
| | Man Machine Interfacing Summer Program, Massachusetts Institute of Technology |
| 1980 | INPO Human Factors Engineering Workshop |
| | Simulator Accident Analysis Training |
| | EPRI Human Factors Engineering Seminar |
| 1979 | Senior Operator Certification, Westinghouse Initial Operator Training, Phases I, II, and III, Westinghouse |
| 1976 | B.S. - Electrical Engineering, Texas Tech University |

EXPERIENCE:

| | |
|---|---|
| 1979 - Present | TEXAS UTILITY GENERATING COMPANY |
| | Engineer, Plant Operations - Past and present activities include: TUGCO Lead on the Comanche Peak Steam Electric Station Detailed Control Room Design Review Evaluation of Units 1 and 2. |
| | Task Team Leader for Comanche Peak Steam Electric Station Human Factors Engineering Preliminary Assessment of Unit 1 Control Room. |
| | Engineering Review of System Turnover Packages from Startup to TUGCO Operations. |
| | Engineering Review of Startup Test Procedures. |
| | Preparation of Comanche Peak Steam Electric Station Emergency Operating Procedures, Alarm Procedures, Abnormal Operating Procedures and Integrated Plant Operating Procedures. |
| 1978 | Associate Engineer Comanche Peak Steam Electric Station, Nuclear Operations Department. |
| 1976 | Junior Engineer - Morgan Creek Steam Electric Station. |

## DONALD J. CASTRO, P.E.

EDUCATION:

| | |
|---|---|
| 1981 | Standards Workshop on Human Factors and Nuclear Safety, IEEE. |
| | Human Factors Engineering Study Program, Gibbs & Hill, Inc. |
| 1980 | Management Discussion Skills |
| 1979 | Solar Energy, Gibbs & Hill |
| | Reliability Analysis, Gibbs & Hill |
| 1978 | Designing with Microprocessors, Gibbs & Hill |
| 1977 | CADAE System Training Program, Gibbs & Hill |
| 1976 | Reliability in Nuclear Power Generating Sations, IEEE |
| | I&C Theory and Application Course, Gibbs & Hill |
| 1975 | Supervisor's Seminar, American Management Association |
| 1969 | B.S. - Mechanical Engineering, New York University |
| 1964 | Associate in Mechanical Technology, New York Community College |

EXPERIENCE:

1981 - Present

GIBBS & HILL

Assistant Chief Engineer, Controls - Responsible for the technical and administrative supervision of the Instrumentation and Controls group, including staffing of projects, training and development of personnel providing guidance and direction on the development of engineering standards and guides, as well as technical supervision of assigned projects. Prepares proposals and estimates for new work, reviews applicable industry codes and standards. Currently, emphasis has been on retrofit projects for nuclear power plant emergency response facilities involving computer upgrades, safety parameter display systems, verification and validation programs for related digital computer systems. These retrofit projects also encompass various aspects of multiplexing systems for data acquisition, CRT display techniques, and human factors engineering applications applied to the power plant operator/machine interface. Retrofit projects include: Duquesne Light Company, Beaver Valley No. 1 (Emergency Response Facility Data Acquisition System); Consolidated

Edison Company of New York, Indian Point 2 (Human Factors Engineering and Simulator Upgrade); Northern States Power Company, Prairie Island 1 and 2 (Computer Upgrade Project - plant computer replacement and enhancement, safety assessment computers, and radiological dose assessment computers, multiplexers); Texas Utilities Generating Company, Comanche Peak 1 and 2 (overall plant engineering and design, human factors engineering, emergency response system computers).

Chairman of IEEE-381 committee responsible for qualification of class IE modules in nuclear power stations. Member of IEEE-subcommittee 2, Equipment Qualification. Consulting expert for IEEE Project 500, the IEEE Failure Rate Data Manual.

1973 - 1981 Supervising Instrument Engineer - Directed the engineers and technicians engaged in engineering, design, licensing, and construction liaison for the Comanche Peak Steam Electric Station, Units 1 and 2 (1150 MW each, PWR) for Texas Utilities Services Inc. Additionally, directed the instrumentation engineering efforts on the Caorrso Power Station (ENEL IV) (860 MW, BWR) for Ente Nazionale per l'Energia Elettrica, Italy; and for the Cofrentes Power Station (970 MW, BWR) for Hidroelectrica Espanola, Spain. Responsible for all instrumentation and control engineering, control boards, panels, instrument racks, control valves, planning and scheduling, manpower forecasts, and client and construction liaison. Design review engineer for GIBBSSAR, the Gibbs & Hill standard nuclear plant.

Reviews NRC regulations and professional society standards to establish corporate positions, and has contributed to the development of Gibbs & Hill's standards and engineering guides related to instrumentation.

1964 - 1973 BURNS AND ROE, Inc.; AMERICAN ELECTRIC POWER SERVICE CORPORATION

Instrument and Control Engineer
Cognizant Engineer (I&C)
Engineer
Senior Performance Technician - Responsible for control room panel specifications, control valve sizing and procurement, logic diagrams for balance-of-plant systems, and instrument installation specifications. Provided instrumentation and controls engineering for a 900-MW BWR nuclear plant, for two 1150-MW PWR nuclear units and for 450-, 600-, and 800-MW coal-fired supercritical power plants. Completed instrumenation and control engineering for a training simulator for a 600-MW coal-fired facility. Conducted heat balance and cycle studies, and power plant and turbine performance tests.

PROFESSIONAL REGISTRATION:

Control Systems Engineer - California, 1978

PROFESSIONAL SOCIETIES:

Institute of Electrical and Electronics Engineers

Committee Chairman (IEEE-381, Type Testing of Class IE Modules)

Consulting Expert (IEEE Project 500, Reliability Data Manual)

Instrument Society of America

## JOSEPH T. CALAMITO, P.E.

EDUCATION:

1971 B.S. - Mechanical Engineering, Newark College of Engineering

Additional studies include Human Factors, Protective Relay, Seismic Qualification of IE Systems.

EXPERIENCE:

1980 - Present GIBBS & HILL

Supervising Engineer - Presently Instrumentation Job Engineer for Comanche Peak Steam Electric Station, a two-unit nuclear power plant in Texas. Responsibilities include technical and administrative supervision of all project instrumentation and control systems work. Involved in the review of the Final Safety Analysis Report modification being prepared for Three Mile Island, Unit 1 for General Public Utilities Service Corporation. Presently performing technical support center (NUREG-0696) review and human factors engineering review of several nuclear facilities. Serves on in-house technical committees concerning Human Factors Engineering and Nuclear Plant Design Review activities. Responsible for instrumentation and controls for the Yanbu Industrial Power Project (960 MW, 25 MGD) for the Royal Commission of Jubail and Yanbu, Saudi Arabia. The complex contains gas turbines, steam turbine generators and heat recovery boilers, necessitating various process controls and application skills and requiring familiarity with solid state logic systems and interface, plant-wide multiplexing, and computerized control data acquisition system.

1971 - 1980 PUBLIC SERVICE ELECTRIC AND GAS COMPANY

Lead Instrumentation and Controls Engineer
Instrumentation and Controls Engineer - Engineered and performed startup activities for I&C systems of BWR and PWR stations. Work included providing design review of all I&C related items for Hope Creek Nuclear Station. Detailed system experience included plant NSSS, plant safeguards, computer and information CRT display, security, process sampling, radiation monitoring, and balance-of-plant. Served on corporate technical committees on reliability, working on improved reliability utilizing outage and maintenance planning, rigorous operator training methods, improved plant design, and test procedures. For Three Mile Island Nuclear Unit No. 1, provided I&C liaison on the technical support center and improved control room design. Served as simulator-Hardware Sponsor, producing detail specifications of computer simulators for Hope Creek and Salem

Nuclear Stations; and as Startup-defining program interface between A/E construction personnel and utility startup forces. Previously functioned as sponsor engineer for safety and balance-of-plant systems including component cooling, circulating water, turbine electro-hydraulic control, and reactor projection. Responsible for detailed conceptual design, specification and purchase of system components, and field assistance in construction and startup.

PROFESSIONAL REGISTRATION:

Professional Engineer - New Jersey, 1976

PROFESSIONAL SOCIETIES:

Instrument Society of America

KENNETH M. MALLORY, JR.

EDUCATION:

M.S. - Experimental Psychology, Tufts University

B.S. - Experimental Psychology and Mathematics, Lynchburg College

Intensive course in computer programming and analysis (Assembly language and FORTRAN)

EXPERIENCE:

September 1978- Present

ESSEX CORPORATION
Alexandria, Virginia

Director, Essex Energy Programs - Plan and manage Essex projects aimed at the design development, test and evaluation of control rooms for nuclear power plants, and projects to develop standards and criteria for control room man/system interfaces.

Projects for the Nuclear Regulatory Commission include: development of human engineering guidelines for the evaluation of nuclear power plant control rooms; human engineering evaluations of Near Term Operating License plant control rooms; and the identification of generic human engineering design problems in control rooms across the nuclear power industry.

Projects for independent utilities include: identification and evaluation of discrepancies from human engineering standards and practices in panel design, workspace layout, and operating procedures; recommendations of backfit design to increase human reliability; and evaluation of design-phase nuclear power plant control rooms.

Directed an assessment of management factors involved in the design and operation of TMI-2. Evaluated adequacy of human engineering industry standards and regulatory requirements available during the design phase.

Staff Scientist - Human Factors Engineering planning and management. Responsible for the design and development of procedures and documentation; for evaluation and specification of spacecraft habitability; and for operator integration into complex man/computer systems.

| | |
|---|---|
| July 1974-<br>September 1978 | KENNETH MALLORY AND ASSOCIATES, INC. |
| | President - Worked on documentation and program planning/implementation activities. |
| Procedures and Documentation | Prepared user documentation to support NASA's Life Sciences program. Included were TECHNICAL AND PLANNING GUIDES used by several thousand life scientists; experiment procurement documents; JOB PERFORMANCE AIDS (JPAs) used to operate Life Sciences data retrieval systems; QUESTIONNAIRES sent to scientists and used by NASA to plan its Life Sciences Program; QUESTIONNAIRES used to collect data on Flight Experiment hardware and vehicle requirements, NEWSLETTER reports published periodically to inform the Life Sciences community on the status of NASA's Life Sciences Program. |
| | Also developed a two volume, fully human engineered QUESTIONNAIRE for General Dynamics/Convair. This questionnaire collected information on engineering requirements for the Space Shuttle and Spacelab. |
| | Developed a set of HUMAN ENGINEERING GUIDELINES for documentation design, based on a thorough search of relevant literature. |
| | Developed and automated a 2000-citation Life Sciences BIBLIOGRAPHY cross-referenced and printed in 88 discipline categories. Report format was human engineered. |
| Program Planning | Designed, specified, tested and used procedures and SOFTWARE to evaluate the suggestions made by several thousand scientists concerning the objectives and implementation of NASA's Life Science Program. |
| | Developed a Monte Carlo MODEL for optimizing the assignment of experiments to several Shuttle/Spacelab missions. |
| | Designed, specified, tested and used SOFTWARE to synthesize free-form text descriptions of 2500 suggested experiment objectives into 27 scientific objectives. |
| | Developed MANAGEMENT PLANS for the Life Sciences Flight Experiment Program. Plans covered all phases (planning to post-flight) and all three Life Sciences centers and headquarters; responsibilities were allocated to activities; preliminary schedules were outlined; documentation requirements were identified. |
| Hardware | Assisted NASA/Headquarters personnel in a critical evaluation of HUMAN ENGINEERING STANDARDS to be applied to manned spacecraft and ground equipment design. |

Designed, developed and fabricated a voice recorder CONTROL PANEL for use by a QUADRAPLEGIC. Project involved a complete static/dynamic anthropometric work-up, selection of control surfaces and selection of off-the-shelf hardware that could be operated by chin or shoulder.

