D. C. COOK NUCLEAR PLANT UNITS 1 & 2

DETAILED CONTROL ROOM DESIGN REVIEW

SUMMARY REPORT

VOLUME 1

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

LIST OF FIGURES

LIST OF FIGURES (Cont'd)

LIST OF TABLES

APPENDICES

VOLUME 2

A. Detailed Instructions for Review Phase Tasks

B. NRC Staff Comments on Program Plan

C. Summary of May 8, 1984 Meeting with NRC Staff

D. Letter AEP:NRC:0773H

E. Control Room Operating Personnel Survey Interview Questions

F. Summary Sheets for Control Room Operating Personnel Interviews

G. Letter AEP:NRC:0773I and NRC Response

H. Human Engineering Discrepancy Assessment Methodology and Criteria

I. Control Room Operator Questionnaire for Columbus Mockup

J. Control Room Improvements Photos, Samples and Drawings

K. Personnel Resumes

VOLUME 3

CLO/HED Descriptions and Assessments

COOK DCRDR ACRONYMS/ABBREVIATIONS

AEPSC	AMERICAN ELECTRIC POWER SERVICE CORPORATION
AIT	ACTION ITEM TRACKING
ASST. MGR.	ASSISTANT MANAGER
AT	ASSESSMENT TEAM
CLO	CHECKLIST OBSERVATION
COOR.	COORDINATOR
CRHEC	CONTROL ROOM HUMAN ENGINEERING CRITERIA
CRHFS	CONTROL ROOM HUMAN FACTORS SURVEY
CRI	CONTROL ROOM INVENTORY
CROPS	CONTROL ROOM OPERATING PERSONNEL SURVEY
CRS	CONTROL ROOM SURVEY
CTF	COMMITMENT TRAVELER FORM
DCRDR	DETAILED CONTROL ROOM DESIGN REVIEW
DRT	DESIGN REVIEW TEAM
DWGS	DRAWINGS
EED	ELECTRICAL ENGINEERING DIVISION
ENG	ENGINEER
ENGG	ENGINEERING
EOP	EMERGENCY OPERATING PROCEDURES
GEN. PROC. NO.	GENERAL PROCEDURE NUMBER
HED	HUMAN ENGINEERING DIVISION
MCR	MATERIAL CONTROL RECORD
MED	MECHANICAL ENGINEERING DIVISION
MGR	MANAGER
NED	NUCLEAR ENGINEERING DIVISION
NRC	NUCLEAR REGULATORY COMMISSION
NS&L	NUCLEAR SAFETY & LICENSING
OER	OPERATIONAL EXPERIENCE REVIEW
PPR	PROGRAM PLANT REPORT
PRT	PROJECT REVIEW TEAM
QA	QUALITY ASSURANCE
RFC	REQUEST FOR CHANGE
SECT	SECTION
SECTR	SECRETARY
SFTA	SYSTEM FUNCTION REVIEW AND TASK ANALYSIS
A[DS	SAFETY PARAMETER DISPLAY SYSTEM
W	WESTINGHOUSE
WOG/ERG	WESTINGHOUSE OWNERS GROUP/EMERGENCY RESPONSE GUIDELINES

1.0 INTRODUCTION

The Indiana and Michigan Electric Company currently operates a two-unit nuclear power plant located along the eastern shore of Lake Michigan. This facility, designated the Donald C. Cook Units 1 and 2, began commercial operation in August 1975 and July of 1979, respectively. Each unit employs a Westinghouse four-loop pressurized water reactor with a net electrical output of 1,054 MWe for Unit 1 and 1,094 MWe for Unit 2.

The control rooms for Donald C. Cook Units 1 and 2 are essentially identical, except for main/feedpump turbines and moisture separator reheater panels. Both control rooms are operational and complete except for those areas of activity which are being performed to address the requirements of NUREG-0737, Supplement 1. For the purpose of this report, the control room for each unit is defined as the panels and other equipment in the main control board area including the hot shutdown panels. A general arrangement drawing is shown in Figure 1-1; functional layout drawings of the control room panels are shown in Figures 1-2 and 1-3, and a panel abbreviation and function list is shown in Figure 1-4.

The Detailed Control Room Design Review (DCRDR) is part of a broad program within the nuclear industry and the Nuclear Regulatory Commission to evaluate nuclear power plant control rooms and the operability of emergency operating procedures (EOPS) within the control rooms from a human factors engineering point of view. The goals of the DCRDR were as follows:

- o Determine whether the existing control rooms provide the system status information, control capabilities, feedback and analytical aids necessary for the control room operators to perform their functions effectively.
- o Identify characteristics of the control room instrumentation, controls, other equipment and physical arrangements which may significantly impair/impede control room operator performance.
- o Analyze and evaluate the problems which could occur during emergency conditions and identify means of correcting those discrepancies which could lead to substantial operational or safety concerns.
- o Verify and validate the proposed means of correction to provide an effective plan of action which applies human factors principles to improve the control room design and enhance operator efficiency and effectiveness.
- o Integrate the DCRDR program with other areas of human factors identified in the NRC task action plan.

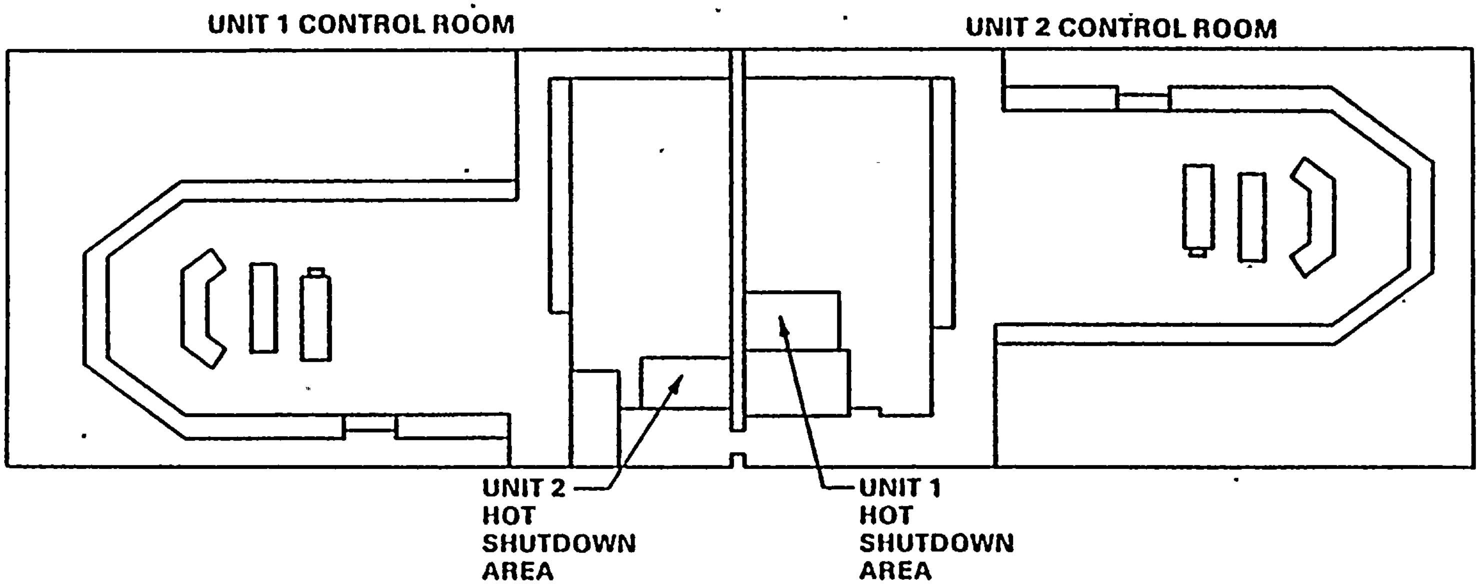

Figure 1-1. General Arrangement Drawing of Donald C. Cook Units 1 and 2 Control Rooms

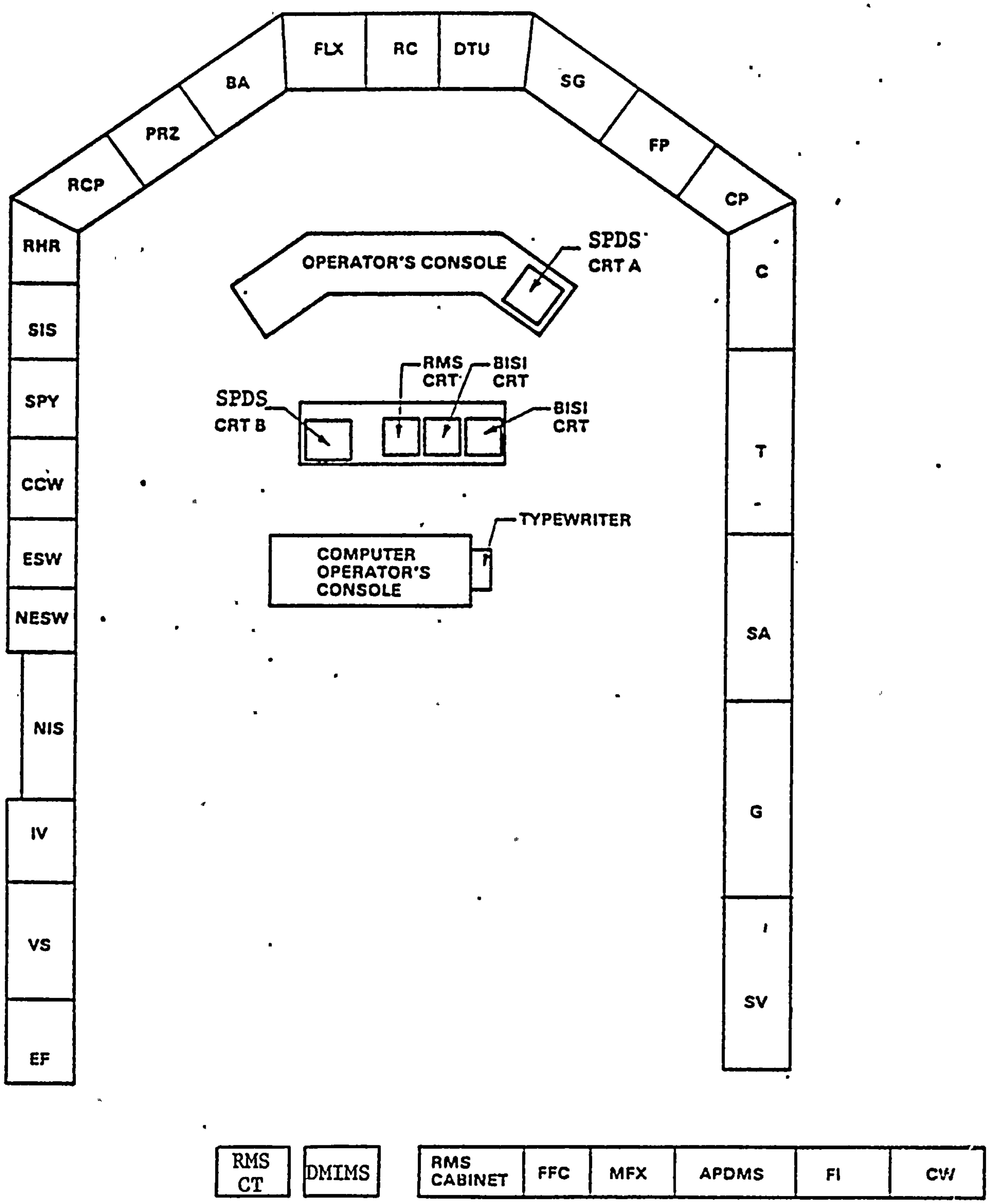

Figure 1-2. Functional Layout Drawing of Donald C. Cook Unit 1 Control Room Panels

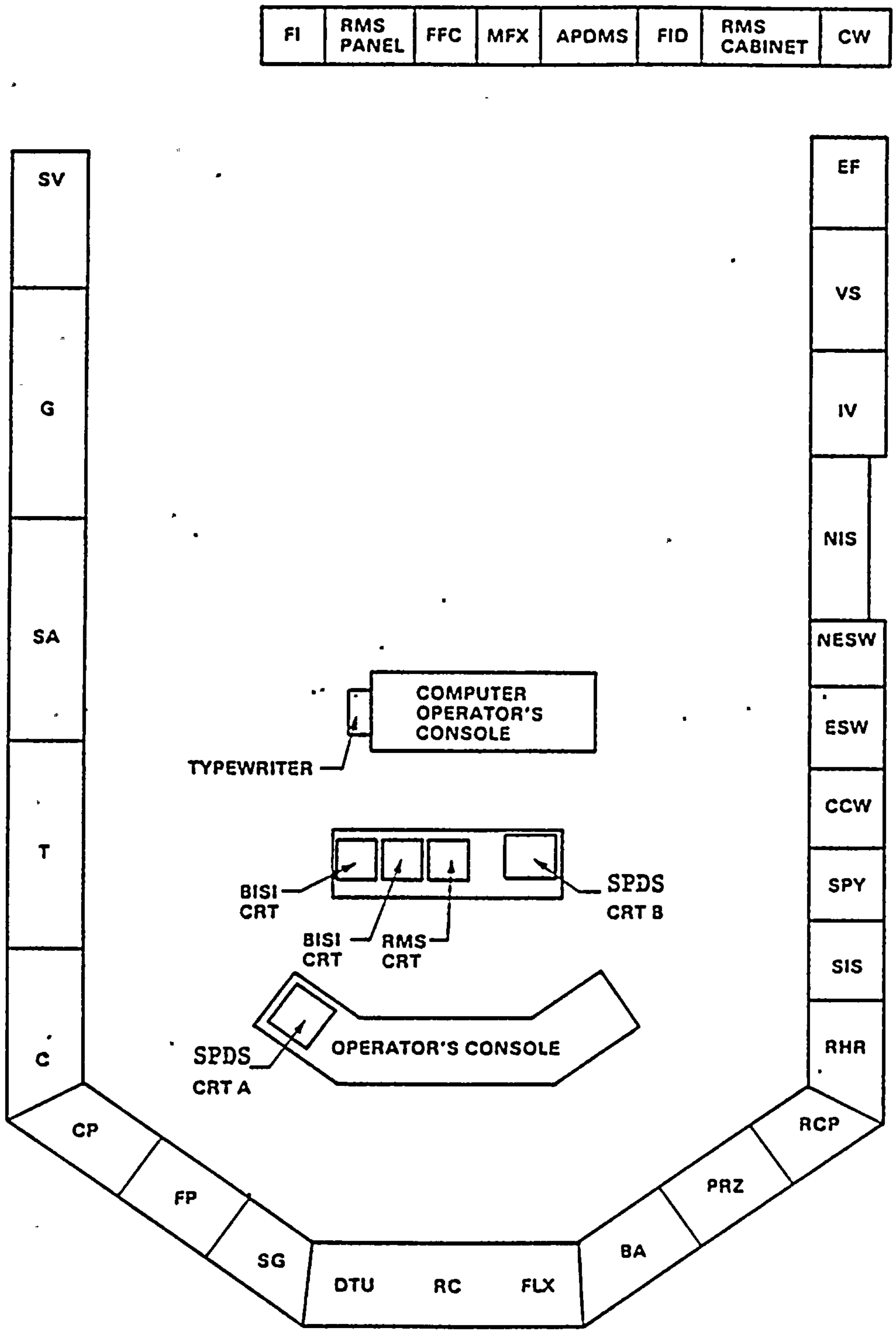

Figure 1-3. Functional Layout Drawing of Donald C. Cook Unit 2 Control Room Panels

APMS	-	Axial Power Distribution Monitoring System Cabinet
BA	-	Boric Acid Panel
BISI	-	Bypassed and Inoperable Status Indication
C	-	Condensate Panel
CCW	-	Component Cooling Water Panel
CP	-	Condensate Pump Panel
CW	-	Circulating Water Panel
DMIMS	-	Digital Metal Impact Monitoring System
DTU	-	Delta T and Unit Panel
EF	-	Emergency Fire Panel
ESW	-	Essential Service Water Panel
FFC	-	Failed Fuel Communications Panel
FI	-	Fixed In-Core Panel
FID	-	Fixed In-Core Cabinet
FLX	-	Flux Panel
FP	-	Feed Pump Panel
G	-	Generator Panel
IV	-	Isolation Valves Panel
MFX	-	Movable In-Core Cabinet
NESW	-	Nonessential Service Water Panel
NIS	-	Nuclear Instrumentation System Cabinets
PRZ	-	Pressurizer Panel
RC	-	Rod Control Panel
RCP	-	Reactor Coolant Pump Panel
RHR	-	Residual Heat Removal Panel
RMS	-	Radiation Monitoring System
RMS-CT	-	Radiation Monitoring
SA	-	Station Auxiliary Panel
SG	-	Steam Generator Panel
SIS	-	Safety Injection System Panel
SPDS	-	Safety Parameter Display System
SPY	-	Containment Spray Panel
SV	-	Plant Service Panel
T	-	Turbine Panel
VS	-	Ventilation System Panel

Figure 1-4. List of Abbreviations and Function for Control Panels

1.1 Overview

This report describes the methodology findings, assessment and implementation of the D. C. Cook Units 1 and 2 DCRDR. The review was conducted to ensure that the control rooms would support operations during emergency conditions and to meet the requirements of item 1.D.1 (Control Room Design Review) of Supplement 1 to NUREG-0737 published by Generic Letter 82-33. Note that the format of this report varies from that shown in Figure 8-1 of the D. C. Cook program plan. The present format better organizes and presents the material contained herein. The review was conducted in accordance with the D. C. Cook DCRDR program plan. The plan organized the review into five phases: Planning, Review, Assessment, Implementation and Reporting. In addition to the program plan, detailed instructions were generated (Appendix A) for each of the following review phase tasks.

- o Task 1 - Operating Experience Review
- o Task 2 - Control Room Inventory
- o Task 3 - Control Room Survey
- o Task 4 - System Review and Task Analysis
- o Task 5 - Verification of Control Room Functions
- o Task 6 - Validation of Control Room Functions

The products of each task (where applicable) were Checklists Observation Reports (CLO's), which identified departures and provide suggestions for potential resolution for the discrepancies based on NUREG-0700 guidelines.

In the assessment phase, each CLO was reviewed in detail by the Assessment Team to determine which CLO's were human engineering discrepancies (HED's). The HED's, along with the resolutions provided by the Assessment Team, were then given to the Project Review Team for disposition. Upon agreement of the Project Review Team a plan for implementation of the HED resolution was generated. The above review phases are further documented within this report. "Implementation and Scheduling of Corrective Actions" discusses the time frame for resolving the HED's identified in this report. Also discussed in this section will be the implementation descriptions for the HED resolutions.

1.2 Management and Staffing

This section will identify the DCRDR program teams and their area of responsibility. An overview of the DCRDR organization is shown in Figure 1-1. The Program Administrator has primary responsibility for the overall DCRDR program.

1.2.1 Management Organization

The management review and approval function for the DCRDR program was provided under AEPSC General Procedures for "Engineering Design Changes", and "Preparation of Submittals to the U.S. Nuclear Regulatory Commission", and by corporate procedures for capital improvement authorizations.

The function of management is to:

- o Approve the Program Plan Report
- o Review and approve recommendations for control room design changes
- o Provide the resources necessary for implementation of the DCRDR
- o Approve the Program Summary Report
- o Provide the mechanism for the preparation and submittal of documents to the NRC

1.2.2 Project Review Team

The Project Review Team provided the overall coordination of the DCRDR program. The functions of this team were to:

- o Approve Task Plans prior to the performance of the associated Review Task
- o Ensure the DCRDR program is performed in accordance with the AEPSC Quality Assurance Program
- o Provide overall support to the DCRDR process
- o Monitor the DCRDR progress
- o Ensure the design review objectives and tasks, in relation to other NUREG-0737 efforts are properly coordinated.
- o Establish and initiate a control room improvement program

1.2.3 Design Review Team (DRT)

The Design Review Team is a multidisciplined team of individuals with the wide range of skills necessary to perform the review process in accordance with the Program Plan Report. The Design Review Team responsibilities were to:

- o Develop the Program Plan Report
- o Develop the Licensee Event Report Review Report
- o Develop the Control Room Inventory
- o Develop Task Plans
- o Perform Review Tasks
- o Develop Task Summary Reports
- o Identify departures from NUREG-0700 Section 6 guidelines
- o Assist Assessment Team as technical support
- o Develop the Program Summary Report

1.2.4 Assessment Team (AT)

The Assessment Team function was to:

- o Evaluate the significance of the observed departures (CLO's) from NUREG-0700 Section 6, guidelines
- o Identify the applicable departures as human engineering discrepancies (HED's)
- o Assign a category and priority to the HED for scheduling of corrective action
- o Review/approve recommendations for HED corrective action prior to origination of a request for change (AEPSC Procedure 25*) or engineering design.

* AEPSC Procedure 25 to be designated AEPSC Procedure 3.1 in near future

1.3 Program Plan

The initial step of the DCRDR was the preparation of a Program Plan based on the requirements of Supplement 1 to NUREG-0737 and the guidance contained in NUREG-0700 and NUREG-0801. As described above, the Program Plan addressed the design review activities in five phases:

- o Phase I — Planning
- o Phase II — Review
- o Phase III A — Assessment
- o Phase III B — Implementation
- o Phase IV — Reporting

The Program Plan Report (PPR) was submitted to the NRC for review on December 29, 1983. The NRC staff comments on the plan were returned on March 13, 1984 (see Appendix B). In general the NRC staff stated the plan demonstrates a commitment to meet the requirements of Supplement 1 to NUREG-0737. However, additional information was needed before a decision regarding the efficacy of the proposed DCRDR could be made. More specifically, information was needed in the following areas:

1. Qualifications and Structure of the DCRDR Review Team
   - Specific task assignments and level of effort
   - Full-time involvement of human factors specialist

2. System Function Review and Task Analysis (SRTA)
   - Contents of the Control Room Human Engineering Criteria (CRHEC) report
   - Scope of the SRTA
   - Methodology for conduct of the SRTA

3. Assessment of HED's
   - Criteria for categorization of HED's

1.3 Program Plan (Cont'd)

4. Selection of Design Improvements

   - Methodology

   - System for tracking HED's

5. Verification that improvements will provide the necessary corrections

   - Methodology

   - Criteria

6. Verification that control room modifications do not introduce new HED's

   - Methodology

7. Coordination of the DCRDR with other improvement programs

   - Plans for how this will be accomplished

Based on the additional information needed by the NRC staff, a meeting was held in Bethesda, Maryland on May 8, 1984. A summary of the meeting is contained in Appendix C.

Additional information was requested, in writing, to assure that some concerns raised during the course of the meeting were fully addressed. These items were:

- o Functions of each team, personnel task and responsibilities and how the teams interacted with one another.

- o The process the licensee will use to address items 2 and 4 in the summary letter from the WOG/NRC meeting (March 29, 1984) on the task analysis requirements (see Section 4, Paragraph 4.1.3).

- o Plan for achieving integration and coordination with other Emergency Response Capability efforts (see Section 7).

The response to this request was supplied to the staff on August 6, 1984 by letter AEP:NRC:0773H (Appendix D).

1.3 Program Plan (Cont'd)

Changes made to the program plan as a result of the meeting were as follows:

1. Replaced references to Control Room Human Engineering Criteria Report (CRHEC) with NUREG-0700 Guidelines.

2. Replaced references to Canyon Research Group with ESSEX Corporation. This was a name change only. The Human Factors specialist personnel involved were unaffected.

3. Updated the listing of key personnel on the DCRDR teams to show personnel presently involved or those with the highest participation level. These changes resulted from transfers and promotions during the early part of the review phase.

   In response to the NRC staff concern of full-time involvement of human factors specialist, Dr. G. A. Elliff of ESSEX Corporation replaced Dr. T. Sheridan as a member of the assessment team. Dr. Elliff was also added as a Human Factors Consultant to the Project Review Team.

   Mr. R. Surman of Westinghouse who managed the System Function Review and Task Analysis program and the Instrumentation and Control Characteristic Requirements Review was added to the Design Review Team. Figure 1-5 shows the updated listing of key personnel.

4. Added the following description of the DCRDR teams interfaces and key personnel responsibilities and level of effort. This description is an updated version of Attachment 1 to letter AEP:NRC:0773H.

5. The Phase 1 and Phase II schedule shown in the program plan were based on submittal of the Program Summary Report in December 1985. An extension of this schedule was requested by letter AEP:NRC:0773I to December 1986. This request was granted by NRC letter dated December 1985 (Appendix G). Figure 1-6 shows this revised schedule.

6. The assessment process methodology section of the program plan was replaced with a more detailed description to illustrate how the CLOs move through the assessment process. This assessment process methodology is discussed in Appendix H.

PROJECT REVIEW TEAM (PRT)

* DCRDR Program Administrator: A. S. Grimes
* DCRDR Program Lead Engineer: R. F. Shoemaker
* DCRDR Program Plant Coordinator: T. R. Stephens
* AEPSC Nuclear Safety & Licensing Scientist: K. J. Toth
* DCRDR Program Manager (Westinghouse): J. D. Young
* AEPSC Human Factors Consultant: Dr. T. Sheridan
* DCRDR Human Factors Consultant (ESSEX Corp.): Dr. G. A. Elliff

DESIGN REVIEW TEAM (DRT)

* DCRDR Program Administrator: A. S. Grimes
* DCRDR Program Lead Engineer: R. F. Shoemaker
* AEPSC I&C Engineer: W. E. Arnold
* AEPSC Nuclear Safety & Licensing Scientist: K. J. Toth
* I&MECO Reactor Operators
* DCRDR Program Plant Coordinator: T. R. Stephens
* AEPSC Quality Assurance Engineer: J. B. Brittan
* DCRDR Program Project Engineer: W. R. Moran
* AEPSC Electrical Engineer: J. A. Schlunt
* DCRDR Program Manager (Westinghouse): J. D. Young
* DCRDR Human Factors Consultant (ESSEX Corp.): Dr. G. A. Elliff
* I&MECO & Westinghouse Training Personnel
* Westinghouse Training Personnel: R. J. Wartenberg
* Westinghouse SFTA-ICCR Team: R. Surman

ASSESSMENT TEAM (AT)

* DCRDR Program Administrator: A. S. Grimes
* DCRDR Program Lead Engineer: R. F. Shoemaker
* AEPSC I&C Section Manager: J. C. Jeffrey
* AEPSC Nuclear Safety and Licensing Section Manager: J. G. Feinstein
* D. C. Cook Plant Management: B. A. Svensson
* I&MECO Senior Reactor Operator(s)
* AEPSC Manager of Quality Assurance: R. F. Kroeger
* AEPSC Electrical Generation Section Manager: R. C. Carruth
* DCRDR Human Factors Consultant (ESSEX Corp.): Dr. G. A. Elliff

DCRDR Program Organization Structure

Figure 1-5

REVISED SCHEDULE PHASE I AND II

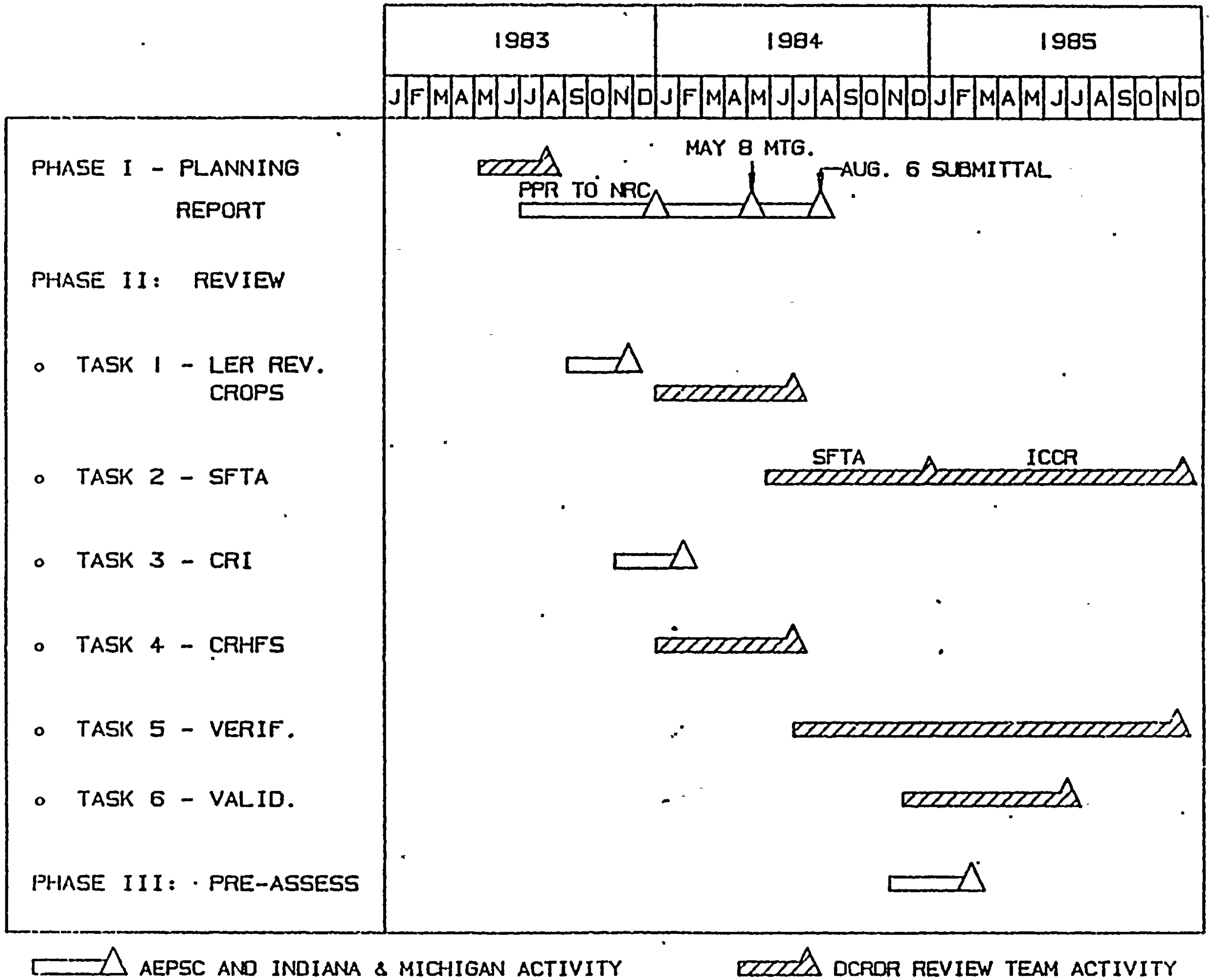

FIGURE 1-6

COOK DCRDR
Project Review, Assessment and Design
Review Teams Interface

(1) The Project Review Team performs the management functions of review, approval and coordination of the DCRDR Program, program phases and reports. It reviews/approves the other teams work and documentation. It generates, initiates, reviews and approves plans and strategies to accomplish the overall program objectives.

Its primary interfaces with the Assessment and Design Review Teams are the positions common to all three teams, the Program Administrator, the Lead Engineer and the Human Factors Specialist, and the review/approval of the teams output.

The expertise of the team personnel as currently staffed to accomplish these tasks is as follows:

The Program Administrator - presently a consulting engineer in the AEPSC Mechanical Engineering Division. Past experience involves assistant division manager responsibilities and Instrumentation & Control Section Manager throughout the design, construction and startup of the D. C. Cook Plant.

The Lead Engineer, has both I&C and operator supervision experience in control rooms. He has both designed and put into service control and instrumentation systems. He has written both control and operation startup procedures.

Human Factors Specialist expertise is provided by Dr. T. A. Sheridan, a widely known industrial consultant, MIT Professor, researcher, author and editor, and Dr. G. A. Elliff of ESSEX Corporation. Dr. Elliff is a Division Director for ESSEX Corporation and has over five years experience managing and conducting Human Factors Surveys for Control Room Design Reviews and related programs for the nuclear power industry.

The Plant Coordinator provides the D. C. Cook Nuclear Plant operations department representation. He is a Production Supervising Engineer on the Operations Department staff with seven years nuclear plant experience.

The Program Manager of Westinghouse provides the team with NSSS vendor expertise with 14 years of nuclear control board layout and design, reactor protection, safeguards and testing systems.

The Nuclear Safety & Licensing Scientist, also assigned as Emergency Response Capabilities-Nuclear Division Overall Project Coordinator, provides the team overall expertise of project coordination and scheduling, regulatory requirements, safety and licensing requirements.

(2) The Assessment Team is responsible for identifying HEDs from CLOS, categorizing the HEDs to establish the significance of their deviation from the NUREG-0700 Guidelines, and the assessing of the probability of operator error and the consequences of operator error in order to determine the priority rating for implementation of corrective actions.

They assess corrective action design alternatives to determine that the required correction is provided and no new departures from NUREG-0700 are created. They select which design alternative will be implemented, recommend a schedule for implementation, assess the corrective action for full, partial, or no fix, justify and document less than full fixes.

These considerable responsibilities require a team of depth, knowledge and experience. Nuclear plant systems expertise is provided by the various engineering manager's and plant management. Human factors specialist input was provided by Dr. G. A. Elliff and T. J. Voss of ESSEX Corporation.

The expertise of the team personnel to accomplish its tasks is an follows:

The Program Administrator and Lead Engineer, already described under the PRT. Instrumentation, control, safety and interlock systems engineering management experience is supplied by the I&C and Electrical Generation Section Managers.

Human Factors Specialist expertise is provided by the same team that generates the reported departures from the NUREG-0700 Guidelines during the Review Phase.

D. C. Cook Nuclear Plant management expertise is provided by the Assistant Plant Manager, Operations. Operations expertise is supplied by both the Assistant Plant Manager, Operations and the Operations Superintendent. The Assistant Plant Manager, Operations was recently designated Executive Staff Assistant.