May 1967-
July 1974

URS/MATRIX CO.

President (1971-1974)

Director, Huntsville Division (1967-1968, 1969-1971)

Staff Scientist (1968-1969)

Procedures and Documentation

Directed the development of CREW PROCEDURES and JOB PERFORMANCE AIDS for operation of Skylab's solar observatory.

Directed the development of PROCEDURES and JOB PERFORMANCE AIDS for Skylab EVA operations.

Participated in the development of NASA HUMAN ENGINEERING STANDARDS.

Developed a USER-ORIENTED PROCEDURE for selecting optimum extravehicular systems for spacecraft.

Systems Development

Applied modified DELPHI TECHNIQUE in the selection of the final configuration of Skylab's Apollo telescope Mount Control Console.

Participated in design of SIMULATOR for training of MOTORCYCLE OPERATIONS.

Managed design of CREW STATION for manned remote manipulator system.

Participated in the design and managed the development of a 6 d.f. HANDCONTROLLER suitable for a variety of manual control applications.

Participated in design of general purpose EVA WORKSTATION for the Shuttle space vehicle.

Managed the man/systems design and CREW FAMILIARIZATION of Skylab's Apollo Telescope Mount Control Panel.

Designed and managed design activities on several Skylab EVA WORKSITES.

Developed MODELS for semi-automatic reduction of video tape data on human performance and reliability.

**System Testing and Evaluation**

Developed and managed implementation of technique for IDENTIFYING CONTROL PANEL DESIGN DEFICIENCIES through analysis of operational telemetry data.

Participated in and directed development of DIAGNOSTIC PROCEDURE to locate man/equipment interface deficiencies.

Planned and directed FUNCTIONAL AND TASK ANALYSES on spacecraft man-in-the-loop control system. Verification of design through computer-based visual/kinematic and zero-gravity simulation.

Performed data reduction and STATISTICAL ANALYSES on man-in-the-loop simulation results.

Developed flight experiments, using noninterference testing techniques, to QUANTIFY CREW WORK PERFORMANCE in zero and partial gravity environments.

Developed TAXONOMY for relating human performance to tasks and task environments.

Participated as EXPERIMENTER and TEST MONITOR in human performance tests in the hardware development phase of the Skylab Program.

Designed and managed development of an automatic in-vehicle system to COLLECT VIDEO DATA ON DRIVER PERFORMANCE and the causes of traffic accidents.

Participated in design and managed developmental testing of a complete video system for the collection of IN-SITU HUMAN PERFORMANCE data (SPACELAB).

Managed the design of a full-scale simulation of Skylab extravehicular solar environment. Later used simulator to EVALUATE EQUIPMENT DESIGN and verify procedures.

Designed neutral buoyancy simulation of intravehicular cargo transfer on Skylab. Results closely approximated transit times and rates on board the spacecraft.

**Safety**

Developed and implemented program to provide OCCUPATIONAL SAFETY AND HEALTH SURVEYS to small business enterprises.

Provided Occupational Safety and Health CONSULTING SERVICES to architectural and engineering activities.

Developed a comprehensive SAFETY AND HEALTH LIBRARY with associated information retrieval system.

Managed program TO MINIMIZE HAZARDS in Skylab extravehicular activities.

Implemented program for TRAINING ENGINEERS in occupational safety and health.

Performed an analysis of the EFFECTIVENESS of the Occupational Safety and Health Administration through April 1974.

Program Planning Participated in the application of a LATTICE TECHNIQUE to the development of research objectives for NASA's Office of Life Sciences.

Participated with A&E firms in the application of human and system engineering techniques to HEALTH CARE facility master planning.

Participated in the development of a MODEL to assess the costs of including EVA on Space Shuttle missions.

Managed effort to DEFINE THE SKILLS which must be provided by crews of future space vehicles.

Participated with A&E firms to INTEGRATE HUMAN ENGINEERING into planning and design.

June 1965-
May 1967

GENERAL DYNAMICS/ELECTRIC BOAT DIVISION

Human Engineer - Developed analytical man-computer MODELS and DISPLAY INTEGRATION TECHNIQUES to be used in submarine control systems having ten years' lead time.

Proposed and developed prototype of a REAL-TIME MAN/COMPUTER INDUCTIVE REASONING SYSTEM for use in submarine attack control systems.

Designed and monitored development of 3-D TV SYSTEM for use with underwater remote manipulators.

Provided MATHEMATICS SUPPORT to submarine training simulator development (analog computer).

Participated in series of experiments on DECISION MAKING STRATEGIES in anti-submarine warfare.

March 1963-
June 1965

AVCO/RAD

Human Engineer - Designed and verified an automated (fault tree) method for ASSIGNING RELIABILITY REQUIREMENTS TO HUMAN OPERATORS in re-entry vehicle systems.

Participated in the implementation of a HUMAN ERROR REDUCTION PROGRAM for re-entry vehicle assembly, maintenance and test operations.

Designed a series of experiments aimed at QUANTIFYING HUMAN RELIABILITY, including: readying the connector pins; mating of connectors in close quarters; digital to binary translation; localization of a low-light-level beacon.

Participated in evaluation and re-design of GROUND TEST EQUIPMENT (large scale and multi-man)

Evaluated use of switch setting checks as a means to IMPROVE HUMAN RELIABILITY.

August 1962-
March 1963

PHILCO CO.

Computer Programmer/Analyst - Developed computer programs (Assembly language) for the STATISTICAL REDUCTION of SAGE radar data.

Designed and programmed a DIGITAL SIMULATION of a biological organism responding to the hunger drive.

PUBLICATIONS & PRESENTATIONS

"Human Engineering Design of Nuclear Power Plant Control Rooms," presentation to Licensing Information Service Spring 1980 Conference.

"Human Factors Evaluation of Control Room Design and Operator Performance at Three Mile Island," presentation to Ohio State Conference on the Challenge of Educating Power Plant Personnel, 1980.

"Human Factors Evaluation of TMI-2," presentation to IEEE Advanced Electrotechnology Conference, 1979.

Conduct of Subcommittee Conference of the Atomic Industrial Forum on Human Engineering in Nuclear Power Plant Control Rooms, 1979.

"Human Factors Evaluation of Control Room Design and Operator Performance at Three Mile Island." NRC-04-79-209, December 1979. Co-authored by Malone, T.B., Kirkpatrick, M., Eike, D.R., Johnson, J.H., and Walker, R.W.

"Life Sciences Status Report - No. 8." To NASA/Headquarters, Washington, D.C., July 1979.

"Program Requirements Document - Organization and Management of the (NASA) Life Sciences Flight Experiments Program." (Draft). To NASA/Headquarters, Washington, D.C., October 1978.

"Specialized Life Sciences Bibliographies." Fifteen reports prepared for NASA/Headquarters, Washington, D.C., July 1978.

"Life Sciences in the Shuttle Era." 78-ENAs-34 Co-authored with Dr. Stanley Deutsch/NASA, 1978.

"Space Shuttle Payload Requirements Questionnaire." (Draft) Vol. 1 & 2. To General Dynamics/Convair, San Diego, CA, February 1978.

"Life Sciences Guide to Space Shuttle and Spacelab." (Draft). To NASA/Headquarters, Washington, D.C., March 1977.

"Fact Sheet for Proposed Life Sciences Flight Experiments." (Draft). To NASA/Headquarters, Washington, D.C., March 1978.

"Guide to the Preparation of Life Sciences Flight Experiment Proposals." (Draft). To NASA/Headquarters, Washington, D.C., March 1978.

"Planning for Life Sciences Research in Space." 76-ENAs-52 Co-authored with Dr. Stanley Deutsch/NASA.

"An Operations Research Approach to Assigning Flight Experiments to Life Sciences Missions." To NASA/Headquarters, Washington, D.C., July 1976.

"Achievements and Forecasts for Human Factors in Manned Spaceflight." 1975 Human Factors Annual Meeting. Co-authored with Dr. Stanley Deutsch/NASA.

"OSHA - Will it Work?", presentation to New York Academy of Sciences, New York, April 10, 1974.

"The Role of the Human Factors Company in Consumer Product Safety" workshop at the 17th annual meeting of the Human Factors Society, October 16-18, 1973.

"An Artificial Gravity Performance Assessment Experiment," presentation to AIAA Weightlessness and Artificial Gravity Meeting, Williamsburg, VA, August 9-11, 1971.

Selection of Systems to Perform Extravehicular Activity, Final Report on Contract NAS8-24834, April 27, 1970.

Application of Teleoperators to EVA Tasks, Honorarium at the University of Michigan, October 1970.

"Man vs Manipulator," presentation given to NASA Committee on EVA, Washington, D.C., April 1970.

Serpentine Actuator Man/System Feasibility Analysis Report, Technical Report to Brown Engineering Co., November 1967.

Man/Systems Feasibility of Using the Serpentine Actuator in AAP-4, Final Report, task under NAS8-20073, December 1967.

"Concept Identification - A Critical Comparison of Rote Learning and Inductive Reasoning," presented at the Eastern Psychological Association, March 1967.

Apollo Telescope Mount Dynamic Crew Procedures Demonstration, NASA MSFC Report 10M33202, September 1968.

Controller Comparison for the ATM Experiment Pointing Control System, NASA MSFC Report 10M33209, July 1968.

Automated Link Analysis Model, Technical Report to Brown Engineering (under NAS8-20073), January 1968.

A Submarine Tactics Evaluation System, Technical Report, General Dynamics Corporation, March 1967.

Description of a Real-Time Statistical Technique to Determine Level of Training, Technical Report to Brown Engineering (under NAS8-20073), October 1967.

The Integration of Two Non-Metric Scaling Techniques, Technical Report, Tufts University, February 1967.

A Fault Tree Technique for Assigning Reliability Requirements to Operator Tasks, Technical Report, AVCO Corporation, August 1965.

An Experimental Assessment of Illumination Requirements for Human Operator Detection of a Blinking Light in a Low Light Level Environment, Technical Report, AVCO Corporation, February 1965.

"Experimental Comparison of Connector Coding Techniques", paper presented to Air Force Conference on Electrical Connectors, Los Angeles, California, May 1964.

"Human Operator Connector Torqueing Capabilities", paper presented to Air Force Conference on Electrical Connectors, Los Angeles, California, May 1964.

## G. ALLEN ELLIFF

EDUCATION:

| | | |
|---|---|---|
| 1973 | Ph.D. - | Industrial Engineering/Operations Research, Texas A&M University |
| 1971 | M.S. - | Industrial Engineering/Operations Research, Texas A&M University |
| 1970 | B.S. - | Industrial Engineering, Texas A&M University |

EXPERIENCE:

July 1981 - Present

ESSEX CORPORATION
Alexandria, Virginia

Manager, Operations Analysis Branch, Process Control Systems Department - Provide management and technical direction for conduct of all Essex process control systems operations analysis projects. Have primary technical responsibility for all operational task analysis, probabilistic risk assessment, and human reliability analyses for the Process Control Systems Department. Serve as senior technical resource for application of industrial engineering and operations research techniques to client situations. Responsible for technical review of client deliverables.