Independent nuclear safety analysis and expertise is provided by the NS&L Manager.

Overall program and company quality assurance expertise and company procedures and practice expertise is provided by the Manager of Quality Assurance.

One of its primary interfaces with the Project Review and Design Review Teams are the two persons common to all three teams, the Program Administrator and Lead Engineer. A primary interface with the Project Review Team is the Assessment and Implementation Reports of the Assessment Team which requires the review/approval of the PRT. Another is the PRT review/approval of the DRT member Design Study results and comments for each HED that the Assessment Team requested corrective action proposals on.

The Assessment Team interface with the DRT is the DRT primary output of CLO's and the DRT assistance in evaluating HED's in the Assessment Phase and DRT assistance with the Implementation Report during the Implementation Phase.

(3) The Design Review Team is essentially the "working" team. Westinghouse and ESSEX are part of the DRT and perform the bulk of all Review Phase tasks and provide the human factors specialist expertise required for these tasks. The AEP members of the DRT are responsible for reviewing LERs, assembling the Control Room Inventory, assisting Westinghouse & ESSEX in their tasks as required, and furnishing reference materials and documentation to Westinghouse and ESSEX. The DRT will assist the AT with the evaluation of HED's and the Assessment Report during the Assessment Phase and Implementation Report during the Implementation Phase.

The DRT Develops the Program Plan Report and the Program Summary Report.

Its primary interfaces with the Project Review Team and the Assessment Team are the two persons common to all three teams, (the Program Administrator and the Lead Engineer), its primary output of CLOs to the Assessment Team, and its output of Task Summary Reports reviewed/approved by the PRT. It interfaces withe the AT in assisting with the evaluation of HED's, development of the Assessment and Implementation Reports.

The expertise of the team personnel to accomplish these design review tasks is as follows:

Westinghouse and ESSEX provide extensive human factors specialist talent, NSSS and balance of plant vendor knowledge, I&C control board design, and training expertise.

AEP provides the Program Administrator and Lead Engineer qualities defined under the PRT, mechanical and electrical instrumentation and control system engineering, D. C. Cook Nuclear Plant licensed reactor operator and operator staff and training staff personnel, nuclear safety and licensing engineering, quality assurance engineering and project engineering.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: DCRDR Program Administrator

Name: A. S. Grimes

Team: Assessment, Project Review, Design Review

Responsibilities:

* Communication between Management & DCRDR Teams
* Overall program scheduling
* Overall program coordination with related projects
* Overall program Quality Assurance procedures & practice
* Overall program reporting & documentation
* HED review process
* Obtaining Technical & Administrative support as necessary

Level of effort: As required. Estimated Manhours:

* Phase II, Task 1, 24; Task 2, 8; Task 3,4; Task 4, 8; Task 5, 8; Task 6, 8.
* Phase III, Assessment, 160; Implementation, 80.
* Phase IV, Reporting, 60.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: DCRDR Program Lead Engineer

Name: R. F. Shoemaker

Team: Assessment, Project Review, Design Review

Responsibilities:

* Communication between Program Administrator & Teams
* Communications between Teams & AEPSC Engineering
* Overall program Engineering Documentation Files & Reference
* Design improvements implementation coordination
* Develop control room inventory
* Advise Program Administrator on HED Disposition

Level of effort: As required. Estimated Manhours:

* Phase II, Task 1, 48; Task 2, 80; Task 3, 320; Task 4, 8; Task 5, 8; Task 6, 40.
* Phase III, Assessment, 1000; Implementation, 1000.
* Phase IV, Reporting, 200.

Estimated Manhours for I&C Personnel under Lead Engineer's Supervision:

* Phase II, Task 3, 120.
* Phase III, Assessment 10,000; Implementation 10,000.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: DCRDR Program Manager (Westinghouse)

Name: John D. Young

Team: Design and Project Review

Responsibilities:

* Overall Review Phase Coordination & Documentation
* Program Plan Report Development & Documentation
* Program Summary Report Development & Documentation
* Documentation & Compilation of Checklist Observation Forms

Level of effort: As required. Estimated Manhours by Manager and People Under his supervision:

* Phase II, Task 1, 48; Task 2, 20; Task 3, 20; Task 5, 696; Task 6, 348
* Phase III, Assessment, 16
* Phase IV, Reporting, 348.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC Human Factor Consultant

Name: Dr. T. Sheridan

Team: Project Review

Responsibilities:

* Overall Human Factors Support to Project Review Team in Planning Phase

Level of Effort: As Required

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: DCRDR Human Factors Consultant (ESSEX)

Name: Dr. G. A. Elliff

Team: Design & Project Review, Assessment

Responsibilities:

* Checklist Observation Form Documentation
* Control Room operating Personnel Survey Interviews, Questionnaires, Documentation & Reports
* Control Room Human Factors Survey Measurements, Documentation & Reports
* Overall Review Phase human factors support
* Review Phase task plans development
* Human Factors expertise for CLO/HED assessment
* Human Factors expertise for corrective action plans
* Generate Assessment Report

Level of effort: As required. Estimated Manhours by Consultant or People Under his supervision:

* Phase II, Task 1, Crops, 166; Task 4, Crops, 1446; Task 6, 332.
* Phase III, Assessment, 192

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC Manager of Quality Assurance

Name: R. F. Kroeger

Team: Assessment

Responsible to: DCRDR Program Administrator

Responsibilities:

* Evaluate observed departures from NUREG-0700
* Identify HED's
* HED review
* Validation of HED priority
* Review & approval of HED correction recommendations
* Overall Quality Assurance Engineering support for Assessment Team.

Level of effort: As required. Estimate 96 manhours through 1986.

COOK·DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC Nuclear Safety & Licensing Section Manager

Name: J. G. Feinstein

Team: Assessment

Responsible to: DCRDR Program Administrator

Responsibilities:

* Evaluate observed departures from NUREG-0700
* Identify HED's
* HED review
* Validation of HED priority
* Review & approval of HED correction recommendations
* Overall Nuclear Safety and Licensing Engineering support to Assessment Team.

Level of effort: As required. Estimate 96 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC I&C Section Manager

Name: J. C. Jeffrey

Team: Assessment

Responsible to: DCRDR Program Administrator

Responsibilities:

* Evaluate observed departures from NUREG-0700
* Identify HED's
* HED review
* Validation of HED priority
* Review & approval of HED correction recommendations
* Overall Instrumentation and Control Engineering support for Assessment Team.

Level of effort: As required. Estimate 480 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: I&MECo. Senior Reactor Operator

Team: Assessment

Responsible to: DCRDR Program Administrator

Responsibilities:

* Evaluate observed departures from NUREG-0700
* Identify HED's
* HED review
* Validation of HED priority
* Review & approval of HED correction recommendations
* Overall Cook Plant Licensed Senior Reactor Operator support to Assessment Team.

Level of effort: As required. Estimate 288 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: D. C. Cook Management

Team: Assessment

Responsible to: DCRDR Program Administrator

Responsibilities:

* Evaluate observed departures from NUREG-0700
* Identify HED's
* HED review
* Validation of HED priority
* Review & approval of HED correction recommendations
* Overall Cook Plant Management support to Assessment Team.

Level of effort: As required. Estimate 288 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC Electrical Generation Section Manager

Name: R. C. Carruth

Team: Assessment

Responsible to: DCRDR Program Administrator

Responsibilities:

* Evaluate observed departures from NUREG-0700
* Identify HED's
* HED review
* Validation of HED priority
* Review & approval of HED correction recommendations
* Overall Electrical Engineering support for Assessment Team.

Level of effort: As required. Estimate 288 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: DCRDR Program Plant Coordinator

Name: T. R. Stephens

Team: Design Review, Project Review

Responsible to: DCRDR Program Administrator

Responsibilities:

* AEPSC and plant liaison & communications
* CROPS & CRHFS coordination and scheduling
* Monitoring program progress
* Reporting program status
* Providing overall support to program process
* Ensuring program is performed in accordance with AEPSC-Cook Plant Quality Assurance Program
* Ensuring program objectives & tasks are coordinated with other NUREG-0660 efforts
* Coordination of all tasks involving Cook Plant Operations Department

Level of effort: As required. Estimate 400 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: DCRDR Program Plant Engineer

Name: F. Van Pelt, Jr./ W. R. Moran

Team: Project Review, Design Review

Responsible to: DCRDR Program Administrator

Responsibilities:

* Monitoring program progress
* Reporting program status
* Providing overall support to program process
* Ensuring program is performed in accordance with AEPSC-Cook Plant Quality Assurance Program
* Ensuring program objectives & tasks are coordinated with other NUREG-0660 efforts
* Overall project engineering and coordination support for Project Review and Design Review Teams.

Level of effort: As required. Estimate 40 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC Electrical Engineer

Name: L. P. DeMarco/ J. A. Schlunt

Team: Design Review

Responsible to: DCRDR Program Administrator

Responsibilities:

* Technical support to Assessment Team
* Develop HED corrections and implementation plans
* Help develop Program Plan Report and Program Summary Report
* Planning, Review, Assessment and Implementation Phase assignments as directed
* Overall Electrical Engineering support to Design Review Team.

Level of effort: As required. Estimate 1000 manhours through 1986.

Estimated manhours for Electrical Generation Section personnel under AEPSC Electrical Engineers direction:

* Phase III, Assessment, 2700; Implementation, 4700.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: I&MECo. Training Personnel

Team: Design Review

Responsible to: DCRDR Program Administrator

Responsibilities:

* Technical support to Assessment Team, with plant training and operation procedures speciality.

Level of effort: As required. Estimate 300 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC I&C Engineer

Name: R. F. Shoemaker/ W. E. Arnold

Team: Design Review

Responsible to: DCRDR Program Administrator

Responsibilities:

* Technical support to Assessment Team
* Develop HED corrections and implementation plans
* Help develop Program Plan Report and Program Summary Report
* Planning, Review, Assessment and Implementation Phase assignments as directed
* Overall Instrumentation & Control Engineering support to Design Review Team.

Level of effort: As required. Estimate 1400 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: Westinghouse Training Personnel

Team: Design Review

Responsible to: DCRDR Program Manager

Responsibilities:

* Overall Operating Procedures and Training Support for Westinghouse Review Phase tasks.

Level of effort: As required.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC Quality Assurance Engineer

Name: J. B. Brittan

Team: Design Review

Responsible to: DCRDR Program Administrator

Responsibilities:

* Technical support to Assessment Team
* Develop HED corrections and implementation plans
* Help develop Program Plan Report and Program Summary Report
* Planning, Review, Assessment and Implementation Phase assignments as directed
* Overall quality assurance engineering support for Design Review Team.

Level of effort: As required. Estimate 40 manhours through 1986.

COOK DCRDR PROGRAM
Personnel Job Position Description

Title: AEPSC Nuclear Safety & Licensing Scientist

Name: K. J. Toth

Team: Design Review, Project Review

Responsible to: DCRDR Program Administrator

Responsibilities:

* Technical support to Assessment Team
* Develop HED corrections and implementation plans
* Help develop Program Plan Report and Program Summary Report
* Planning, Review, Assessment and Implementation Phase assignments as directed
* Overall nuclear safety analysis engineering support for Design Review and Project Review Teams.
* Coordination of the various Emergency Response Capabilities programs.

Level of effort: As required. Estimate 300 manhours through 1986.

1.4 Documentation and Documentation Control

Throughout the DCRDR program the design review activities and results were carefully documented. Three categories of documentation were used to support the DCRDR: Reference documentation, process documentation and control documentation.

Reference Documentation:

A library of reference documentation was established to support the DCRDR. This library contained the following documents:

- o Main control board front panel layout drawings
- o Control room arrangement drawings
- o Control panel photographs
- o Control room preliminary assessments
- o Final safety analysis report
- o Flow diagrams
- o Plant computer software description
- o System descriptions
- o Piping and instrumentation drawings
- o Licensee event reports
- o AESPC quality assurance procedure
- o Operating Procedures (Emergency and Normal)
- o Applicable NUREGs

Process Documentation:

During the review phase, task plans, data collection methodology and findings were recorded for reporting purposes. Task plans and data collection methodology are shown in Appendix A.

Process Documentation: (Cont'd)

Findings of the reviews task, assessment of the findings and implementation of corrective actions are discussed and recorded in later sections of this report. In addition to the above documentation, component sheets were generated at the completion of all of the required review phases. The component sheets, as discussed in the DCRDR program plan, identify the findings of each task related to each component in the control rooms. A sample component sheet form is shown in Figure 1-7.

Documentation Control:

All of the above documentation was filed in the DCRDR file maintained by the Westinghouse DCRDR Program Manager and transferred to AEPSC following completion of this report. All CLOs were maintained in their original hard copy form. Other documentation such as task plans, task summary reports and component sheets were maintained in computer files with computer printouts in the DCRDR file.

1.5 Quality Assurance:

The DCRDR was performed in accordance with the applicable portions of the Updated Quality Assurance Program Description for the Donald C. Cook Nuclear Plant (FSAR Section 1.7) as implemented by AEPSC and the D. C. Cook plant procedures and the applicable portions of Contractors Quality Assurance Programs, including Westinghouse WCAP-8370.

Modifications to the D. C. Cook plant resulting from the DCRDR program are being controlled under the AEPSP and the D. C. Cook plant procedures for design changes. The AEPSC procedure was revised to incorporate the requirements to assess the impact future design changes may have on control room panels, panel displays, etc.

SAMPLE COMPONENT SHEET FORM

COMPONENT NAME	TAG NO.	PANEL IT. #	DEVICE TYPE	FINDINGS/REMARKS

Figure 1-7

2.0 OPERATING EXPERIENCE REVIEW AND CONTROL ROOM INVENTORY

An operating experience review is required to ensure that problems previously encountered during plant start-up and plant operation have been examined and evaluated. This review was divided into two tasks: An examination of Licensee Event Reports (LER), and a Survey of Control Room Operating Personnel (CROPS).

2.1 LER Review

The LERs reviewed were from D. C. Cook Units 1 and 2 for the time period of 1975 through 1982. The LERs were screened to eliminate those not involved with control room functions. Six LERs were identified for additional review by the DCRDR design review team.

An industry-wide survey of similar plants that were in commercial operation for the period of January 1978 through September 1983 was also conducted. This survey identified 497 LERs, 18 of which involved control room problems and were identified for additional examination by the DCRDR team.

Copies of the LERs identified for additional examination were reviewed by the DCRDR design review team for the specific problem, equipment involved, probable cause and corrective actions. The LERs and findings were then compared to the checklist observation reports from the control room human factors surveys, verification of task performance capabilities and the Validation of control room functions to determine if the specific problem had been addressed.

2.1.1 Findings

The LER review resulted in no additional CLOs being generated. Twenty-four LERs were identified for additional review by the design review team. Each of the problems resulting in an LER had been identified in a CLO from one of the other review processes. Table 2.1 lists the twenty-four LERs, the probable cause and the related CLO from the other task.

LER REVIEW SUMMARY

	UTILITY	LER NUMBER	DESCRIPTION	PROBABLE CAUSE	CORRECTIVE ACTION	RELATED CLO
1)	D. C. COOK UNIT 2	316-79027	Computer printout data incorrect for Axial Power Distribution Monitor System	System not reset prior to scan Procedure problem	Operators instructed Procedure changed	7.1-7
2)	SURREY UNIT 2	281-78036	Computer trend block not restored following computer re-initialization	Computer re-initialization not properly performed	Computer trend block re-initiated	7.1-7
3)	PRAIRIE ISLAND UNIT 1	282-82028	During power increase flux difference drifted outside of target band	Computer annunciated condition unrecognized	Operators instructed	7.1-6 7.1-7
4)	POINT BEACH UNIT 2	301-82009	Computer monitoring program for flux differential monitoring and associated alarms had been stopped for extended period	Operator stopped program to diagnose another problem and did not restart program	Not determined	7.1-7
5)	POINT BEACH UNIT 1	266-79005	Computer monitoring program for flux differential monitoring and associated alarms out of service for 9 hours	Operator initialized the computer incorrectly	Computer restored Procedure changed	7.1-7
6)	KEWAUNEE	305-82020	Rod deviation monitor failed to operate while performing a control rod exercise rod position update not performed following last computer failure	Computer procedure problem Operator training	Procedure change	7.1-7

TABLE 2.1

LER REVIEW SUMMARY (Continued)

	UTILITY	LER NUMBER	DESCRIPTION	PROBABLE CAUSE	CORRECTIVE ACTION	RELATED CLO
7)	McGUIRE UNIT 1	369-82020	Computer memory dumped resulting in the fire protection system being declared inoperable	Operator training Inadequate warning label	Warning label installed	7.1-7
8)	D. C. COOK UNIT 1	315-79021	Operator opened pressurizer spray valve when attempting to bleed pressure from pressurizer relief tank	Inadvertent activation indicator label control switch label	Operators cautioned	1.1-1 6.1-6 6.1-1
9)	D. C. COOK UNIT 2	316-78094	Halon System discharged when operator depressed wrong pushbutton when resetting Co_2 System	Inadvertent activation switch label	Operators cautioned Protective covers	1.1-1 6.1-1 4.1-2
10)	D. C. COOK UNIT 1	315-76057	West containment spray pump suction valve found in wrong position	Valve alignment procedure problem accidental actuation	Operators cautioned	1.6-1 1.1-1 4.1-1
11)	D. C. COOK UNIT 1	315-81013	CEQ fan switch found in wrong position (STOP instead of AUTO)	Accidental actuation operator error	Operators cautioned	1.1-1 1.6-1
12)	TROJAN	344-81005	Containment isolation valves found in incorrect position with power source incorrectly aligned (Tech Spec violation)	Valve label problem Control switch alignment Procedure identification	Procedure change	6.1-1 6.1-3

TABLE 2.1

LER REVIEW SUMMARY (Continued)

	UTILITY	LER NUMBER	DESCRIPTION	PROBABLE CAUSE	CORRECTIVE ACTION	RELATED CLO
13)	POINT BEACH UNIT 1	301-81008	SI pump discharge valve found in closed position	Accidental operation during changing status light above control switch	Operators cautioned Protective covers	4.1-1
14)	McGUIRE UNIT 1	369-81078	Pressurizer safety injection pushbutton depressed instead of safety injection reset pushbutton during valve timing test	Inadvertent actuation Possible label problem	Test procedure changed covers over pushbuttons	6.1-1 4.1-1
15)	FARLEY UNIT 2	364-83028	Inadvertent operation of pushbutton mistaken for indicating light	Inadvertent actuation possible label problem	Operator cautioned labels added for pushbuttons	4.1-1 6.1-1
16)	D. C. COOK UNIT 1	315-77003	Radioactive gas release without auto trip function enabled	Procedure error	Procedure change	No CLO/HED
17)	DIABLO CANYON UNIT 1	275-81009	Iodine flow rate sampler monitor inoperable - alarm not checked	Response procedure problem resulting in operator error	Procedure change	3.1-13
18)	POINT BEACH UNIT 1	266-78017	Flux tilt due to rod misalignment	Alarm problem operator training	Alarm changes operators instructed	3.1-8 7.1-7 7.1-6

TABLE 2.1

LER REVIEW SUMMARY (Continued)

	UTILITY	LER NUMBER	DESCRIPTION	PROBABLE CAUSE	CORRECTIVE ACTION	RELATED CLO
19)	D. C. COOK UNIT 1	315-79062	Inoperative steam flow channel removed from tripped condition	Indicator label problem	Label corrected	6.1-1
20)	ZION	295-79041	Operator bumped potentiometer on pressurizer controller while dating chart	Accidental operation controller location	Operator restored pressure No equipment change	4.1-1
21)	D. C. COOK UNIT 2	316-80039	Low pressure alarm failed to clear resulting in high pressure alarm	Alarm setpoint drift Indicator wide range	Equipment recalibrated Indicator change	5.1-2
22)	PRAIRIE ISLAND UNIT 2	306-78009	Auxiliary operator opened wrong circuit breaker	Operator error Communication problem	Operators cautioned	2.1-1 2.1-2 2.1-3
23)	D. C. COOK UNIT 1	315-83061	Recorder chart drive not turned on by auxiliary operator after changing chart paper	Operator error	Operator error	Not CLO/HED
24)	PRAIRIE ISLAND UNIT 1	282-83028	Surveillance test exceeded Tech Spec time limit	Scheduling problem not control room operator problem	Schedule updated	Not CLO/HED

TABLE 2.1

2.1.2 Staffing

The staffing for the LER review was as follows:

NAME	FUNCTION	PARTICIPATION
A. S. Grimes	DCRDR Program Administrator	40%
R. F. Shoemaker	I&C Engineering (AEPSC)	60%
T. R. Stephens	Plant Operations (I&MECo)	10%
T. J. Voss	Human Factor (ESSEX Corp.)	30%
R. G. Orendi	Plant Operations & Evaluation (W)	10%
J. D. Young	Control Board Design (W)	60%

2.2 Control Room Operating Personnel Survey (CROPS)

A control room operating personnel survey was conducted at the D. C. Cook nuclear plant as recommended by NUREG-0700. The general approach to conducting the survey was to interview those individuals who have sufficient experience in the D. C. Cook control rooms to provide knowledgeable and useful insights into the design features of the control room and its equipment.

2.2.1 Methodology

The CROPS was conducted by interviewing the operating personnel individually or in groups of two. Human factors specialists experienced in conducting interviews paraphrased a standard set of questions to each of the operating personnel being interviewed. All responses were recorded on the interview sheets. The interview data was reviewed and a summary sheet for the responses to each question was generated. The summary sheets contain: (1) a paraphrasing of the question; (2) a listing of number and percentage of operations personnel who responded F (favorably), U (unfavorably), or NR (no response); and (3) a summary statement of the findings or major concerns expressed by the operators.

Based on the general approach to conducting the survey and the D. C. Cook plant operations information, there were 83 operating shift personnel who had an appropriate level of control room experience for the survey. The 49 individuals selected for interviews were: 15 senior reactor operators including shift supervisors, 20 reactor operators and 14 auxiliary operators.

The questions used for the operator interviews were based on NUREG-0700 guidelines and were grouped similar to the human factors surveys described in Section 3 of this report. Copies of the interview questions and the summary sheets are contained in Appendix E and F respectively.

2.2.3 Findings

The findings of the CROPS interviews were used as input information in the human factors surveys and are recorded there. They are identified under data collection method as "I" in the CLO/HED Assessment Tables in Section 5.2.4.

2.3 Control Room Inventory (CRI)

The objective of the control room inventory was to itemize and describe the components of the existing control room for comparison with the instrumentation, controls and equipment requirements established by the system function review and task analysis.

2.3.1 Methodology

The control room inventory was compiled by filling out an inventory data sheet designed to identify all the different types of control panel equipment contained in the D. C. Cook control rooms. Figure 2.1 shows the inventory data sheet form.

Each and every item on the D. C. Cook Unit 1 control panel front view drawings was identified on an inventory data sheet both by panel abbreviation and panel item number. The inventory data sheets were then organized into sections by panel and compared to material control records to obtain the make and type of device, plus the mechanical or electrical engineering identifiers (mark numbers) for cross reference. An item-by-item check against a photo mosaic was made to obtain all pertinent data such as device nameplate inscriptions, switch position engravings and colors for position indicating lights, meters and recorders scale ranges and markings and functions and meters for controller stations. The system and subsystem data was obtained from other reference drawings and documents such as the system descriptions, flow diagrams, electrical elementaries and mechanical material control records.

The control panel front view drawings were checked against the actual panels in the D. C. Cook control rooms and marked to show the existing status. Inventory data sheets were then added or deleted to reflect the existing status.

Additional control room inventory data sheets were filled out for the equipment on Unit 2 that differs from Unit 1. These additional sheets were identified as Unit 2.

Name Plate Inscription 2,35 ______________________________

Location: Panel (3,3) _____ Item # (4,3) _____ FE coordinate (5,4) _____
I.D. MED # (6,6) _____ fed # (7,6) _____ ECP # (8,10) ___________
PO # (9,10) _____ Unit (67,1) _______
System (10,35) ________________________________
Subsystem (11,35) ________________________________
Equipment (12,35) ________________________________

Switch: Model (13,6) ____ (S,M,P)
Trip, Stop, Off, Close, Lower (14,1) ___ Pull (15,1) ___ Flag (16,1) ___
Run, Start, On, Open, Raise (17,1) ___ Auto (18,1) ___ Key (19,1) ___
Other (20,10) _____

Indication Lights: Model (21,6) _____(R,G,W,A,B,C)(#)
Trip, Stop, Off, Close, Lower (22,1) _____ Lockout (23,1) _____
Run, Start, On, Open, Raise (24,1) _____ Power On (25,1) ______
Other (26,1) _____

Controller Station: Model (27,15) _______
Functions; Manual (28,1) ___ Auto/Manual (29,1) ___ Bias (30,1) ___
Tieback (31,1) ___ Setpoint (32,1) ___
Meters;(A,B,C,D) Output (33,1) ___ Position (34,1) ___ Deviation (35,1) ___
B,T,S (36,1) ___
Measured Variable (38,1) ___

Meter: Model(39,6) ___ Measured Variable (40,15) ___
Digital (42,3) ___(A#/F#.#) Analog (42,1) ___ Parallax Mirror (43,1) ___
Engg. Units (44,6) ___ Units/Graduation (45,3) ____
Face; Linear (46,1) ___ Circular (47,1) ___
Range; From (48,4) ___ To (49,4) ___

Recorder: Model (50,15) ___________
Chart Speed (in/min (51,3) ___ Continuous(C) or Cycletime(sec.)(52,3) ___
Trips defeated by door (53,1) ___ I.D.# (54,10) ____

Annunciator: I.D.# (55,15) _______________

Knife Switch: E.E. I.D.#(56,15) _____________

Switch#	Function
1	(57,14) _____________
2	(58,14)
3	(59,14)
4	(60,14)
5	(61,14)
6	(62,14)
7	(63.14)
8	(64,14)
9	(65,14)

Figure 2.1

2.3.2 Findings

The control room inventory was used as an input documents to other DCRDR review tasks such as the control room human factors surveys, verification of task performance capabilities and validation of control room functions. No CLO's were issued against the control room inventory.

2.3.3 Staffing

AEPSC I&C Engineer R. F. Shoemaker, I&C Engineers & Technicians as required.

3.0 CONTROL ROOM HUMAN FACTORS SURVEY

The methodology used to conduct the control room human factors survey at the D. C. Cook nuclear plant was to execute a set of detailed task plans involving specific control room design features. Four basic methods of data collection (measurement, observation, interview, documentation review) were employed with each of the task plans to insure a comprehensive data collection, data reduction and analysis process.

The control room human factors survey process was structured into fourteen separate tasks. Each task was defined by a detailed task plan as follows:

1)	Workspace	TP-1.1
2)	Anthropometric	TP-1.2
3)	Emergency Equipment	TP-1.3
4)	Heating, Ventilation and Air Conditioning	TP-1.4
5)	Illumination	TP-1.5
6)	Ambient Noise	TP-1.6
7)	Maintainability	TP-1.7
8)	Communications	TP-2.1
9)	Annunciators	TP-3.1
10)	Controls	TP-4.1
11)	Displays	TP-5.1
12)	Labels and Location Aids	TP-6.1
13)	Computers	TP-7.1
14)	Conventions	TP-8.1

All task plans followed the general format of:

1) Introduction (including the objectives)
2) Review Team Selection and Responsibilities
3) Criteria (from NUREG-0700, Section 6.0)
4) Procedures
5) Equipment and Facility Requirements
6) Input and Data Forms
7) Output and Results
8) Figures and Tables
9) Procedure Exceptions
10) Appendices (as required)

The control room human factors survey task plans incorporated a standardized set of appendices that insured a consistent, well documented process for data collection, analysis, and audits. The appendix structure employed for the task plans was:

Appendix A (Criteria) - This is a listing of all NUREG-0700, Selection 6.0 guidelines that are relevant to the task plan.

Appendix B (Data Forms and Analysis Aids) - This appendix is further divided into the following:

B1	Measurements Data
B2	Interviews and Questionnaires
B3	Observation Checklists
B4	Documentation Review Checklists
B5 - B8	Analysis Aids for B1 through B4 respectively
B9	Additional forms, as required

The design Review Team for the Control Room Human Factors Survey Task was as follows:

NAME	FUNCTION	PARTICIPATION
T. J. Voss	Human Factors (ESSEX Corp.)	100%
D. J. Seibert, Jr.	Human Factors (ESSEX Corp.)	100%
E. M. Talley	Human Factros (ESSEX Corp.)	50%
M. K. Davidson	Human Factors (ESSEX Corp.)	30%

3.1 Workspace Survey TP-1.1

This section documents the results of the workspace survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.1.1 Objectives

The objectives of the workspace survey were to:

a. Evaluate the workspace layout for safe, effective, efficient and comfortable operation.

b. Assess furnishings, equipment and operation aids in the control room

c. Identify and document the features of the workspace that do not conform to the criteria in NUREG-0700.

3.1.2 Scope

The scope of the effort was to evaluate the workspace design of Unit 1 and Unit 2 control rooms at the D. C. Cook plant using the applicable NUREG-0700 guidelines. The workspace topics evaluated included:

- Furniture and equipment layout
- Document organization and storage
- Supervisor access
- Nonessential personnel access
- Use of procedures and other reference material at consoles
- Desk dimensions
- Chairs
- Unit integration and interference
- Personal storage
- Ambiance and comfort

3.1.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph number are: paragraph 6.1.1.3a through g; 6.1.1.4a through e; 6.1.1.61 and b; 6.1.1.7; 6.1.2.6; 6.1.2.7a through d; 6.1.2.8a through g; 6.1.3.1a and b; 6.1.5.61 and b; and 6.1.5.7a through c.

The detailed definitions for the critera are presented in Table 3-1.

3.1.4.1 Data Collection

a. Data were collected using the checklist contained in the workspace Task Plan.

b. Working space, furniture dimensions and equipment layout dimensions recommended in NUREG-0700 were recorded on measurement data forms.

3.1.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO (checklist observation) reports. Recorded information included the equipment involved, a description of the problem including the NUREG-0700 paragraph number of the criteria, and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.1.5 Findings

The findings of the workspace survey are presented in Table 3.1 "Workspace Survey Findings and CLOs Generated." A total of 55 criteria were applied to the workspace of the D. C. Cook control rooms. Of the criteria applied, 4 were not applicable, 34 were not violated and 17 were violated. A total of 15 CLOs were generated which document all of the 17 criteria violated. In general, those CLOs describe personnel access, documentation accessibility and use and operator comfort.