Provide management review of project plan, technical scope, and resource estimates for all Process Control Systems Department projects.

As branch manager, supervise human factors analysts and licensed senior reactor operators (SROs). Assign appropriate personnel to client projects, as needed. Monitor cost and schedule status on all Process Control Systems Department projects to ensure completion of products to client satisfaction.

Managed detailed human factors control room design review for Texas Utilities Generating Company's Comanche Peak Steam Electric Station (CPSES) Unit 1. Evaluated control room for compliance with human engineering principles and applicable regulatory guidelines. Directed Essex human factors analysts and SROs in assessment of proposed client rearrangement of CPSES control boards. Assisted client in design and application of mimics, demarcation, and hierarchical labeling of the CPSES Unit 1 control boards.

Developed a model for predicting human reliability in nuclear power plant control room operations. For a foreign nuclear utility, developed estimates of expected improvements in operator reliability for suggested backfits to resolve thirty generic control room design problems.

Provided general management direction for major procedures development and production project for a near term operating license (NTOL) plant. The first phase of the project involved rewriting/reformatting of all emergency, abnormal, and standard operating procedures. As a result of project team performance, Essex was also awarded contract for development and production of approximately 300 nuclear power plant surveillance/test procedures. This phase involved rewrite/reformat, technical review, and editing of procedures; technical direction of all project staff; and coordination of the production of the procedures from initial writing through final word processing. Essex project team was composed of 6 to 8 technical writers, two editors, two nuclear plant operations specialists, and 8 word processors, plus two shift supervisors from client organization.

Jan. 1979 - June 1981 — EVALUATION RESEARCH CORPORATION
Vienna, Virginia

Principal Engineer and Branch Manager, Systems Engineering and Analysis Group - Provided technical and engineering support to NAVSEA, NAVELEX, NAVAIR, and other Federal government clients. This support included integrated logistics support (ILS) analyses, systems analysis, systems engineering, cost analysis, and application of operations research techniques for ship and system acquisition programs and ILS functional offices.

Participated in development of NAVSEA Reliability and Maintainability Technical Seminar.

Performed a comparative life cycle cost (LCC) analysis of JERED and CHT marine sanitation systems for DD 963 class ships. Results were a prime input to NADEC briefing.

As a member of CAPTOR Production Readiness Review (PRR) Team, assessed the capability of prime contractor and first tier subcontractor to effectively manage full-scale production. As a result of the PRR, the contractors were required to make substantive improvements to production control procedures prior to full production release.

Developed multiple regression model to project Navy shipbuilding quality assurance (QA) manpower requirements based on workload descriptor parameters.

Developed an analytic approach and plan for trade-off and cost impact analysis of alternative aviation intermediate maintenance support strategies for the Aviation Intermediate Maintenance Improvement Project Office. Objective of this task was identification of the complement of intermediate-level maintenance equipment, spare parts, and personnel skills that would most improve mission effectiveness of the deckload of a given aircraft carrier. Analytic approach integrated existing Navy data files and models to the greatest extent practical.

Managed project to assess performance and effectiveness of defense contractor in providing supply and depot repair support on AN/SLQ-32(V). Evaluated timeliness, quality, and cost of depot repair and supply support provided by contractor. Integrated and cross-validated transaction data from numerous contractor internal data sources, including ADP reports, manual log books, and source documents. Assessed operational availability based on analysis of CASREPTS and 4790-2K forms and data.

Determined system stock and maintenance repair parts requirements to support AN/SLQ-32(V). Assisted in conducting FY 1981 provisioning conference. Prepared contract orders to implement results of provisioning conference. Attended program reviews in support of program office.

Provided technical review of Logistic Support Analysis (LSA) Program Plan for Army Stand-off Target Acquisition System (SOTAS) under contract to Motorola.

Senior Analyst and Project Manager, Planning and Sciences Group - Managed and directed numerous projects for U.S. Department of Energy clients. Senior technical analyst for quantitative analysis tasks for the Planning and Sciences Group. Directed independent validations of various DOE and industry information systems and models.

Managed a project to validate the DOE Crude Oil Transfer Pricing System (ERA-51). Project included assessment of user requirements, respondent reporting and measurement practices, and DOE data processing procedures. Qualitative and quantitative analyses for data consistency and validity were performed, both within ERA-51 and between ERA-51 and related DOE reporting systems.

Provided technical and management direction for quantitative data analyses for four data systems providing information on major industrial combustors to support enforcement of the Power Plant and Industrial Fuel Use Act. Systems analyzed included the DOE Boiler Manufacturer's Report (ERA-97), DOE 1975 Major Fuel Burning Installation Coal Conversion Report (FEA-C-602-S-0), DOE 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors (EIA-463), and EPA National Emissions Data System (NEDS).

Developed scenarios for assessment of refinery industry capability to respond to various supply and demand scenarios. Analysis required familiarity with two refinery models: Bonner and Moore Refinery and Petrochemical Modeling System (RPMS) and Turner, Mason, Solomon (TMS) refinery model. RPMS and TMS models were linked to account for refinery processing capabilities, transportation network, and petroleum inventory management considerations.

Developed product prices and cost, quality, and quantity characteristics of crude slates for several refineries using DOE data in quick-reaction support for the Office of Special Counsel (OSC). Data was input to RPMS, which was used in support of OSC audit and compliance analysis.

1975 - 1979 PEAT, MARWICK, MITCHELL & CO.
Washington, D.C.

Senior Consultant and Project Manager - Managed the development and implementation of a life cycle cost/budgetary projection model for the HARPOON project office. Determined and documented logistics resources for support of a given procurement schedule; developed and validated predictive cost estimating relationships; identified appropriation and budget sponsors for each end item and logistic resource category; and developed time-phased funding requirements by appropriation to support a particular acquisition scenario.

As a member of a management audit team, evaluated the analytic capability of the F-16 System Project Office organization. Areas evaluated included life cycle cost/design to cost (LCC/DTC) estimation and tracking capability, configuration management, ILS planning and coordination, and assessment of the extent to which a common data base of cost and performance parameters was maintained for use in performing the various analytic tasks.

Defined and developed an integrated project task management information system (MIS) for the Shipboard Intermediate Range Combat System Project Office. Surveyed information requirements; conducted an inventory and assessment of information sources; defined information flows; investigated information processing and display alternatives; and developed an MIS to provide key project personnel with current and projected cost/schedule status, variance analyses, financial flexibility analyses, and assessment of the probable impact of potential management decisions.

Developed and presented seminars for commercial clients on life cycle cost/design to cost, Department of Defense (DOD) acquisition policies, and DOD marketing. Served as corporate representative to the Weapon System Life Support (WSLS) group under NSIA Logistics Management Committee (LOMAC).

Managed a project for the Federal Railroad Administration to perform Systems Engineering for Intermodal Freight Systems. Identified, described, and analyzed the full range of improved and innovative components, subsystems, and systems. Assessed proposed innovations and improved technologies for potential to improve profitability and return on investment for rail-based intermodal freight systems.

Principal Investigator for a project to develop an improved passenger car maintenance and utilization program for the National Railroad Passenger Corporation (AMTRAK). Specific responsibilities included assessment of the effectiveness of the current AMTRAK passenger car maintenance process, identification of trade-offs between passenger car maintenance and passenger car utilization, and development of recommendations for improving both the quality of AMTRAK maintenance and utilization of its passenger car fleet.

Managed a study for the Federal Railroad Administration to assess alternative organizational structures for yards and terminals for the United States rail industry. Analyzed management control systems, measures of effectiveness, and the effect of organizational alternatives for yards and terminals on the infrastructure of the rail industry.

Managed projects for private railroads involving market, operations, and traffic analysis, and development of business strategies. For a major motor carrier, performed an analysis of terminal and line-haul operations to improve carrier profitability and operational efficiency.

1974 - 1975 LOGISTICS MANAGEMENT INSTITUTE
Washington, D.C.

Senior Research Associate - For PMS 306, under joint sponsorship with the Assistant Secretary of Defense (Installations and Logistics), analyzed and evaluated the ability of the Navy's intermediate-level maintenance activities to support the surface Fleet in the mid-1980's. Responsibility included assessment of the adequacy of the Navy's maintenance data collection system (MDCS) in documenting maintenance delivered to the Fleet, trade-off analyses to determine the most effective utilization of Navy resources in supporting the surface Fleet, and development of specific recommendations for improvement.

Developed a management information system and the associated data base to assist planners in the Office of the Assistant Secretary of Defense (Installations and Logistics) in making policy decisions regarding avionics standardization. The system was capable of producing annual projections of the demand for avionics systems in terms of functional requirement and/or associated hardware by TMS of aircraft, at the equipment level, for aircraft scheduled for major modification or acquisition during the 1975-1985 timeframe. The data base could be readily updated on an annual basis, thereby enabling the system to continue providing 10 year projections.

Developed a Cost Element Structure (CES) for life cycle cost (LCC) analysis of tracked vehicles as input to an LMI task addressing the feasibility of a standardized LCC CES for various types of DOD systems.

1972 - 1974 TEXAS A&M UNIVERSITY
College Station, Texas

Assistant Professor of Industrial Engineering - Taught graduate courses and supervised thesis research in operations research, production engineering, manufacturing processes, production management, engineering cost estimating, production and inventory control, and quality assurance to graduate students in reliability and maintainability engineering programs sponsored by the Army Material Command (now DARCOM). Dissertation topic addressed economic design of a continuous sampling quality assurance plan, which has resulted in a publication and presentations.

## PROFESSIONAL SOCIETY MEMBERSHIPS:

American Institute of Industrial Engineers
Operations Research Society of America
Alpha Pi Mu (Industrial Engineering Honor Society)
Sigma Xi

## PUBLICATIONS, REPORTS, AND PRESENTATIONS:

Franco, J., Elliff, G. A., and Tulis, E. A. Memorandum Report - Development of Product Prices for RPMS Static Refinery Model, June 2, 1981. Prepared for Office of Technology and Computer Sciences, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A., and Franco, J. Applicability of DOE Models in Short-Term Contingency Planning, March 27, 1981. Prepared for Office of Technology and Computer Science, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A. Memorandum Report - Assignment of Costs to Crude Oil Feedstocks for Establishing Static Refinery Base Cases, March 19, 1981. Prepared for Office of Technology and Computer Science, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A., and Tulis, E. A. Memorandum Report - Analysis of the "Average Day" Concept for Establishing Crude and Product Slates for Sohio Base Cases, February 9, 1981. Prepared for Office of Technology and Computer Science, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A., and Tulis, E. A. Preliminary Analysis of the DOE Transfer Pricing System, February 1, 1981. Prepared for the Office of Energy Information Validation, Energy Information Administration, U.S. Department of Energy.

Leilich, R. H., Elliff, G. A., et al. Systems Engineering for Intermodal Freight Systems (3 volumes). Prepared for the Federal Railroad Administration, U.S. Department of Transportation, March 1978.

Yager, R., Elliff, G. A., and Bauer, R. Study to Develop an Intercity Passenger Car Maintenance and Utilization Program, April 1977. Prepared for the Federal Railroad Administration, U.S. DOT, and National Railroad Passenger Corporation (AMTRAK).

Fisher, W., Elliff, G. A., and White, J. M. DOD Demand for Selected Avionic Assemblies - Phase I. Interim Report on LMI Task 75-9, November 1975.

Shepherd, F., Elliff, G. A., and Wroblewski, P. Surface Ship Maintenance, LMI Report 74-21, AD A008233, January 1975.

Elliff, G. A., and Foster, J. W. "A Note of Calculation of the Average Fraction Inspected for a Continuous Sampling Plan." International Journal of Production Research, 1975.

Elliff, G. A., and Foster, J. W. "Least Cost Continuous Sampling Plans." Presented at ORSA/TIMS Joint National Meeting, Las Vegas, Nevada, November 1975.

Elliff, G. A., and Foster, J. W. "Economic Design of a Multilevel Continuous Sampling Plan." Presented at AOA Symposium on Logistics, Fort Lee, Virginia, February 1974.

Elliff, G. A. "An Economic Basis with Inspector Accuracy Considerations for Design of a Multi-level Continuous Sampling Plan," unpublished doctoral dissertation, Texas A&M University, 1973.

Elliff, G. A. "Cost Optimization of a Trickling Filtration Sewage Treatment Facility Using Pattern Search with Summation of Gradients," unpublished masters' thesis, Texas A&M University, 1971.

SECURITY CLEARANCE:

SECRET, granted by DISCO (1974).

TIMOTHY K. O'DONOGHUE

EDUCATION:

| | | |
|---|---|---|
| Expected 1983 | M.A. - | Candidate, Industrial Psychology, George Mason Univeristy, Fairfax, Virginia |
| 1979 | B.A. - | Psychology, George Mason University, Fairfax, Virginia |

EXPERIENCE:

ESSEX CORPORATION
Alexandria, Virginia

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| April 4 - Present | Research Associate - Technically responsible for human factors engineering review of Comanche Peak Steam Electric Station's Unit 1 control room in a contract with Texas Utilities Generating Company. Prepared HFE review program plan, developed time scheduling of tasks, and delegated work to technical support personnel. Directed data collection and evaluation efforts and supervised quality of work performed. Developed backfiits to human engineering problems. Managed and produced technical reports to customer.<br><br>Contributed to the development of a specification for a failure backup display to the Safety Parameter Display System (SPDS) used in nuclear power plant control rooms. Co-authored the specification and assisted in the design of a job performance aid as an alternative to a hardware backup display.<br><br>Contributed to the development of guidelines for an advanced nuclear power plant control room in a contract with Mitsubishi Heavy Industries. Authored the guidelines on voice output in the Voice-Computer Communication section. |
| 1980 - 1981 | Research Assistant - Developed filing and access system for documentation of comprehensive human engineering evaluation nuclear power plant control rooms for various utility contracts. Prepared scale photographic mockups for review of proposed human engineering enhancements. Developed demarcation and labeling schemes to enhance operator discrimination of control and display groupings. Conducted data collection and reduction of panel and workspace design requirements, reporting discrepancies from human engineering criteria and recommending corrective backfits. Conducted surveys of the use of labeling abbreviations in the control room and contributed to the development of a dictionary of standardized terms and abbreviations. Authored various sections of the evaluation final reports. |

Contributed to the development of nuclear power plant human engineering design guidelines in a contract with the Electric Power Research Institute (EPRI). Authored the section on control room operator tasks and visual system processing.

As part of a specialized team, conducted checklist evaluation of several operating and design phase nuclear power plant control rooms. Contributed to the development of guidelines for conducting human engineering evaluation of operating nuclear power plant control rooms on contract to the Nuclear Regulatory Commission. Developed and validated checklists and other evaluation instruments.

On contract to NASA's Life Sciences Program, reviewed past Life Sciences' experiments (from Biospex, Cosmos 936, etc.). Reviewed proposals for Space Platform experiments to determine if the variables to be measured in each proposed experiment progress as a function of mission duration to avoid redundancy in experiments conducted.

Assisted in developing an automated mailing list for application to NASA's Life Science Program.

Conducted research and review of literature in support of contract to update MIL-STD-1472B, human engineering design guide for military systems, equipment, and facilities. Abstracted literature concerned with modern control/display criteria.

Performed literature review on research to develop a methodology for evaluating the human factors characteristics of the human-computer interface and dialogue for the U.S. Army Test and Evaluation Command (TECOM). Review literature concerned with modern human computer interface and dialogue criteria.

Acted as liaison on a contract to the Cybernetics Technology Office of the Defense Advanced Research Projects Agency (DARPA). Research support to that office and their suppliers included identification of new technologies, acquisition of equipment and publications, and editing and packaging of technical papers.

SKILLS: Experience in Lockheed Dialog Information Retrieval Service.

Security Clearance Level:
Secret (DISCO).

Publications:

Kane, R., Manning, H., Fleger, S., Farbry, J., O'Donoghue, T., Tulloh, N. & Grealis, L. System-Specific Specifications, Basic Console Evaluation and Human Engineering Library Bibliography for Advanced Control Rooms. The Essex Corporation, Alexandria, Virginia, November 1981.

West, R., O'Donoghue, T., McCafferty, D.B., Boyd, E., Krick, C., Kain, C., Piccione, F., Kane, R., Fleger, S. & Baker, C. Human Factors Evaluation of the Calvert Cliffs Nuclear Power Plant Units 1 & 2 Control Room Volume I. The Essex Corporation, Alexandria, Virginia, March 1981.

# WALTER T. TALLEY

EDUCATION:

| | | |
|---|---|---|
| 1977 | M.S. - | Applied Psychology, Stevens Institute of Technology |
| 1974 | B.A. - | General Experimental Psychology, New Mexico State University |
| 1972 | A.A. - | Arts and Sciences, New Mexico State University |
| | Military Training in Electronics: | |
| 1962 | Refresher Course in Electronic Fundamentals | |
| 1960 | Radar Fire Control and Bombing Computer Systems, Republic Aviation Corporation | |
| 1955 | Radar Fire Control and Bombing Systems | |

EXPERIENCE:

December 1978 - Present — ESSEX CORPORATION
Alexandria Virginia

September 1981 - Present — Research Scientist/Chief Project Manager - Alexandria, Virginia. Chief Project Manager for the Process Control Systems Department. Responsible for the planning, coordination, and conduct of all department projects. The majority of most current projects are human factors engineering evaluations of nuclear and fossil-fueled electrical generating plants. Responsible for the technical and scientific content of all project deliverables. Acts as technical resource to all project staff for the determination of relevent human factors criteria and the analysis of data for the current evaluation contracts. Develops and/or adapts new and current methodology and procedures to the specialized requirements of each project. Administratively responsible for the personnel affairs of the project management staff. Responsible for the development of solicited and unsolicited proposals which includes the technical description of work, scope definition, cost and hours estimations, and staffing.

May 1980 - September 1981 — Research Scientist/Project Manager - Raleigh, North Carolina. Project Manager for a human factors engineering evaluation contract with Carolina Power and Light Company. Directed the work of one Research Scientist, three Research Associates, one Research Assistant and one contract consultant in the human factors engineering evaluation of four nuclear power plant control rooms (three existing and one under construction). Duties consisted of the planning and coordination of all contract activities which included scheduling between two Essex offices and three customer field locations; the development of evaluation plans which incorporated modified existing procedures and newly developed procedures tailored to this particular customer's requirements; and general customer interface activities such as conduct of monthly project review meetings, submittal of monthly progress reports, and the development and planning of special studies. Also responsible for the development of all final reports for the evaluation and the development and delivery to the customer of comprehensive evaluation files which serve as a detailed record of the total contract performance.

March 1979 - May 1980

Research Scientist - White Sands Missile Range, New Mexico. Responsible for the conduct of the human factors engineering evaluation of the U.S. Army Patriot Air Defense System. Directed the work of one Research Associate in the development of a detailed test plan, various interim reports and new field evaluation techniques and procedures applied to the Patriot System testing. Performed the first non-supplier safety study on the Patriot System and produced the Interim Safety Release Study Report which was essential for the continued evaluation of the system.

February 1979 - March 1979

Research Scientist - Fort Hauchuca, Arizona. As a member of the Essex quick-response team, assisted in the initial contract phases of U.S. Army Communications System Test and Evaluation projects. Duties consisted of the performance of human factors engineering evaluations of current and prototype communications equipment and satellite telecommunications systems. Collected and evaluated human performance, environmental, and hardware data. Wrote final reports concerning the compliance of various equipment to existing military human factors specifications and requirements.

December 1978 - February 1979

Research Scientist - Alexandria, Virginia. As a member of the Essex human factors staff, analyzed work performance data and developed a summary report for the AT&T Company's Human Performance Laboratory concerning corrective maintenance task times for telephone company central office switchworkers. Assisted in writing the technical areas of contract proposals for the evaluation of Army weapons systems.

July 1978 - November 1978

ALLEN CORPORATION OF AMERICA
Alexandria, Virginia
(White Sands, New Mexico)

Senior Human Factors Engineer - As the project manager of the Corporation's White Sands Office, directed the work of two Senior and one Junior Human Factors Engineers, and one Secretary/Clerk. Work consisted of Human Factors evaluation of current and prototype U.S. Army Weapons systems. Test plans were developed which established the methodology and scheduling of complete human factors evaluations of operation, maintenance and transportability for tactical and strategic weapons.

September 1974 - June 1978 — BELL TELEPHONE LABORATORIES
Piscataway, New Jersey

Member of Technical Staff - As a member of computer software development groups, developed specifications for the human interface requirements of large computer-based data management systems used throughout the Bell Telephone System. Designed and implemented the specific human interface functions from the aforementioned requirements. Developed the performance standards and operational (human performance) definitions of the functional allocations for both the human and the machine in these software systems.

May 1971 - August 1974 — DYNALECTRON CORPORATION
Land-Air Division
White Sands Test Facility - NASA
Las Cruces, New Mexico

Electro/Mechanical Designer - Developed various new designs and modifications to existing designs for facilities, structures, and equipment used for destructive and nondestructive materials testing. Produced structural, mechanical, and electrical designs on the modifications to cyrogenic storage and pumping systems. Also produced drafted drawings and technical illustrations to NASA standards for use in documenting the facility's configuration and for use in test reports.

February 1970 - April 1971 — DYNALECTRON CORPORATION
Land-Air Division
Holloman Air Force Base, New Mexico

Medical Illustrator - Produced illustrations for publications and technical reports. Illustrations were in the following categories: Line Graphs, Charts, Cumulative Records, Equipment Layouts and Anatomy Drawings. Using autopsy procedures, produced preliminary drawings of thoracic musculature of the baboon. Developed comparative Sacro-lumbar, and lower trunk comparative anatomical drawings of the human, baboon, and chimpanzee.

September 1968 - January 1970 — A. G. SCHOONMAKER COMPANY, INC.
Sausalito, California

Project Engineer - Developed all phases of detailed design requirements for diesel and gas turbine powered generator sets. Set capabilities were usually in the range of 5000 volt, 2000 kilowatt outputs. Also coordinated total design packages including all mechanical aspects of the units and developed electrical requirements and cost analysis for contract bids.

Electrical design details involved the evaluation of customer contract requirements, translation of them into specific components, ordering the components and materials and designing the circuits, bus connections, enclosures, front panels and controls. Some technical writing was required in the area of maintenance and operating instructions.