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SURVEY FINDINGS AND CLOs GENERATED TABLE 3.1

	N/A	YES	NO	COMMENTS
6.1.1.3 FURNITURE AND EQUIPMENT LAYOUT				
a. VIEWING — Desks and consoles placed in the primary operating area should permit operators at those desks and consoles full view of all control and display panels (including annunciator panels) in the primary operating area (see Exhibit 6.1-2).		X		
b. COMMUNICATIONS — Desk and console placement should facilitate voice communications from operators seated at those work stations to any point in the primary operating area.		X		
c. OPERATOR ACCESS			X	CLO#1.1-5
(1) Operator should be able to get to any work station without having to overcome obstacles such as tripping hazards, poorly positioned filing cabinets or storage racks, maintenance equipment, etc.				
(2) Operators should be able to position themselves conveniently for performing task actions at any work station.		X		
d. CIRCULATION PATTERNS				
(1) The control room arrangement should facilitate efficient unobstructed movement and communication.		X		
(2) The control room arrangement should minimize interference between the members of the operational crew.		X		

Item	N/A	YES	NO	COMMENTS
6.1.1.3 (Cont'd)				
e. OPERATOR MANEUVERING SPACE — Between the back (operator's position) of desk/consoles and any surface or fixed object behind the operator, adequate space should be allowed for the operator to get into and out of a chair freely or to turn in the chair to view the equipment behind.				
(1) A minimum separation of 36 inches from the back of any desk to any opposing surface is suggested as the minimum (see Exhibit 6.1-3). A greater separation is preferable.			X	Between computer op console and CRT display bench. CLO#1.1-7
(2) Lateral space for a seated operator should be no less than 30 inches (see Exhibit 6.1-3). Greater latitude is preferable.		X		
f. EQUIPMENT-TO-OPPOSING-SURFACE DISTANCE — Enough space should be allowed so that personnel can perform all required tasks. The space should accommodate kneeling and bending, simultaneous work by more than one operator, and simultaneous performance of operational and maintenance tasks as may be required. Recommended minimum separations are illustrated in Exhibit 6.1-4.				
(1) A minimum separation of 50 inches is recommended between a single row of equipment/panel and a wall or other opposing surface.		X		
(2) A minimum separation of 50 inches is also recommended between two rows of facing equipment if both rows are worked by a single operator.		X		

	N/A	YES	NO	COMMENTS
6.1.1.3f. (Cont'd)				
(3) A minimum separation of 8 feet is recommended between opposing rows of equipment where more than one person must work simultaneously on operational or maintenance tasks and kneeling, bending, or use of test equipment may be necessary.		X		
g. OPENINGS — Panels should be laid out and maintained, and equipment enclosures designed, so that there are no unguarded openings through which unwanted objects can be introduced.			X	CLO#1.1-8
6.1.1.4 DOCUMENT ORGANIZATION AND STORAGE				
a. ACCESSIBILITY				
(1) All procedures and other documents that may be needed for ready reference should be kept in the control room.		X		
(2) Reference douments should be stored where they are easy to locate and extract for use. They should not be locked up, stored in places too low or too high for large and small personnel to access easily, in cramped spaces, or where poor illumination exists.			X	CLO#1.1-9
b. LOCATION AIDS				
(1) Clearly visible title labels should be provided to identify specific documents.			X	CLO#1.1-10
(2) Labels should distinguish documents as much as possible.		X		

Item	N/A	YES	NO	COMMENTS
6.1.1.4b. (Cont'd)				
(3) Putting many volumes in one location creates a search problem, especially if titles are similar. One means of reducing search time would be to put operational documentation in one location and other documentation in a secondary location.		X		
c. CONVENIENCE OF USE				
(1) Documents should not be fixed in racks; it should be possible to remove documents for use.		X		
(2) Documents should be bound so that they can be opened fully and will remain open at the desired place without holding.			X	CLO#1.1-11
d. PROTECTION — Documents should be protected from wear so that they do not become dog-eared, dirty, loose, torn, and difficult to read.			X	CLO#1.1-12
e. DEDICATED SETS OF PROCEDURES — Sets of procedures should be separately stored for each unit in a multiunit control room.	X			
6.1.1.6 SUPERVISOR ACCESS				
a. ACCESS — The shift supervisor's office should be located so as to permit prompt physical access to the control room under all conditions, including control room isolation. The preferred location is within the control room isolation boundary, with placement to permit good visual and voice contact with the primary operational area.			X	CLO#1.1-4

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.1

	N/A	YES	NO	COMMENTS
6.1.1.6 (Cont'd)				
b. COMMUNICATIONS — When the shift supervisor's office is not within the control room boundary, dedicated communications links between the primary operating area and the shift supervisor's office should be provided. (See Guideline 6.2.1.7)		X		
6.1.1.7 NONESSENTIAL PERSONNEL ACCESS				
Provision should be made to limit the access and movement of nonessential but authorized personnel to prescribed areas within the control room.			X	CLO#1.1-1
6.1.2.6 USE OF PROCEDURES AND OTHER REFERENCE MATERIALS AT CONSOLES				
Provision should be made so that the procedures manuals and other reference materials can be consulted easily while task sequences are performed at the consoles. Exhibit 6.1-15 shows the poor practice of laying manuals down on the benchboard when no convenient place has been provided for them. Exhibit 6.1-16 shows a good solution adopted by several plants: a rolling bookcase is provided for storing and using procedures manuals.		X		
6.1.2.7 DESK DIMENSIONS				
a. WORKING SPACE — Desks should provide enough clear working space for all materials required for task performance.		X		
b. CHAIR POSITIONS — The desk should allow for different chair positions as required, with adequate knee space.		X		

Item	N/A	YES	NO	COMMENTS
6.1.2.7 (Cont'd)				
c. OPERATOR COMFORT — The relationships of working surface height and area, knee room, and chair height should allow operators to work comfortably. Exhibit 6.1-17 illustrates an uncomfortable situation created by desk height and chair design.		X		
d. DIMENSIONS — The following desk dimensions are recommended and shown in Exhibit 6.1-18:				
(1) For seated work only, 26 to 31 inches above the floor (29 inches is a standard height).		X		
(2) For sit-stand desks, 36 to 38 inches above the floor.	X			There are no sit-stand desks.
(3) Work surface area depth: 16 inches minimum.		X		
(4) Work surface area width: 24 inches minimum if tasks involve reading and writing only; 30 inches minimum if other kinds of tasks are required.		X		
(5) Knee room height: A distance of approximately 25 inches from the floor to the under-surface of the desk top should provide adequate clearance for 5th to 95th percentile male and female adults at sit-down-only stations.		X		
(6) Knee room depth: 18 inches minimum.			X	Computer console - 10½" CLO#1.1-6.
(7) Knee room width: 20 inches minimum (greater width preferred).		X		

6.1.2.8 CHAIRS

	N/A	YES	NO	COMMENTS
a. MOBILITY — Chairs should pivot so that operators can readily adjust position. Mobile bases (casters) are recommended for chairs at sit-only stations.		X		
b. BACKRESTS — Chairs should support at least the lower back curvature (lumbrosacral region). The recommended angle between the back and the seat is about 100° for office tasks (such as keyboard tasks). A greater angle is preferred for reading and resting.		X		
c. ARMRESTS — Where personnel may remain seated for relatively long periods, chairs with armrests are preferred. Adjustable or retractable armrests may be necessary to allow the elbows to rest in a natural position and for compatibility with a particular desk/console.			X	CLO#1.1-14
d. CUSHIONING — Seat and backrest should be cushioned with at least 1 inch of compressible material, enough so that some resilience remains when the chair is occupied.		X		
e. SEAT AREA — The thighs and the backs of the knees should not be compressed so as to cause fatigue and circulation problems. The seat should be at least 17 inches wide. Seat depth should be 15-17 inches (see Exhibit 6.1-19).		X		
f. SEAT ADJUSTABILITY — For chairs at sit-down stations, seat height should generally be adjustable from 15 to 18 inches (Exhibit 6.1-19). For chairs at sit-stand stations, seat height should be adjustable from 26 to 32 inches (Exhibit 6.1-20).			X	CLO#1.1-15

	N/A	YES	NO	COMMENTS
6.1.2.8 (Cont'd)				
g. FOOTRESTS — An adjustable footrest or heel catch should be provided to support the feet at a level no more than 18 inches below the seat surface. If a footrest is part of the chair, a circular design is recommended, diameter 18 inches. The footrest might be provided on the console base.			X	CLO#1.1-13
6.1.3.1 UNIT INTEGRATION AND INTERFERENCE				
a. EQUIPMENT ARRANGEMENT — Equipment should be arranged with movement and communication patterns in mind, so that unit operations do not interfere with each other.		X		
b. SENIOR OPERATOR STATION — Senior operators who supervise and assist operations of more than one unit need to be stationed so that they can communicate effectively with operators in each unit and have an unobstructed visual path to the control boards of each unit.	X			Do not have senior operators who supervise more than one unit at a time.
6.1.5.6 PERSONAL STORAGE				
a. STORAGE LOCATIONS — There should be a suitable, out-of-the-way but secure place in which control room personnel may keep their coats and other personal belongings.		X		
b. STORAGE SUITABILITY — If lockers are provided, they should be large enough to hold the items that can reasonably be expected to go into them.		X		
6.1.5.7 AMBIENCE AND COMFORT				
An effort should be made to create a pleasant and comfortable work setting in view of the long hours and confining aspects of the control room operator's job.				

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.1

	N/A	YES	NO	COMMENTS
6.1.5.7 (Cont'd)				
a. DECOR — Features to be considered include:				
(1) Color coordination.		X		
(2) Use of color and lighting to create a cheerful atmosphere (without introducing glare and brightness to a degree that causes eye fatigue of an overly intense atmosphere).		X		
(3) Visual relief from arrays of instrumentation.		X		
(4) Comfortable seating.		X		
(5) Carpeting to lessen the fatigue of standing and walking.			X	CLO#1.1-2
b. RESTROOM AND EATING FACILITIES				
(1) A restroom and kitchen or eating area should be provided within (preferably) or near the control room isolation boundary.			X	CLO#1.1-3
(2) Since formal breaks are not scheduled in most control rooms, it is important that personnel have access to these facilities without delay. It is preferable that they be used only by control room personnel.			X	CLO#1.1-3
(3) Provision should be made for communication if facilities are out of voice contact, so that an operator taking a break can be contacted as necessary by personnel in the control room. (See Guideline 6.2.1.7.)			X	CLO#1.1-3

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.1

	N/A	YES	NO	COMMENTS
6.1.5.7 (Cont'd) c. REST AREA/LOUNGE — Consideration should be given to providing a rest area (possibly in conjunction with the eating area) conducive to relaxation and revitalization, especially where shifts are long.	X			Have area for eating at rear of CR. CR area too limited in size for separate rest area or lounge.

3.2 Anthropometrics Survey TP-1.2

This section documents the results of the anthropometrics survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.2.1 Objectives

The objectives of the anthropometrics survey were as follows:

a. Assess to what degree all set-down, stand-up and sit-stand work stations, with or without CRT displays, in the control rooms conform to the criteria in NUREG-0700.

b. Identify and document any features of the work stations that do not conform to the criteria in NUREG-0700.

3.2.2 Scope

The scope of the effort was to assess the work station design in the main control rooms at the D. C. Cook plant using the applicable guidelines in NUREG-0700. The anthropometrics topics evaluated were:

- o Stand-up console dimensions
- o Sit-down console dimensions
- o Vertical panels
- o Operator-display/controls relationships

3.2.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph number are: paragraphs 6.1.2.2a through g; 6.1.2.3a through h; 6.1.2.4a through c; 6.1.2.5a and b; and 6/7.2.3a through f. The detailed definitions for the criteria are presented in Table 3.2.

3.2.4.1 Data Collection

a. Data were collected using the checklist contained in the anthropometrics task plan.

b. Reach and visual envelopes recommended in NUREG-0700 were demarcated on the control board photomosaic and visual observations were made of the location of controls and displays. Controls and displays falling outside of the recommended envelopes were noted and recorded.

3.2.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.2.5 Findings

The findings of the anthropometrics survey are presented in Table 3.2 "Anthropometrics Survey Findings and CLOs Generated." A total of 40 criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 3 were not applicable, 32 were not violated. One of the criteria violated was also covered in the workspace survey and was documented there. Two CLOs were generated which covered the other 4 criteria violated. Those CLOs describe controls and displays located too high or too low on the vertical panels.

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	N/A	YES	NO	COMMENTS
6.1.2.2 STAND-UP CONSOLE DIMENSIONS				
a. CONSOLE HEIGHT TO SEE OVER — When it is necessary for a standing operator to see over the top, console height (with or without annunciator panels) should not exceed 58 inches.		X		
b. CONTROL HEIGHT — (Exhibits 6.1-5 and 6.1-6)				
(1) The highest control on a stand-up console should be within the highest reach of the 5th percentile female without stretching or using a stool, ladder, etc.		X		
(2) The lowest controls on a stand-up console should be within the lowest reach of the 95th percentile male without bending or stooping.		X		
c. BENCHBOARD SLOPE — The benchboard slope, in conjunction with its depth, should result in all controls being within the reach radius of the 5th percentile female, as illustrated in Exhibit 6.1-6.		X		
d. CONTROL DISTANCE FROM THE FRONT EDGE OF THE CONSOLE				
(1) Controls should be set back a minimum of 3 inches from the front edge to protect against accidental activation.		X		
(2) No control should be more than 25 inches from the front edge of the console. This accommodates the maximum reach of the 5th percentile female adult as illustrated in Exhibit 6.1-6.		X		

	N/A	YES	NO	COMMENTS
6.1.2.2 (Cont'd)				
e. DISPLAY POSITIONING — (Exhibit 6.1-7)				
(1) DISPLAY HEIGHT AND ORIENTATION				
(a) All displays, including annunciator tiles, should be mounted so that they are within the upper limit of the visual field (75° above the horizontal line of sight) of the 5th percentile female.		X		
(b) In addition, all displays and annunciators should be mounted so that the angle from the line of sight to the face plane is 45° or greater. The 5th percentile female determines the upper limit. The 95th percentile male determines the lower limit.		X		
(2) HORIZONTAL DISPLACEMENT — The oblique angle from the line of sight to a display located to either side of the working position from which the display must be read should be at least 45°. This includes annunciator tiles, which should be readable from the acknowledge button. (See Exhibit 6.1-8.)		X		
f. LATERAL SPREAD OF CONTROLS AND DISPLAYS — The operator should be able to perform task sequences at a given work station with minimum respositioning. The amount of operator movement required depends on the arrangement of controls and displays, not simply on the lateral dimensions of the segments of the control board. The maximum lateral spread of controls and displays at a single-operator work station should not exceed 72 inches.		X		

	N/A	YES	NO	COMMENTS
6.1.2.2 (Cont'd)				
g. FOOT ROOM — Enough foot room is needed to allow the operator to get close to the board without leaning. A clearance of 4 inches vertically and 4 inches horizontally is recommended.		X		
6.1.2.3 SIT-DOWN CONSOLE DIMENSIONS				
a. CONSOLE HEIGHT TO SEE OVER				
(1) If the seated operator must see over the console, the console height should be no more than approximately 27 inches above the seat to accommodate the 5th percentile adult female. Assuming seat height adjusted to 18 inches, maximum console height should therefore be 45 inches above the floor.		X		
(2) See-over console heights above 45 inches may be acceptable, for example, where the seated operator need only monitor (not read) status lights and annunciators beyond the console, if they are at a suitable distance and height.	X			
b. CONTROL HEIGHT — All controls on a sit-down console should be within the reach radius of the 5th percentile female. Measurements should be made using seated shoulder height with the shoulder in line with the leading edge of the benchboard. This is illustrated in Exhibit 6.1-9.		X		
c. BENCHBOARD SLOPE — The benchboard slope, in conjunction with its depth, should be such that all controls are within the functional reach radius of the 5th percentile female (as illustrated in Exhibit 6.1-9) and all displays and markings can be read.		X		

	N/A	YES	NO	COMMENTS
6.1.2.3 (Cont'd)				
d. **CONTROL DISTANCE FROM THE FRONT EDGE OF THE CONSOLE**				
(1) Controls should be set back a minimum of 3 inches from the front edge to protect against accidental activation.		X		
(2) Other controls may be mounted as far back as 25 inches from the console edge. This distance accommodates the extended functional reach of the 5th percentile as defined.	X			
e. **DISPLAY POSITIONING**				
(1) All displays, including annunciator tiles, should be mounted so that they are within the upper limit of the visual field — 75° above the horizontal line of sight — of the 5th percentile female (see Exhibit 6.1-10). (Practically, there is no lower limit for a plausible sit-down console design.)		X		
(2) In addition, all displays should be mounted so that the angle from the line of sight to the display face plane is 45° or greater (see Exhibit 6.1-10). The 5th percentile female determines the upper limit.		X		
f. **LATERAL SPREAD OF CONTROLS AND DISPLAYS — (Exhibit 6.1-11)**				
(1) For control and monitoring actions that must occur in sequence, all necessary controls and displays should be within the maximum extended reach and the viewing range of the seated operator from a single reference point.		X		

Item	N/A	YES	NO	COMMENTS
6.1.2.3f (Cont'd)				
(2) For the situation described in item 1, above, and sustained or precise control action, the operator should be able to reach the controls without having to bend/stretch significantly.		X		
g. LEG AND FOOT ROOM — Sufficient leg and foot room should be provided to enable seated operators to avoid awkward and uncomfortable positions. Exhibit 6.1-12 shows the dimensions involved and gives minimums and ranges necessary to accommodate the 5th to 95th percentiles (as defined in Exhibit 6.1-5).			X	Covered in workspace. CLO#1.1-6
h. WRITING SPACE ON CONSOLES — Writing space may be needed by operators working at consoles.				
(1) An area at least 16 inches deep and 24 inches wide is recommended where these dimensions in the total configuration would fit operator reach capabilities. Less space may be adequate considering the frequency and duration of writing requirements at control room consoles.		X		
(2) If writing space is provided on the console itself, it should not interfere with viewing and manipulation of controls and displays.		X		
(3) If writing is necessary but space on the console is not available, other arrangements such as a nearby desk or table should be provided.		X		

	N/A	YES	NO	COMMENTS
6.1.2.4 SIT-STAND WORK STATIONS				
a. CONTROL AND DISPLAY POSITIONING — The height and lateral limits for controls and displays should conform to the guidelines given for stand-up consoles (Guideline 6.1.2.2).		X		
b. CHAIR HEIGHT — The operator should be provided with a high chair so that the seated eye height is approximately the same as standing eye height.	X			
c. KNEE ROOM — Knee room and comfortable foot support should be provided.		X		
6.1.2.5 VERTICAL PANELS				
a. CONTROL HEIGHT				
(1) Controls should be placed in an area between 34 inches and 70 inches above the floor.			X	CLO#1.2-1
(2) Controls requiring precise or frequent operation and emergency controls should be placed in an area between 34 inches and 53 inches above the floor.			X	CLO#1.2-1
b. DISPLAY HEIGHT				
(1) Displays should be placed in an area between 41 inches and 70 inches above the floor.			X	CLO#1.2-2
(2) Displays that must be read frequently or precisely should be placed in an area between 50 inches and 65 inches above the floor.			X	CLO#1.2-2

Item	N/A	YES	NO	COMMENTS
6.7.2 CATHODE RAY TUBE (CRT) DISPLAYS				
6.7.2.3 OPERATOR-DISPLAY RELATIONSHIPS				
a. VIEWING DISTANCE — Viewing distance should be greater than 18 inches.		X		
b. VIEWING ANGLE — The minimum angle between the operator's actual line-of-sight (LOS) as measured from the operator's normal work station, and the plane of the display screen should be 45° or greater in either the horizontal or vertical direction. See Exhibits 6.7-8 and 6.7-10.		X		
c. SCREEN LOCATION, SEATED OPERATORS				
(1) CRT displays which require frequent or continuous monitoring, or which may display important (e.g., alarm) information, should be located within the following limits as measured from the normal operator work station (see Exhibit 6.7-9): (a) Horizontal limits — Not more than 35° to the left or right of the operator's straight-ahead LOS. (b) Vertical limits — Not more than 20° above and 40° below the operator's horizontal LOS.		X		
(2) CRT displays which do not require frequent or continuous monitoring, and which will not display important (e.g., alarm) information, should be located within the following limits (as measured from normal operator work stations which permit full operator head and eye rotation.		X		

	N/A	YES	NO	COMMENTS
6.7.2.3c (Cont'd)				
(a) Horizontal limits — Not more than 95° to the left or right of the operator's straight-ahead LOS.				
(b) Vertical limits — Not more than 70° above and 90° below the operator's horizontal LOS.				
d. SCREEN LOCATION, STANDING OPERATORS				
(1) CRT displays which require frequent or continuous monitoring, or which may display important (e.g., alarm) information, should be located within the following limits as measured from the normal operator work station:		X		
(a) Horizontal limits — Not more than 35° to the left or right of the operator's straight-ahead LOS.				
(b) Vertical limits — Not more than 35° above and 25° below the operator's horizontal LOS.				
(2) CRT displays which do not require frequent or continuous monitoring, and which will not display important (e.g., alarm) information, should be located within the following limits (as measured from normal operator work stations which permit full operator head and eye rotation):		X		
(a) Horizontal limits — Not more than 95° to the left or right of the operator's straight-ahead LOS.				
(b) Vertical limits — Not more than 85° above and 90° below the operator's horizontal LOS.				

	N/A	YES	NO	COMMENTS
6.7.2.3d (Cont'd)				
e. MOUNTING IN CONSOLES — When CRTs are permanently mounted in consoles, the console configuration, dimensions, and type of use (such as seated, sit-stand, or standing) affects the CRT/operator interface. Consoles in which CRTs are installed should conform to the guidelines of Section 6.1.2.		X		
f. VISIBILITY OF DATA — All data and messages on the CRT screen should be within the unobstructed view of an operator at the normal work station.		X		

3.3 Emergency Equipment Survey TP-1.3

This section documents the results of the Emergency Equipment survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700 as specified in the D. C. Cook DCRDR program plan.

3.3.1 Objectives

The objectives of the emergency equipment survey were to:

a. Assess to what degree the operator protective equipment, fire, radiation, and rescue equipment are accessible and maintainable as defined by NUREG-0700.

b. Assess the utility of operator protective equipment, fire radiation, and rescue equipment as defined by NUREG-0700.

c. Assess the utility of the emergency lighting system as defined by NUREG-0700.

d. Assess the utility of the emergency communications as defined by NUREG-0700.

e. Identify and document any features of the emergency equipment design that does not conform to the criteria of NUREG-0700.

3.3.2 Scope

The scope of the effort was to assess the emergency equipment features for the main control rooms at the D. C. Cook plant using the applicable guidelines in NUREG-0700. The emergency equipment topics evaluated were:

- o Operator protective equipment
- o Fire, radiation and rescue equipment
- o Emergency equipment storage
- o Emergency lighting
- o Emergency communications
- o General principles

3.3.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph number are: paragraphs 6.1.4a through i; 6.1.4.2a through e; 6.1.4.3a and b; 6.1.5.4a and b; 6.2.1.8a through c(3); and 6.4.1.1d. The detailed definitions for the criteria are presented in Table 3.3.

3.3.4.1 Data Collection

a. Data were collected using the checklist contained in the emergency equipment task plan.

b. Data were collected primarily through observation and operator interview questions.

3.3.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.3.5 Findings

The findings of the emergency equipment survey are presented in Table 3.3 "Emergency Equipment Survey and CLOs Generated." A total of 22 criteria were applied to the emergency equipment. Eleven of the criteria were not violated. One criteria violated was covered under controls survey TP-4.1 and labels survey TP-6.1 with the violation recorded there. Nine CLOs were generated which cover the 10 criteria violated.

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SURVEY FINDINGS AND CLOs GENERATED

TABLE 3.3

	N/A	YES	NO	COMMENTS
6.1.4.1 OPERATOR PROTECTIVE EQUIPMENT				
a. TYPES OF EQUIPMENT — Protective equipment should include protective clothing and breathing apparatus.		X		
b. ANTHROPOMETRY — Protective clothing and breathing equipment should be compatible with operator body sizes and tasks to provide adequate tactile sensitivity and ability to see, reach, move, communicate, and hear.			X	CLO#1.3-2 CLO#1.3-3 CLO#1.3-4
c. PERIODIC CHECKS — Operator protective equipment should be periodically checked to determine if it is in good condition.			X	CLO#1.3-7
d. QUANTITY — There should be protective equipment available in sufficient quantities and sizes for the required number of operators.			X	CLO#1.3-3
e. MARKING — Protective clothing sizes should be clearly identifiable.		X		
f. EXPENDABLES — There should be an adequate supply of personal protection equipment expendables, such as filters.		X		
g. ACCESSIBILITY — All protective equipment should be easily and readily accessible.		X		
h. TRAINING — Operators should be well practiced in donning protective equipment.		X		
i. PROCEDURES — Instructions for donning, doffing, and controlling personal protective equipment should be provided.			X	CLO#1.3-8

	N/A	YES	NO	COMMENTS
6.1.4.2 FIRE, RADIATION, AND RESCUE EQUIPMENT				
a. PERIODIC CHECKS — All equipment should be periodically checked to determine if it is in good condition.		X		
b. ACCESSIBILITY — All equipment should be easily and readily accessible.			X	CLO#1.3-5
c. TRAINING — Operators should be trained in the use of all emergency equipment.		X		
d. PROCEDURES — There should be a written, administratively approved procedure for each type of emergency or combination of emergencies.			X	CLO#1.3-9
e. AUTOMATIC WARNING SYSTEM — There should be an automatic fire warning system for control room fires.		X		
6.1.4.3 EMERGENCY EQUIPMENT STORAGE				
a. PROPER STORAGE — Provision should be made for the orderly storage, in the control room, of emergency equipment that is needed by control room personnel.			X	CLO#1.3-1
b. ACCESS — The storage location(s) may be away from the primary operating area but should be accessible, clearly marked, and known to all personnel.		X		
6.1.5.4 EMERGENCY LIGHTING				
a. AUTOMATIC ACTION — A control room emergency lighting system should be automatically activated and immediately available upon failure of the normal control room lighting system. This system should be independent of any other plant lighting system that is available in the control room.		X		

	N/A	YES	NO	COMMENTS
6.1.5.4 EMERGENCY LIGHTING (cont'd)				
b. OPERABILITY — Failure of the normal control room lighting system should not degrade operability of the emergency lighting system.		X		
6.2.1.8 EMERGENCY COMMUNICATIONS				
a. BACKUP EQUIPMENT — Provisions should be made to assure complete internal and external communications capabilities during emergencies.			X	CLO#1.3-6
b. EQUIPMENT USABILITY — Communications equipment should be usable by personnel wearing protective gear without impediment to their tasks.			X	CLO#1.3-4
c. VOICE COMMUNICATIONS WITH MASKS			X	CLO#1.3-4
(1) Emergency face masks should be equipped with diaphragms that are specially designed to transmit speech.				
(2) The diaphragms should be able to separate voice from exhaust valve action.				
(3) If not equipped with diaphragms, masks should be equipped with electronic speech systems which pick up the voice with an internal microphone and transmit it to a loudspeaker attached outside the mask.				
6.4.1.1 GENERAL PRINCIPLES				
d. COMPATIBILITY WITH EMERGENCY GEAR — If used while wearing protective equipment (e.g., oxygen masks, protective gloves), controls should be:	X			Ease of identification covered by CLO#6.1-1 operability covered by CLO#4.1-8 and 4.1-9.
(1) Easy to identify.				
(2) Easy to activate.				

3.4 Heating, Ventilation and Air Conditioning Survey TP-1.4

This section documents the results of the heating, ventilation and air conditioning (HVAC) survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. The review was conducted in accordance with the requirements of NUREG-0700 as specified in the D. C. Cook DCRDR program plan.

3.4.1 Objectives

The objective of the heating, ventilation and air conditioning survey was to identify and document any nonconformance with NUREG-0700 criteria pertaining to the climate control portion of the control rooms environment.

3.4.2 Scope

The scope of the effort was to assess the climate of the Unit 1 and Unit 2 control rooms using the applicable guidelines in NUREG-0700. The climate control topics evaluated were:

- o Temperature and Humidity
- o Ventilation

3.4.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph number are: paragraphs 6.1.5.1a; 6.1.5.1b; 6.1.5.2a and 6.1.5.2b. The detailed definitions for the criteria are presented in Table 3.4

3.4.4.1 Data Collection

a. Data were collected using the checklist contained in the HVAC task plan.

b. Comfort zones recommended in NUREG-0700 were measured and recorded. Values falling outside the recommended value were noted and recorded.

3.4.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.4.5 Findings

The findings of the HVAC survey are presented in Table 3.4 "Heating, Ventilation and Air Conditioning Survey Findings and CLOs Generated." Four criteria were applied in this survey. Two of the criteria were not violated. Two CLOs were generated for the 2 criteria violated. These CLOs describe temperature-humidity and air velocity problems.

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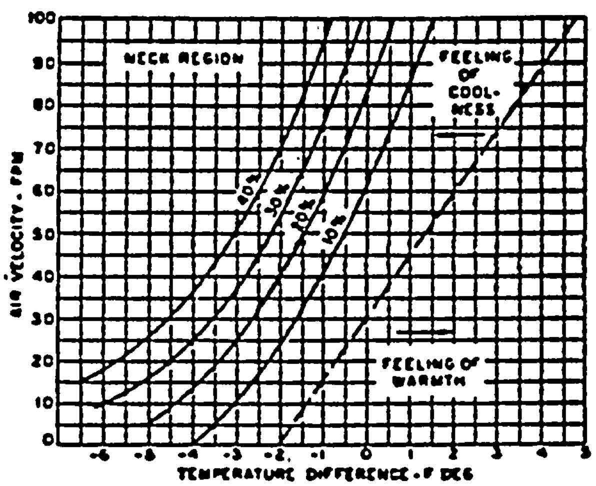
SURVEY FINDINGS AND CLOs GENERATED TABLE 3.4

Item	N/A	YES	NO	COMMENTS
6.1.5.1 TEMPERATURE AND HUMIDITY				
a. COMFORT ZONE — The climate control system should be capable of maintaining temperature and humidity within the shaded area comfort zone shown in the figure on the following page.			X	Not true primarily due to low dry-bulb temperatures measured. CLO#1.4-1
b. TEMPERATURE DIFFERENTIAL — Air temperature at floor level and at head level should not differ by more than 10°F.		X		72°F
6.1.5.2 VENTILATION				
a. AIR QUANTITY — The ventilation system should be capable of introducing outdoor air into the control room at a rate of at at least 15 cubic feet per minute (cfm) per occupant.		X		OK
b. AIR VELOCITY — Air velocities in the primary operating area should not exceed 45 feet per minute (fpm) measured at operator head level and should not produce a noticeable draft. The figure below shows perceptions of draft in relation to air velocity and temperature.			X	CLO#1.4-2



Percentage of occupants objecting to drafts at neck.

3.5 Illumination Survey TP-1.5

This section documents the results of the illumination survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700 as specified in the D. C. Cook DCRDR program plan.

3.5.1 Objectives

The objectives of the illumination survey were to:

a. Assess to what degree the normal and emergency lighting in the main control room conform to the criteria of NUREG-0700.

b. Identify and document any lighting characteristics that do not conform to the criteria of NUREG-0700.

3.5.2 Scope

The scope of this survey was to identify any undesirable lighting characteristics in the main control rooms as defined by NUREG-0700 guidelines. The illumination topics evaluated were:

- o Illumination level and uniformity
- o Glare
- o Emergency lighting

3.5.3 Criteria

The criteria applied in this survey are from NUREG-0700 paragraphs 6.1.5.3 and 6.1.5.4c. The detailed definitions for the criteria are present in Table 3.5.

3.5.4.1 Data Collection

a. Data were collected using the checklist contained in the illumination task plan.

b. Normal ambient illumination and normal luminance were measured throughout the control room. These values were recorded on a grid format for each control room. Response to operator interview questions were also recorded.

3.5.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem including the NUREG-0700 paragraph number of the criteria and a suggested solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.5.5 Findings

The findings of the illumination survey are presented in Table 3.5 "Illumination Survey Findings and CLOs Generated." A total of 9 criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 2 were not violated. Seven CLOs were generated which covered the 7 criteria violated. These CLOs describe problems with illumination level, uniformity, shadowing, glare, reflectance and surface color.

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	N/A	YES	NO	COMMENTS
6.1.5.3 ILLUMINATION				
a. LEVELS — (from Exhibit 6.1-22) Numbers are the min-recommended-max in ftC.			X	CLO#1.5-4
(1) Panels, primary 20-30-50				
(2) Aux panels 20-30-50				
(3) Scale indicators 20-30-50				
(4) Seated operations 50-75-100				
(5) Reading, handwriting 50-75-100				
(6) Reading, print 20-30-50				
(7) Writing 50-75-100				
(8) Maintenance 20-30-50				
(9) Emergency operations - minimum of 10, recommended and maximum as above for area/task.				
b. UNIFORMITY — The level of illumination should not vary greatly over a given work station.			X	CLO#1.5-6
c. SUPPLEMENTAL LIGHT — Supplemental lighting should be provided for personnel performing specialized visual tasks in areas where fixed illumination is not adequate.		X		
d. TASK AREA LUMINANCE RATIOS — To determine task lighting requirements, it is necessary to consider the levels of lighting which surround a task. Great disparities between task and background lighting can lead to adaptation problems. To ensure effective visual performance, the task area luminance ratios in Exhibit 6.1-23 should not be exceeded.			X	CLO#1.5-1

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.5

Item	N/A	YES	NO	COMMENTS
6.1.5.3 (Cont'd)				
e. SHADOWING — To reduce operator fatigue and eyestrain, shadows should be avoided.			X	CLO#1.5-7
(1) Ambient illumination should be provided via indirect or diffuse lighting.				
(2) Labels, instructions, and other written information should not be in shadowed positions.				
f. GLARE — Glare should not interfere with the readability of displays, labels, or indicators.			X	CLO#1.5-2
g. REFLECTANCE — The amount of reflected light is affected by illuminated surface colors. Reflectance should conform to the recommendations shown in Exhibit 6.1-24. (See also Exhibit 6.1-25.)			X	CLO#1.5-5
h. COLOR — Surface colors should be recognizable under both normal and emergency lighting conditions.			X	CLO#1.5-3
6.1.5.4 EMERGENCY LIGHTING				
c. LIGHTING LEVELS — The control room emergency illumination system should be designed to provide a minimum illumination level of 10 footcandles at all work stations in the primary operating area.		X		According to operators, the emergency lighting does not provide adequate light in center of room. Is adequate along panels and operator's desk as well as necessary work stations. Unable to measure emergency lighting levels due to plant operating status.

3.6 Ambient Noise Survey TP-1.6

This section documents the results of the ambient noise survey conducted in the main control rooms of the D. C. Cook Nuclear Plant. The review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.6.1 Objective

The objective of the ambient noise survey was to identify and document any nonconformance with NUREG-0700 criteria pertaining to the auditory environment and acoustic design of the control rooms.

3.6.2 Scope

The scope of the effort was to assess the ambient noise level in the Unit 1 and Unit 2 control rooms using the applicable guidelines in NUREG-0700. The ambient noise topics evaluated were:

- o Auditory environment
- o Background noise
- o Noise distractions

3.6.3 Criteria

The criteria applied in this survey are from NUREG-0700 paragraphs 6.1.5.5a through e. Detailed definitions for the criteria are presented in Table 3.6.

3.6.4.1 Data Collection

a. Data were collected using the checklist contained in the ambient noise task plan.

b. Noise level measurements were taken at specific locations throughout the control rooms. Those measurements were noted and recorded.

3.6.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the area involved, a description of the problem including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.6.5 Findings

The findings of the ambient noise survey are presented in Table 3.6. Ambient Noise Survey and CLOs generated. Six criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 3 were not violated. Three CLOs were generated which covered the criteria violated. Those CLOs describe background noise, noise distractions and auditory environment problems.

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SURVEY FINDINGS AND CLOs GENERATED

TABLE 3.6

	N/A	YES	NO	COMMENTS
6.1.5.5 AUDITORY ENVIRONMENT — The acoustic design of the control room should ensure that verbal communications between operators are not impaired; auditory signals are readily detected; and auditory distraction, irritation, and fatigue of operators are minimized.			X	CLO#1.6-3
a. BACKGROUND NOISE — Background noise should not impair verbal communication between any two points in the primary operating area. Verbal communications between these points should be intelligible using normal or slightly raised voice levels. See figure, page A-2.			X	CLO#1.6-1
b. LIMIT — Background noise levels should not exceed 65 dB(A).		X		Measurements taken during low activity periods and without alarms, talking and speakers.
c. FURTHER REDUCTIONS — Further reductions in background noise may be required where communications between the primary operating area and other control room locations are necessary and voice transmission systems are not provided.		X		
d. NOISE DISTRACTIONS — Noise distractions generated either inside or outside the control room should be minimized.			X	CLO#1.6-2
e. REVERBERATION TIME AND SOUND ABSORPTION — The acoustical treatment of the control room should limit reverberation time to one second or less.		X		

3.7 Maintainability Survey TP-1.7

This section documents the results of the maintainability survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700 as specified in the D. C. Cook DCRDR program plan.