September 1967 - August 1968 ELECTRONICS CONSULTING FIRMS
San Francisco, California

Electronics Technician, Research and Development - Performed a broad range of technician/designer duties as a job-shop employee. Most work was involved in the build-up, modification and checkout of production test equipment for testing missile guidance systems. Individual consultant company names with specific job explanations furnished on request.

August 1962 - August 1967 DOUGLAS AIRCRAFT COMPANY, INC.
Santa Monica and Huntington Beach, California

Electronics Technician, Research and Development - Worked in vehicle checkout areas at Santa Monica and Huntington Beach on the initial installation of the Ground Support Equipment for the Saturn SIV and SIV-B Space Vehicles. Performed scheduled periodic maintenance and assisted engineering in trouble-shooting, modification, calibration and functional checkout of this equipment. SIV Ground Support Equipment was manually operated, SIV-B equipment was computer controlled.

May 1955 - June 1962 UNITED STATES AIR FORCE

Supervisor of Fire Control Section, R&D - At the Fighter Weapons Squadron, Nellis AFB, Las Vegas, Nevada, had charge of five technicians in the Research and Development section. Work involved the design and packaging of R&D projects relating to the testing, modification and extension of Radar Fire Control and Bombing Computer Systems' capabilities on the then current fighter aircraft; the F-100D and F-105D fighter/bombers. Rocket and missile systems which were modified and tested consisted of conventional 2.5, 2.75 and 3.25 air-to-air rockets, sidewinder (infrared guided) rockets and the GAM-83 air-to-ground BULLPUP missile. (1961-1962)

Fire Control Technician, R&D - Worked in the Research and Development section of the Fighter Weapons Squadron, Nellis Air Force Base, Las Vegas, Nevada. Technical work responsibilities were the same as those listed above. (1959-1961)

Fire Control Technician - Maintained Radar Fire Control Systems in fighter aircraft at Turner Air Force Base, Albany, Georgia. (1958-1959)

Test Equipment Technician - At the USAF Standards Laboratory in Chateauroux, France, worked on all phases of repair and calibration of general and special purpose electronics test equipment. Designed and built test and calibration benches for new types of equipment as needed. Maintained bench stock supply of all necessary spare parts. (1955-1958)

PERSONAL DATA:

Member of Psi Chi, Psychology National Honor Society
Member of the Human Factors Society

Military Status - Veteran
Enlisted USAF, June 8, 1954.
Honorably discharged, June 7, 1962.

TERENCE J. VOSS

EDUCATION:

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| 1979 | A.B.D. - Experimental Psychology/Learning, University of Montana |
| 1972 | M.A. - General Experimental Psychology, Florida Atlantic University |
| 1965 | B.A. - Sociology/Psychology, State University of New York |

EXPERIENCE:

November 1980 - Present — ESSEX CORPORATION
Alexandria, Virginia

Research Scientist/Project Manager - Functioned as project manager for the Duke Power Company's emergency procedures writer's guide development project. Developed 3 plant specific writer's guides for emergency and abnormal procedures. Major human factors engineering concerns were that writers be able to prepare procedures that maximize understanding and accessibility of information. The format specifics were modified in accordance with client needs from either Babcock and Wilcox or Westinghouse generic guidelines. The goal was to ensure that the procedures produced would be readable, complete, convenient, accurate, and acceptable to control room personnel. Adherence to writer's guide specifics would also ensure consistency in organization, format, style, and content as recommended in NUREG-O899.

Performed an operability task analysis for St. Lucie 1 & 2, and Turkey Point 3 & 4 Control Rooms for Florida Power and Light Company. The task analysis is structured to assess task performance capability, appropriate instrumentation inventory, plus validity and human engineering suitability of control room functions. Developed human factored examples of an emergency procedure to demonstrate use adequacy during task analysis walk-throughs.

As a member of the Essex procedures team at South Carolina Electric and Gas Company's V. C. Summer Nuclear Station, validated emergency and general operating procedures format and constrained language usage in revised procedures.

Interfaced with representatives of the Comanche Peak Nuclear Power Plant, Texas Utilities Generating Company, to review, verify and determine the seriousness of previously identified human engineering discrepancies (HEDs). The meetings culminated in the selection of appropriate remedies (backfits), or the justification and disposal of specific discrepancies.

Project Manager for the planning and implementation of human factors enhancements to the V. C. Summer Nuclear Station Control Room for

South Carolina Electric and Gas. Ensured that as built modifications (Post-TMI, NUREG-0700) met accepted criteria for man-machine systems. Modifications included instrumentation rearrangements, system/sub-system demarcation, summary labeling, increased use of color coding, relabeling of all components, and restructuring of many component parts, such as, indicator scales, switch handles, and annunciator windows.

Conducted the preliminary human factors engineering evaluation for St. Lucie Unit 2 Control Room. Later provided on-site consultant services to Florida Power and Light during the Nuclear Regulatory Commission human factors engineering audit of the St. Lucie Unit 2 Control Room. The scope of both the Essex Corporation and the NRC evaluations was to assess control room systems from a human factors engineering perspective and to prepare listings of possible HEDs to be further investigated and addressed by the utility prior to licensing for fuel load. During the NRC audit efforts were focused upon answering on behalf of the utility, questions posed by the NRC auditors particularly as concerned the earlier Essex findings.

Reviewed previously identified HEDs and proposed backfits for the Brunswick Nuclear Power Plant Control Room for Carolina Power and Light Company. The purpose of the review was to validate, modify or otherwise disposition the discrepancy documents prior to final presentation to the utility.

Research Associate - Assessed the aspects of control room design that might contribute to human error in the operation of V. C. Summer Nuclear Power Station. Conducted task analysis of emergency and operating procedures and documented design features which could contribute to potential operator error affecting plant safety. Suggested potential remedies to eliminate design deficiencies and improve the interface between the human operator and the reactor system.

1979-1980 UNIVERSITY OF MONTANA
Missoula, Montana

Supervisor of Leisure Information Services - Supervised employees surveying recreational facilities and opportunities in Montana. Produced a Leisure Catalogue, and collected and maintained leisure program materials.

1978-1979 UNIVERISTY OF MONTANA AND MOUNTAIN WEST RESEARCH
Billings, Montana

Research Assistant - Bureau of Business and Economic Research. Conducted large research projects including one survey for the Northern Tier Pipeline; data collection, analysis and report writing.

1973-1977 UNIVERSITY OF MONTANA
Missoula, Montana

Teaching Assistant - Lectured, led discussion sections, authored exams, wrote study notes, and assigned grades in various undergraduate psychology courses.

1971-1972 FLORIDA ATLANTIC UNIVERISTY
Boca Raton, Florida

Teaching Assistant - Taught Introductory Psychology.

PUBLICATIONS AND TECHNICAL PAPERS:

Baker, Cliff, Mosier, Jane, and Voss, T.J. Preliminary Human Engineering Assessment of the Saint Lucie Unit 2 Nuclear Power Plant Control Room. Prepared for Florida Power and Light Company, June, 1981.

Jeorling, Diane M., Steele, Elliot H., Verdi, Angelo P., and Voss, T.J. Human Factors Engineering Evaluation and Improvement of the Virgil C. Summer Nuclear Station Control Room. Prepared for South Carolina Electric and Gas, January, 1981.

Scheuer, Cynthia, and Voss, T.J. Aversive Properties of Time-out from Maximal FR Schedules of Positive Reinforcement. The Psychological Record, 1974, 24, 53-60.

Taylor, D.F., and Voss, T.J. A Pilot Evaluation of Three Alternative Formats for Control Room Procedures. Paper in preparation for presentation to the American Nuclear Society, November, 1982.

Voss, T.J. Human Factors Engineering Evaluation and Improvement of the V. C. Summer Nuclear Station Control Room: Implementation of Phase I Backfits. Prepared for South Carolina Electric and Gas, March, 1982.

Voss, T.J., Taylor, D.F., Eike, Robin K., and McCafferty, Denise B. Writer's Guide for Emergency and Abnormal Procedures: Catawba N. S. Prepared for Duke Power Company, July, 1982.

Voss, T.J., Taylor, D.F., Eike, Robin K., and McCafferty, Denise B. Writer's Guide for Emergency and Abnormal Procedures: McGuire N. S. Prepared for Duke Power Company, July, 1982.

Voss, T.J., Taylor, D.F., Eike, Robin K., and McCafferty, Denise B. Writer's Guide for Emergency and Abnormal Procedures: Oconee N. S. Prepared for Duke Power Company, July, 1982.

Voss, T.J., Taylor, D.F., Eike, Robin K., and McCafferty, Denise B. Summary Report for Procedure Writer's Guide Project. Prepared for Duke Power Company, July 1982.

PROFESSIONAL MEMBERSHIPS:

Human Factors Society

Sigma XI, The Scientific Research Society of North America

# ELLIOTT H. STEELE

## EDUCATION:

Various classes towards BSME, Northern Virginia Community College and San Diego Evening College

Satisfactorily completed North American Master Conservationist Course

### NAVY:

Damage Control Assistant
Allison 501-K17 GTG Operation and Maintenance
EN "C" Power Train Maintenance
Leadership and Management
DD-963 Engineering Control & Surveillance Systems
General Electric LM2500 Maintenance
Basic Electricity and Electronics
Patrol Gunboat Engineering Systems
EN "C" Gas Turbine
Riverine Assault Craft Maintenance
Engineman "A"
Basic Propulsion and Engineering

## EXPERIENCE:

Total Specialized Experience: Fourteen years in US Navy, and engineering firms progressing from engineman, marine engineering technican to technical specialist. Through hands-on operation and maintenance and military schools, have attained a working knowledge of Navy marine engineering plants. Directly involved with ship systems relative to propulsion, auxiliary machinery, automatic controls, electrical, fuel service transfer, lubrication, fire protection, waste collection and disposal, and main drainage. Developed and reviewed operation and maintenance software for above.

1979 - Present

ESSEX CORPORATION
San Diego, CA

Technical Specialist - Presently reviewing and rewriting Emergency Procedures for PWR and BWR Nuclear Power Plants. Performed Quality Assurance of Engineering Operational Sequencing System (EOSS) documentation developed for AO-177 Class ships. Conducted a study to determine the feasibility of establishing Intermediate Maintenance Assist Teams (IMATs) to support gas turbine maintenance on DD 963 and FFG 7 Class ships. Developed the requirements to implement IMATs.

1976-
1979

GEORGE G. SHARP, INC.
Arlington, Virginia

Marine Engineering Technician - Responsible for technical review of all EOSS for 1200 psi, and 600 psi, and gas turbine Navy ships. Reviewed and rewrote the EOSS Development Manual and Naval ships' Technical Manual Chapter 079, Volume 3. Developed Chapter 7 of the EOSS Development Manual for DD 963 Class ships. Reviewed, corrected, and revised various naval technical manuals, allowance parts lists, and planned maintenance documentation for auxiliary equipment. Performed approved SHIPALTS to Navy low-pressure air compressors; analyzed fleet-wide fire pump casualty report and developed a medium-pressure air compressor military specification.

1973-
1976

USS SPRUANCE (DD-963)

Assigned as Main Engineroom Supervisor and as Leading Petty Officer of auxiliary group. Responsible for the operation, maintenance, and repair of all propulsion and auxiliary machinery and systems. Contributed direct technical inputs to Personnel Qualification Standards and EOSS development and validated prototype packages. Qualified at all engineering watch stations, including Engineer Officer of the Watch and Repair V Scene Leader. Selected for Limited Duty Officer.

1972-
1973

USS WELCH (PG-93)

Operated, maintained, and repaired all main propulsion and auxiliary machinery and their support systems. Qualified Engineer Officer of the Watch.

1970-
1971

NAVAL ADVISORY GROUP
DaNang, Det Cua Viet, RVN

Assigned as Engineering Advisor. Responsible for operation, maintenance, and repair training for base electrical generation systems and Patrol Junks. River patrol advisor and communications liaison.

1969-
1970

NAVAL SUPPORT ACTIVITY
Det Nha Be/Dong Ha, RVN

Assigned to maintenance group. Operated, maintained, and repaired LCM8/6 systems. Participated in RVN personnel training and acted as deployed LCM-8 troubleshooter and relief boat engineer.

1968-
1969

INACTSHIPFAC
Portsmouth, VA

Assigned to outside maintenance. Operated and maintained diving boat and activity emergency generator.

**DIANE JEORLING**

EDUCATION:

| | |
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| 1982 | Nuclear Power System Operations, TUGCO, Glen Rose, Texas |
| 1980 | B.A. - Mathematics, Saint Louis University, Saint Louis, Missouri |

EXPERIENCE:

June 1982 - Present

TEXAS UTILITIES SERVICES, INC.
Glen Rose, Texas

Associate Engineer - Involved in the tracking and implementation of human factors upgrades to the Comanche Peak Steam Electric Station control boards.

Assisted in the development of a demarcation and labeling scheme to incorporate heirarchical labeling for the CPSES control boards. Involved in the installation of demarcation lines to the boards. Compiled standardized dictionary of abbreviations and acronyms, developed labeling format, and generated an engraving list for all controls and displays.

Determined annunciator alarm priorities and developed panel configuration to ensure that high priority alarms were highly discernable. Standardized annunciator vocabulary and legend format. Developed human engineering specifications for annunciator alarm design.

June 1980 - June 1982

ESSEX CORPORATION
Alexandria, Virginia

Performed Annunciator Analysis for the Virgil C. Summer Nuclear Station (SCE&G).

Conducted on-site and mockup checklisting data collection at Grand Gulf (MP&L), Robinson (CP&L), Rancho Seco (SMUD), Calvert Cliffs (BG&E), and Callaway (SNUPPS) nuclear power plants. Average on-site effort ran three weeks. Utilized checklists to identify and evaluate discrepancies from human engineering standards and practices in nuclear power plant control room panel design, workspace layout, and control/display integration. Developed potential backfits to eliminate design deficiencies and enhance the interface between the control room operator and power plant instrumentation.

TECHNICAL REPORTS:

Fleger, S., Avery, L., Kane, R., Jeorling, D., Elliff, Dr. A., Justice, T., Kirkpatrick, Dr. M., Results of the Review and Evaluation of the TEPCO/Toshiba/Hitachi Control Room Improvement Plan, September 1981.

Jeorling, D. M., Steele, E. H., Verdi, A. P., Voss, T. J. Human Factors Engineering Evaluation and Improvement of the Virgil C. Summer Nuclear Station Control Room, January 1981.

PROFESSIONAL RECOGNITION:

Member ISA (Pending)

# LARRY W. AVERY

## EDUCATION:

| | | |
|---|---|---|
| 1978 | M.A.(ABT) - | Industrial Psychology<br>George Mason University, Fairfax, Virginia |
| 1971 | B.A. - | Business Administration<br>George Mason University, Fairfax, Virginia |

## EXPERIENCE:

Aug. 1978- Present

ESSEX CORPORATION
Alexandria, Virginia

Research Scientist

Test Operations Methodology for Assessing the Human Engineering Adequacy of the Soldier-Computer Interface - Participating in the development of a methodology to assess the human engineering design of computer systems deployed in Army material. Methodology will assess both the hardware and software design during all phases of developmental testing. Methodology will be incorporated into the TECOM TOP 1-2-610, Human Factors Engineering Test Procedures.

Technical Support - Provide technical expertise to all project engineers in the areas of human engineering design for nuclear reactor control rooms. Directed an evaluation of proposed redesign of Comanche Peak Steam Electric Station control boards. Assisted in project planning for control room evaluations of Comanche Peak and Turkey Point.

Project Director - Tokyo Electric Power Company and the Japan Atomic Power Company contract. Acted as manager of Task 1 of this contract. This consisted of managing a data collection team on-site at the Fukushima-2 and Tokai-2 plants in Japan and the data reduction team back at Essex headquarters. Presented the Task 1 final report in Tokyo, Japan.

Project Director - Standard Nuclear Utility Power Plant System (SNUPPS) contract. Human factors evaluation of simulator at Zion, Callaway and Wolf Creek control rooms. Includes evaluation and recommendations for redesign of control room. Tasks include coordination of various technical staff, report preparation, technical inputs to evaluation, and interface with client.

Project Director - Grand Gulf Nuclear Power Plant, Mississippi Power and Light contract. Human factors evaluation of control room design for the Grand Gulf Nuclear Power Plant. Included evaluation and redesign of control room, evaluation of operating and emergency procedures as pertaining to design, and task analysis of the operators' performance in the control room.

Research Associate

Nuclear Reactors - NRC, PASNY/Con. Ed. Performance of test and evaluation on near-term operating license plants for the NRC. Responsibilities included data collection and reduction, report preparation, and presenting results before NRC representatives. Assisted in the development of a guidebook for Human Factors Test and Evaluation of Nuclear Reactor Control Rooms for the NRC. Responsibilities included developing evaluation criteria, writing portions of the procedures section, and validating methodology on control rooms.

Human Factors Engineering Test and Evaluation - USAEPG, Ft. Huachuca. Performed HFE T&E on a wide range of electronic and communication systems during all phases of the developmental testing; developed man-hour estimates and test plans; conducted tests; reduced and analyzed data; wrote up results of tests into HFE test reports; maintained experimental instrumentation; assisted in liaison with other test agencies such as HEL.

Test Operations Procedures for Human Reliability Measurement for Man/Machine Systems - Army Test and Evaluation Command. Performed literature search to evaluate available instrumentation as to appropriateness and effectiveness in human performance measurement during developmental testing of system; developed test operations procedure methodology; administered methodology to system undergoing testing to demonstrate effectiveness of TOP; and revised and drafted final test operational procedure.

Motorcycle Operators Skill Test - Department of Transportation. Performed maintenance of apparatus; collected data and administered test procedure; and analyzed data and subject acquisition for study to determine whether present methodology could be revised to allow reduction of physical space necessary for administration.

Assessment of Instructional Methods for Driver Improvement Courses - National Public Services Research Institute. Conducted monitoring, data collection and analysis in field study evaluating three instructional techniques for driver improvement course.

PUBLICATIONS/TECHNICAL REPORTS:

Waters, Robert M. and Avery, Larry W., "A Comparison of Visual Acuity Performance Between a Binocular Night Vision Goggle and Two Types of Monocular Night Vision Goggles." Proceedings of the Human Factors Society, 24th Annual Meeting, October 1980, 306-309.

Mallory, K., Fleger, S., Johnson, J., Avery, L., Walker, R., Baker, C. and Malone, T., Human Engineering Guide to Control Room Evaluation. (2 Vols.). Division of Human Factors Safety under NRC Contract No. 04-79-209, August, 1980.

Avery, L., Durham, L., Price, L., Neal, V., Malone, T., Steele, E. Human Factors Engineering Evaluation of the Grand Gulf Unit 1 Control Room. Mississippi Power and Light, November 25, 1980.

Avery, L., Fleger, S. A., Kane, R., Krick, C., Kain, C., Bathurst, J., Baker, C., Malone, T., Price, L., and Mallory, K. Human Factors Evaluation of the Standard Nuclear Unit Power Plant System. Standard Nuclear Unit Power Plant System, January, 1981.

Fleger, S., Avery, L., Kane, R., Jeorling, D., Elliff, A., Justice, T., and Kirkpatrick, M. Evaluation of Proposed Improvements for Control Room Supervising Function and Supporting Function for Existing Plants (4 vols.). Tokyo Electric Power Company, Japan Atomic Power Company, September, 1981.

CLIFFORD C. BAKER

EDUCATION:

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|---|---|---|
| 1980 | M.A. - | Candidate, George Mason University, Experimental Psychology (coursework 50% completed) |
| 1976 | B.S. - | Psychology, Minor subjects, Mathematics and Computer Science (languages and packages include: FORTRAN; UNIVAC Assembly; Basic; and SPSS) University of Maryland, College Park |

EXPERIENCE:

March 1977-
Present

ESSEX CORPORATION
Alexandria, Virginia

Manager-Human Factors Analysis Branch/Research Scientist - Responsible for the development and implementation of human factors methodology for all current contracts. Technically directs and administratively handles the work and personnel affairs of all branch staff.

Research Scientist - Project Manager for Human Factors operability test and evaluation of the Saint Lucie and Turkey Point Nuclear power stations. Activities include: assessment of compliance of main control room instrumentation and controls with HF design guidelines; performance evaluations of control room system operation; detailed analysis of operational and emergency task sequences; identification of potential HF problem areas via the above; and resolution of design discrepancies via redesign, panel enhancements, and procedure/ training design.

Project manager for a "quick look" survey and assessment of the operability of the Saint Lucie Unit 2 Nuclear Power Plant Control Room.

Development of data base of human factors engineering problems identified in a cross-section of Nuclear Electric Power Plants.

Conduct of a behavioral analysis of operator interface problems in dealing with mirror imaged control rooms. Analysis targeted stimulus-response chains and reinforcement expectancy as means to predict errors resulting from mirror imaged design of control panels.

Participated in the evaluations of the Comanche Peak (Texas Utilities Generating Company), SNUPPS (Nuclear Projects

Incorporated), V. C. Summer (South Carolina Electric and Gas), and the Sharon Harris (Carolina Power and Light) nuclear power plants.

Project manager for the Human Engineering enhancement of the Indian Point Nuclear Power Plant Control Rooms by reducing visual search task requirements through panel demarcation, switch handle shape coding, and component relabeling.

Project manager for a "quick look" survey and assessment of the operability of the V.C. Summer Nuclear Power Plant Control Room. Activities included comparing control room design with operator task requirements, procedural definitions of task sequences, and task activity data such as performance frequency, criticality, and so forth.

Project manager for the conduct of detailed HFE evaluation of the Indian Point Units 2 and 3 nuclear power station control room. Principal data collection methods were: comparison of task requirements, control room layout, and human operator capabilities; task evaluations via videotaping and analysis of plant operating and emergency procedures; and application of detailed checklists.

Assisted in development of guidelines and procedures for conducting HFE operability assessments of existing nuclear power plant control spaces, with emphasis placed on: 1) modes and formats of information presentation; 2) control, display and workspace design; and 3) job performance aid design.

Participation in Human Engineering evaluation of the control spaces of the nuclear power plant at Three Mile Island. Responsibilities included identification of Federal and Industry human engineering and control room related design criteria and guides, and relating these to human engineering of control room design.

Research Associate - Human engineering evaluation of the information presentation and control modes AN/UYQ-21 Standard Display System designed for Electronic Warfare, Tactical Data Systems, and Fire Control, Combat Information Center applications.

Assessment of the applicability of the Human Factors Test and Evaluation Manual (HFTEMAN) methodology in Navy ship systems HFE test and evaluation.