3.7.1 Objectives

The objectives of the maintainability survey were to:

a. Assess to what degree components with integral lighting are operator maintainable as defined by NUREG-0700.

b. Assess to what degree display failures are recognizable by the operator as defined by NUREG-0700.

c. Assess to what degree spare parts, operating expendables and special tools are available and adequate for use by the operator.

d. Identify and document any features in the control room maintainability design that do not conform to the criteria of NUREG-0700.

3.7.2 Scope

The scope of the effort was limited to assessing maintainability design with respect to the maintenance responsibilities of control room operators as identified in NUREG-0700.

The maintainability topics evaluated were:

- o Spare parts, operating expendables and tools
- o Lamp replacement
- o Bulb test capability

3.7.3 Criteria

The criteria applied in this survey are from NUREG-0700, paragraphs 6.1.1.5a through f; 6.2.1.1b; 6.3.3.1c (1) through (3); 6.4.3.3c (1) through (4); 6.5.3.1a (1) through (3) and c(2) and 6.5.4.1e and f. The detailed definitions for the criteria are presented in Table 3.7.

3.7.4.1 Data Collection

Data were collected by interviews, observations and document reviews. All data collected were recorded on the checklist contained in the maintainability task plan.

3.7.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from more than one source were contradictory, resolution was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.7.5 Findings

The findings of the maintainability survey are presented in Table 3.7 "Maintainability Survey Findings and CLOs Generated." A total of 20 criteria were applied to the D. C. Cook control rooms. Eight of the criteria were not violated. Seven CLOs were generated which covered the 12 criteria violated. Those CLOs describe, assessability, supply and storage of spares, and maintenance and availability of tools for replacement.

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Item	N/A	YES	NO	COMMENTS
6.1.1.5 SPARE PARTS, OPERATING EXPENDABLES, AND TOOLS				
a. SUPPLY — There should be an adequate supply of expendables and spare parts: fuses, bulbs, ink and inking pens, recorder charts, printer paper, etc.			X	CLO#1.7-1
b. ACCESSIBILITY — Expendables and spare parts should be readily accessible.		X		
c. TOOLS — All necessary or special replacement tools needed to install expendables and spare parts should be available.			X	CLO#1.7-2
d. STORAGE SPACE — There should be adequate storage space for expendables and spare parts.		X		
e. CODING — When different types, sizes, or styles of expendables and spare parts are required, they should be clearly and distinctively marked to avoid misapplication.			X	CLO#1.7-3
f. INVENTORY — Records should be kept as to the status of expendables and spare parts.		X		
6.2.1.1 GENERAL REQUIREMENTS FOR VOICE COMMUNICATIONS SYSTEMS				
b. PERIODIC MAINTENANCE TESTS — These should be performed on all communication systems to ensure that the system is normally operative and effective under changes in ambient noise levels that may have occurred since the last check.			X	CLO#1.7-7
6.3.3.1 VISUAL ANNUNCIATOR PANELS				
c. LAMP REPLACEMENT				
(1) If a lamp replacement requires legend tile removal, there should be a way to ensure that the tile is replaced in the correct location.			X	CLO#1.7-4

Item	N/A	YES	NO	COMMENTS
(2) Lamp replacement should not subject the operator to a shock hazard.		X		
(3) Operator aids should be provided if needed for lamp replacement.			X	CLO#1.7-2
6.4.3.3 LEGEND PUSHBUTTONS				
c. PROVISION FOR LAMP FAILURE				
(1) A lamp test or dual lamp/dual filament capability should be provided.			X	CLO#1.7-5
(2) Lamps within the pushbutton should be replaceable from the front of the panel.		X		
(3) Legend pushbuttons should not short out during lamp replacement or be susceptible to inadvertent activation during the process of lamp removal or replacement.		X		
(4) Legend covers should be keyed to prevent the possibility of interchanging the covers.			X	CLO#1.7-4
6.5.3.1 CHARACTERISTICS AND PROBLEMS OF LIGHT INDICATORS				
a. PRECAUTIONS TO ASSURE AVAILABILITY				
(1) Dual-bulb or dual-filament light assemblies should be used.			X	CLO#1.7-6
6.5.3.1 CHARACTERISTICS AND PROBLEMS OF LIGHT INDICATORS (Cont'd)				
a. PRECAUTIONS TO ASSURE AVAILABILITY (Cont'd)				
(2) Bulb-test capability should be provided.			X	CLO#1.7-6

	N/A	YES	NO	COMMENTS
(3) Design should encourage immediate replacement of burned-out bulbs by providing for rapid and convenient bulb replacement with power on and without hazard to personnel or equipment.			X	Some sockets are recessed far enough into panel to make it difficult to replace bulbs without correct tools (bulb pullers). CLO#1.7-2
c. PRECAUTIONS TO AVOID MISINTERPRETATION				
(2) Provisions (design or procedural) should be made to prevent interchanging indicator lenses.			X	Lenses can be interchanged and there are no known provisions to ensure they're not interchanged. CLO#1.7-4
6.5.4.1 GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS				
e. AVAILABILITY OF EXPENDABLES — Paper, ink, and other operator-maintained expendables should be provided and accessible in the control room.		X		Inside CR and outside CR between units.
f. EASE OF ROUTINE REPLENISHMENT — Recorder design should permit quick and easy replenishment of paper and ink.		X		Ink and paper daily check according to operator.

3.8 Communications Survey TP-2.1

This section documents the results of the communications survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. The review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.8.1 Objectives

The objectives of the communications survey were to:

a. Assess to what degree the control rooms communications system conforms to the criteria of NUREG-0700.

b. Identify and document any communications performance problems.

3.8.2 Scope

The scope of the effort was to assess the communications systems within the main control rooms at the D. C. Cook plant using the applicable guidelines in NUREG-0700. The communications topics evaluated were:

- o General requirements for voice communications systems
- o Conventional powered telephone systems
- o Sound-powered telephone systems
- o Walkie-talkie transceivers
- o Announcing systems
- o Emergency communications
- o Reliability

3.8.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph numbers are: paragraphs 6.1.3.1b; 6.2.1.1c; 6.2.1.2 through 6.2.1.8; and 6.2.2.1 through 6.2.2.7. The detailed definitions for the criteria are presented in Table 3.8.

3.8.4.1 Data Collection

a. Data were collected using the checklists contained in the communications task plan.

b. Data were collected by operator interviews/ questionnaires, observations and documentation reviews. Also the noise survey results were reviewed for communications relevant data.

3.8.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a suggested solution.

b. The data collection description was also recorded on the CLO forms. Where data from two or more sources were contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.8.5 Findings

The findings of the communications survey are presented in Table 3.8 "Communications Survey Findings and CLOs Generated." A total of 79 criteria were applied to this survey. Of the criteria applied, 8 were not applicable, 48 were not violated. One of the criteria violated was covered in the workspace survey (Section 3.1). Sixteen CLOs were generated which covered the other 22 criteria violated. Those CLOs cover problems with communication systems instructions, telephone cords, sound powered telephone storage and discomfort, announcing system intelligibility and emergency communications.

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	N/A	YES	NO	COMMENTS
6.2.1.1 GENERAL REQUIREMENTS FOR VOICE COMMUNICATION SYSTEMS				
a. INSTRUCTIONS — Instructions should be provided for use of each communication system, including suggested alternatives if a system becomes inoperable.			X	CLO#2.1-8
c. EMERGENCY MESSAGES				
(1) OUTGOING — Priority procedures should be established for the transmission of emergency messages from the control room by any of the communication systems.			X	CLO#2.1-9
(2) INCOMING — Procedures should be established for handling communications during an emergency and these procedures must be known by all operators.			X	CLO#2.1-9
6.2.1.2 CONVENTIONAL-POWERED TELEPHONE SYSTEMS				
a. FREQUENCY RESPONSE — The powered telephone system must provide good frequency response in that portion of the auditory spectrum most essential for intelligibility. Standard telephone bandpass is acceptable (200-3300 Hz).			X	CLO#2.1-1
b. HANDSETS — Design should incorporate the following features:		X		
(1) Size and shape should be compatible with operator's hand size and mouth-ear distance (standard telephone dimensions acceptable).				

6.2.1.2 b.(Cont'd)

Item	N/A	YES	NO	COMMENTS
(2) Should maintain firm ear contact by receiver while transmitter is positioned to receive voice waves directly from mouth.		X		
(3) Cords should be of nonkink or self-retracting type.			X	CLO#1.1-5
(4) Cords should be of sufficient length to permit reasonable operator mobility.		X		
(5) Cords should be positioned so as to avoid entangling critical controls or endangering passing traffic.			X	Covered in other Task Plans CLO#1.1-5.
(6) Vertically mounted handset cradles should be designed and located to prevent the handset from being knocked out of the cradle by passing traffic.			X	CLO#2.1-10
(7) Where multiple telephone instruments are located close together (e.g., on a single desk) they should be coded to indicate circuit or function.		X		
(8) If a press-to-talk button is used, the button should be convenient to both left and right hand operation.	X			A press-to-talk button is not used.
c. SWITCHING MECHANISM —				
(1) Switching should be designed and/or programmed to minimize delay in making desired connections under both normal and emergecy conditions.		X		
(2) Switching should be programmed to give the control room automatic priority of access to the switching system.		X		
d. TELEPHONE RINGING — Loudness of ringing should be adjustable at the individual telephone instrument.		X		

	N/A	YES	NO	COMMENTS
6.2.1.2 (Cont'd)				
e. ANNOUNCING USE — When transmitters, within the powered telephone system, are used as the microphone input to the announcing system, the transmitter should be compatible with the rest of the announcing system.		X		
6.2.1.3 SOUND-POWERED TELEPHONE SYSTEMS				
a. SOUND QUALITY — Within engineering constraints imposed by sound-powering, the system *should provide:*			X	CLO#2.1-2
(1) Good frequency response in the band from 200 to 3300 Hz (standard telephone quality).				
(2) In-phase feedback to the user.				
b. HEADSETS — Headsets should reflect the following design requirements:				
(1) Earphone cushioning to provide comfort for extended periods of wear. Earphones should cover the outer ear but without causing uncomfortable pressure.		X		
(2) Supporting structure for earpieces should not impose discomforts of weight, concentrated pressures, or metal contact with the skin.			X	CLO#2.1-11
(3) The earpiece should be held firmly in place, yet be easy to remove.		X		
(4) Ideally, headsets should provide hands-free operation. This may have to be compromised, however, to accommodate a push-to-talk switch in anticipation of possible use in areas of high ambient noise.		X		

6.2.1.3b (Cont'd)

	N/A	YES	NO	COMMENTS
(5). Biaural headsets should be available for use by control room personnel when they are required to leave the control room for plant areas with high ambient noise levels and communicate with the control room from these areas using sound-powered communication equipment.		X		
(6) A well-marked and accessible place should be provided for headset stowage.			X	CLO#2.1-12
c. RINGING —				
(1) Need for ringing must be determined for the individual plant depending on the sound-powered phone procedures.		X		
(2) If ringing is not installed, then the user should be provided capability for directly switching the sound-powered transmitter to the paging system so that a desired party can be called to the line.	X			
d. JACK PROVISIONS —				
(1) Plug-in jacks for the sound-powered system should be provided within the control room.		X		
(2) Jacks should be located close to the work stations to prevent need for unduly long cords.		X		
(3) Jacks should not accommodate plugs of the conventionally powered phone system, in order to avoid wrong instrument-system connections.		X		
e. SWITCHING —				
(1) The requirements for switching must be assessed for the individual plant depending on procedures for use of sound-powered phones.		X		

Item	N/A	YES	NO	COMMENTS
6.2.1.3 e. (Con't)				
(2) Patch panels, when used, should be conspicuously marked and located in reasonably accessible places. These requirements are particularly critical in back-panel areas.	X			
(3) A complete set of cords should be provided at each panel if cord-type patching is used.	X			
6.2.1.4 WALKIE-TALKIE TRANSCEIVERS				
a. SOUND QUALITY — Within the engineering constraints imposed by radio frequency spectrum availability and by design for easy portability, walkie-talkies should realize the same quality desired throughout all of the communications systems, namely:			X	CLO#2.1-3
(1) Good frequency response, preferably to telephone standards of 200 to 3300 Hz.				
(2) Sufficient dynamic range and gain to handle instantaneous pressures found in speech and develop necessary signal level at the headphone or loudspeaker.				
b. AREA COVERAGE —				
(1) Modulation and a radio frequency should be chosen, as FCC regulations permit, to provide broad-area walkie-talkie communication to the control room. One consideration for frequency selection should be radio-wave penetration of metal or reinforced concrete barriers, which at certain frequencies would tend to attenuate or bounce the signal.			X	CLO#2.1-3

Item	N/A	YES	NO	COMMENTS
6.2.1.4b (Cont'd)				
(2) Use of walkie-talkies should be prohibited in areas close to low-level analog or digital equipment unless EMI noise susceptibility tests have been conducted that demonstrate that equipment is not affected by the frequency bands used.			X	CLO#2.1-7
c. PACKAGING —				
(1) To the extent permitted by design for effective electrical/RF function, walkie-talkies should be small, light, and easy to carry.		X		
(2) Their use should leave one hand, and preferably both, available most of the time for other tasks.				
(3) The microphone should be integrated into the transceiver package.		X		
d. PARTY IDENTIFICATION — When there are more than two parties on a channel operating at separate locations, procedures must provide for unambiguous identification of the speaker.		X		
e. BATTERY REPLENISHMENT —				
(1) A supply of fresh replacement batteries should be stowed in an accessible, well-marked space.			X	CLO#2.1-13
(2) The stock should be kept large enough to support long periods of continuous operation in case of emergency.				

	N/A	YES	NO	COMMENTS
6.2.1.5 FIXED-BASE UHF TRANSCEIVERS				
a. SIGNAL QUALITY — Unlike walkie-talkies, fixed-base UHF transceivers are not constrained by being designed for portability. Therefore, they should readily achieve good voice intelligibility, provided by adequate frequency response at least within telephone standards of 200 to 3300 Hz. They should exhibit sufficient dynamic range to handle instantaneous pressures found in speech and develop sufficient gain to develop the necessary signal level at the loudspeaker.		X		
b. GAIN — Gain should be adjustable, but the gain control should be limited so that even at its lowest setting an audible signal is still presented.			X	CLO#2.1-14
c. PROCEDURES — Procedures should be established (and conspicuously posted) for use of the system.			X	CLO#2.1-15
6.2.1.6 ANNOUNCING SYSTEMS				
a. INTELLIGIBILITY AND COVERAGE —				
(1) Intelligibility requires the integration of carefully selected components (microphones, amplifiers, and loudspeakers) into an overall system providing good frequency response in the audio band which is critical for intelligibility. At a minimum, telephone quality is required (200 to 3300 Hz); higher intelligibility is achieved by a band of 200 to 6100 Hz.			X	CLO#2.1-4
(2) Coverage depends on loudspeaker location. Adequate coverage requires that speakers should be placed so that they are available in all necessary areas and that there are no "dead spots" within any area.			X	CLO#2.1-4

	N/A	YES	NO	COMMENTS
6.2.1.6 (Cont'd)				
b. MICROPHONE CHARACTERISTICS —		X		
(1) Frequency response should be compatible with that of the rest of the system.				
(2) If the powered telephone system is used to provide microphone input to the announcing system, the telephone system should contain transmitters of quality compatible with that of the announcing system.		X		
(3) Microphones should have high sensitivity to speech signals.		X		
(4) Dynamic range should permit 50 dB variations in signal input.				
(5) Microphone input should be provided within the control room.		X		
c. LOUDSPEAKER LOCATION				
(1) Speakers should be provided in the control room and.other areas where control room personnel operations might be (e.g., restrooms, eating areas, locker rooms, etc.).			X	CLO#1.1-3
(2) Speakers should be placed to yield an intelligible level of signal throughout the area.		X		
d. SPEECH CLARITY — Since proper speech over an announcing system differs from normal conversation, operators should be familiarized with the proper way to speak on the announcing system.		X		
e. LOUDSPEAKER VOLUME —				
(1) Speaker volume should be adjusted to ensure that speaker communications will not prevent detection of auditory alarms.			X	CLO#2.1-5

Item	N/A	YES	NO	COMMENTS
6.2.1.6e (Cont'd)				
(2) Audio gain controls (if provided) should be limited to preclude reducing volume below an audible level.	X			
f. PRIORITY — Control room inputs to the plant announcing system should have priority over any other input. The control room input should be capable of interrupting an announcement in progress, or of bypassing queued announcements.			X	CLO#2.1-16
6.2.1.7 POINT-TO-POINT INTERCOM SYSTEMS				
a. INTELLIGIBILITY — At a minimum, the intercom system should provide transmission of the voice spectrum to telephone standards (200 to 3300 Hz).		X		
b. GAIN ADJUSTMENT — Gain should be adjustable at each intercom unit, but adjustability should be limited to preclude reducing volume below an audible level.		X		
6.2.1.8 EMERGENCY COMMUNICATIONS				
a. BACKUP EQUIPMENT — Provisions should be made to assure complete internal and external communications capabilities during emergencies.			X	CLO#2.1-6 and 2.1-7
b. EQUIPMENT USABILITY — Communications equipment should be usable by personnel wearing protective gear without impediment to their tasks.			X	CLO#1.3-4

	N/A	YES	NO	COMMENTS
6.2.2.1 USE OF AUDITORY SIGNALS				
a. DEDICATED USE — Systems used to transmit nonverbal auditory signals should be used only for that purpose.		X		
b. LOCALIZATION — Auditory signals should provide localization cues that direct operators to those control room work stations where operator attention is required.		X		
c. SELECTION —				
(1) Auditory signals should be selected to avoid confusion with ambient control room noises.		X		
(2) Auditory signals should be selected to avoid interference with other auditory sources, including verbal communication.		X		
6.2.2.2 SIGNAL MEANING				
a. The meaning of each auditory signal should be clear and unambiguous.		X		
b. Similar auditory signals must not be contradictory in meaning with one another.		X		
c. Auditory signals intended to alert the operator to a malfunction or failure must be different from routine signals such as bells, buzzers, and normal operating noises.		X		

	N/A	YES	NO	COMMENTS
6.2.2.3 AUDITORY CODING TECHNIQUES				
a. DISTINCTIVE CODING — Coding methods should be distinct and unambiguous; and should not conflict with other auditory signals.		X		
b. PULSE CODING — Auditory signals may be pulse coded by repetition rate, but the number of codes should be limited (2 or 3). Repetition rates should be sufficiently separated to ensure operator discrimination.		X		
c. FREQUENCY CHANGE CODING — If modulation of the frequency (Hz) of a signal denotes information, center frequencies should be between 500 and 1000 Hz.	X			Data not available.
d. DISCRETE-FREQUENCY CODING — Discrete-frequency codes may be used for audible signal coding. Frequencies should be broad band (±100 Hz) and widely spaced within the 200-5000 Hz range. No more than 5 separate frequencies should be used.	X			Data not available.
e. CODING BY INTENSITY — Coding by intensity is not recommended.		X		
6.2.2.4 PROPAGATION OF SIGNALS				
a. DIRECTION OF SOUND — Sound sources (speakers, buzzers, etc.) should direct sound toward the center of the primary operating area.		X		
b. AUDIBILITY — Auditory alert and warning signals should be audible in all parts of the control room.		X		
6.2.2.5 FREQUENCY				
a. RANGE — Auditory signal frequencies should be between 200 and 500 Hz. The optimum frequency range is between 500 and 3000 Hz.		X		

Item	N/A	YES	NO	COMMENTS
6.2.2.5 (Cont'd				
b. BANDWIDTH — Wide-band auditory signals of approximately 200 Hz should be used.	X			
6.2.2.6 SIGNAL INTENSITY				
a. GENERAL — In general, a system capability to develop a signal-to-noise ratio of 20 dB in at least one octave band between 200 an 5000 Hz should be adequate for all control rooms and environments. This signal-to-noise ratio capability should apply throughout the primary operating area. However, a 20 dB differential may not be necessary for all signals and all environments. A normal value of 10 dB(A) above average ambient noise is generally adequate (See Guideline 6.3.2.1.)		X		
b. COMFORT — Auditory signal intensity should not cause discomfort or "ringing" in the ears.		X		
c. MAXIMUM INTENSITY — Auditory signal intensities should not exceed 90 dB(A), except for evacuation signals, which may be up to 115 dB(A).		X		
6.2.2.7 RELIABILITY				
a. FAILURE OF ALARM CIRCUITRY — Failure of auditory signal circuitry should not adversely affect plant equipment.		X		
b. FALSE ALARMS — Auditory alarm systems should be designed so that false alarms are avoided.		X		
c. SYSTEM TEST — Auditory signal system test capabilities should be provided.		X		

3.9 Annunciator System Survey TP-3.1

This section documents the results of the annunciator system survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. The review was conducted in accordance with the requirements of NUREG-0700 as specified in the D. C. Cook DCRDR program plan.

3.9.1 Objectives

The objectives of the annunciator system survey were as follows:

a. Assess to what degree the annunciator system conforms to the criteria of NUREG-0700.

b. Identify and document any features of the annunciator system design that do not conform to the criteria of NUREG-0700.

3.9.2 Scope

The scope of the effort was to assess the annunciator system design in the main control rooms at the D. C. Cook plant using the applicable guidelines of NUREG-0700. The annunciator system topics evaluated include:

- General system design
- Alarm parameter selection
- First out annunciators
- Prioritization
- Cleared alarms
- Signal detection
- Auditory coding
- Visual annunciator panels
- Visual alarm recognition and identification
- Arrangement of alarm tiles
- Tile legends
- Tile readability
- Annunciator controls
- Response procedures

3.9.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph number are: paragraphs 6.3.1.1; 6.3.1.2a through d(2); 6.3.1.3.a through d; 6.3.1.4a and b; 6.3.1.5a through b(3); 6.3.2.1a through f;6.3.2.2.a through b(2); 6.3.3.2a through f(2); 6.3.3.3a through f; 6.3.3.4a through c; 6.3.3.5a through d(6); 6.3.4.1a through d(2); 6.3.4.2a through c; 6.3.4.3a and b; 6.5.1.6a through c(2) and e(1) through (3); and 6.6.6.2a through c. The detailed definitions for the criteria are presented in Table 3.9.

3.9.4.1 Data Collection

a. Data were collected using the checklists contained in the annunciator system task plan.

b. Data were collected primarily through measurements, and observations of the annunciator systems in the control rooms. Where necessary interviews and system documentation were reviewed to augment and confirm observations and measurements.

3.9.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.9.5 Findings

The findings of the annunciator system survey are presented in Table 3.9 "Annunciator System Survey Findings and CLOs Generated." A total of 96 criteria were applied in this survey. Of the criteria applied, 13 were not applicable and 34 were not violated. Five of the violated criteria were also covered in the conventions survey and they were documented there. One violated criteria was covered and documented in the labels and location aids survey. Thirty-three CLOs were generated to cover the remaining 43 criteria violated. In general, the CLOs address alarm setpoints and duration, shared alarms, first out annunciators lack of prioritization, auditory coding, tile arrangements, tile engraving and color coding.

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	N/A	YES	NO	COMMENTS
6.3.1.1 GENERAL SYSTEM DESIGN				
Annunciator warning systems are the primary control room interface to immediately alert the operator to out-of-tolerance changes in plant condition. Annunciator warning systems consist of three major subsystems: (a) an auditory alert subsystem, (b) a visual alarm subystem, and (c) an operator response subsystem (see Exhibit 6.3-1). Together, these three subsystems should be designed to provide a preferred operational sequence for annunciator warnings as indicated in Exhibit 6.3.2.		X		
6.3.1.2 ALARM PARAMETER SELECTION				
a. SET POINTS — The limits or set points for initiating the annunciator warning system should be established to meet the following goals:				
(1) Alarms should not occur so frequently as to be considered a nuisance by the operators.			X	CLO#3.1-8
(2) However, set points should be established to give operators adequate time to respond to the warning condition before a serious problem develops.			X	CLO#3.1-9
b. GENERAL ALARMS —				
(1) Alarms that require the control room operator to direct an auxiliary operator to a given plant location for specific information should be avoided.		X		
(2) If general alarms must be used, they should only be used for conditions that allow adequate time for auxiliary operator action and subsequent control room operator action.			X	CLO#3.1-11 and 3.1-14

	N/A	YES	NO	COMMENTS
6.3.1.2 (Cont'd)				
c. MULTICHANNEL OR SHARED ALARMS —				
(1) Annunciators with inputs from more than one plant parameter set point should be avoided. Multi-input alarms that summarize single-input annunciators elsewhere in the control room are an exception.			X	CLO#3.1-5 and 3.1-19
(2) Where multi-input annunciators must be used, an alarm printout capability should be provided. The specifics of the alarm should be printed on an alarm typer with sufficient speed and buffer storage to capture all alarm data.			X	CLO#3.1-19
(3) A reflash capability should be provided to allow subsequent alarms to activate the auditory alert mechanism and reflash the visual tile even though the first alarm may not have been cleared.			X	CLO#3.1-5
d. MULTI-UNIT ALARMS —				
(1) Alarms for any shared plant systems should be duplicated in all control rooms.		X		
(2) When an item of shared equipment is being operated from one control room a status display or signal should be provided in all other control rooms which could potentially control this equipment.		X		
6.3.1.3 FIRST OUT ANNUNCIATORS				
a. REACTOR SYSTEM —				
(1) A separate first out panel should be provided for the reactor system.			X	CLO#3.1-1

Guideline	N/A	YES	NO	COMMENTS
6.3.1.3a (Cont'd)				
(2) The first out panel should consist of separate annunciator tiles for each of the automatic reactor trip functions.	X			
(3) In the event of a reactor trip, the tile associated with the event should illuminate, and no other.			X	CLO#3.1-1
b. TURBINE-GENERATOR SYSTEM — A separate first out panel, similar in function to the reactor system panel, is recommended.			X	CLO#3.1-1
c. POSITION — First out panels should be located directly above the main control work station for the system.	X			
d. APPLICATION — First out annunciators should conform to the general auditory, visual, and operator response guidelines of this section.	X			
6.3.1.4 PRIORITIZATION				
A. LEVELS OF PRIORITY —				
(1) Prioritization should be accomplished using a relatively small (2-4) number of priority levels.	X			Annunciators lack adequate prioritization. CLO#3.1-2
(2) Prioritization should be based on a continuum of importance, severity, or need for operator action in one or more dimensions, e.g., likelihood of reactor trip, release of radiation. Exhibit 6.3-3 provides an example of prioritization based on three levels of prioritization.	X			

	N/A	YES	NO	COMMENTS
6.3.1.4 (Cont'd)				
b. PRIORITY CODING —				
(1) Some method for coding the visual signals for the various priority levels should be employed. Acceptable methods for priority coding include color, position, shape, or symbolic coding.			X	CLO#3.1-2
(2) Auditory signal coding for priority level is also appropriate. See Guideline 6.2.2.3 for recommended coding techniques.			X	CLO#3.1-2
6.3.1.5 CLEARED ALARMS				
a. AUDITORY SIGNAL — Cleared alarms should have a dedicated, distinctive audible signal which should be of finite duration.		X		
b. VISUAL SIGNAL — The individual tile should have one of the following:			X	CLO#3.1-29
(1) A special flash rate (twice or one-half the normal flash rate is preferred, to allow discrimination), or				
(2) Reduced brightness, or				
(3) A special color, consistent with the overall control room color coding scheme, produced by a differently colored bulb behind the tile.				
6.3.2.1 SIGNAL DETECTION				
a. INTENSITY — The signal should be such that operators can reliably discern the signal above the ambient control room noise. A nominal value of 10 dB(A) above average ambient noise is generally adequate.		X		

	N/A	YES	NO	COMMENTS
6.3.2.1 (Cont'd)				
b. CONTROL — Signal intensity, if adjustable, should be controlled by administrative procedure.	X			Not adjustable.
c. LIMITS — The signal should capture the operator's attention but should not cause irritation or a startled reaction.			X	CLO#3.1-3
d. DETECTION — Each auditory signal should be adjusted to result in approximately equal detection levels at normal operator work stations in the primary operating area.			X	No for Unit-2. OK for Unit-1. CLO#3.1-26
e. RESET — The annunciator auditory alert mechanism should automatically reset when it has been silenced.		X		
f. IDENTIFICATION — The operator should be able to identify the work station or the system where the auditory alert signal originated. Separate auditory signals at each work station within the primary operating area are recommended.			X	CLO#3.1-25
6.3.2.2 AUDITORY CODING				
a. LOCALIZATION				
(1) Auditory coding techniques should be used when the operator work station associated with the alarm is not in the primary operating area.			X	CLO#3.1-18
(2) Coded signals from a single audio source should not be used to identify individual work stations within the primary operating area.	X			
b. PRIORITIZATION — Coding may be used to indicate alarm priority. (See Guideline 6.3.1.4.)		X		But not consistent/complete.

Item	N/A	YES	NO	COMMENTS
6.3.3.1 VISUAL ANNUNCIATOR PANELS				
a. LOCATION — Visual alarm panels should be located above the related controls and displays which are required for corrective or diagnostic action in response to the alarm. (See Exhibit 6.3-4.)			X	CLO#3.1-10
b. LABELING—				
(1) Each panel should be identified by a label above the panel.			X	Some labels are placed below ALBs. CLO#6.1-14
(2) Panel identification label height should be consistent with a subtended visual angle of a least 15 minutes when viewed from a central position within the primary operating area.		X		
6.3.3.2 VISUAL ALARM RECOGNITION AND IDENTIFICATION				
a. FLASHING — The specific tile(s) on an annunciator panel should use flashing illumination to indicate an alarm condition.		X		
b. FLASH RATE — Flash rates should be from three to five flashes per second with approximately equal on and off times.		X		
c. FLASHER FAILURE — In case of flasher failure of an alarmed tile, the tile light should illuminate and burn steadily.		X		
d. CONTRAST DETECTABILITY — There should be high enough contrast between alarming and steady-on tiles, and between illuminated and nonilluminated tiles, so that operators in a normally illuminated control room have no problem discriminating alarming, steady-on, and steady-off visual tiles.		X		

	N/A	YES	NO	COMMENTS
6.3.3.2 (Cont'd)				
e. "DARK" ANNUNCIATOR PANELS — A "dark" annunciator panel concept should be used. This means that under normal operating conditions no annunciators would be illuminated; all of the visual tiles of the annunciator panels would be "dark."			X	CLO#3.1-4
f. EXTENDED DURATION ILLUMINATION — If an annunciator tile must be "ON" for an extended period during normal operations (e.g., during equipment repair or replacement), it should be:				
(1) Distinctively coded for positive recognition during this period, and			X	CLO#3.1-6
(2) Controlled by administravie procedures.		X		
6.3.3.3 ARRANGEMENT OF VISUAL ALARM TILES				
a. MATRIX ORGANIZATION — Visual alarms should be organized as a matrix of visual alarm tiles within each annunciator panel.		X		
b. FUNCTIONAL GROUPING — Visual alarm tiles should be grouped by function or system within each annunciator panel. For example area radiation alarms should be grouped on one panel, not spread throughout the control room.		X		
c. LABELING OR AXES —				
(1) The vertical and horizontal axes of annunciator panels should be labeled with alphanumerics for ready coordinate designation of a particular visual tile.			X	CLO#3.1-28

	N/A	YES	NO	COMMENTS
6.3.3.3 (Cont'd)				
(2) Coordinate designation is preferred on the left and top sides of the annunciator panel.			X	CLO#3.1-28
(3) Letter height for coordinate designation should be consistent with a subtended visual angle of at least 15 minutes as viewed from a central position within the primary operating area.	X			No coordinate designation on panels.
d. PATTERN RECOGNITION —				
(1) The number of alarm tiles and the matrix density should be kept low (a maximum of 50 tiles per matrix is suggested).			X	CLO#3.1-24
(2) Tiles within an annunciator panel matrix should be grouped by subsystem, function, or other logical organization.			X	CLO#3.1-32
e. OUT-OF-SERVICE ALARMS — Cues for prompt recognition of an out-of-service annunciator should be designed into the system.			X	CLO#3.1-7
f. BLANK TILES — Blank or unused annunciator tiles should not be illuminated (except during annunciator testing).		X		
6.3.3.4 VISUAL TILE LEGENDS				
a. UNAMBIGUOUS — Annunciator visual tile legends should be specific and unambiguous. Wording should be in concise, short messages.			X	CLO#3.1-17 and 3.1-22
b. SINGULARITY — Alarms which refer the operator to another, more detailed annunciator panel located outside the primary operating area should be minimized.		X		

	N/A	YES	NO	COMMENTS
6.3.3.4 (Cont'd)				
c. SPECIFICITY — Tile legends should address specific conditions; for example, do not use one alarm for HIGH-LOW, TEMPERATURE-PRESSURE.			X	CLO#3.1-12 and 3.1-15
6.3.3.5 VISUAL TILE READABILITY				
a. DISTANCE — The operator should be able to read all the annunciator tiles from the position at the work station where the annunciator acknowledge control is located.		X		
(1) Letter height should subtend a minimum visual angle of 15 minutes, or .004 x viewing distance. The preferred visual angle is 20 minutes, or .006 x viewing distance.		X		
(2) Letter height should be identical for all tiles, based on the maximum viewing distance. Separate calculations should be made for stand-up and sit-down work stations.			X	CLO#3.1-20
b. TYPE STYLE — The size and style of lettering should meet the following:				
(1) Type styles should be simple.			X	CLO#3.1-20
(2) Type styles should be consistent on all visual tiles.			X	CLO#3.1-20
(3) Only upper-case type should be used on visual tiles.			X	CLO#3.1-23
c. LEGEND CONTRAST — Legends should provide high contrast with the tile background.				
(1) Legends should be engraved.			X	CLO#3.1-27
(2) Legends should be dark lettering on a light background.			X	Contrast is poor on non-engraved tiles. CLO#3.1-27

	N/A	YES	NO	COMMENTS
6.3.3.5 (Cont'd)				
d. LETTER DIMENSIONS AND SPACING —				
(1) Stroke-width-to-character-height ratio should be between 1:6 and 1:8.			X	CLO#3.1-31
(2) Letter width-to-height ratio should be between 1:1 and 3:5.			X	CLO#3.1-31
(3) Numeral width-to-height ratio should be 3:5.			X	CLO#3.1-31
(4) Minimum space between characters should be one stroke width.			X	CLO#3.1-31
(5) Minimum space between words should be the width of one character.			X	CLO#3.1-31
(6) Minimum space between lines should be one-half the character height.			X	CLO#3.1-31
6.3.4.1 CONTROLS (See Exhibit 6.3-5.)				
a. SILENCE —				
(1) Each set of operator response controls should include a silence control.		X		
(2) It should be possible to silence an auditory alert signal from any set of annunciator response controls in the primary operting area.	X			Given the design of the D.C. Cook annunciators, this is not applicable from an HF perspective.
b. ACKNOWLEDGE				
(1) A control should be provided to terminate the flashing of a visual tile and have it continue at steady illumination until the alarm is cleared.		X		No separate control, but acknowledge by pressing individual alarm tile.

Item	N/A	YES	NO	COMMENTS
6.3.4.1 (Cont'd)				
(2) Acknowledgement should be possible only at the work station where the alarm originated.	X			
c. RESET				
(1) If an automatic cleared alarm feature is not provided, a control should be provided to reset the system after an alarm has cleared.			X	CLO#3.1-16
(2) The reset control should silence any audible signal indicating clearance and should extinguish tile illumination.		X		
(3) The reset control should be effective only at the work station for the annunciator panel where the alarm initiated.		X		
d. TEST				
(1) A control to test the auditory signal and flashing illumination of all tiles in a panel should be provided.		X		
(2) Periodic testing of annunciators should be required and controlled by administrative procedure.		X		
6.3.4.2 CONTROL SET DESIGN				
a. POSITIONING OF REPETITIVE GROUPS — Repetitive groups of annunciator controls should have the same arrangement and relative location at different work stations. This is to facilitate "blind" reaching.	X			Only have reset and test.
b. CONTROL CODING — Annunciator response controls should be coded for easy recognition using techniques such as:			X	CLO#8.1-7

	N/A	YES	NO	COMMENTS
6.3.4.2b. (Cont'd)				
(1) Color coding;			X	CLO#8.1-7
(2) color shading the group of annunciator controls;			X	CLO#8.1-7
(3) demarcating the group of annunciator controls; or			X	CLO#8.1-7
(4) shape coding, particularly the silence control. (See Exhibit 6.3-5, Example 2.)			X	(Location coding). CLO#8.1-7
c. NONDEFEATABLE CONTROLS — Annunciator control designs should not allow the operator to defeat the control. For example, some pushbuttons used for annunciator silencing and acknowledgement can be held down by inserting a coin in the ring around the pushbutton. This undesirable design feature should be eliminated.			X	CLO#3.1-30
6.3.4.3 ANNNUCIATOR RESPONSE PROCEDURES				
a. AVAILABILITY — Annunciator response procedures should be available in the control room.			X	CLO#3.1-13
b. INDEXING — Annunciator response procedures should be indexed by panel identification and annunciator tile coordinates.		X		
6.5.1.6 COLOR CODING				
a. REDUNDANCY — In all applications of color coding, color should provide redundant information. That is, the pertinent information should be available from some other cue in addition to color.		X		

	N/A	YES	NO	COMMENTS
6.5.1.6 (Cont'd)				
b. NUMBER OF COLORS —				
(1) The number of colors used for coding should be kept to the minimum needed for providing sufficient information.		X		
(2) The number of colors used for coding should not exceed 11.		X		
c. MEANING OF COLORS —				
(1) The meaning attached to a particular color should be narrowly defined.			X	CLO#3.1-33
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolarance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.				
d. CONSISTENCY OF MEANING				
(1) The meaning assigned to particular colors should be consistent across all applications within the control room.		X		
e. PRINCIPLES OF COLOR SELECTION				
(1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safety implications of red, green, and		X		

	N/A	YES	NO	COMMENTS
6.5.1.6e(1) (Cont'd)				
amber is to ensure that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list. The first 9 colors have been selected so as to yield satisfactory contrast for red-green-deficient as well as color-normal observers. The remaining 13 colors are useful only for color-normal observers.				
(2) Colors selected for coding should contrast well with the background on which they appear.		X		
(3) Ambient lighting in the area in which color coding is used will influence the apparent color of the coded element (especially for surface colors). Each color selected for coding should be evaluated under all illumination conditions under which it is used.		X		
6.6.6.2 DEMARCATION				
a. USE — Lines of demarcation can be used to:			X	CLO#3.1-21
(1) Enclose functionally related displays.				
(2) Enclose functionally related controls				
(3) Group related controls and displays.				

SURVEY FINDINGS AND CLOs GENERATED

TABLE 3.9

	N/A	YES	NO	COMMENTS
b. CONTRAST — Lines of demarcation should be visually distinctive from the panel background.	X			Not used.
c. PERMANENCE — Lines of demarcation should be permanently attached.	X			Not used.

3.10 Controls Survey TP-4.1

This section documents the results of the controls survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700 as specified in the D. C. Cook DCRDR program plan.

3.10.1 Objectives

The objectives of the controls survey were to:

a. Assess to what degree all controls in the control rooms conform to the criteria of NUREG-0700.

b. Identify and document any features of controls design that do not conform to the criteria of NUREG-0700.

3.10.2 Scope

The scope of the effort was to assess the controls design in the main control rooms at the D. C. Cook plant using the applicable guidelines in NUREG-0700. The control topics evaluated included:

- o General principles of control design
- o Prevention of accidental activation
- o Direction of movement
- o Coding of controls
- o Pushbutton design
- o Round pushbutton
- o Legend pushbuttons
- o Rotary controls
- o J-handle controls
- o Key-operated controls
- o Continuous adjustment rotary controls
- o Thumbwheels
- o Slide and toggle switches
- o Separation of controls

3.10.3 Criteria

The criteria applied to this survey are from NUREG-0700 paragraphs 6.4.1.1a through c and e; 6.4.1.2a through g 6.4.2.1; 6.4.2.2c, e and f; 6.4.3.1b and c; 6.4.3.2; 6.4.3.3b(1), (2), (4), (5) and 6.4.3.3d and e; 6.4.4.1a; 6.4.4.2 through 6.4.4.5; 6.4.5.1 through 6.4.5.4; 6.5.1.6a through c(2), d(3) and e; and 6.8.3.1a and b. The detailed definitions for the criteria are presented in Table 3.10.

3.10.4.1 Data Collection

a. Data were collected using the checklists contained in the controls task plan.

b. Data were collected by observations and measurements of required parameters. Operator interview replies were included in the data.

3.10.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from more than one source was contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.10.5 Findings

The findings of the controls survey are presented in Table 3.10 "Controls Survey Findings and CLOs Generated." A total of 122 criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 16 were not applicable. Seventy-six were not violated. One of the criteria violated was covered in the labels and location aids survey and was documented there. Four of the criteria violated were covered in the conventions survey and were documented there. Twenty-four CLOs were generated which covered the remaining 25 criteria violated. Those CLOs describe problems of human suitability, adequacy, economy, durability, accidental activation and direction and ease of movement.

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SURVEY FINDINGS AND CLOs GENERATED TABLE 3.10

	N/A	YES	NO	COMMENTS
6.4.1.1 GENERAL PRINCIPLES				
a. ADEQUACY —				
(1) It should provide a sufficient range of control.	X			Dependent upon verification of suitability results.
(2) It should be easily adjusted with the required level of precision.			X	CLO#4.1-8
b. ECONOMY —				
(1) There should be a good reason to require a control for the function concerned.			X	CLO#4.1-4
(2) Duplication of controls should not occur, except for a specific reason.		X		
(3) The precision and range of a control should not greatly exceed the need.		X		
(4) Selected controls should be economic of space.	X			
c. HUMAN SUITABILITY —				
(1) Each control should be recognizable in terms of its function.			X	CLO#8.1-10
(2) Each control should be of the type normally anticipated for the operation concerned. This means conforming to operator expectations, matching to other controls for the same function, and generally conforming to conventional practice.			X	CLO#4.1-5
e. DURABILITY —				
(1) Broken, chipped, or crumbled control surfaces should not ordinarily occur.			X	CLO#4.1-13, 4.1-20 and 4.1-21

Item	N/A	YES	NO	COMMENTS
6.4.1.1e. (Cont'd)				
(2) Control knobs or handles should not rotate, slip, or move loosely on their shafts.		X		
(3) No internal wear or breakage should occur which alters the "feel" or other sensory feedback of a control. Controls should not develop internal looseness, binding, or backlash.			X	CLO#4.1-6 and 4.1-7
6.4.1.2 PREVENTION OF ACCIDENTAL ACTIVATION				
a. PROPER LOCATION — Controls should be located and oriented so that the operator is not likely to strike or move them accidentally in any sequence of control movements.			X	CLO#4.1-1
b. FIXED PROTECTIVE STRUCTURES —				
(1) Controls may be recessed, shielded, or otherwise surrounded by physical barriers. (See Exhibit 6.4-1)		X		
(2) The control should be entirely contained within the envelope described by the recess or barrier.		X		
c. MOVABLE COVERS OR GUARDS —				
(1) Controls may be covered or guarded with movable (e.g., hinged) barriers. (See Exhibit 6.4-2)			X	CLO#4.1-1
(2) Safety or lock wires should not be used.			X	CLO#4.1-14
(3) When the guard is in the open position, it should not interfere with the operation of the guarded control or other adjacent controls.		X		

Item	N/A	YES	NO	COMMENTS
6.4.1.2 (Cont'd)				
d. **INTERLOCKING CONTROLS** — Controls may be provided with interlocks so that:		X		
(1) Extra movement is required (e.g., a side movement out of a detent position or a pull-to-engage clutch).		X		
(2) Prior operation of a related or locking control is required.		X		
e. **RESISTANCE TO MOVEMENT** — Controls should be provided with resistance (e.g., friction or spring-loading), so that distinct or sustained effort is required for activation.		X		
f. **SEQUENTIAL ACTIVATION** — When a strict sequential activation is necessary, controls should be provided with locks to prevent the controls from passing through a position. Further movement should require a new control action.			X	CLO#4.1-3
g. **CHOICE OF ACTION** — Rotary action controls should be used in situations where linear or pushbutton controls would be subject to inadvertent activation, and fixed protective structures are impractical or inappropriate.			X	CLO#4.1-2
6.4.2.1 DIRECTION OF MOVEMENT				
To minimize operator error, control movements should conform to the following population stereotypes (for U.S. population only):			X	CLO#4.1-9 and 4.1-16
a. **ON, START, RUN, OR OPEN** — Up, right, forward, clockwise, or pull.				
b. **OFF, STOP, CLOSE** — Down, left, backward, counterclockwise, or push.				

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.10

Item	N/A	YES	NO	COMMENTS
6.4.2.1 (Cont'd)				
c. RIGHT (AS A FUNCTION) — Clockwise or right.				
d. LEFT (AS A FUNCTION) —Counter-clockwise or left.				
e. RAISE — Up.				
f. LOWER — Down.				
g. INCREASE — Forward, up, right, or clockwise.				
h. DECREASE — Backward, down, left, or counterclockwise.				
6.4.2.2 CODING OF CONTROLS				
c. SIZE CODING				
(1) No more than three different sizes of controls should be used for discrimination by absolute size.		X		
(2) Controls used for performing the same function on different items of equipment should be the same size.		X		
(3) When knob diameter is used as a coding parameter, differences between diameters should be at least 0.5 inch.		X		
(4) When knob thickness is a coding parameter, differences between thicknesses should be at least 0.4 inch.		X		

	N/A	YES	NO	COMMENTS
6.4.2.2 (Cont'd)				
e. ROTATING KNOB SHAPE OPTIONS — Rotating knob controls for different types of control actions should be distinguishable by sight and touch and not easily confused with each other. Exhibits 6.4-4 through 6.4-6 give examples of 15 suitable knob designs developed for three major classes of knobs, each class intended for a different purpose: multiple rotation, fractional rotation, and detent positioning.		X		
f. COLOR CODING				
(1) Color coding should follow the recommendations of Guideline 6.5.1.6.		X		
(3) The color of the control should contrast with the panel background. (See Guideline 6.1.5.6.e)			X	CLO#4.1-19
6.4.3.1 PUSHBUTTON DESIGN PRINCIPLES				
b. INDICATION OF ACTIVATION — To ensure that the operator knows that a pushbutton has been pressed far enough for activation, a positive indication should be provided in the form of a snap feel, an audible click, or an integral light.		X		
c. PUSHBUTTON SURFACE — For best operation, the surface of a pushbutton should offer slip resistance, or be concave.		X		

	N/A	YES	NO	COMMENTS
6.4.3.2 ROUND PUSHBUTTONS (See Exhibit 6.4-7)				
a. Diameter (D), for fingertip operation (inches)		X		
(1) Unguarded and nonrecessed pushbuttons Minimum 0.385				
(2) Guarded or recessed pushbuttons Minimum 0.75		X		
b. Diameter (D), for thumb or heel of hand operation (inches) Minimum 0.75		X		
c. Displacement (A), for thumb or finger operation (inches) Minimum 0.125	X			No measurement taken. Operator interviews provided sufficient data. See CLO#4.1-6 and 4.1-7
d. Resistance (R), for fingertip operation (ounces) Minimum 10 Maximum 40	X			As directly above.
6.4.3.3 LEGEND PUSHBUTTONS				
b. LEGEND				
(1) The legend should be readable under ambient light conditions, with or without internal illumination.		X		
(2) The illuminated condition should be clearly recognizable under the highest predicted ambient light condition and should be at least 10% brighter than the surrounding panel.		X		

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.10

	N/A	YES	NO	COMMENTS
6.4.3.3b. (Cont'd)				
(4) The legend message should be specific, unambiguous, and concise.		X		
(5) The legend message should contain no more than three lines of lettering.			X	CLO#3.1-22
d. BARRIERS				
(1) Barriers should be used when legend pushbuttons are contiguous.			X	CLO#4.1-15
(2) Barriers should have rounded edges.		X		
e. LEGEND PUSHBUTTON DIMENSIONS — For maximum effectiveness of legend pushbutton controls, the following dimensions should be used (see Exhibit 6.4.8):				
(1) Size (S) (inches) Minimum 0.75 Maximum 1.5		X		
(2) Displacement (A) (inches) Minimum 0 (touch plate) Minimum 0.125 (all others) Maximum 0.250	X			No measurement taken. Operator interview data sufficient. See CLO#4.1-6 and 4.1-7
(3) Barrier width (B_W) (inches) Minimum 0.125		X		Pushbuttons on computer operators console are marginal.
(4) Barrier depth (B_d) (inches) Minimum 0.183 Maximum 0.250		X		
(5) Resistance (ounces) Minimum 10 (except touch plate) Maximum 40	X			No measurement taken. Operator interview data sufficient. See CLO#4.1-6 and 4.1-7.

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.10

Item	N/A	YES	NO	COMMENTS
6.4.4.1 ROTARY CONTROL DESIGN PRINCIPLES				
a. DIRECTION OF ACTIVATION —Rotary control settings should increase in value with a clockwise rotation.			X	CLO#4.1-17
6.4.4.2 J-HANDLES				
a. HIGH-TORQUE DESIGNS — J-handles should conform to dimensions as follows (see Exhibit 6.4-9): (1) Length (L) (inches) Minimum 3.75 Optimum 4.0 (2) Clearance (C) (inches) Minimum 1.0 Optimum 2.0			X	Maximum length found was 2¼". Operator interview CLO#4.1-7 covers controls that are hard to turn/use.
b. LOW-TORQUE DESIGNS — For certain purposes, smaller scale J-handles may be used. In such cases the handle proportion usually has a flattened or flared tip for finger placement, and the clearance between handle and panel surface can be less.		X		
6.4.4.3 KEY-OPERATED CONTROLS				
a. USE — Key-operated controls should be used when system requirements dictate that the function being controlled should be secured against activation by unauthorized personnel. If key-operated controls cannot be justified in terms of security, they are probably not necessary and should not be used. Key-operated switches should not be used solely as a means of shape coding.			X	CLO#4.1-12
b. TEETH: SINGLE ROW — Keys with a single row of teeth should be inserted into the lock with the teeth pointing up or forward.		X		

	N/A	YES	NO	COMMENTS
6.4.4.3 (Cont'd)				
c. TEETH: DOUBLE ROW — If keys have teeth on both edges, they should fit the lock with either side up or forward.		X		
d. ON-OFF ORIENTATION — Locks should be oriented so that the switch is OFF (or SAFE) when the key is in the vertical position.		X		
e. KEY REMOVAL — Operators should not normally be able to remove the key from the lock unless the switch is turned to the OFF or SAFE position.		X		
f. LABELING — Control positions should be labeled.			X	CLO#4.1-22
g. KEY-OPERATED CONTROL DIMENSIONS — The following dimensions should be used for key-operated controls (see Exhibit 6.4-10).				
(1) Displacement (A) (degrees) Minimum 80° Maximum 90°		X		
(2) Height (H) (inches) Minimum 0.5 Maximum 3.0		X		
(3) Resistance (inch/pounds) Minimum 1.0 Maximum 6.0	X			No measurement taken. Operator interview data supplied sufficient information. See CLO#4.1-6 and 4.1-7.
6.4.4.4 CONTINUOUS ADJUSTMENT ROTARY CONTROLS — To ensure precise control along a continuous variable, continuous adjustment rotary controls are appropriate.		X		
a. KNOBS — Knobs for continuous adjustment controls should be round in shape, with knurled or serrated edges.		X		

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.10

	N/A	YES	NO	COMMENTS
6.4.4.4 (Cont'd)				
b. POSITION INDICATION — When an indication of position is desirable, the pointer configurations shown in Exhibit 6.4-11 may be used. Where more accuracy is required, a line should be engraved (and filled with contrasting pigment) both on top and down the side of the pointer, as shown on the knob at the bottom of the exhibit.		X		
c. DIMENSIONS				
(1) Fingertip grasp knobs should conform to the following dimensions:				
(a) Height (inches) Minimum 0.5 Maximum 1.0		X		
(b) Diameter (inches) Minimum 0.375 Maximum 4.0		X		
(2) Thumb and forefinger encircled knobs should conform to the following dimensions: Diameter (inches) Minimum 1.0 Maximum 3.0		X		
d. TORQUE — Knob torque should be within the range of 4.5 to 6.0 inch/ounces.	X			No measurement taken. Operator interviews supplied sufficient information. See CLO#4.1-6 and 4.1-7.
e. CONTINUOUS ADJUSTMENT ROTARY CONTROLS WITH KNOB SKIRTS — If knob skirts are used, such controls should conform to approximately the following dimensions. See Exhibit 6.4-12.	X			There are none.
(1) Skirt diameter (D_S): 2.0 inches.				
(2) Skirt height (H_S): 0.25 inch.				

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.10

	N/A	YES	NO	COMMENTS
6.4.4.4e. (Cont'd)				
(3) Finger stop diameter (D_F): 1.25 inches.	X			There are none.
(4) Finger stop height (H_F) plus rotary knob height (H_K): total 0.75 inch.				
(5) Knob diameter (D_K): 0.75 inch.				
6.4.4.5 ROTARY SELECTOR CONTROLS				
a. SELECTION — Rotary selector controls should be used when three or more detented positions are required, and may be used for two-detented position operation.			X	CLO#4.1-11
b. POSITIONING				
(1) To ensure proper positioning of a discrete rotary control, detents should be provided at each control position.		X		
(2) It should not be possible to position a control between detented positions.		X		
(3) A maximum of 24 positions should be used on a rotary selector control.		X		
(4) To minimize the possibility of placing a rotary selector control in an unused position, stops should be provided at the limits of the control range.		X		
c. READABILITY — To maximize readability, rotary controls should have a moving pointer and fixed position settings.			X	CLO# 4.1-18

	N/A	YES	NO	COMMENTS
6.4.4.5 (Cont'd)				
d. POSITION INDICATION				
(1) Position indication should be provided. Desirable alternatives are: (a) Illuminated indicator lights, (b) A line engraved both on the top of the knob and down the side, or (c) A pointer shape.		X		
(2) It should not be possible to confuse the position of the knob in reference to position markers on the panel. To minimize the problem of parallax, pointers on knobs should be mounted close to the settings to which they point.			X	CLO#6.1-58
e. DIMENSIONS — Recommended dimensions for rotary selector switches are as follows (see Exhibit 6.4-13):				
(1) Length (L) (inches) Minimum 1.0		X		
(2) Width (W) (inches) Maximum 1.0		X		
(3) Diameter (D) (inches) Minimum 1.0			X	Many thumb rotaries are 3/4" or 13/16". CLO#4.1-24
(4) Depth (H) (inches) Minimum 0.625			X	CLO#4.1-24
(5) Resistance (inch/pounds) Minimum 1.0 Maximum 6.0		X		

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.10

	N/A	YES	NO	COMMENTS
6.4.4.5 (Cont'd)				
f. MOMENTARY CONTACT ROTARY SELECTOR CONTROLS — Knobs for spring-loaded momentary contact rotary selector controls should be large enough to be easily held against the spring torque, without fatigue, for as long as necessary to accomplish the control action.		X		
6.4.5.1 THUMBWHEELS				
a. VISIBILITY — To minimize error, thumbwheel readouts should be visible from the thumbwheel operating position.		X		
b. CODING — If the thumbwheel is used as an input device, the OFF, zero, or normal position should be coded to facilitate visual recognition of status.			X	CLO#4.1-23
c. CONTINUOUS ADJUSTMENT THUMBWHEELS — The dimensions of thumbwheel controls which permit continuous adjustment (not stepped or detented) should be as follows:				
(1) At least 1 inch of the wheel should be exposed to permit easy manipulation.		X		
(2) Resistance should be between 3 and 6 ounces.	X			No measurement taken. Operator information sufficient. See CLO#4.1-6 and 4.1-7
(3) If the thumbwheel has an OFF position, a detent should be provided for feedback at that point.		X		

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.10

	N/A	YES	NO	COMMENTS
6.4.5.1 (Cont'd)				
d. DISCRETE SETTING (STEPPED) THUMBWHEELS				
(1) Thumbwheel controls which have discrete settings should be detented between positions. The control should snap into each position, and resist intermediate or uncertain settings.		X		
(2) Discrete thumbwheel controls should conform to the following specifications. (See Exhibit 6.4-14)				
(a) Diameter (D) (inches) Minimum 1.5 Maximum 2.5			X	CLO#4.1-24
(b) Trough distance (L) (inches) Minimum 0.45 Maximum 0.75			X	CLO#4.1-24
(c) Width (W) (inches) Minimum 0.1		X		
(d) Depth (H) (inches) Minimum 0.125 Maximum 0.5		X		
(e) Resistance (ounces) Minimum 6 Maximum 20		X		
6.4.5.2 SLIDE SWITCHES				
a. SURFACE — The surface of slide switches should be serrated or knurled.		X		
b. DIMENSIONS — Slide switches should conform to approximately the following dimensions. See Exhibit 6.4-15.				
(1) Thickness (T): 0.25 inch.		X		

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.10

	N/A	YES	NO	COMMENTS
6.4.5.2b (Cont'd)				
(2) Length (L): 1.0 inch.		X		
6.4.5.3 TOGGLE SWITCHES				
a. POSITIONING — To minimize the possibility of inadvertent activation or setting between control positions, toggle switches should have an elastic resistance that increases as the control is moved and drops as the switch snaps into position.		X		
b. FEEDBACK — Toggle switches should emit an audible click, or provide some other source of feedback on activation.		X		
c. DIMENSIONS — To ensure the most effective use, toggle switches should conform to the following dimensions. See Exhibit 6.4-16.				
(1) Arm length (L), for use by one finger (inches) Minimum 0.5 Maximum 2.0		X		
(2) Tip diameter (D) (inches) Minimum 0.125 Maximum 1.0		X		
(3) Resistance (small switch) (ounces) Minimum 10 Maximum 16		X		
(4) Resistance (large switch) (ounces) Minimum 10 Maximum 40		X		
(5) Displacement (A), two position (degrees) Minimum 30 Maximum 120		X		

Item	N/A	YES	NO	COMMENTS
6.4.5.3c (Cont'd)				
(6) Displacement (A), three position (degrees between settings) Minimum 18 Maximum 60 Optimum 25		X		
6.4.5.4 ROCKER SWITCHES				
a. ORIENTATION — Rocker switches should ordinarily be oriented vertically.	X			There are no rocker switches
(1) Activation of the upper part should control the ON or INCREASE function.				
(2) Horizontal orientation should be used only when the location of the controlled function or equipment requires it.				
b. INDICATION OF ACTIVATION	X			
(1) Activation should be indicated by a snap feel, an audible click, or an integral light.				
(2) In the ON position, the top of the switch should be flush with the panel surface.				
c. RESISTANCE	X			
(1) Control resistance should gradually increase, then drop to zero when the control snaps into position.				
(2) This resistance should preclude the switch being placed between positions.				
d. INADVERTENT ACTIVATION — If it controls a critical function, the switch should be protected by channel guards or other means to prevent inadvertent activation.	X			

	N/A	YES	NO	COMMENTS
6.4.5.4 (Cont'd)				
e. ROCKER SWITCH DIMENSIONS — (see Exhibit 6.4-17):	X			
(1) Width (W) (inches) Minimum 0.75 Maximum 1.5				
(2) Resistance (ounces) Minimum 10 Maximum 40				
(3) Displacement, two-position switches (A) (degrees) Minimum 30 Maximum 120				
(4) Displacement, three-position switches (A) (degrees) Minimum 18 Maximum 60 Optimum 25				
6.5.1.6 COLOR CODING				
a. REDUNDANCY — In all applications of color coding, color should provide redundant information. That is, the pertinent information should be available from some other cue in addition to color.		X		
b. NUMBER OF COLORS				
(1) The number of colors used for coding should be kept to the minimum needed for providing sufficient information.		X		
(2) The number of colors used for coding should not exceed 11.		X		

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.10

	N/A	YES	NO	COMMENTS
6.5.1.6 (Cont'd)				
c. MEANING OF COLORS				
(1) The meaning attached to a particular color should be narrowly defined.			X	CLO#8.1-11
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.			X	CLO#8.1-10
d. CONSISTENCY OF MEANING				
(3) The meaning of a particular color should remain the same both within and among the various systems to which it is applied.			X	CLO#8.1-9
e. PRINCIPLES OF COLOR SELECTION				
(1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safey implications of red, green, and amber is to ensure that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list.		X		

Item	N/A	YES	NO	COMMENTS
6.5.1.6 (Cont'd)				
c. MEANING OF COLORS				
(1) The meaning attached to a particular color should be narrowly defined.			X	CLO#8.1-11
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.			X	CLO#8.1-10
d. CONSISTENCY OF MEANING				
(3) The meaning of a particular color should remain the same both within and among the various systems to which it is applied.			X	CLO#8.1-9
e. PRINCIPLES OF COLOR SELECTION				
(1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safey implications of red, green, and amber is to ensure that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list.		X		

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.10

	N/A	YES	NO	COMMENTS
6.5.1.6 (Cont'd)				
c. MEANING OF COLORS				
(1) The meaning attached to a particular color should be narrowly defined.			X	CLO#8.1-11
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.			X	CLO#8.1-10
d. CONSISTENCY OF MEANING				
(3) The meaning of a particular color should remain the same both within and among the various systems to which it is applied.			X	CLO#8.1-9
e. PRINCIPLES OF COLOR SELECTION				
(1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safey implications of red, green, and amber is to ensure that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list.		X		

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.10

	N/A	YES	NO	COMMENTS
6.5.1.6 (Cont'd)				
c. MEANING OF COLORS				
(1) The meaning attached to a particular color should be narrowly defined.			X	CLO#8.1-11
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.			X	CLO#8.1-10
d. CONSISTENCY OF MEANING				
(3) The meaning of a particular color should remain the same both within and among the various systems to which it is applied.			X	CLO#8.1-9
e. PRINCIPLES OF COLOR SELECTION				
(1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safey implications of red, green, and amber is to ensure that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list.		X		

	N/A	YES	NO	COMMENTS
6.5.1.6e(1) (Cont'd) The first 9 colors have been selected so as to yield satisfactory contrast for red-green-deficient as well as color-normal observers. The remaining 13 colors are useful only for color-normal observers.				
(2) Colors selected for coding should contrast well with the background on which they appear.		X		
(3) Ambient lighting in the area in which color coding is used will influence the apparent color of the coded element (especially for surface colors). Each color selected for coding should be evaluated under all illumination conditions under which it is used.		X		
6.8.3.1 SEPARATION OF CONTROLS Recommended minimum control separation distances are shown in Exhibits 6.8-2 and 6.8-3. In most cases, control room operations will require greater separation. The function requirements that should be considered are:				
a. ACCESS — Control access should not be impeded by any position of an adjacent control.		X		
b. INADVERTENT ACTUATION — Control actuation should not result in advertent actuation of an adjacent control.		X		

3.11 Displays Survey TP-5.1

This section documents the results of the displays survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.11.1 Objectives

The objectives of the displays survey were to:

a. Assess to what degree all displays in the control rooms confirm to the criteria in NUREG-0700.

b. Identify and document any features of the displays that do not conform to the criteria in NUREG-0700.

3.11.2 Scope

The scope of the survey was to assess the display designs in the main control rooms at the D. C. Cook plant using the applicable guidelines of NUREG-0700. The display topics evaluated were:

- Information to be displayed
- Usability of display values
- Readability
- Printing on the display face
- Scale markings
- Coding
- Display movement
- Scale pointers
- Zone marking
- Light indicators
- Light legends design
- Recorders design
- Counters design

3.11.3 Criteria

The criteria applied to this survey, identified by NUREG-0700 paragraph numbers are: paragraphs 6.5.1.1f; 6.5.1.2d and e; 6.5.1.3a through c(1) and d; 6.5.1.4a through f; 6.5.1.5a through c and e and f; 6.5.1.6a through c and e; 6.5.2.1 through 6.5.2.5; 6.5.3.1a through c(1) and d; 6.5.3.2a(1), a(3) and b; 6.5.3.3.a and b; 6.5.4.1a through d and g through k; 6.5.4.2; 6.5.5.1; and 6.5.5.2. The detailed definitions for the criteria are presented in Table 3.11.

3.11.4.1 Data Collection

a. Data were collected using the checklists contained in the displays survey task plan.

b. Data were collected primarily through direct observation and operator interviews. Where guidelines referred to consistency with operating procedures, preliminary DOPs were reviewed.

3.11.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data form two or more sources were contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.11.5 Findings

The findings of the display survey are presented in Table 3.11 "Display Survey Findings and CLOs Generated". A total of 104 criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 1 was not applicable and 48 were not violated. Two of the criteria violated were covered in the convention survey and were documented there. One of the violated criteria was covered in the labels and location aids survey and was documented there. Fifty-four CLOs were generated which covered the 52 violated criteria. Three CLOs were later deleted and their information was combined with others in this survey. The CLOs address display information, readability, printing on the display face, scale markings, consistency of measurings, zone markings and legend indicator light engravings.

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	N/A	YES	NO	COMMENTS
6.5.1.1 INFORMATION TO BE DISPLAYED				
f. DISPLAY FAILURE — When panel instruments, such as meters, fail or become inoperative, the failure should be apparent to the operator (e.g., through off-scale indication).			X	CLO#5.1-4
6.5.1.2 USABILITY OF DISLAYED VALUES				
d. SCALE RANGE — Scales should be selected to:				
(1) Span the expected range of operational parameters, or			X	CLO#5.1-2
(2) Employ appropriate scale ranging techniques, or				
(3) Be supported by auxiliary wide-range instruments.			X	CLO#5.1-3
e. SCALE SIZE — Scale ranges may be expanded (or contracted) by multiplying or dividing indicated scale values by powers of ten. All such scales should be clearly marked as to whether the indicated values should be multiplied or divided, and the factor involved (e.g., 10, 100, 1000).			X	CLO#5.1-21, 5.1-22, and 5.1-49
6.5.1.3 READABILITY				
a. CHARACTER HEIGHT — Character height should subtend a minimum visual angle of 15 minutes, or 0.004 x viewing distance. The preferred visual angle is 20 minutes, or 0.006 x viewing distances.		X		Adequate for viewing distance.
b. TYPE STYLE — Exhibits 6.5-1 and 6.5-2 present two recommended sets of characters. Character size and style should meet the following:				
(1) Type styles should be simple.		X		
(2) Type styles should be consistent.		X		

	N/A	YES	NO	COMMENTS
6.5.1.3b (Cont'd)				
(3) Only upper-case letters should be used.		X		
c. CONTRAST — Highest contrast is provided by black and white.				
(1) Visual displays should normally contain black markings on a white background.			X	CLO#5.1-15, 5.1-33 and 5.1-52
(2) The use of color should be consistent with the recommendations of Guideline 6.5.1.6. Color combinations should be selected to provide good contrast.		X		
d. CHARACTER DIMENSIONS AND SPACING —				Adequate for viewing distance.
(1) Stroke-width-to-character-height ratios should be between 1:6 and 1:8.		X		
(2) Letter width-to-height ratios should be between 1:1 and 3:5.		X		
(3) Numeral width-to-height ratios should be 3:5.		X		
(4) Minimum space between characters should be one stroke width.		X		
(5) Minimum space between words should be the width of one character.		X		
(6) Minimum space between lines should be one-half the character height.		X		
6.5.1.4 PRINTING ON THE DISPLAY FACE				
a. PROVISION OF NEEDED MESSAGE — If any information is required to use the display, it must be provided close enough to the scale so that the scale and the message are clearly associated. The message may be communicated:		X		

	N/A	YES	NO	COMMENTS
6.5.1.4 (Cont'd)				
(1) By printing on the display face.				
(2) By an appropriate label adjacent to the display.				
b. AVOIDANCE OF EXTRANEOUS ITEMS — Categories of information not needed in using the display should be avoided (e.g., patent notices, manufacturer's trademark or address).		X		Many maufacturers names do appear, but do not detract from the readability of the displays.
c. BREVITY — To avoid distraction and interference with the needed essential markings, messages should be written as briefly as clarity permits.			X	CLO#5.1-50
d. ABBREVIATIONS — Only standard and commonly accepted abbreviations should be used.			X	CLO#5.1-50
e. CONSISTENCY WITH PROCEDURES — The printed message should use the same terms as the procedures in display identification, parameter identification, and units displayed.			X	CLO#5.1-50
f. INDICATION OF TRANSFORMATIONS NEEDED — Where necessary to multiply or divide the displayed readings by powers of 10 to determine quantitative value, the operation required and result derived must be clearly indicated.			X	CLO#5.1-41 and 5.1-49
6.5.1.5 SCALE MARKINGS				
a. USE OF GRADUATIONS — Scales for quantitative reading should be provided with graduations consistent with the progression of their numerals.				
(1) No more than 9 graduations should separate numerals.			X	CLO#5.1-26
(2) Major and minor graduations should be used if there are up to four graduations between numerals.		X		

6.5.1.5 (Cont'd)

(3) Major, intermediate, and minor graduation should be used if there are five or more graduations between numerals.