Definition of the Naval major weapon system acquisition process (WSAP) and identification of Training, Human Factors and personnel requirements therein. Review of available training, trade-off and human engineering design techniques and methods suitable to fulfill HFE design requirements during weapon system acquisition.

As part of validation of Human Factors for Ship Acquisition program, performed design and evaluation efforts for developing and existing ship systems, including task analysis and definition of human operational and maintenance functions, design of displays, control selection, and layout for the Mark-14 aircraft recovery gear. Conducted similar evaluation of man/machine allocations and interface design of aircraft catapult systems.

Determination of maintenance manning requirements for Mark-86 and SEAFIRE Gun Fire Control Sub-system Integration by examining maintenance task requirements and failure rate data of the hardware.

Human Factors problem identification of habitation by men and machines in extreme cold weather environments, as part of the development of a Test and Evaluation manual for man/machine systems subject to Arctic environments.

Evaluation of alternate automobile rear lighting configuration by correlations with incidences of rear-end stop-related collisions. Responsible for computer-assisted data maintenance, reduction and analysis of automobile lighting conditions before and after the incidence of accidents.

Conducted computer-assisted statistical analysis of railroad locomotive simulator training and pre-constructed tests used as a selection device for appointing Railroad Engineers.

TECHNICAL REPORTS & PROFESSIONAL PUBLICATIONS:


Baker, C.C., Mosier, J., and Voss, T.J. Preliminary Human Engineering Assessment of the Saint Lucie Unit 2 Nuclear Power Plant Control Room, Technical report prepared for the Florida Power and Light Company, June 1981.

Malone, T.B., Baker, C.C., and Kosmela, W.T., Human Factors Technology for Ships, Technical report prepared for the Naval Sea Systems Command, January 1981.

Avery, L., et al., Human Factors Evaluation of the Standard Nuclear Unit Power Plant System (SNUPPS). Technical report prepared for Nuclear Projects Incorporated, 1981.

Eike, R., et al., Human Factors Evaluation of the Calvert Cliffs Nuclear Power Plant Units 1&2 Control Rooms. Technical report prepared for the BG&E Company, 1981.

Baker, C., Mallory, K., and West, R. "Survey of Assessment of Nuclear Power Plant Control Room Operability." Paper presented at the 24th Annual meeting of the Human Factors Society, 1980.

Mallory, K., West, R., and Baker, C. "Human Engineering Guidelines for Nuclear Power Plant Control Rooms." Paper presented at the 24th Annual meeting of the Human Factors Society, 1980.

Mallory, K., Baker, C., and West, R. "Procedures for Human Engineering Evaluation of Nuclear Power Plant Control Rooms." Paper presented at the 24th Annual meeting of the Human Factors Society, 1980.

Mallory, K., Baker, C., Neal, V., and Shields, N. HFE Review of the V.C. Summer Nuclear Power Station Control Room. Technical Report prepared for the South Carolina Electric and Gas Company, July, 1980.

Mallory, K., Fleger, S., Johnson, J., Avery, L., Walker, R., Baker, C., and Malone, T. Human Engineering Guide to Control Room Evaluation, Vols I and II. Prepared for the Nuclear Regulatory Commission, August, 1980.

Baker, C.C. and Malone, T.B. "Evaluation of the Applicability of the HFTEMAN Methodology to Navy Ship Systems," prepared for the Naval Sea Systems Command, August 1979.

Baker, C.C., Malone, T.B. and Kosmela, T., "Manning Requirements Estimation for Mark-86/SEAFIRE Gun Control System Integration." Technical report prepared for the Naval Sea Systems Command, July 1979.

Baker, C.C., Malone, M.T., Johnson, J. and Malone, T.B. "Identification of HFE Technology Gaps in Addressing HFE Requirements of the Navy Major Weapon System Acquisition Process." Paper accepted for forum presentation at the 23rd Annual Meeting of the Human Factors Society.

Baker, C.C., Johnson, J., Malone, M.T. and Malone, T.B. Human Factors Engineering Technology for Major Naval Weapon Systems Acquisition. March 1979. Report prepared under Contract N00024-76-C-6129.

Baker, C.C. and Malone, T.B. Human Factors Engineering Evaluation of Catapult Systems. Prepared for the Naval Sea Systems Command, January 1979.

Baker, C.C. and Malone, T.B. Human Factors Engineering Technology for the Mark-14 Carrier Arresting Gear. Prepared for the Naval Sea Systems Command, 1978.

Malone, T.B., Eike, D.R., Baker, C.C. and Andrews, A.S "Human Factors Engineering technology Integration into the Naval Ship Acquisition Process: Designing for Operability." Paper presented at the 22nd Annual Human Factors Society Meeting, November 1978.

Malone, T.B., Kirkpatrick, M., Kohl, J.S. and Baker, C.C. Field Test Evaluation of Rear Lighting Systems. Report prepared under Contract DOT-HS-5- 01228, February 1978.

## DANNA L. BEITH

### EDUCATION:

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| 1976 | B.A. - | Psychology, University of California, Santa Barbara, California |

### EXPERIENCE:

1980 to Present

ESSEX CORPORATION
Alexandria, Virginia

Research Scientist/Project Manager — Project manager for the development and production of approximately 300 nuclear power plant surveillance/test procedures for South Carolina Electric and Gas Company. Work envolves technical review and editing of developed procedures, technical direction of all project staff, and coordination of the production of the procedures from initial writing through final word processing. Responsible for the technical work and personnel affairs of a staff composed of 6 to 8 technical writers, two editors, two nuclear plant operations specialists, and 8 word processors.

On-site supervisor for the rewriting/formatting of nuclear power plant emergency, normal and standard operating procedures at South Carolina Electric and Gas Company's Virgil C. Summer Nuclear Station. Procedure formats were reviewed using criteria concerned with readability, legibility, and consistancy.

Directed the Human Factors evaluation of the on site data collection for the Comanche Peak 1 Nuclear Power Plant control room. This evaluation included criteria specified in NUREG/CR-1580 and NUREG-0700. Duties also included documenting and identifying Human Engineering discrepancies and backfits.

Research Associate — Participated in the Human Factors evaluation of three Nuclear Power Plants for Carolina Power & Light. One plant evaluation included a control board assessment of engineering drawings for a plant under construction. Duties consisted of procedures development for control room evaluation and identifying, reporting and suggesting suitable backfits for Human Engineering Descrepancies found in the control room. Duties also included the establishment of permanent records for all data and report writing.

Prepared checklist and surveys to meet evaluation requirements specified in NUREG/CR-1580. Also conducted an analysis of NUREG-0700 to assess new human factors criteria. Validated checklist items from first sources references.

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| 1978-1980 | XEROX CORPORATION<br>El Sequndo, California and Rochester, New York<br><br>Associate Human Factors Designer — Support to the Human Factors Department in the Business Machine and Copies/Duplication Divisions. Duties included control system design, behavioral testing and new product assessments. Also, wrote machine operating procedures and developed dialogues used for operator assistance. |
| 1978 | CANYON RESEARCH GROUP, INC.<br>Westlake, California<br><br>Assistant Researcher — Contract research assistant to Xerox Corp., Industrial Design/Human Factors Department. Suport to the Human Factors Department in the Business Machines Division. Duties consisted of control system design and behavioral testing. |
| 1976-1978 | BIO TECHNOLOGY, INC.<br>Falls Chruch, Virginia<br><br>Field Investigator — Northern California and Northern Nevada. Conducted a "Large Truck Accident Study" for the Federal Highway Administration of the Department of Transportation. Supervised Field Investigators conducting interviews with truck owners, drivers and California Highway Patrol officers and analyzed accident sites and accident reports. Conducted highway surveys involving road characteristics, traffic density and speed data using remote control cameras and radar equipment. |
| 1976 | GRADUATE SCHOOL OF EDUCATION<br>University of California<br><br>General Assistant — Office of the Dean. Conducted a study of Professor-Student contact hours and performed general office duties. |
| 1975 | ARNOLD HOMES FOR CHILDREN, INC.<br>Sacramento, California<br><br>Counselor — Behaviorist for emotionally disturbed children. Acted as an Assistant to the Administrative Counselor as a Project Research to refine and update Behavior Modification Programs. |
| MEMBERSHIPS: | Member of the National Human Factors Society |

DALE L. PILSITZ

EDUCATION:

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| 1976-1981 | Senior Reactor Operator License - Three Mile Island Nuclear Power Station Unit 1 |
| 1974-1976 | Reactor Operator License - Three Mile Island Nuclear Power Station Unit 1 |
| 1973 | Pressurized Water Reactor Training Program - Babcock and Wilcox Simulator, Lynchburg, Virginia |
| 1971 | Reactor Familiarization Program - Penn State University Reactor Facility, State College, Pennsylvania |
| 1969 | Reactor Operator Training Course - Metropolitan Edison Company |

EXPERIENCE:

Nov. 81 - Present

ESSEX CORPORATION
Alexandria, Virginia

Senior Nuclear Operations Specialist - Provide nuclear power plant operational expertise to support Essex human engineering services to the nuclear power industry. Ensure practicality of recommended backfits identified by human engineering analysis. Currently directing system function and task analysis portion of detailed control room reviews for St. Lucie Units 1 and 2. Develop format and text of Emergency and Operating Procedures and provide technical support for previously written procedures. Reviewed human engineering deficiencies for Comanche Peak and St. Lucie nuclear power stations. Participated in control room design and control panel layout reviews for Comanche Peak and St. Lucie. Performed detailed control panel design layout analysis at a component level for Comanche Peak and St. Lucie Unit 2. Utilized P&IDs to evaluate rearrangement of Comanche Peak Unit 1 control panels to facilitate mimics and demarcation to maximize operator efficiency in handling routine and emergency situations. Participating in developing Human Engineering Design Handbook for Nuclear Power Plants prepared for Electrical Power Research Institute. Performing Systems Review and Task Analysis for Florida Power and Light Company. This includes the analysis of response selection and sequences of operator Actions; evaluation of procedures and task performance capability.

Sep. 81 - Nov. 81

INSTRUMENT AND ENGINEERING SERVICE COMPANY
Elizabethtown, Pennsylvania

Consultant - Provided technical support and wrote operational and emergency procedures for nuclear power stations. Prepared lesson plans for transient and accident analysis lectures.

May 61 - Aug. 81

GPU NUCLEAR/METROPOLITAN EDISON COMPANY
Middletown, Pennsylvania

Nuclear Shift Supervisor - Senior Reactor Operator, Three Mile Island Power Station, Unit 1 - Accountable for overall shift supervision and direction of foreman and production personnel in the efficient and safe operation of Unit 1 at Three Mile Island Nuclear Generating Station to ensure plant and system reliability within the guidelines of Plant Technical Specifications and the unit operating license. Developed and reviewed all procedures and those changes to procedures involving operations. Implemented changes dealing with plant problems. Responsible for ensuring that plant operations are conducted in such a manner that no detrimental environmental conditions arise, and that operations in no way jeopardize the health and safety of plant personnel or the public. Directed shift operation during plant startups, shutdowns, and refueling outages. Assisted in the recovery program following the accident at Three Mile Island, Unit 2. Assisted in planning operations and scheduling maintenance for refueling outage.

Nuclear Shift Foreman - Senior Reactor Operator, Three Mile Island Nuclear Power Station, Unit 1. Responsible for daily on-shift supervision to ensure that the generating unit is operating safely and efficiently in accordance with the technical specifications and the operating license. Responsible for scheduling shift personnel to ensure required shift coverage. Instructed personnel in the performance of their duties. Administered Surveillance Testing program in accordance with the Final Safety Analysis Report required by the NRC. Coordinated all plant technical, operational, and auxiliary support functions during all phases of plant operation.