N/A	YES	NO	COMMENTS
		X	CLO#5.1-38

b. GRADUATION HEIGHT — Graduation heights as a function of viewing distance should be:

VIEWING DISTANCE (feet)	INDEX HEIGHT (inches) MAJOR	INTERMEDIATE	MINOR
1½ or less	0.22	0.16	0.09
3 or less	0.40	0.28	0.17
6 or less	0.78	0.56	0.34
12 or less	1.57	1.12	0.65
20 or less	2.63	1.87	1.13

N/A	YES	NO	COMMENTS
		X	Guideline is inappropriate for most of the displays used. It fails to take into account stroke width of scale marks. Greater stroke width permits shorter scale markings. No CLO necessary.

c. VALUES INDICATED BY UNIT GRADUATIONS — Successive values indicated by unit graduations should be one of those shown below or those values multiplied by some power of 10.

GOOD					FAIR				
1	2	3	4	5	2	4	6	8	10
5	10	15	20	25	20	40	60	80	100
10	20	30	40	50					

N/A	YES	NO	COMMENTS
		X	CLO#5.1-45

e. LINEAR VS LOGARITHMIC SCALES — Logarithmic scales should be avoided unless needed to display a large range of values.

N/A	YES	NO	COMMENTS
X			

f. MULTISCALE INDICATORS — Multiscale indicators (i.e., single pointer, multiple scales) should be avoided unless they can be justified as of operational benefit, and precautions are taken to avoid operator confusion.

N/A	YES	NO	COMMENTS
		X	CLO#5.1-5

Item	N/A	YES	NO	COMMENTS
6.5.1.6 COLOR CODING				
a. REDUNDANCY — In all applications of color coding, color should provide redundant information. That is, the pertinent information should be available from some other cue in addition to color.		X		
b. NUMBER OF COLORS —				
(1) The number of colors used for coding should be kept to the minimum needed for providing sufficient information.		X		
(2) The number of colors used for coding should not exceed 11.		X		
c. MEANING OF COLORS				
(1) The meaning attached to a particular color should be narrowly defined.			X	Covered in conventions task plan. CLO#8.1-11
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value of parameter exists..			X	CLO#5.1-44
d. CONSISTENCY OF MEANING				
(1) The meaning assigned to particular colors should be consistent across all applications within the control room.			X	Covered in conventions task plan. CLO#8.1-9

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.11

Item	N/A	YES	NO	COMMENTS
e. PRINCIPLES OF COLOR SELECTION				
(1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safety implications of red, green, and amber is to ensure that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list. The first 9 colors have been selected so as to yield satisfactory contrast for red-green-deficient as well as color-normal observers. The remaining 13 colors are useful only for color-normal observers.			X	CLO#5.1-31
(2) Colors selected for coding should contrast well with the background on which they appear.		X		
(3) Ambient lighting in the area in which color coding is used will influence the apparent color of the coded element (especially for surface colors). Each color selected for coding should be evaluated under all illumination conditions under which it is used.			X	CLO#5.1-31
6.5.2.1 DIRECTIONALITY OF MOVEMENT AND NUMBERING WITH FIXED-SCALE AND MOVING-POINTER METERS				
a. CIRCULAR SCALES — Scale values should increase with clockwise movement of the pointer as in Exhibit 6.5-8.		X		
b. VERTICAL STRAIGHT SCALES — Scale values should increase with upward movement of the pointer as in Exhibit 6.5-9.			X	CLO#5.1-27 and 5.1-51

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.11

	N/A	YES	NO	COMMENTS
c. **HORIZONTAL STRAIGHT SCALES** — Scale values should increase with pointer movement to the right as in Exhibit 6.5-10.		X		
6.5.2.2 POINTERS				
a. **POINTER TIP FORM** —				
(1) Pointer tips should be simple. Examples of preferred and non-preferred types are given in Exhibit 6.5-11.			X	CLO#5.1-28
(2) Pointer tips should be selected to minimize concealment of scale graduation marks or numerals. (See Exhibit 6.5-8)			X	CLO#5.1-43
b. **POINTER POSITIONING RELATIVE TO SCALE** —				
(1) Pointer tip should extend to within about 1/16 inch of (but not overlap) the smallest graduation marks on the scale. (See Exhibits 6.5-8, -9,-10.)			X	CLO#5.1-39
(2) Pointers should be mounted to avoid parallax errors.		X		
c. **POINTER VISIBILITY** — Pointer/background contrast and pointer size should be adequate to permit rapid recognition of pointer position.			X	CLO#5.1-7 and 5.1-40
6.5.2.3 ZONE MARKING (Exhibit 6.5-12)				
a. Zone markings should be conspicuous and distinctively different for different zones.			X	CLO#5.1-6, 5.1-29, 5.1-46 and 5.1-47
b. Zone marking should not interfere with reading of quantitative markings.			X	CLO#5.1-30
c. If color is used for coding, color should be related to meaning as given in Guideline 6.5.1.6.c.			X	CLO#5.1-44

	N/A	YES	NO	COMMENTS
6.5.2.4 ORIENTATION OF MARKINGS ON FIXED-SCALE METERS				
a. **NUMERAL ORIENTATION** —Individual numerals on any type of fixed scale should be vertical (see Exhibit 6.5-13). This holds true for circular as well as linear scales.			X	CLO#5.1-51
b. **ZERO-POINT ORIENTATION** —				
(1) Where pointer movement is more than 360°, the zero point should be located at the 12 o'clock position.		X		
(2) Where positive and negative values are displayed around a zero or null position, the zero or null point should be located at the 12 o'clock position.		X		
c. **END-POINT INDICATION ON PARTIAL-REVOLUTION SCALES** —				
(1) Where the scale covers less than a full rotation of the pointer, scale end-points should be indicated by a break in scale (see Exhibit 6.5-13).		X		
(2) The break should be at least one numbered interval in length.		X		
(3) The break should be oriented at the 6 o'clock position.		X		
6.5.2.5 MOVING-SCALE METERS				
Moving-scale fixed-pointer meters are infrequently seen in nuclear power plant control rooms. They should be avoided in favor of the more effective fixed-scale moving-pointer types.			X	CLO#5.1-32

	N/A	YES	NO	COMMENTS
6.5.3.1 CHARACTERISTICS AND PROBLEMS OF LIGHT INDICATORS				
b. **PRECAUTIONS TO ASSURE UNAMBIGUOUS SENSING BY OPERATORS** — Lights should not appear to be glowing when in fact they are off, or vice versa. To that end, ambient light sources should be selected, located, or controlled to avoid reflections or refractions. (See Guideline 6.1.5.3.)			X	CLO#5.1-53
c. **PRECAUTIONS TO AVOID MISINTERPRETATION** —				
(1) System/equipment status should be inferred by illuminated indicators, and never by the absence of illumination.			X	CLO#5.1-1
d. **USE AS ALERTING INDICATORS** — Alerting the operator to unfavorable status should be a function of the annunciator system and not assigned to light indicators.			X	CLO#5.1-54
6.5.3.2 DESIGN AND USE OF NONLEGEND LIGHT INDICATORS				
a. **IDENTIFICATION OF MEANING** —				
(1) Where meaning is not apparent, labeling must be provided close to the light indicator showing the message intended by its glowing.			X	CLO#5.1-17
(3) The color of the light should be clearly identifiable.		X		
b. **LIGHT INTENSITY** — The illuminated indicator should be at least 10% greater in light intensity than the surrounding panel (as measured by a spot photometer).			X	CLO#5.1-53

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.11

	N/A	YES	NO	COMMENTS
6.5.3.3 DESIGN AND USE OF LEGEND LIGHT INDICATORS				
a. VISIBILITY FACTORS —				
(1) Light intensity of the illuminated indicators should be at least 10% greater than the surrounding panel (as measured by a spot photometer).		X		
(2) Legends should be legible under ambient illumination with indicator lights off.			X	CLO#5.1-24
(3) Legend lettering should contrast well with background under both ambient and transilluminated lighting.			X	CLO#5.1-24
b. LEGEND DESIGN				
(1) General legend design should be consistent throughout the control room.		X		
(2) Lettering should be simple, and should follow Guideline 6.5.1.3 for style and size.			X	CLO#5.1-18
(3) Symbolic legends should be clear and unambiguous as to their meaning.			X	CLO#5.1-19
(4) Text should be short, concise, and unambiguous.		X		
(5) Legend messages should contain no more than three lines of text.			X	CLO#5.1-20
(6) Nomenclature and abbreviations should be standard, and consistent with usage throughout the control room and in the procedures.			X	CLO#5.1-48
(7) Legends should be worded to tell the status indicated by glowing of the light.		X		

Guideline	N/A	YES	NO	COMMENTS
6.5.4.1 GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS				
a. **QUALITY OF EXPENDABLE MATERIALS** — Pens, inks, and paper should be of a quality to provide clear, distinct, and reliable marking. For example, ink should not clog pens or smudge on the paper.			X	CLO#5.1-11
b. **SCALE COMPATIBILITY** — Scales printed on the recording paper should be the same as the scales shown on the recorder.			X	CLO#5.1-34
c. **SCALE DESIGN** — Recorder scales should be numbered and marked according to the general principles of scale graduation (Guideline 6.5.1.5), with number style and dimensions according to Guidelines 6.5.1.3 and 6.5.1.4.			X	CLO#5.1-38, 5.1-45 and 5.1-49
d. **PAPER TAKEUP AND CUTOFF** — A takeup spool should be provided to receive completed recordings. On most instruments this is provided as an inherent part of the design. Also, means should be provided for tearing off completed records for storage.			X	CLO#5.1-14
g. **USE** — As a general rule, recorders should be used to record trend information and material which may be needed for later reference.		X		
h. **PLACEMENT OF RECORDERS** — As devices which must be verified and attended by the operator, graphic recorders should in principle be located within the primary operating area rather than on back panels.			X	CLO#5.1-8
i. **PAPER-SPEED ADJUSTABILITY** — Not only should high paper speed option be provided to run out records for detachment, but a selection of lower speeds should be available to permit adjustment of the time scale so that rate-of-change information can be indicated.			X	CLO#5.1-9

	N/A	YES	NO	COMMENTS
6.5.4.1 (Cont'd)				
j. ANNOTATION — It should be convenient to annotate recordings with date and time markings, with paper speed if varied from normal, with parameter identification, or with any other relevant information.		X		
k. VISIBILITY — Recorder design should ensure that all data will be visible through the window of the recorder and not require open-door operation to expose it.			X	CLO#5.1-10
6.5.4.2 SPECIFIC RECORDER TYPES				
a. CONTINUOUS RECORDERS —				
(1) LABELING — Labels should identify the parameters recorded. With multiple-pen recorders, parameters should be listed in the order of the associated scales on the recorder.			X	CLO#6.1-1
(2) INK COLORS — Each pen should use a different colored ink to permit channel identification from line color. Colors selected should be distinctively different and should afford good contrast with the paper.		X		
b. DISCRETE RECORDERS —				
(1) CHANNEL OVERLOAD — The recorder should not be loaded beyond its designed channel capacity because this adds complexity to the analysis and prolongs sampling cycle time.			X	CLO#5.1-12
(2) CHANNEL IDENTIFICATION ON INSTRUMENT — Discrete recorders should be equipped to display in an easily viewed manner the channel being plotted. Viewing from odd and inconvenient angles should not be imposed.			X	CLO#5.1-52

Item	N/A	YES	NO	COMMENTS
6.5.4.2b (Cont'd)				
(3) CHANNEL IDENTIFICATION ON RECORDING — Number-printing mechanism should be designed and maintained to provide clear, sharp, and small numbering to avoid crowding of data and consequent analysis problems.		X		
(4) CHANNEL SELECTION CAPABILITY — Provision should be made to select any single channel for immediate display without awaiting completion of a sampling cycle.			X	CLO#5.1-13
6.5.5.1 DRUM-TYPE COUNTERS				
a. NUMERICAL PRESENTATION FACTORS —				
(1) ORIENTATION — Multidigit numbers formed by several counter drums should be read horizontally from left to right (see Exhibit 6.5-14).		X		
(2) WIDTH-HEIGHT RATIO — To compensate for the distortion imposed by the curved surface of the drum, counter numerals should reflect a width-height ratio of 1:1, not 3:5 as recommended for numerals and other displays.		X		Appears OK.
(3) GROUPING OF NUMERALS — If more than four digits are required, they should be grouped and the groupings separated as appropriate by commas, by a decimal point, or by additional space (see Exhibit 6.5-15).			X	CLO#5.1-42
(4) CONTRAST — The color of the numerals and of the background should be chosen to yield high contrast. Black numerals on white drum surface is recommended.			X	CLO#5.1-35

	N/A	YES	NO	COMMENTS
6.5.5.1a (Cont'd)				
(5) DRUM FINISH — The surface of the drums and surrounding areas should have a matte finish to minimize glare.		X		
b. MOUNTING —				
(1) Drum-type counters are clearly readable only within a viewing angle that is more restrictive than for most displays. Accordingly, they should be mounted perpendicular to the operator's line of sight.			X	CLO#5.1-36
(2) Counters should be mounted as close as possible to the panel surface to minimize shadows and maximize viewing angle.		X		
(3) The window should be sized to allow no more than one digit per drum to appear in the window at any one time.		X		
c. DRUM MOVEMENT —				
(1) Numbers should change by snap action rather than through continuous movement.		X		
(2) The counter drums should move upward with increasing values.		X		
6.5.5.2 ELECTRONIC COUNTERS				
a. NUMERICAL PRESENTATION FACTORS —				
(1) ORIENTATION — Multidigit counters should be oriented to read horizontally from left to right.		X		

	N/A	YES	NO	COMMENTS
6.5.5.2a (Cont'd)				
(2) CHARACTER STYLE — Simple character fonts should be used. Styles using variable stroke widths, slanted characters, etc., should be avoided.			X	CLO#5.1-37
(3) NUMERAL HEIGHT — Numerals should be of such a height as to subtend a visual angle of 15 minutes from the farthest anticipated viewing distance.		X		
(4) WIDTH-TO-HEIGHT RATIO — Width-to-heigh ratio of numerals should be approximately 3:5.		X		
(5) SPACING — Horizontal spacing between numerals should be between one-quarter and one-half the numeral width.		X		
b. RATE OF CHANGE — Numerals should not follow each other faster than two per second when the operator is expected to read the numerals consecutively.		X		
c. CONTRAST — Character-to-background contrast ratio should be between 15:1 minimum and 20:1 preferred.		X		

3.12 Labels and Location Aids Survey TP-6.1

This section documents the results of the labels and location aids survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.12.1 Objectives

The objectives of the labels and location aids survey were to:

a. Examine the readability and usability of the labeling in the control rooms according to NUREG-0700 criteria.

b. Assess the design and use of location aids in the control rooms according to NUREG-0700 criteria.

c. Identify and document any cases where labels and location aids do not conform to the criteria of NUREG-0700.

3.12.2 Scope

The scope of this survey was to assess the labels and location aids in the control rooms at the D. C. Cook plant using the applicable guidelines of NUREG-0700. The topics evaluated were:

- Arrangement of visual alarm tiles
- Color coding of labels
- Need for labels
- Hierarchical labeling
- Placement of labels
- Mounting of labels
- Spatial orientation of labels
- Label visibility
- Label content
- Word selection
- Consistency
- Symbols
- Control position labeling
- Readability
- Temporary labels
- Demarcation
- Mimics

3.12.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph number are: paragraphs 6.3.3.3c(3); 6.5.1.6; 6.6.1.1; 6.6.1.2; 6.6.2.1 through 6.6.2.4; 6.6.3.1; 6.6.3.2; 6.6.3.3b and c; 6.6.3.4 through 6.6.3.9; 6.6.4.1; 6.6.4.2; 6.6.5.1; 6.6.5.2; 6.6.6.2; 6.6.6.3; 6.6.6.4a and b; and 6.8.3.2d. The detailed definitions for the criteria are presented in Table 3.12.

3.12.4.1 Data Collection

a. Data were collected using the checklists contained in the labels and location aids task plan.

b. Data were collected primarily through direct observation and operator interviews, measurements and documentation reviews were conducted where necessary.

3.12.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory, resolution of the conflict was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.12.5 Findings

The findings of the labels and location aids survey are presented in Table 3.12 "Labels and Location Aids Survey Findings and CLOs Generated." A total of 104 criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 5 were not applicable and 20 were not violated. Three of the criteria violated were also covered in the conventions survey and were documented there. Seventy-one CLOs were generated which cover the other 76 criteria violated. In general, those CLO address labels need, placement of labels, hierarchical scheme, word selection, symbols, control position labels, readability, temporary labels and mimic labels and lines.

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	N/A	YES	NO	COMMENTS
6.3.3.3 ARRANGEMENT OF VISUAL ALARM TILES				
c. LABELING OF AXES				
(3) Letter height for coordinate designation should be consistent with a subtended visual angle of at least 15 minutes as viewed from a central position within the primary operating area.	X			There is no coordinate designation.
6.5.1.6 COLOR CODING				
a. REDUNDANCY — In all applications of color coding, color should provide redundant information. That is, the pertinent information should be available from some other cue in addition to color.			X	E.g., Red and blue labels on FLX panel recorders (1-56-013 and 1-56-014). Also, red labels indicate labels that refer to train A and green that refers to train B. CLO#8.1-8
b. NUMBER OF COLORS				
(1) The number of colors used for coding should be kept to the minimum needed for providing sufficient information.		X		
(2) The number of colors used for coding should not exceed 11.		X		
c. MEANING OF COLORS				
(1) The meaning attached to a particular color should be narrowly defined.			X	CLO#6.1-5

	N/A	YES	NO	COMMENTS
6.5.1.6c. (CONT'D)				
(2) Red, green, amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.			X	CLO#6.1-5
d. CONSISTENCY OF MEANING				
(2) The meaning of a particular color should remain the same whether applied to panel surfaces or projected in signal lights or on CRTs.			X	Covered in Conventions Task Plan. CLO#8.1-9

	N/A	YES	NO	COMMENTS
6.5.1.6c. (CONT'D)				
e. PRINCIPLES OF COLOR SELECTION				
(1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safety implications of red, green, and amber is to ensure that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list. The first 9 colors have been selected so as to yield saftis-factory contrast for red-green-deficient as well as color-normal observers. The remaining 13 colors are useful only for color-normal observers.			X	Covered in Conventions Task Plan. CLO#8.1-11
(2) Colors selected for coding should contrast well with the background on which they appear.		X		
(3) Ambient lighting in the area in which color coding is used will influence the apparent color of the coded element (especially for surface colors). Each color selected for coding should be evaluated under all illumination conditions under which it is used.		X		
6.6.1.1 NEED FOR LABELING				
Controls, displays, and other equipment items that must be located, identified, or manipulated should be appropriately and clearly labeled to permit rapid and accurate human performance.			X	CLO#6.1-1, 6.1-8, 6.1-9, 6.1-10, 6.1-44, 6.1-51, 6.1-62 and 6.1-64

Item	N/A	YES	NO	COMMENTS
6.6.1.2 HIERARCHICAL SCHEME				
To reduce confusion, operator search time, and redundancy, a hierarchical labeling scheme should be used. (See Exhibit 6.6-1.)				
a. RANKING				
(1) Major labels should be used to identify major systems or operator work stations.			X	CLO#6.1-11
(2) Subordinate labels should be used to identify subsystems or functional groups.			X	CLO#6.1-12
(3) Component labels should be used to identify each discrete panel or console element.			X	CLO#6.1-49
(4) Labels should not repeat information contained in higher-level labels.			X	CLO#6.1-52
b. LETTER GRADATIONS — Labels should be graduated in letter size such that:			X	CLO#6.1-13
(1) System/work station labels are about 25% larger than				
(2) Subsystem/functional group labels which are about 25% larger than				
(3) Component labels which are about 25% larger than				
(4) Control position identifiers.				
6.6.2.1 PLACEMENT				
a. NORMAL PLACEMENT — Labels should be placed above the panel element(s) they describe.			X	CLO#6.1-14

	N/A	YES	NO	COMMENTS
6.6.2.1 (CONT'D)				
b. PANEL LABELING — The placement of labels on control panels should conform to the guidance shown in E hibit 6.6-1.			X	CLO#6.1-14
c. VISIBILITY ENHANCEMENT — Labels of elements located above eye level should be positioned to ensure label visibility.			X	CLO#6.1-46
d. PROXIMITY — Labels should be placed close to the panel element. See Exhibit 6.6-2.			X	CLO#6.1-43
e. LABELS ON CONTROLS — Labels should not appear on the control itself when an adjustment or manipulation is required that causes the operator's hand to obscure the label for an extended time period.			X	CLO#6.1-2 and 6.1-19
f. ADJACENT LABELS — Adjacent labels should be separated by sufficient space so that they are not read as one continuous label.			X	CLO#6.1-15
6.6.2.2 MOUNTING				
a. INTEGRITY — Label should be mounted in such a way as to preclude accidental removal.			X	CLO#6.1-16
b. SURFACE — Labels should be mounted on a flat surface.		X		
6.6.2.3 SPATIAL ORIENTATION				
a. HORIZONTAL ORIENTATION				
(1) Labels should be oriented horizontally so that they may be read quickly and easily from left to right.			X	CLO#6.1-45
(2) Although not normally recommended, vertical orientation may be used only where space is limited.			X	CLO#6.1-45

	N/A	YES	NO	COMMENTS
6.6.2.3 (CONT'D)				
b. CURVED PATTERNS — Curved patterns of labeling should be avoided. See Exhibit 6.6-5.			X	CLO#6.1-17
6.6.2.4 VISIBILITY				
a. OTHER INFORMATION SOURCES — Labels should not cover any other information source. They should not detract from or obscure figures or scales which must be read by the operator.			X	CLO#6.1-48 and 6.1-54
b. CONCEALMENT — Labels should not be covered or obscured by other units in the equipment assembly.			X	CLO#6.1-18, 6.1-19 and 6.1-54
c. CONTROLS — Labels should be visible to the operator during control actuation.			X	CLO#6.1-2 and 6.1-58
d. CLEANING — Administrative procedures should be in place for the periodic cleaning of labels.			X	CLO#6.1-65
6.6.3.1 KINDS OF INFORMATION				
a. PRIMARY FUNCTION — Labels should describe the function of equipment items.			X	CLO#6.1-3, 6.1-7 and 6.1-47
b. SECONDARY FUNCTION — If needed for clarity, engineering characteristics or nomenclature may also may also be described.	X			
6.3.3.2 WORD SELECTION				
a. INTENDED ACTION — The words employed in the label should express exactly what action is intended.			X	CLO#6.1-4
b. CLARITY — Instructions should be clear.			X	CLO#6.1-1
c. DIRECT — Instructions should be direct.			X	CLO#6.1-1 and 6.1-20

	N/A	YES	NO	COMMENTS
6.6.3.2 (CONT'D)				
d. MEANING — Words should be used that have a commonly accepted meaning for all intended users.			X	CLO#6.1-6
e. TECHNICAL TERMS — Unusual technical terms should be avoided.		X		
f. SPELLING — Words should be correctly spelled.			X	CLO#6.1-24
6.6.3.3 CONSISTENCY				
b. INTERNAL CONSISTENCY — Labels should be consistent within and across pieces of equipment in their use of words, acronyms, abbreviations, and part/system numbers. See Exhibit 6.6-6.			X	CLO#6.1-10 and 6.1-21
c. CONSISTENCY WITH PROCEDURES — There should be no mismatch between nomenclature used in procedures and that printed on the labels.			X	CLO#6.1-66
6.6.3.4 SYMBOLS				
a. MEANING — Abstract symbols should be used only if they have a commonly accepted meaning for all intended users (e.g., %).		X		
b. DISTINGUISHABILITY — Symbols should be unique and distinguishable from each other.		X		
c. STANDARD — A commonly accepted standard configuration should be used.		X		
d. CONSISTENCY — Symbols should be consistently used within and across panels.			X	CLO#6.1-22
e. ROMAN NUMERALS — Use of Roman numerals should be avoided.			X	CLO#6.1-50

	N/A	YES	NO	COMMENTS
6.6.3.5 BREVITY				
Brevity should not be stressed if the results will be unfamiliar to operating personnel. Words on labels should be concise and still convey the intended meaning. See Exhibit 6.6-7.			X	CLO#6.1-1
6.6.3.6 SIMILARITY				
Words and abbreviations of similar appearance should be avoided where an error in interpretation could result. When labels containing similar words, abbreviations, or acronyms are located in close proximity to each other, different words should be selected or means of coding should be used to reduce the probability of selecting the wrong control or reading the wrong display. See Exhibit 6.6-8.		X		
6.6.3.7 FUNCTIONAL GROUPS				
a. FUNCTIONAL RELATIONSHIP — Labels should be used to identify functionally grouped controls or displays.			X	CLO#6.1-59
b. LOCATION — Labels should be located above the functional groups they identify.		X		
6.6.3.8 CONTROL POSTION LABELING				
a. POSITION — All discrete functional control positons should be identified.			X	CLO#6.1-23
b. DIRECTION — Direction of motion (increase, decrease) should be identified for continuous motion rotary controls.			X	CLO#6.1-42
c. VISIBILITY — Control position information should be visible to the operator during operation of the control.			X	CLO#6.1-2

	N/A	YES	NO	COMMENTS
6.6.3.9 ACCESS OPENING, DANGER, WARNING, AND SAFETY INSTRUCTION LABELING				
a. **ACCESS OPENING LABELS** — Each access opening used by control room operators should be labeled to identify the function of items accessible through it.		X		
b. **DANGER, WARNING, AND SAFETY INSTRUCTION LABELS** — All danger, warning, and safety instruction labels should be in accordance with appropriate safety standards.			X	CLO#6.1-60
6.6.4.1 READABILITY				
a. **CHARACTER HEIGHT**				
(1) Character height should subtend a visual angle of 15 minutes as a minimum, or 0.004 x viewing distance. A visual angle of 20 minutes, or 0.006 x viewing distance, is preferred.			X	CLO#6.1-51 and 6.1-57
(2) Letter height should be identical for all labels within the same hierarchical level, based on the maximum viewing distance.			X	CLO#6.1-25
b. **CONTRAST**				
(1) To ensure adequate contrast and prevent loss of readability because of dirt, dark characters should be provided on a light background.			X	CLO#6.1-26
(2) If color print is used for coding purposes, it should conform to the established color coding scheme for the control room. (See Guideline 6.5.1.6.) Colors should be chosen for maximum contrast against the label background. Exhibit 6.6-9 rates various color combinations in terms of relative legibility.		X		

Item	N/A	YES	NO	COMMENTS
6.6.4.2 STYLE (Exhibits 6.5-1 and 6.5-2)				
a. CHARACTER SELECTION				
(1) Labels should be prepared in capital letters.			X	CLO#6.1-27
(2) The design of letters and numerals should be simple and without flourishes or serifs.		X		
b. CHARACTER WIDTH				
(1) Letter width-to-height ratio should be between 1:1 and 3:5.			X	CLO#6.1-67
(2) Numeral width-to-height ratio should be 3:5 except for the numeral "4" which should be one stroke width wider and the numeral "1" which should be one stroke in width.			X	CLO#6.1-67
c. STROKE WIDTH — Stroke width-to-character height ratio should be between 1:6 and 1:8.			X	CLO#6.1-68
d. SPACING				
(1) The minimum space between characters should be one stroke width.			X	CLO#6.1-55
(2) The minimum space between words should be one character width.			X	CLO#6.1-53
(3) The minimum space between lines should be one-half of the character height.			X	CLO#6.1-56
6.6.5.1 USE OF TEMPORARY LABELS				
a. NECESSITY — Temporary labels should be used only when necessary.			X	CLO#6.1-29
b. HUMAN FACTORS PRACTICES — Temporary labels should conform to good human engineering principles.			X	CLO#6.1-30

	N/A	YES	NO	COMMENTS
6.6.5.1 (CONT'D)				
c. VISIBILITY — Temporary labels should not obscure prior permanent labels unless the old label is to be replaced.			X	CLO#6.1-69
d. IDENTIFICATION — Tag-out labels should clearly identify out-of-service components and equipment.			X	CLO#6.1-61
e. MOUNTING — Tag-outs should be securely affixed.			X	CLO#6.1-31
f. OBSCURATION — Tag-outs should not obscure the label associated with the nonoperable device.			X	CLO#6.1-70
g. ACTIVATION — Tag-outs should be designed to physically prevent actuation of a control.		X		
h. ADJACENT DEVICES — Tag-outs should not obscure any adjacent devices or their associated labels.			X	CLO#6.1-32
6.6.5.2 CONTROL OF TEMPORARY LABELS				
a. ADMINISTRATIVE PROCEDURES — The use of temporary labels should be administratively controlled.			X	CLO#6.1-71
b. REVIEW PROCEDURES — A review procedure should be in place that will result in a determination of:				
(1) when temporary labels are needed;			X	CLO#6.1-71
(2) how they will be used;			X	CLO#6.1-71
(3) their content (given human engineering requirements);			X	CLO#6.1-71
(4) their installation;			X	CLO#6.1-71
(5) the impact of their use on other system equipment (e.g., annunciators, mimics);			X	CLO#6.1-71

Guideline	N/A	YES	NO	COMMENTS
6.6.5.2b. (CONT'D)				
(6) documentation requirements;			X	CLO#6.1-71
(7) retraining requirements;			X	CLO#6.1-71
(8) their periodic review; and			X	CLO#6.1-71
(9) their removal.			X	CLO#6.1-71
6.6.6.2 DEMARCATION (See Exhibit 6.8-1)				
a. USE — Lines of demarcation can be used to:			X	CLO#6.1-33
(1) Enclose functionally related displays.				
(2) Enclose functionally related controls.				
(3) Group related controls and displays.				
b. CONTRAST — Lines of demarcation should be visually distinctive from the panel background.		X		
c. PERMANENCE — Lines of demarcation should be permanently attached.		X		
6.6.6.3 COLOR				
Color should be dedicated to specific functions or conditions throughout the control room in order for the code to elicit the expected operator response. The color coding scheme should be used consistently throughout the control room. Refer to Guideline 6.5.1.6 for specific recommendations on the use of color.			X	CLO#6.1-63

	N/A	YES	NO	COMMENTS
6.6.6.4 USE OF MIMICS				
a. COLOR				
(1) Flow paths should be color coded. Colors should be selected in conformance with Guidelines 6.5.1.6.			X	CLO#6.1-34
(2) The mimic colors should be discriminably different from each other.			X	CLO#6.1-35
(3) There should be adequate contrast between the mimic colors and the panel.			X	CLO#6.1-36
(4) Mimic lines depicting flow of the same contents (e.g., steam, water, electricity) should be color coded the same throughout the control room.			X	CLO#6.1-37
(5) No more than 4 mimic lines of the same color should run in parallel if the operator must quickly identify any one of the lines.		X		
b. MIMIC LINES				
(1) Differential line widths may be used to code flow paths (e.g., significance, volume, level).			X	CLO#6.1-38
(2) Overlapping of mimic lines should be avoided.		X		
(3) Flow directions should be clearly indicated by distinctive arrowheads.			X	CLO#6.1-28
(4) All mimic origin points should be labeled or begin at labeled components.			X	CLO#6.1-40
(5) All mimic destination or terminal points should be labeled or end at labeled components.			X	CLO#6.1-39 and 6.1-40
(6) Component representations on mimic lines should be identified.	X			

	N/A	YES	NO	COMMENTS
6.6.6.4 (CONT'D)				
c. SYMBOLS				
(1) Graphic symbols should be readily understood and commonly used.	X			
(2) Symbols should be used consistently.	X			
6.8.3.2 STRINGS OR CLUSTERS OF SIMILAR COMPONENTS				
d. LARGE MATRICES				
(1) Large matrices of similar components should have the coordinate axes labeled for identification of any single component within the grid. The left and top sides of the matrix should be used for labeling (see Exhibit 6.8-6).		X		
(2) Large matrices should be subdivided by appropriate demarcation.			X	CLO#6.1-41

3.13 Computer System Survey TP-7.1

This section documents the results of the computers system survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.13.1 Objectives

The objectives of the computer system survey were to:

a. Assess to what degree the control rooms computer system conforms to the criteria of NUREG-0700.

b. Identify and document any element in the design or operation of the computer system that does not conform to the criteria of NUREG-0700.

3.13.2 Scope

The scope of this survey was limited to assessing only the control rooms computer system as defined by NUREG-0700. It does not address the Safety Parameter Display System (SPDS). The computer topics evaluated include:

- Color consistency meaning
- Software security
- Operator/computer dialogue
- Prompting and structuring
- Data entry-keyboards
- Computer function controls
- Computer response time
- Computer system procedures
- CRT display characteristics
- Operator display relationships
- Data presentation format
- Screen layout and structuring
- Messages
- Printer characteristics
- Alarm messages

3.13.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph number are: paragraphs 6.5.1.6d(2); 6.7.1la through d; 6.7.1.2a through d; 6.7.1.3a through e; 6.7.1.4a through l; 6.7.1.5a through d; 6.7.1.6a through d; 6.7.1.8a and b; 6.7.2.1a through h; 6.7.2.2a through g; 6.7.2.3a through f; 6.7.2.4a through g; 6.7.2.5a through n; 6.7.2.6a through l; 6.7.2.7a through m; 6.7.2.8a through e; 6.7.3.1a through f 6.7.3.2a through f; 6.7.3.3a through d. The detailed definitions for the criteria are presented in Table 3.13.

3.13.4.1 Data Collection

a. Data were collected using the checklists contained in the computer survey task plan.

b. Data were collected primarily through measurement and direct observation. Interview responses and documentation review findings were also recorded.

3.13.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory, resolution was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.13.5 Findings

The findings of the computer system survey are presented in Table 3.13 "Computer System Survey Findings and CLOs Generated." A total of 218 criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 18 were not applicable and 151 were not violated. One of the violated criteria was covered and recorded in the displays survey. One violated criteria was covered and recorded in the conventions survey. Thirty-one CLOs were generated which covered the other 47 criteria violated. Those CLO addressed color consistency of meaning, operator/computer dialogue, prompting and structuring, keyboards, computer function controls, response time, procedures, data presentation, screen layout and structuring, messages and printers.

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	N/A	YES	NO	COMMENTS
6.5.1.6 COLOR CODING				
d. CONSISTENCY OF MEANING				
(2) The meaning of a particular color should remain the same whether applied to panel surfaces or projected in signal lights or on CRTs.			X	CLO#7.1-16
6.7.1.1 SOFTWARE SECURITY				
a. AUTHORIZATION — The system should include positive protection provisions to ensure that only properly authorized personnel can make changes (by entry, deletion, or alteration).			X	CLO#7.1-17
b. SECURE STORAGE — At least one copy of the current operating software should be stored in a secure remote location.		X		
c. EDITING — When characters, words, or phrases are to be inserted, such items should first be collected and displayed on a buffer area of the screen, and then collectively inserted by one operator command.	X			No edit capability. No CRT associated with process computer.
d. ACKNOWLEDGEMENT — Before any operator requests are processed that would result in permanent changes to existing data, the computer system should require operator acknowledgement.		X		
6.7.1.2 OPERATOR/COMPUTER DIALOGUE				
a. LANGUAGE CHARACTERISTICS				
(1) Dialogue should be based on the operator's point of view, not the programmer's.		X		
(2) Dialogue should be logical.			X	CLO#7.1-6
(3) Dialogue should be used in a consistent manner.		X		

	N/A	YES	NO	COMMENTS
6.7.1.2a (Cont'd)				
(4) Dialogue should reflect the vocabulary and syntax of the expected user population.			X	CLO#7.1-6
(5) Input words (e.g., keywords) should approximate real words.		X		
(6) Dialogue should require an explicit command in order to terminate an interaction.		X		
b. ENTRY LENGTH — Individual input words which must be typed should not exceed 7 characters.		X		
c. ABBREVIATIONS				
(1) Abbreviations should be used whenever possible to minimize operator input requirements.		X		
(2) If the operator is using a synonym or abbreviation for a system command name, the computer system should use the same synonym or abbreviation when referring to that command in messages, prompts, etc., to the operator.			X	CLO#8.1-13
(3) The use of abbreviations or contractions for output text should be avoided.			X	CLO#7.1-27
d. ERROR AVOIDANCE — Operator inputs, responses, or actions which could significantly degrade computer system or plant performance should not be dependent on a single keystroke.		X		
6.7.1.3 PROMPTING AND STRUCTURING				
a. OPERATOR REQUESTS — The computer system should contain prompting and structuring features by which an operator can request additional information.		X		CLO#7.1-31

	N/A	YES	NO	COMMENTS
6.7.1.3a (Cont'd)				
b. CORRECTION OF DATA — The computer system should contain prompting and structuring features by which an operator can request corrected information when an error is detected.			X	CLO#7.1-31
c. MODE/FILE DISPLAY — The computer system should display the mode designation and the file(s) being processed.		X		
d. SPECIFIC ERROR CORRECTION — The computer system should permit correction of individual errors without requiring re-entry of correctly entered data.			X	CLO#7.1-25
e. ENTRY FILE — The computer system should contain a sequential file of operator entries, available upon operator request.		X		
6.7.1.4 DATA ENTRY — KEYBOARDS			X	CLO#7.1-4
a. ALPHANUMERIC KEYBOARD ARRANGEMENT — Keyboards that combine alphabetic and numeric functions on a single keyboard should conform to the standard "QWERTY" arrangement. See Exhibit 6.7.-1.		X		
b. NUMERIC KEYBOARD ARRANGEMENT — The configuration of a keyboard used to enter solely numeric data should be a 3x3+1 matrix, either "telephone" style or "calculator" style. see Exhibit 6.7-2.		X		
c. USE OF MULTIPLE KEYBOARDS — If there is more than one computer system keyboard in a control room, the alphanumeric and/or numeric-only key configuration should be the same in all cases.	X			
d. KEY MEASUREMENTS — To maximize the effectiveness of keyboards, key dimensions and separation should be as illustrated (see Exhibit 6.7-3).		X		

	N/A	YES	NO	COMMENTS
6.7.1.4 (Cont'd)				
e. KEY DISPLACEMENT AND RESISTANCE — To provide positive key movement feedback to the operator, and to reduce inadvertent activation of keys,		X		
(1) Key displacement should be as shown in Exhibit 6.7-4.				
(2) Key resistance should be as shown in Exhibit 6.7-4.				
f. POSITIVE INDICATION — To provide positive key actuation feedback to the operator, a definite indication should be provided (e.g., snap, feel, audible click, release of resistance).		X		
g. KEYBOARD SLOPE — Keyboards should have a slope between 15° and 25° from the horizontal (see Exhibit 6.7-5).		X		
h. VISUAL FEEDBACK — Data being entered via keyboards should be displayed as it is keyed.			X	CLO#7.1-28
i. RELEVANT KEYS — The presence of nonrelevant keys, such as those that might be used by programmer personnel, adds to keyboard complexity and induces operator errors. Control room keyboards should contain only those keys which are used by operators.			X	CLO#7.1-30
6.7.1.5 COMPUTER FUNCTION CONTROLS				
a. CONTROL DESIGN — When dedicated controls are used for selection of computer or display functions or modes, the design of the controls should conform to the appropriate guidelines specified in Section 6.4, Controls.			X	CLO#5.1-52

	N/A	YES	NO	COMMENTS
6.7.1.5 (Cont'd)				
b. LABELING AND NOMENCLATURE — Terms, nomenclature, and abbreviations used on function controls should be the same as or consistent with the terms, nomenclature, and abbreviations of the computer function which is selected or displayed.		X		
c. MASTER CONTROL — When CRTs are subject to operation by centrally located master controls, a positive indication should be provided:		X		
(1) At the master-control location to identify those displays under local or master control.				
(2) At the individual CRT to indicate whether the display is under master or local control.				
d. FUNCTION CONTROLS				
(1) When dedicated controls are used to initiate/activate functions, the keys should be grouped together.		X		
(2) Function controls should be easily distinguished from other types of keys on the computer console.		X		
(3) Each function control should be clearly labeled to indicate its function to the operator.		X		
(4) If multiple computer consoles exist in the control room, the design and layout of the function controls should be consistent for all consoles.	X			

	N/A	YES	NO	COMMENTS
6.7.1.5d (Cont'd)				
(5) When function keys are included with an alphanumeric keyboard, the function keys should be physically separate. (Avoid multiple-mode keyboards which utilize the same keys for both alphanumerics and functions by using "shift" keys or mode selection controls.)			X	CLO#7.1-26
6.7.1.6 OTHER CONTROL DEVICES				
a. LOCATION — The control devices should be operable from the location where the operator is most likely to need to interact with the computer (e.g., keyboard, computer console, display screen).	X			No other control devices.
b. SPEED — The control device should provide rapid positioning of cursors or selection of choices.	X			
c. ACCURACY — Device or method accuracy should be commensurate with the functions to be served.	X			
d. DISPLACEMENT — Control design should allow the operator freedom of movement to perform other duties.	X			
6.7.1.7 COMPUTER RESPONSE TIME TO OPERATOR QUERIES				
a. MAXIMIZE RESPONSE TIMES — The computer system should provide the correct response to each type of query within the recommended response times listed in Exhibit 6.7-6.			X	CLO#7.1-1 and 7.1-3
b. RESPONSE DELAY MESSAGES — When response time for any query exceeds 3 seconds, a delay message should be presented to maintain the operator's attention and to confirm normal computer operation. (See also Guideline 6.7.2.6.)		X		

	N/A	YES	NO	COMMENTS
6.7.1.8 ACCESS AIDS				
a. COMPUTER SYSTEM PROCEDURES			X	CLO#7.1-7
(1) A compute set of computer system operating procedures and contingency procedures should be available in the control room.				
(2) Procedures should be prepared from the point of view of the control room operator.			X	CLO#7.1-7
(3) Procedures should be in hardcopy form as a minimum.			X	CLO#7.1-7
(4) Operating procedures should describe:				
(a) The overall computer system.			X	CLO#7.1-7
(b) The computer system components with which the operator can interface.			X	CLO#7.1-7
(c) The specific procedures necessary to accomplish all of the operator-computer interface functions.			X	CLO#7.1-7
(5) Contingency procedures should describe:				
(a) Indications available to the operator which identify failure or malfunctioning of the computer system.			X	CLO#7.1-7
(b) Necessary actions to be performed by the operator if the computer fails or malfunctions.			X	CLO#7.1-7

	N/A	YES	NO	COMMENTS
6.7.1.8 (Cont'd)				
b. DATA POINT INDICES				
(1) The specific codes, or addresses, by which data displays can be called up by an operator should be cross-indexed by:				
(a) Alphanumeric or numeric code		X		
(b) Program name		X		
(c) System/subsystem identification			X	CLO#7.1-20
(d) Functional group identification.			X	CLO#7.1-20
(2) Cross-indices should be available in the control room in hardcopy form as a minimum.		X		
6.7.2.1 CRT DISPLAY CHARACTERISTICS				
a. READABILITY — Alphanumeric and graphic characters should be easily readable by the operator under all control room lighting conditions.			X	CLO#7.1-9
b. REFLECTED GLARE — CRT screens should be installed to minimize or eliminate reflected glare at normal operator viewing angles.			X	CLO#7.1-9
c. SCREEN LUMINANCE				
(1) Ambient illumination should contribute no more than 25% to screen luminance through diffuse reflection and phosphor excitation.		X		
(2) When ambient illumination in the vicinity of the CRT is in the medium to high range (see Guideline 6.1.5.3), the CRT should use dark characters and symbols on a light background.		X		

	N/A	YES	NO	COMMENTS
6.7.2.1c (Cont'd)				
(3) When the CRT uses dark characters on a light background, the screen background luminance should be 23 foot-Lamberts (ft-L) minimum and 46 ft-L preferred.		X		
(4) When the CRT uses light characters on a dark background, the character luminance should be 23 ft-L minimum and 46 ft-L preferred.		X		
d. LUMINANCE CONTRAST				
(1) Contract between light characters and a dark screen background should be 15:1 minimum and 20:1 preferred.		X		
(2) Contrast between dark characters and a light screen background should be 1:15 minimum and 1:20 preferred.		X		
e. GEOMETRIC DISTORTION — The cumulative effects of all geometric distortion should not displace any point within the viewable area of the screen from its correct position by more than 5% of picture height.		X		
f. RESOLUTION — Discrimination of fine detail is a function of the number of scan lines or addressable points ("resolution elements") per unit length.		X		
(1) CRTs for displaying simple alpha-numeric text should have a minimum of 20 resolution elements per inch.		X		
(2) CRTs for displaying complex symbols and graphic detail should have a minimum of 100 resolution elements per inch.	X			

	N/A	YES	NO	COMMENTS
6.7.2.1f (Cont'd)				
(3) Complex symbols which must be distinguished from other complex shapes should have a minimum of 10 resolution elements for the longest dimension of the symbol.		X		
(4) Alphanumeric characters should have a minimum of 10 resolution elements per character height.		X		
g. REGENERATION RATE — The regeneration rate for a particular CRT display should be above the critical frequency at fusion so that the occurrence of disturbing flicker is not perceptible.		X		
h. CRT DISPLAY CONTROLS				
(1) Parameters such as luminance (brightness), contrast, and color should be adjustable by the control room operator.			X	CLO#7.1-10
(2) Adjustment controls should conform to the appropriate guidelines in Section 6.4, Controls, and Section 6.9, Control-Display Integration.	X			
6.7.2.2 SYMBOLS AND CHARACTERS				
a. SYMBOL SIZE — When a displayed symbol of complex shape is to be distinguished from another symbol shape that is also complex, the visual angle of the symbol should subtend not less than 20 minutes of arc at the required viewing distance.		X		
b. ALPHANUMERIC CHARACTER SIZE				
(1) The height of alphanumeric characters should have a visual angle of not less than 12 minutes of arc at the required viewing distance.		X		

Item	N/A	YES	NO	COMMENTS
6.7.2.2b (Cont'd)				
(2) Alphanumeric characters should be uppercase letters.		X		
c. CHARACTER WIDTH-TO-HEIGHT RATIO — The width-to-height ratio for alphanumerics should be between 3:5 and 1:1.		X		
d. STROKE-WIDTH-TO-CHARACTER-HEIGHT RATIO — Stroke-width-to-character-height ratio should be between 1:5 and 1:10.		X		
e. GRAPHICS — A graphic line will appear continuous if the separation between addressable points, or resolution elements, is less than one minute of arc. To provide the illusion of continuity, graphic lines should contain a minimum of 50 resolution elements per inch.		X		
f. CHARACTER AND SYMBOL SEPARATION				
(1) Horizontal separation between characters or symbols should be between 10% and 65% of character or symbol height.		X		
(2) Separation should be not less than 25% of character or symbol height when any of the following degraded conditions exists:		X		
(a) When character or symbol width is less than 85% of height;				
(b) When character or symbol luminance is less than 12 ft-L;				
(c) When luminance contrast is less than 88%;				
(d) When CRT screen location is greater than 35° to the left or right of the operator's straight-ahead line of sights				

	N/A	YES	NO	COMMENTS
6.7.2.2f(2) (Cont'd)				
(e) When the visual angle subtended by symbol height is less than 15 minutes of arc;				
(f) When the visual angle subtended by character height is less than 12 minutes of arc.				
g. CHARACTER STYLE (FONT)				
(1) Simple character fonts should be used, with no serifs, variable stroke widths, slanting, etc.		X		
(2) When dot-matrix characters are used, 7x9 dot-matrix should be used in preference to 5x7 dot-matrix.		X		
(3) Character styles such as Lincoln/ Mitre or Leroy should be used.		X		
6.7.2.3 OPERATOR-DISPLAY RELATIONSHIPS				
A. VIEWING DISTANCE — Viewing distance should be greater than 18 inches.		X		
b. VIEWING ANGLE — The minimum angle between the operator's actual line-of-sight (LOS) as measured from the operator's normal work station, and the plane of the display screen should be 45° or greater in either the horizontal or vertical direction. See Exhibits 6.7-8 and 6.7-10.		X		
c. SCREEN LOCATION, SEATED OPERATORS				
(1) CRT displays which require frequent or continuous monitoring, or which may display important (e.g., alarm) information, should be located within the following limits as measured from the normal operator work station (see Exhibit 6.7-9):		X		

Item	N/A	YES	NO	COMMENTS
6.7.2.3c (Cont'd)				
(a) Horizontal limits — Not more than 35° to the left or right of the operator's straight-ahead LOS.		X		
(b) Vertical limits — Not more than 20° above and 40° below the operator's horizontal LOS.		X		
(2) CRT displays which do not require frequent or continuous monitoring, and which will not display important (e.g., alarm) information, should be located within the following limits (as measured from normal operator work stations which permit full operator head and eye rotation). See Exhibit 6.7-10):		X		
(a) Horizontal limits — Not more than 95° to the left or right of the operator's straight-ahead LOS.				
(b) Vertical limits — Not more than 70° above and 90° below the operator's horizontal LOS.				
d. SCREEN LOCATION, STANDING OPERATORS				
(1) CRT displays which require frequent or continuous monitoring, or which may display important (e.g., alarm) information, should be located within the following limits as measured from the normal operator work station:		X		
(a) Horizontal limits — Not more than 35° to the left or right of the operator's straight-ahead LOS.				
(b) Vertical limits — Not more than 35° above and 25° below the operator's horizontal LOS.				

	N/A	YES	NO	COMMENTS
6.7.2.3d (Cont'd)				
(2) CRT displays which do not require frequent or continuous monitoring, and which will not display important (e.g., alarm) information, should be located within the following limits (as measured from normal operator work stations which permit full operator head and eye rotation):		X		
(a) Horizontal limits — Not more than 95° to the left or right of the operator's straight-ahead LOS.				
(b) Vertical limits — Not more than 85° above and 90° below the operator's horizontal LOS.				
e. MOUNTING IN CONSOLES — When CRTs are permanently mounted in consoles, the console configuration, dimensions, and type of use (such as seated, sit-stand, or standing) affects the CRT/operator interface. Consoles in which CRTs are installed should conform to the guidelines of Section 6.1.2.		X		
f. VISIBILITY OF DATA — All data and messages on the CRT screen should be within the unobstructed view of an operator at the normal work station.		X		
6.7.2.4 DATA PRESENTATION FORMAT				
a. USABILITY OF DATA				
(1) Data should be presented to the operator in a readily usable format.		X		
(2) There should be no requirement for transposing, computing, interpolating, or mentally translating displayed data into other units or numerical bases.		X		

Item	N/A	YES	NO	COMMENTS
6.7.2.4 (Cont'd)				
b. ILLUSTRATIONS — Illustrations should be used whenever possible to supplement or explain text.		X		
c. CHARACTER GROUPING				
(1) When 5 or more digits and/or non-text alphanumerics are displayed, and no natural (i.e., population stereotyped) organization exists, characters should be grouped in blocks of 3 to 4 characters each.		X		
(2) Groups should be separated by a minimum of 1 blank character space.		X		
d. MAINTENANCE OF ORDERING — Elements in a data field should be displayed in logical order (e.g., chronological).		X		
e. PRESENTATION OF IDENTICAL DATA				
(1) The manner of presentation of identical data should be based on the uses to which the data will be put by the operator.		X		
(2) Within the limits of (1) above, identical data in different presentations should be displayed in a consistent, standardized manner.		X		
f. MENU DESIGNATORS				
(1) Numbers should be used as designators when listing selectable items.		X		
(2) Numerical designators should start with the number "1" (not zero).		X		

Item	N/A	YES	NO	COMMENTS
6.7.2.4f (Cont'd)				
(3) If the use of numbers as designators would create confusion because of other numbers which make up the item to be designated, alphabetic characters should be used.		X		
(4) When used, alphabetic designators should start with the letter "A."	X			
g. LISTS				
(1) Lists should be vertically aligned and left-justified.		X		
(2) Indentation should be used for subclassifications.		X		
h. TABLES AND GRAPHS — Quantitative data which must be scanned and compared should be presented in either tabular or graphic form.		X		
i. HYPHENATION — The use of hyphenation should be minimized.		X		
j. ALIGNMENT				
(1) When presented in tabular form, alphanumeric data should be left-justified.		X		
(2) When presented in tabular form, numeric data should be right-justified with decimal points aligned.		X		
k. PERIODS — Periods should be placed after item selection designators and at the end of a sentence.			X	CLO#7.1-11

	N/A	YES	NO	COMMENTS
6.7.2.4 (Cont'd)				
l. STANDARDIZED FIELDS — The following standardized fields should be used:				
(1) Telephone Number: (914)555-1212	X			Not used.
(2) Time: HH:MM:SS, HH:MM, MM:SS:(.S)			X	CLO#7.1-12
(3) Date: MM:DD:YY.			X	CLO#7.1-12
m. DATA GROUP LABELING				
(1) Each individual data group or message should have a descriptive title.		X		
(2) Labels should reflect some unique characteristic of the content of the data group or message.		X		
n. LABEL PLACEMENT — Labels should be located in a consistent manner either above or to the left of the data group or message they describe.		X		
o. LABEL ORIENTATION — Labels should be oriented horizontally.		X		
p. LABEL HIGHLIGHTING				
(1) Labels should be highlighted or otherwise accentuated to facilitate operator scanning and recognition.		X		
(2) The technique used to highlight labels should be easily distinguished from that used to highlight emergency or critical messages.		X		
q. OPTION LABELS — When presenting a list of operator options, the label should reflect the question or choices being posed to the operator.		X		

	N/A	YES	NO	COMMENTS
6.7.2.5 SCREEN LAYOUT AND STRUCTURING				
a. ORGANIZATION OF DATA				
(1) Displayed data should be organized in a logical, consistent manner.		X		
(2) Displayed data should reflect some obvious and inherent quality of the data groups (e.g., hierarchical, sequential, or mimic relationships).		X		
b. LOCATION OF DATA GROUPS — Physical location of specific data groups (e.g., alarms, menus) on the screen should be consistent.		X		
c. DEMARCATION OF DATA SUBGROUPS — Organization and separation of information subgroups should be made apparent to the operator through the use of blank spaces, lines, or some other form of visible demarcation.		X		
d. USE FREQUENCY RANKING — Lists of options should be organized according to the probability of selection for each item, with high probability items presented first.		X		
e. ALPHANUMERIC RANKING — Non-option lists of equal-probability options should be presented in alphabetical or numerical order.		X		
f. SEPARATION OF PARAGRAPHS — Paragraphs in continuous text should be separated by at least one blank line.		X		
g. SELECTION DESIGNATORS — Selection designators in menus should be separated from text descriptors by at least one blank space.		X		

	N/A	YES	NO	COMMENTS
6.7.2.5 (Cont'd)				
h. PAGE DESIGNATION — When data are contained on multiple pages, each page should display both page number and total number of pages.	X			
i. CONTINUOUS NUMBERING — Items contained in a numbered list and described on "continue" pages should be numbered relative to the first number on the first page of the list.	X			
j. PLACEMENT OF INSTRUCTIONS — When directions to the operator accompany a list of options, such directions should precede presentation of the list.		X		
k. URGENT MESSAGES				
(1) Urgent messages requiring immediate operator response should be highlighted to attract the operator's attention.			X	CLO#7.1-8
(2) Urgent messages should always be displayed in the same location.		X		
l. USE OF CURSOR — In systems in which selection is made by use of a cursor, formats should be organized to minimize positioning movements of the cursor.		X		
m. SCREEN LOADING — The amount of information-bearing activated screen area should not exceed 25% of the total screen area. This does not include demarcation lines used to separate groups of data.		X		

Item	N/A	YES	NO	COMMENTS
6.7.2.5 (Cont'd)				
n. TREND PLOT SCALES — CRT displayed trend plot scales should be consistent with the intended functional use of the data. (For example, the monitoring of neutron flux at reactor trip may have a variable scale of 0% to 1% of the design value and a time scale resolution of seconds. However, post-trip monitoring may have a variable scale of 0% to 10% with a time scale resolution of minutes. Finally, operational log data of neutron flux may have a time scale resolution of hours.)		X		
6.7.2.6 MESSAGES				
a. MESSAGES, GENERAL				
(1) Messages should be concise.		X		
(2) Messages should provide the operator with the information necessary to complete a specific action or decision sequence.		X		
b. MESSAGE CONTENT — Information contained in messages should be necessary, complete, and readily usable.		X		
c. USE OF PROMPTS — Prompts should be displayed whenever the operator may need directions or guidance to initiate or complete an action or sequence of actions.		X		
d. CONTENT OF PROMPTS — Prompts should contain clear and specific cues and instructions which are relevant to the action to be taken.		X		
e. PROMPT INFORMATION SEQUENCE — Directions should be placed in the sequence to be used by the operator.		X		

	N/A	YES	NO	COMMENTS
6.7.2.6 (Cont'd)				
f. USE OF ERROR MESSAGES — Whenever an operator error or invalid input is detected, an error message should be displayed.		X		
g. ERROR CORRECTION GUIDANCE — Error messages should contain instructions to the operator regarding required corrective action.			X	CLO#7.1-13
h. ERROR CORRECTION EASE — Capability should be provided for operator correction of individual errors without affecting adjacent valid entries.		X		
i. SYSTEM STATUS FEEDBACK MESSAGES — Feedback messages should be provided to the operator to indicate changes in the status of system functioning.		X		
j. SELECTION FEEDBACK — When a displayed message or datum is selected as an option or input to the system, the subject item should be highlighted, or otherwise positively identified, to indicate acknowledgement by the system.		X		
k. DELAY FEEDBACK — When system functioning requires the operator to stand by, such as when the computer is searching for requested data, periodic feedback should be provided to the operator to indicate normal system operation and the reason for the delay.		X		
l. ACTIVITY COMPLETION FEEDBACK — When a process or sequence is completed by the system, positive indication should be presented to the operator concerning the outcome of the process and requirements for subsequent operator actions.			X	CLO#7.1-14

Item	N/A	YES	NO	COMMENTS
6.7.2.7 GRAPHIC CODING AND HIGHLIGHTING				
a. USE OF HIGHLIGHTING —Highlighting should be used to attract the operator's attention to any displayed data item or message which is important to decision-making or action requirements.		X		
b. CONSISTENT APPROACH				
(1) Highlighting methods which have information value beyond their attention-getting quality should have the same meaning in all applications.		X		
(2) Highlighting methods associated with emergency conditions should not also be used in association with normal conditions.		X		
c. CONTRAST ENHANCEMENT — When contrast enhancement (i.e., increased illumination intensity level) is used for highlighting, not more than two (preferable) or three (maximum) brightness levels should be used in a single presentation.	X			
d. FLICKER OR BLINKING — Blinking of a symbol or message (e.g., ON-OFF or alternating high-low brightness) for purposes of highlighting should be reserved for emergency conditions or similar situations requiring immediate operator action.		X		
e. BLINK RATES				
(1) When blinking is used for high-lighting, a maximum of 2 blink rates should be used.		X		
(2) When a single blank rate is used, the rate should approximate 2 to 3 "blinks" per second with a minimum of 50 msec "on" time between blinks.		X		

	N/A	YES	NO	COMMENTS
6.7.2.7e (Cont'd)				
(3) When 2 blink rates are used, the fast blink should approximate 4 per second and the slow blink should approximate 1 per second.		X		
(4) When 2 blink rates are used, the "on-off" ratio should approximate 50%.		X		
(5) When 2 blink rates are used, the higher rate should apply to the most critical information.		X		
f. INVERSE VIDEO — Image reversal (e.g., dark characters on a light background) should be used primarily for highlighting in dense data fields, such as a word or phrase in a paragraph of text, or a set of characters in a table of data.	X			
g. USE OF GRAPHIC CODING — Graphic coding methods (e.g., symbols, boxes, underlines, colors) should be used to present standard qualitative information to the operator or to draw the operator's attention to a particular portion of the display.		X		
h. GRAPHIC CODE CONSISTENCY — Graphic codes, used separately or in combination, should have the same meaning in all applications.		X		
i. GEOMETRIC SHAPE CODING — When geometric shape (symbol) coding is used, the basic symbols should vary widely in shape.		X		
j. NUMBER OF SYMBOLS				
(1) The number of basic symbols used for coding should be kept small.		X		
(2) The upper limit under optimum display conditions should be 20.		X		

	N/A	YES	NO	COMMENTS
6.7.2.7j (Cont'd)				
(3) The upper limit under adverse display conditions should be 6.		X		
(4) When needed, other highlighting and graphic techniques (color, filled versus unfilled, and other "modifiers") should be used to display different states or qualities of a basic symbol.		X		
k. USE OF COLOR — (Exhibit 6.7-11)				
(1) Colors used on the CRT to convey information should be consistent in use and meaning with all other color codes in the control room.			X	CLO#7.1-25
(2) Once colors are assigned a specific use or meaning, no other color should be used for the same purpose.		X		
l. COLOR MEANINGS — When color is used, the meaning of the colors should, where applicable, equate with the commonly understood meaning of those colors. The following specific meanings for selected colors should apply when these colors are used in CRT displays:			X	CLO#7.1-15
(1) Red — Unsafe condition, danger, immediate operator action required, or critical parameter value out of tolerance.			X	CLO#7.1-15
(2) Green — Safe condition, no operator action required, or parameter value is within tolerance.			X	CLO#7.1-15
(3) Yellow/Amber — Hazard, potentially unsafe, caution, attention required; marginal parameter value exists.			X	CLO#7.1-15

	N/A	YES	NO	COMMENTS
6.7.2.7 (Cont'd)				
m. RED-GREEN COMBINATIONS				
(1) Whenever possible, red and green colors should not be used in combination.		X		
(2) Use of red symbols/characters on a green background should especially be avoided.		X		
6.7.2.8 MULTIPLE-PAGE CONSIDERATIONS				
a. OPERATOR MEMORY				
(1) Page design and content planning should minimize requirements for operator memory.		X		
(2) All data relevant to a specific operator entry should be displayed on a single page.		X		
b. AUDIT TRAIL — When pages are organized in a hierarchical fashion, containing a number of different paths through the series, a visual audit trail of the choices should be available upon operator request.		X		
c. LOCATION REFERENCES				
(1) When the operator is required to scroll or pan on a large logical frame, location references should be provided in the viewable portion of the frame. (For example, when scrolling a list, ony part of which is visible at eny one time, the present and maximum location should be shown.)		X		
(2) Sectional coordinates should be used when large schematics must be panned or magnified.	X			

	N/A	YES	NO	COMMENTS
6.7.2.8 (Cont'd)				
d. OPERATOR CONTROL — The operator should have some capability for controlling the amount, format, and complexity of information (e.g., core dumps, program outputs, error messages) being displayed by the system.		X		
e. LOCATION CONSISTENCY — If the message is a variable option list, common elements should maintain their physical relationship to other recurring elements.		X		
6.7.3.1 PRINTER CHARACTERISTICS				
a. PRINTER APPLICATIONS				
(1) Printers should be part of the process computer system and be located in the primary operating area.		X		
(2) Control room printers should provide the capability to record alarm data, trend data, and plant status data.		X		
b. DISPLAY COPIES				
(1) The system should, if possible, be designed to provide hardcopy of any page appearing on the CRT at the request of the operator.			X	CLO#7.1-18
(2) If the copy will be printed remote to the operator, a print confirmation or denial message should be displayed.	X			
(3) Printer operation should not alter screen content.	X			
c. FORM OF PRINTED INFORMATION — Printed information should be presented in a directly usable form with minimal requirements for decoding, transposing, and interpolating.			X	CLO#7.1-27

	N/A	YES	NO	COMMENTS
6.7.3.1 (Cont'd)				
d. PRINTER SPEED — Printers used for recording trend data, computer alarms, and critical status information should have a high-speed printing capability of at least 300 lines a minute to permit printer output to keep up with computer output.		X		
e. PRINTER OPERATION — Paper, ribbons, and ink (if used) should be consistent with the following:			X	CLO#7.1-2
(1) Hard-finish matte paper should be used to avoid smudged copy and glare.		X		
(2) There should be a positive indication of the remaining supply of recording materials.		X		
(3) Instructions for reloading paper, ribbon, ink, etc., should appear on an instruction plate attached to the printer.			X	CLO#7.1-19
(4) When the printer is down during reloading, data and information which would normally be printed must not be lost.		X		
(5) A takeup device for printed materials should be provided which requires little or no operator attention and which has a capacity at lease equal to the feed supply.		X		
f. PRINT COPY ACCESSIBILITY — The following features should be provided to enhance operator accessibility of printed material:				
(1) Provisions should be made so that the operator can always read the most recently printed line.		X		

Item	N/A	YES	NO	COMMENTS
6.7.3.1f (Cont'd)				
(2) Printed material should have an adequate contrast ratio to ensure easy operator reading.		X		
(3) It should be possible to annotate the print copy while it is still in the machine.		X		
(4) The recorded matter should not be obscured, masked, or otherwise hidden in a manner which prevents direct reading of the material.			X	CLO#7.1-21
6.7.3.2 ALARM MESSAGES				
a. ALARM RECORDS				
(1) A printer should be provided for recording alarm messages.		X		
(2) All annunciator alarms should be recorded.			X	CLO#7.1-22
b. ALARM SEQUENCE — Alarm messages should be recorded in the sequence of their occurrence.		X		
c. OPERATOR-REQUESTED PRINTOUT — Provisions should be included to provide, upon operator request, printouts by alarm group (e.g., system, subsystem, component).			X	CLO#7.1-23
d. ALARM IDENTIFICATION — Alarm messages should be readily distinguishable from other messages.		X		
e. ALARM DISCRIMINATION — Alarm messages should provide rapid identification of the nature of the alarm.		X		
f. CONSISTENT TERMINOLOGY — Wording in alarm messages should:				
(1) Clearly relate to the specific annunciator tile that is illuminated.			X	CLO#7.1-5

	N/A	YES	NO	COMMENTS
6.7.3.2f (Cont'd)				
(2) Contain at least that information (i.e., wording) presented in the illuminated annunciator tile.			X	CLO#7.1-5
(3) Provide additional specific data.				
6.7.3.3 GRAPH AND TABLE REQUIREMENTS				
a. SHAPE OF FUNCTION — If the general shape of the function is important in making decisions, a graph should be used.		X		
b. INTERPOLATION — If interpolation is necessary, line graphs are preferable to bar graphs and tables.		X		
c. GRIDS				
(1) Graphs should be constructed so that numbered grids are bolder than unnumbered grids.		X		
(2) If 10-grid intervals are used, the fifth intermediate grid should be less bold than the numbered grid, but bolder than the unnumbered grids.		X		
d. TABLES				
(1) Tables should be simple, concise, and readable.			X	CLO#7.1-29
(2) When table columns are long, numbers should be separated into groups by providing a space between groups of five.			X	CLO#7.1-24
(3) When columns are not separated by vertical lines, the columns should be separated by at least 2 character widths.	X			

3.14 Conventions Survey TP-8.1

This section documents the results of the conventions survey conducted in the main control rooms at the D. C. Cook Nuclear Plant. This review was conducted in accordance with the requirements of NUREG-0700, as specified in the D. C. Cook DCRDR program plan.