Nuclear Control Room Operator - Reactor Operator. Participated in initial plant hot functional testing and in initial plant startup. Developed format and text for Operating Procedures, Emergency Procedures, and Response to Alarm Procedures. Performed startup, emergency, and routine duties associated with operating the 870 MW Pressurized Water Reactor, including preoperational checkouts and design modification drafting of safety-related and non-safety-related systems.

Electrical Technician - Crawford Station. Performed assignments on electrical transmission and distribution systems at coal fired and oil fired units at Crawford Generating Station.

## THOMAS A. HARDING

### EDUCATION:

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| 1980 | Senior Reactor Operator Permit - USNRC North Anna Nuclear Power Station Unit 1 and Unit 2 |
| 1978 | Reactor Operator License - USNRC North Anna Nuclear Power Station Unit 1 |
| 1975 | Retraining Qualification - Westinghouse Zion Power Station - Simulator, Zion, Illinois |
| 1973 | Reactor Operator License - USAEC Surry Power Station - Unit 1 and Unit 2 |

### EXPERIENCE:

May 1980 Present — ESSEX CORPORATION
Alexandria, Virginia

Staff Nuclear Operations Specialist - Provides means of correlating disciplines of theoretical and operational human factors engineering. This has included developing format and text of various emergency and operation procedures for Indian Point Unit 2 and Unit 3 and V. C. Summers and evaluation of procedures content and task requirements for Calloway (SNUPPS), Shearon Harris, H. B. Robinson, Calvert Cliffs and St. Lucie. Performing reviews of Human Engineering Deficiencies for Grand Gulf, Calvert Cliffs, Shearon Harris, H. B. Robinson, Calloway and Comanche Peak. Participated in control room design and layout reviews of Grand Gulf, V. C. Summer, Shearon Harris, Calvert Cliffs, H. B. Robinson, Calloway, Comanche Peak, Indian Point, Fukushima and Tokai Control Rooms. Performed control panel rearrangement for Calvert Cliffs, Shearon Harris, Comanche Peak, Fukushima, Tokai and St. Lucie. Performed annunciator review rearrangement and/or reformat for V. C. Summer, Comanche Peak, Calvert Cliffs, Tokai, Fukushima and St. Lucie. Also the Mitsubishi Advance Control Room and the Safety Parameter Display Systems for Fukushima and Tokai were evaluated for use during both emergency and routine operation to determine the effectiveness of design and efficient management of personnel.

September 1970 - May 1980 — VIRGINIA ELECTRIC AND POWER COMPANY

Shift Supervisor - Senior Reactor Operator, North Anna Power Station - Directed shift operation during routine, emergency, and start-up duties of the 944Mw Pressurized Water Reactor Units.

Coordinated the revisions of Emergency Procedures for implementing two unit operation.

Senior Reactor permit issued with the first post-TMI tested group; included specific training in thermodynamics and natural convection problems of large PWRs.

Served as Site Coordinator of the Control Room Review Task Force to find out and correct deficiencies in human engineering in the control room of North Anna Power Station. This involved serving as liaison between Virginia Electric and Power Company, as operators, Essex Corporation, as reviewers, and the United States Nuclear Regulatory Commission, as monitors. Later the position was concerned with implementing backfits to solve the designated problems.

Control Room Operator - Reactor Operator, North Anna Power Station - Performed start-up, emergency and routine duties of two 944 Mw Pressurized Water Reactor Units including pre-operation checkouts and design modification drafting of safety and nonsafety related systems.

Control Room Operator-Reactor Operator, Surry Power Station - Performed start-up, emergency and routine duties of two 822 Mw Pressurized Water Reactor Units including preoperational checkouts of safety and nonsafety related systems.

Twelfth Street Power Station - Performed start-up and routine operations on two unit coal fired station.

## DONALD J. SEIBERT, JR.

EDUCATION:

| | | |
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| 1981 | B.S. - | Engineering Technology (Power Plant System Major), University of Maryland, College Park |
| 1976 | Certificate in HVAC, Lincoln Technical Institute | |
| 1973 | Boiler Technician, Class A School, U.S. Navy | |

ADDITIONAL EDUCATION:

Additional (35) credits in Human Factors/Safety Engineering, University of Maryland, College Park

EXPERIENCE:

April 1981-
Present

ESSEX CORPORATION
Alexandria, Virginia

Research Associate - St. Lucie-2 control room room evaluation. Participated in the conduct of CR evaluation activities, documentation of findings and report preparation. Assisted in the development of a labelling specification using standardized dictionary for the annunciator system at the plant St. Lucie-2 control room.

Texas Utilities Generating Company. Performed on-site CR evaluations using NUREG-0700 guidelines. Wrote Human Engineering Discrepancy reports and provided supporting documentation. Assisted in the development of a standardized abbreviation and acronym list for use in procedures, labels, and annunciators.

Carolina Power and Light. Assisted in the evaluation and design of the Brunswick 1 & 2 NPPs. Duties extended to systems evaluations, finding documentation, and design of backfits to resolve HFE discrepancies.

Jan. 1973-
July 1975

UNITED STATES NAVY

Boiler Technician - Operated and maintained 1200 psi Boilers and their associated auxiliary equipment. Trained personnel for main and auxiliary room watch stations. Assisted in repairs during a major ship overhaul.

Jan. 1972-
Jan. 1973

WASHINGTON INVENTORY SERVICES
College Park, Maryland

Inventory Control Specialist - Duties involved taking inventory, record keeping and the processing of data for various government and commercial firms on the East Coast.

July 1971-
Dec. 1971

MAIL EXPRESS CORPORATION
Ardmore, Maryland

Machinery Operator - Operated mechanical and computerized systems required to ship bulk mail. Assisted in mechanical repairs.

MEMBERSHIPS:

Fusion Energy Foundation
University of Maryland Alumni Association

## CANDACE K. WEISS

### EDUCATION:

| | |
|---|---|
| 1980 | B.A. - Political Science, George Washington University, Washington, D.C. |

### EXPERIENCE:

June 1980-
Present

ESSEX CORPORATION
Alexandria, Virginia

Research Associate - Performed human factors engineering evaluations of nuclear and fossil power plants. Conducted on-site data collection at Grand Gulf (MP&L), H.B. Robinson (CP&L), Rancho Seco (SMUD), St. Lucie (FP&L), Virgil C. Summer (SCE&G), Comanche Peak (TUGCO), Callaway and Wolf Creek (SNUPPS), and Calvert Cliffs and Brandon Shores (BG&E). Responsible for identifying and evaluating discrepancies from human engineering standards and practices of workspace design, panel layout, and control/display integration. Developed and utilized checklists, as well as interviewed operators to identify human/system deficiencies in power plant control rooms.

Performed panel layout evaluations and designed panel modifications to enhance the interface between the operator and power panel instrumentation. Assigned as task leader in the development of a labeling and demarcation scheme for control panels. Responsible for the development of a labeling scheme to incorporate hierarchical labeling, demarcation of the control boards by systems and functional groups, and generation of labels for all instrumentation.

Performed task analysis of nuclear power plant procedures to evaluate task complexity, operator workload, whether the instrumentation needed for each task is present in the control room, whether unnecessary items are present in the control room, and whether present items fit their task uses. Evaluated the efficiency of panel layout as part of a link analysis study.

Surveyed and analyzed adequacy and efficiency of lighting, noise, communications, anthropometry for instrumentation placement, and coding standards.

Jan. 1980-
May 1980

COMMUNITY MENTAL HEALTH CENTER
Washington, D.C.

Intern - Researched the condominium conversion issue and its effects on the elderly in the community. Duties included: preparation of articles for local newspapers; interpersonnel communication with elderly citizens; and interviewing strategies.

June 1979-
Jan. 1980

OAO CORPORATION
Washington, D.C.

Research Assistant - Organized and indexed a chronological file of documents for the Department of Energy program on Building Energy Performance Standards. Other duties included responding to public requests for DOE documents and the organization of mass mailings.

Jan. 1979-
May 1979

COMMUNITY LAW OFFICES
Washington, D.C.

Paralegal Intern - Responsible for conducting legal research and interviewing clients. Prepared legal documents relating to divorce, landlord and tenant disputes, immigration law, and child support.

TECHNICAL REPORTS:

Avery, L., & Weiss, C. Human Factors Evaluation of the Wolf Creek Panels RL013 and RL014, January 1982.

Eike, R., et al. Human Engineering Evaluation of the Control Room at Brandon Shores Fossil-Fired Power Plants, July 1982.

West, R., et al. Human Factors Evaluation of the Calvert Cliffs Nuclear Power Plant Units 1 & 2 Control Room, April 1981.

Avery, L., et al. Human Factors Evaluation of the Standard Nuclear Unit Power Plant System (SNUPPS), January 1981.

# EVERETT M. BOYD

## EDUCATION:

1980 — B.A. - Psychology, The College of William and Mary, Williamsburg, Virginia

## EXPERIENCE:

October 1980 - Present — ESSEX CORPORATION
Alexandria, Virginia

Research Assistant - Conducted data collection in control rooms at the Calvert Cliffs (BG&E) and Comanche Peak (TUGCO) Nuclear facilities as part of human factors evaluations. Additional duties included construction of control panel mockups, analyzing and writing human engineering discrepancies of problems which may cause or contribute to operator error, and devising standard abbrebviations for labeled terms used in the control room.

Conducted ambient noise surveys and communications studies for control rooms at Calvert Cliffs Nuclear Power Plant and Big Bend Fossil Fuel Plant (TECO). Surveys involved operation of sensitive measuring apparatus, reporting of level readings, and recommending acoustical backfits to conform to NUREG and human factors guidelines.

Researched and developed technical paper on the auditory task system of the human. Conducted a literature review of the psycho-physical relationship of audition in control room operations. Studied effects of noise and audible signals on the auditory monitoring tasks of control room operators. Developed a model of auditory processing in the control room to explain other task dependency on the information handling capacities of the auditory system.

Authored a specification for key-operated rotary switches for Calvert Cliffs Nuclear Power Plant. Research for this specification included testing of discrepant switches for resistance factors, with an ergonometer. Keys and switches were addressed in terms of their suitability for human use in the control room. Several sources of information were used to document findings. Qualifications for satisfactory keys and switches were discussed, and the specification was used to substantiate discrepancies between the utility and the vendor.

Developed test and evaluation plans based on human factors requirement for the nuclear power industry. These plans were written as procedures to be used by human factors specialists in the field. Responsibilities included reviewing NUREG criteria and translating them into instructional language for the conduct of checklisting, surveys and special studies.

As a member of the procedures format revision project for South Carolina Electric and Gas Company, rewrote nuclear power plant operating and testing procedures to established human factors requirements for format and content, including syntax, semantics, context, readability, and consistency.

Publications:

West, R.K., O'Donoghue, T.K., Boyd, E.M., Krick, C.K., Piccione, F., Kane, R.M., Fleger, S.A., and Baker, C.C. Human Factors Evaluation of the Calvert Cliffs Nuclear Power Plants Units 1 & 2 Control Room. Final Report (draft), March 1981.

Avery, L., Boyd, E., and Eike, R. Report on Environmental Studies of the Big Bend Unit 3 Control Room. April, 1982.