3.14.1 Objectives

The objectives of the conventions survey were to:

a. Identify the application of NUREG-0700 defined conventions that are applied across design features in the control rooms.

b. Determine if the applications of the identified conventions are consistent across the applicable design features.

c. Document any inconsistent or missing convention applications.

3.14.2 Scope

The scope of this survey was to evaluate the color, shape and arrangement coding applications across the design features and the review of all terms, abbreviations and acronyms for consistent application across the design features in the control rooms. The convention topics evaluated include:

- o Tile legends abbreviations
- o Coding of controls
- o Color coding of controls and displays
- o Legend light indicators
- o Label content consistency
- o Enhancements of emergency controls
- o Arrangement order and labeling

3.14.3 Criteria

The criteria applied in this survey, identified by NUREG-0700 paragraph numbers are: paragraphs 6.3.3.4d; 6.3.4.2b; 6.4.2.2a, b, f(1) and (2); 6.4.3.3a; 6.5.1.6a, b(2), c(1) and (2), d(1) through (3); 6.5.3.2a(2); 6.6.3.3.a; 6.6.6.4c(1) and (2); 6.8.1.3c and d; 6.8.2.2a and b; 6.8.2.3a and b; 6.8.3.2b, c(1) and (2). The detailed definitions for the criteria are presented in Table 3.14.

3.14.4.1 Data Collection

a. Data were collected using the checklists contained in the conventions survey task plan.

b. Data were collected primarily through documentation review and direct observation. Plant documentation was reviewed for the application and control of terms, abbreviations and acronyms. An observation review was conducted to identify the application of color coding and the use of terms, abbreviations and acronyms for control and display labels.

3.14.4.2 Analysis -- Data were analyzed according to the following procedure:

a. All deviations from the criteria were recorded on CLO reports. Recorded information included the equipment involved, a description of the problem, including the NUREG-0700 paragraph number of the criteria and a recommended solution.

b. The data collection description was also recorded on the CLO form. Where data from two or more sources were contradictory, resolution was achieved through data review and discussions with cognizant D. C. Cook personnel.

3.14.5 Findings

The findings of the conventions survey are presented in TAble 3.14 "Conventions Survey Findings and CLOs Generated." A total of 26 criteria were applied to the D. C. Cook control rooms. Of the criteria applied, 3 were not applicable and 2 were not violated. One of the violated criteria was covered and recorded in the verification task. Thirteen CLOs were generated which documented the remaining 20 criteria violated. One CLO was later deleted and its information combined with others in this survey. The CLOs describe inconsistency in abbreviations for legends, control coding, pushbutton legends discriminability and redundancy, meaning of colors, and legend arrangement and layout.

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SURVEY FINDINGS AND CLOs GENERATED

TABLE 3.14

	N/A	YES	NO	COMMENTS
6.3.3.4 VISUAL TILE LEGENDS				
d. ABBREVIATIONS — Abbreviations and acronyms should be consistent with those used elsewhere in the control room.			X	CLO#8.1-13
6.3.4.2 CONTROL SET DESIGN				
b. CONTROL CODING — Annunciator response controls should be coded for easy recognition using techniques such as: (1) Color coding; (2) color shading the group of annunciator controls; (3) demarcating the group of annunciator controls; or (4) shape coding, particularly the silence control. (See Exhibit 6.3-5, Example 2.)			X	Only location coding used. CLO#8.1-7
6.4.2.2 CODING OF CONTROLS (Exhibit 6.4-3)				
a. CONSISTENCY — The coding system should be uniform throughout the control room.			X	CLO#8.1-10
b. LOCATION CODING — Controls should be located so as to be easily related to functions and functional groupings. Controls with similar functions should be in the same location from panel to panel. (See Guideline 6.8.2.3.)			X	CLO#8.1-10 and 4.1-10
f. COLOR CODING (1) Color coding should follow the recommendations of Guideline 6.5.1.6. (2) When color coding is used to relate a control to its corresponding display, the same color should be used for both the control and the display.			X	CLO#8.1-10
6.4.3.3 LEGEND PUSHBUTTONS				
a. DISCRIMINABILITY — Legend pushbuttons should be readily distinguishable from legend lights.			X	CLO#8.1-3

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.14

6.5.1.6 COLOR CODING

Item	N/A	YES	NO	COMMENTS
a. **REDUNDANCY–In all applications of color coding, color should provide redundant information. That is, the pertinent information should be available from some other cue in addition to color.**			X	CLO#8.1-8
b. NUMBER OF COLORS				
(2) The number of colors used for coding shuld not exceed 11.		X		
c. MEANING OF COLORS				
(1) **The meaning attached to a particular color should be narrowly defined.**			X	CLO#8.1-11
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.			X	CLO#8.1-6
d. CONSISTENCY OF MEANING				
(1) The meaning assigned to particular colors should be consistent across all applications within the control room.			X	CLO#8.1-11
(2) The meaning of a particular color should remain the same whether applied to panel surfaces or projected in signal lights or on CRTs.			X	CLO#8.1-11
(3) The meaning of a particular color should remain the same both within and among the various systems to which it is applied.			X	CLO#8.1-11

SURVEY FINDINGS AND CLOs GENERATED TABLE 3.14

	N/A	YES	NO	COMMENTS
6.5.3.2 DESIGN AND USE OF NONLEGEND LIGHT INDICATORS				
a. IDENTIFICATION OF MEANING				
(2) The color of the light indicator when transilluminated should conform to the general code established for the control room. (See Guideline 6.5.1.6.)			X	CLO#8.1-11
6.6.3.3 LABEL CONTENT CONSISTENCY				
a. ADMINISTRATIVE CONTROL — A list of standard names, acronyms, abbreviations, and part/system numbers should be in place and administratively controlled.			X	CLO#8.1-12
6.6.6.4 USE OF MIMICS				
c. SYMBOLS				
(1) Graphic symbols should be readily understood and commonly used.	X			Graphic symbols not used.
(2) Symbols should be used consistently.	X			Graphic symbols not used.
6.8.1.3 ENHANCING RECOGNITION AND IDENTIFICATION				
c. COLOR SHADING — Color shading may be used to enhance recognition of controls, displays, or functional groups. When color shading is used, colors should provide adequate contrast, and should be consistent with other color coding in the control room.	X			Color shading not used.
d. EMERGENCY CONTROLS — Distinctive enhancement techniques should be used for emergency controls.			X	CLO#8.1

SURVEY FINDINGS AND CLOs GENERATED — TABLE 3.14

	N/A	YES	NO	COMMENTS
6.8.2.2 LOGICAL ARRANGEMENT AND LAYOUT				
a. ORDER AND LABELING – Components should be arranged left-to-right and/or top-to-bottom, and be identified in alphabetic or numeric sequence.			X	CLO#8.1-4 and 9.1-7
b. OTHER EXPECTATIONS – Where other operator expectations can be identified, components should be arranged to match these expectations.			X	More dependent upon control room V&V. CLO#9.1-7
6.8.2.3 LAYOUT CONSISTENCY				
a. REPEATED FUNCTIONS – The layout of identical control or display sets should be consistent at all locations.			X	CLO#8.1-2
b. MIRROR-IMAGING – Layouts of repeated functions should not be mirror-imaged.			X	CLO#8.1-2
6.8.3.2 STRINGS OR CLUSTERS OF SIMILAR COMPONENTS				
b. STRING LENGTH–Strings of small displays should not exceed about 20 inches on the control board.		X		
c. NUMBER OF COMPONENTS				
(1) No more than 5 similar components should be laid out in an unbroken row or column.			X	CLO#8.1-5
(2) If more than 5 similar components must be laid out together, the string or cluster should be broken up by techniques such as physical spacing or demarcation (see Exhibit 6.8-5).			X	CLO#8.1-5

4.0 SYSTEM FUNCTION REVIEW AND TASK ANALYSIS AND VERIFICATION AND VALIDATION

4.1 System Function Review and Task Analysis

The system function review and task analysis forms the basis for the verification of task performance capabilities and the validation of control room functions.

4.1.1 Introduction

The System Function Review and Task Analysis (SRTA) program systematically evaluated and identified the needs of the control room operations crew in response to emergency transients. The SRTA process and documentation was based on the methodology (see Reference 1) developed by the Westinghouse Owners Group (WOG) and the NRC clarification comments (see Reference 2) on task analysis provided to the WOG at the March 29, 1984 meeting. The SRTA documentation provided the information required by the detailed control room design review DCRDR team to perform the Verification of operator task performance capabilities review phase of the DCRDR.

4.1.1.1 Background

The SRTA program was initiated in early 1984 concurrent with the Emergency Operating Procedures (EOP) Upgrade Program for the D. C. Cook Nuclear Plant. The initial SRTA program was based on the task analysis methodology developed by the WOG. Following the March 29, 1984 meeting with the NRC, the SRTA program was augmented to include an activity to define operator information and control needs and instrumentation and control characteristics. This additional activity was coordinated with this initial task analysis activity to provide a two-phase, comprehensive SRTA program.

4.1.1.2 Objectives

The first objective of the SRTA program was to provide task analysis requirements for emergency operations based on the D. C. Cook EOPs and to compile and organize these requirements in a manner to support the DCRDR. The task analysis documentation provided the DCRDR team with documentation that identified operator task requirements and associated instrumentation and control requirements. This objective addressed the recommendations in Section 3.4 of NUREG-0700, Guidelines for Control Room Design Review.

The second objective of the SRTA program was to define the instrumentation and control characteristics that are necessary for proper operator response to emergency transients. This objective addresses item 2 (development of a process), item 3 (identification of generic instrumentation and control characteristics and plant specific deviations) and item 4 (development and justification of instrumentation and control characteristics based on operator information and control needs) of the March 29, 1984 NRC meeting.

4.1.2 Task Analysis Program

The first phase of the SRTA program consisted of a systematic evaluation of representative plant emergency operations to identify operator actions and associated instrumentation and controls necessary to support operator response to emergency transients. The methodology and documentation were based on that developed by the WOG. The following subsections describe the selection of event sequences and EOPs for task analysis and the process used to analyze the EOPs to identify and document operator actions and the required instrumentation and controls.

4.1.2.1 Selection of Event Sequences and EOPs for Task Analysis

Task analysis data was developed for event sequences that reflect a spectrum of plant emergency operations. The event sequences selected comply with the recommendations in NUREG-0700, and ensure that the task analysis documentation address the important areas of emergency operations (e.g., event diagnosis, critical safety functions monitoring, high risk event sequences, etc.). In addition the event sequences selected representatively exercised the EOPs. The event sequences selected for task analysis are itemized in Table 4.1.

4.1.2.1 Selection of Event Sequences and EOPs for Task Analysis (Cont'd)

Based on the selected event sequences, the EOP set was reviewed to determine which procedures should be used in response to the above event sequences. In the symptom based EOP set, at least two EOPs (or portions thereof) and the critical safety function status trees are implemented in response to an emergency transient. Figure 4-1 schematically illustrates EOP implementation in response to a small break loss of coolant accident (LOCA). The review of EOP implementation for the selected event sequences identified the selected EOP to be task analyzed. The selected EOPs task analyzed are itemized in Table 4.2. This table also shows the event sequences for which the EOP is implemented. Note that the Critical Safety Function Status Trees were implemented for all event sequences. Through task analyzing these status trees documentation was developed for monitoring the plant safety state during emergency operations, independent of the emergency transient.

4.1.2.2 Process for Identification of Operator Actions

Having selected the subset of EOPs to be used, the task analysis process was applied to each EOP to identify the operator actions necessary to implement the EOP in response to emergency transients. Following identification of operator actions, the necessary instrumentation and control requirements to support the operator actions were identified. This detailed information (in addition to general information on the operator function and the purpose of each EOP step) was documented on Element Tables (see Figure 4-2) similar in format to those developed in the WOG SRTA program.

The documents used for task analysis were the generic ERGs, the plant specific EOPs and the plant specific design and operational source documentation (flow diagrams, system descriptions, electrical diagrams, etc.). The task analysis activity was a table top evaluation of the plant specific source documentation and identified the operator actions and associated instrumentation and control requirements necessary to support operator response to emergency transients. The table top evaluation was performed based on the existing plant design and was independent of the existing control room configuration and the specific instruments and controls contained therein. The task analysis process was performed as follows:

1. Each EOP step was evaluated to identify the operator function(s) that the step supported and the purpose for the step. This information was entered at the top of the table.

TABLE 4.1

SELECTED EVENT SEQUENCES FOR TASK ANALYSIS

1. Spurious Safety Injection
2. Loss of reactor coolant (small break 1 inch diameter)
* 3. Loss of reactor coolant (small break 4 inch diameter)
4. Loss of reactor coolant (large break)
5. Loss of secondary coolant
6. Combined loss of reactor and secondary coolant
7. Steam generator tube rupture (design basis)
* 8. Steam generator tube rupture (multiple ruptures in one steam generator)
* 9. Steam generator tube rupture (ruptures in more than one steam generator)
* 10. Anticipated transient without scram
* 11. Inadequate core cooling (resulting from failures in emergency core cooling system)
12. Inadequate core cooling (resulting from loss of secondary heat sink)
13. Pressurized thermal shock transient
14. High containment pressure transient

* Event sequences recommended in NUREG-0700

EOP USAGE FOR LOSS OF REACTOR COOLANT (SMALL BREAK)

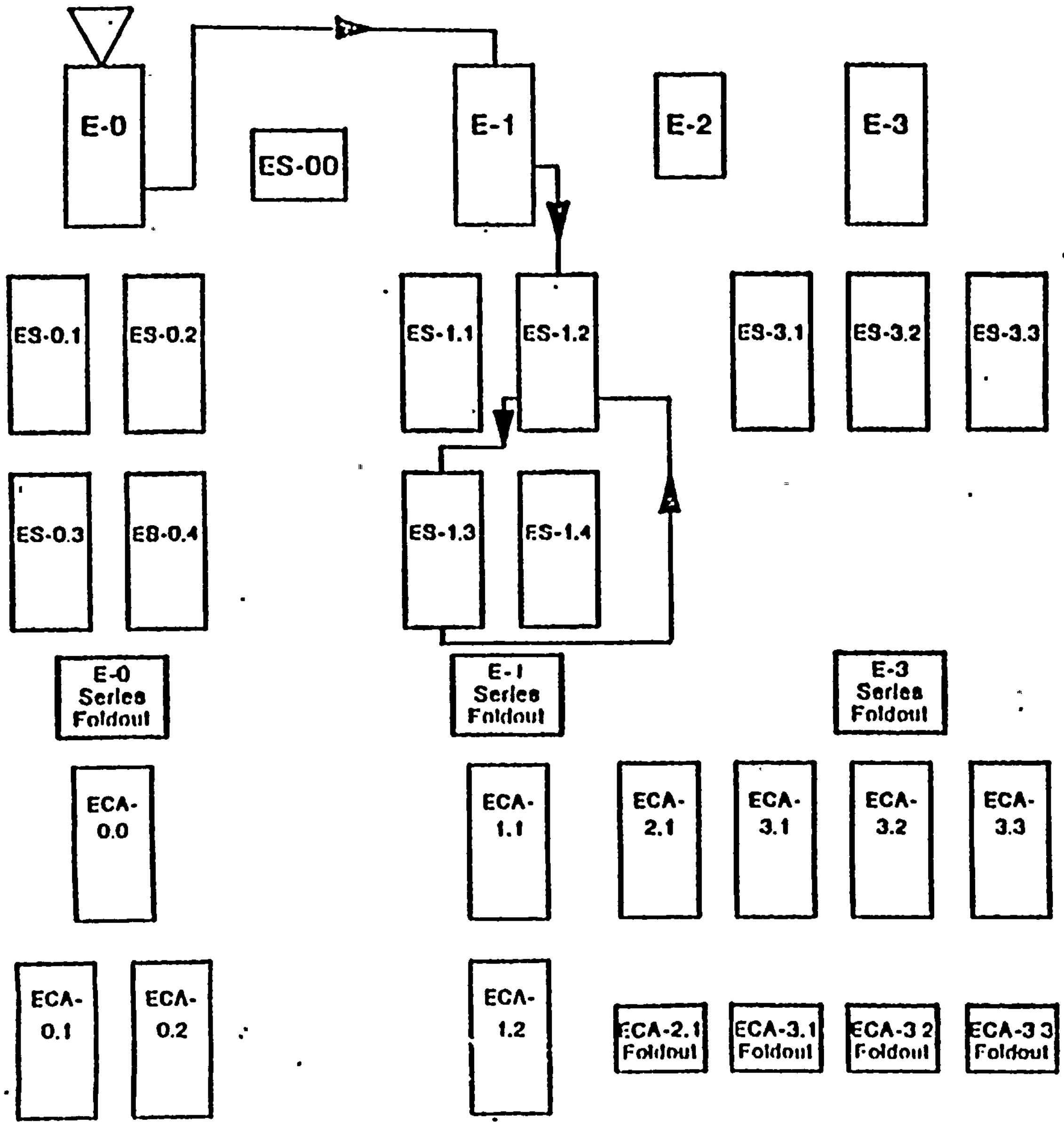


Figure 4.1

TABLE 4.2

SELECTED EOPs FOR TASK ANALYSIS

EOPs	Sequences
Reactor Trip or Safety Injection	All
SI Termination	1,2,5,12
Loss of Reactor or Secondary Coolant	2,3,4,5,6
Post-LOCA Cooldown and Depressurization	2
Transfer to Cold Leg Recirculation	4
Transfer to Hot Leg Recirculation	4
Faulted Steam Generator Isolation	5,6
Steam Generator Tube Rupture	7,8,9
Post-SGTR Cooldown Using Steam Dump	7,8,9
Critical Safety Function Status Trees	All
Response to Nuclear Power Generation/ATWS	10
Response to Inadequate Core Cooling	11
Response to Loss of Secondary Heat Sink	12
Response to Imminent Pressurized Thermal Shock Conditions	13
Response to High Containment Pressure	14

ELEMENT TABLE FOR E-0 STEP 1

FUNCTION: Verify automatic actuations
Diagnose plant condition

STEP: Verify Reactor Trip

PURPOSE: To ensure that the reactor has tripped

ACTIONS:

- o Determine if the reactor has tripped:
  - Rods are at bottom
  - Reactor trip and bypass breakers open
  - Rod position indication at zero
  - Neutron flux decreasing
- o Trip the reactor

INSTRUMENTATION:

- o Control rod bottom lights indication (rods at bottom)
- o Power range neutron flux indication (decreasing)
- o Intermediate range neutron flux indication (decreasing)
- o Source range neutron flux indication (decreasing)
- o Control rod position indication (at zero)
- o Reactor trip and bypass breaker position indications (open)

CONTROL/EQUIPMENT:

Reactor trip switches (trip)

Figure 4-2

4.1.2.2 Process for Identification of Operator Actions (Cont'd)

2. The step was then systematically reviewed to identify the operator actions necessary to implement each EOP step. Since the EOPs frequently utilize concise task statements to trigger operator actions, all actions that are needed for operation of plant systems were not explicitly identified in the EOPs. Where appropriate, the task analysis included identification of the specific actions necessary to perform the tasks identified in the EOPs. The operator actions were then entered on the Element Table.

3. Each operator action was then evaluated to identify the instrumentation and controls necessary for the operator to perform the necessary actions. This evaluation of instrumentation and controls also identified the instrumentation and control criteria requirements necessary for proper performance of operator actions. The instrumentation and controls were entered on the Element Table. Criteria requirements (e.g. decreasing, at zero, etc.) were included in parentheses following the associated instrumentation and controls.

With respect to the task analysis process, any cautions and notes that preceded EOP steps were considered as part of the step and were analyzed on separate Element Tables.

Following preparation of the Element Tables for the selected EOPs, the remaining EOPs were reviewed to identify any operator actions, instrumentation or controls existing in the remaining EOPs but not the selected EOps. This review ensured that the selected EOPs were representative of emergency operations. Any unique actions, instrumentation, or controls identified in this review were included in the task analysis process and identified on Element Tables. This approach provided representative task analysis documentation in an efficient manner while ensuring complete identification of operator actions, instrumentation, and controls utilized in emergency operations.

4.1.2.3 Compilation of Instrumentation and Control Requirements

Following completion of the task analysis process, the resulting information was compiled on summary tables which highlighted specific information. This was especially advantageous for instrumentation and controls since all uses for a specific instrument or control are presented on a single Requirements Table, precluding the need for a user to review all Element Tables to obtain the same data. Consequently, following

4.1.2.3 Compilation of Instrumentation and Control Requirements (Cont'd)

completion of the Element Tables for the selected EOPs and unique emergency operator actions, the instrumentation and control requirements were compiled on Instrumentation Requirements Tables (see Figure 4-3) and Control/Indication Requirements Tables (see Figure 4-4), respectively, similar in format to those developed in the WOG SRTA program.

4.1.2.4 Compilation of System Sequence Requirements.

As part of the task analysis process to identify and evaluate operator actions, plant systems were reviewed to identify equipment (instrumentation and controls) that must be used to accomplish operator actions. Following completion of the task analysis process, the resulting information on operator actions and plant systems were compiled to show the sequence in which the operator uses the plant systems in implementing the EOPs. A System Sequence Matrix was prepared for each selected EOP to show the plant systems that were used to perform each step in the EOP. As with other task analysis documentation, the System Sequence Matrices (see Figure 4-5) are similar in format to those developed in the WOG SRTA program.

4.1.3 Identification of Instrumentation and Control Characteristics

The second phase of the SRTA program identified and justified the instrumentation and control characteristics that are necessary for proper operator response to emergency transients. This phase addressed item 2 (development of a process), item 3 (identification of generic instrumentation and control characteristics and plant specific deviations) and item 4 (development and justification of instrumentation and control characteristics based on operator information and control needs) of the March 29, 1984 NRC meeting.

This Instrumentation and Control Characteristics Review (ICCR) phase included the definition of a process and the development of documentation to identify instrumentation and control characteristics based on operator information and control needs during emergency operations. The process and documentation addressed all instrumentation and controls used in the WOG ERGs and plant specific EOPs. Basis documentation was based on the same representative event sequences and emergency operating procedures utilized in Phase 1 of the program.

INSTRUMENTATION REQUIREMENTS TABLE

SYSTEM: Reactor Coolant

INSTRUMENTATION: RCS Pressure (NPS-121,122)

CRITERIA REQUIREMENTS	PROCEDURE	STEP
1. Less than 1630 psig	E-0	10
2. Less than 300 psig	E-0	10 35C
3. Less than 1250 psig	E-0 E-1 E-3	21 1 1
4. Stable or increasing	E-0	25 35
	E-1	6 9
	ES-1.1	5 9
	ES-1.2 E-3	5 2
5. Greater than 300 psig	E-0 E-1	35 9 14
	ES-1.2 E-3	5 12C 12

Figure 4-3

CONTROL/INDICATION REQUIREMENTS TABLE

SYSTEM: Emergency Core Cooling

CONTROL/INDICATION: SI Pump Discharge Valves Control and Status (ICM-260, 265)

CRITERIA REQUIREMENTS	PROCEDURE	STEP
Open/Close	E-0	11
	FR-C.1	16
		23
	FR-H.1	11

Figure 4-4

SYSTEM SEQUENCE MATRIX TABLE

PROCEDURE: E-0, REACTOR TRIP OR SAFETY INJECTION

STEP	AFS	APS	BMS	CAS	CCW	CIS	CON	CSS	CVC	CVS	ECC	EDG	ESF	ESW	FWS	GEN	HMS	MIS	MSS	NES	NHS	NIS	NSS	PWS	RCS	RDC	RHR	RMS	RPS	SDS	SGP	WDS			
1-N																																			
1																						●				●			●						
2																			●																
3																													●						
4																			●																
5-N																																			
5																●																			
6					●					●			●																						
7							●						●						●						●										
8	●																																		
9	●				●						●			●							●	●		●											
10	●																		●																
11									●		●			●																					
12					●																														
13														●																					
14										●																									
15							●												●																
16-C																																			
16					●			●					●	●																					
17																									●										
18	●																					●													
19	●														●							●			●										
20							●																												
21					●					●	●		●		●									●											

Matrix Table

Figure 4-5

4.1.3.1 Definition of ICCR Process

The ICCR phase first identified generic characteristics based on the WOG high-pressure reference plant design, followed by the identification of plant specific deviations (i.e., differences and detail) and their characteristics. Characteristics were justified through development of or reference to appropriate generic or plant specific basis documentation.

The ICCR process used is as follows:

1. The set of operator functions for response to emergency transients were defined.

2. The generic ERGs were then reviewed and guideline steps were associated with operator functions.

3. For each operator function, the generic ERG background documentation (Step Description Tables) was reviewed to identify:

   o major operator actions necessary to support the operator functions.

   o operator information and control needs necessary to support the operator functions and major actions.

   o plant systems necessary to provide information and control needs.

   o plant instrumentation and controls necessary to provide information and control needs.

4. For plant instrumentation and controls identified in item 3) above, generic characteristics were identified based on the required information and control needs.

   a) Characteristics for instrumentation included:

      o Units - the identification of a parameter in terms of specific quantities for which timely and accurate information can be viewed (examples: psig; %; °F; etc.).

      o Range - the interval over which a parameter may vary during the task performance based on analysis or engineering judgment (examples: 0 to 3000 psig; 250-500°F, 0-100%; etc.).

4.1.3.1 Definition of ICCR Process (Cont'd)

- Resolution - the quality of a display required to make an adequate determination of a parameter's value or performance for task cuing, or timely and accurate feedback information during a task (examples: greater than 1837 psig; less than 14%; greater than 1200^{o}F, etc.)

- Accuracy - a quantitative minimum for an information loop's performance to ensure entry into a task is appropriately cued, or the task performance is maintained within any specific limits (analytical or engineering). (Examples: plus or minus 31 psi; plus or minus 2^{o}F; etc.)

- Response Time - the quantitative maximum for which feedback information on a task's performance and subsequent cuing is required based on analysis or engineering judgment. (Example: 10 sec.).

- Display type - the type of visual information required to support task performance, classified as one or more of the following:

  a) discrete or instantaneous (single value)

  b) continuous (multiple values within a range)

  c) trending (changing values within a range over a time period)

4.1.3.1 Definition of ICCR Process (Cont'd)

b) Characteristics for indications and controls included:

- o Positions - the identification of the status of a control or indication required for making an adequate determination for verification of or performance of a specific task (examples: open; closed; throttled; on; off; etc.).

- o Response Time - a quantitative maximum for which the feedback performance is adequate to prevent excessive rates of change during the task performance (example: stroke time of 10 sec.).

- o Type - the type of control required to support task performance, classified as one or both of the following:

  a) continuous (variable control)

  b) discrete (individual position(s) control)

5. From the information gathered in items 3) and 4) above, a Characteristics Justification Table was developed for instrumentation and controls. This table identified operator action categories and associated operator information needs, criteria (e.g., specific values for instrumentation) and characteristics (e.g., range, resolution, accuracy, etc. for instrumentation). The basis for each action category or information need was described or a reference to other documentation was given.

   The Characteristics Justification Tables were formatted to present both generic and plant specific characteristics, facilitating their development and the comparison of generic to plant specific characteristics. Figure 4-6 (instrumentation) and Figure 4-7 (controls/indications) show examples of the subject tables. These figures show example information for the action categories and associated generic characteristics.

CHARACTERISTICS JUSTIFICATION TABLE

INSTRUMENTATION: RCS Pressure

ERG REQUIREMENTS		CHARACTERISTICS							
ACTION CATEGORY/INFORMATION NEEDS		CRITERIA	VALUE	RANGE	ACC	RESOL	UNITS	RESP	TYPE
1. RCP Trip RCS Pressure in SG U-tubes. less than RCS saturation pressure. (RCP Trip/Restart Generic Issue Background Document, Section 2.3.1.1.)	P								
	G	Less than	P1	NA	NA	NA	PSIG	NA	D
2. SI Termination a. Flow into RCS exceeds flow out of RCS (SI Termination/Reinitiation Background Document, Section 2.1)	P								
	G	Stab or Incr	Value	NA	NA	NA	PSIG	NA	T
b. SI pump flow is zero; RCS pressure greater than SI pump shutoff head (SI Termination/Reinitiation Background Document, Section 2.1)	P								
	G	Greater than	P2	NA	NA	NA	PSIG	NA	D.
c. RHR pump flow is zero; RCS pressure greater than RHR pump shutoff head. (E-1 Background Document, Section 4.0. SDT for Step 9)	P								
	G	Greater than	P3	NA	NA	NA	PSIG	NA	D.

Characteristics Table

Figure 4-6.

CHARACTERISTICS JUSTIFICATION TABLE

CONTROLS / INDICATION: SI Pump Discharge Valves

ERG REQUIREMENTS			CHARACTERISTICS			
ACTION CATEGORY/INFORMATION NEEDS		CRITERIA	POSITIONS	RESP. TIME	TYPE	COMMENTS
1. Verify equipment status: Valves that are required to be open to provide SI flow to the RCS are open. (E-0 Background Document, Section 4, SDT for Step 11)	P					
	G	open	open	NA	Discrete	
2.	P					
	G					

Characteristics Table

Figure 4-7

4.1.3.1 Definition of ICCR Process (Cont'd)

6. Following identification of the generic characteristics in item 5), the plant specific characteristics were identified. The plant specific characteristics consist of applicable generic characteristics and plant specific deviations (i.e., characteristics that differ from generic due to design differences and characteristics for plant specific design features beyond the scope of the generic design).

   To identify plant specific characteristics, the selected subset of plant specific EOPs were reviewed to identify deviations from the generic ERGs. These deviations were evaluated with respect to ICCR process items 3) and 4) above. Characteristics for deviations were identified consistent with ICCR process item 5) above. These plant specific characteristics (consisting of identified deviations and applicable generic characteristics) were then entered on the Characteristics Justification Tables.

   Figure 4-8 (instrumentation) and Figure 4-9 (controls/indications) show examples of the subject tables with plant specific characteristics included. These example tables are identical to Figures 4-6 and 4-7, respectively, except that they include plant specific characteristics, appearing as they were upon completion of ICCR process item 6). The tables facilitate comparison of generic (identified by the letter G) and plant specific (identified by the letter P) characteristics for each operator action category/information need entry.

7. Generic and plant specific characteristics are summarized on Characteristics Comparison Summary Tables for instrumentation (see Figure 4-10 for example) and controls/indications (see Figure 4-11 for example). These tables summarize the limiting requirements for each characteristic.

8. The limiting plant specific characteristics identified in item 7) were then added to the Instrumentation Requirements Tables (see Figure 4-12 for example) and Control/Indication Requirements Tables (see Figure 4-13 for example). This consolidated all criteria and characteristics on a single Requirements Table for each instrument and control.

CHARACTERISTICS JUSTIFICATION TABLE

INSTRUMENTATION: RCS Pressure

ERG REQUIREMENTS		CHARACTERISTICS							
ACTION CATEGORY/INFORMATION NEEDS		CRITERIA	VALUE	RANGE	ACC	RESOL	UNITS	RESP	TYPE
1. RCP Trip RCS Pressure in SG U-tubes less than RCS saturation pressure. (RCP Trip/Restart Generic Issue Background Document, Section 2.3.1.1.)	P	Less than	1300	1170-1430	300 A 100 N	20	PSIG	10	D
	G	Less than	P1	NA	NA	NA	PSIG	NA	D
2. SI Termination a. Flow into RCS exceeds flow out of RCS (SI Termination/Reinitiation Background Document, Section 2.1)	P	Stab or Incr	Value	1600-2235	300 A 100 N	50	PSIG	10	T
	G	Stab or Incr	Value	NA	NA	NA	PSIG	NA	T
b. SI pump flow is zero: RCS pressure greater than SI pump shutoff head (SI Termination/Reinitiation Background Document, Section 2.1)	P	Greater than	1630	1470-1790	100 A 100 N	20	PSIG	10	D.
	G	Greater than	P2	NA	NA	NA	PSIG	NA	D.
c. RHR pump flow is zero: RCS pressure greater than RHR pump shutoff head. (E-1 Background Document, Section 4.0, SDT for Step 9)	P	Greater than	300	270-330	100 N	20	PSIG	10	D.
	G	Greater than	P3	NA	NA	NA	PSIG	NA	D.

Characteristics Table

Figure 4-8

CHARACTERISTICS JUSTIFICATION TABLE

CONTROLS / INDICATION: SI Pump Discharge Valves

ERG REQUIREMENTS			CHARACTERISTICS			
ACTION CATEGORY/INFORMATION NEEDS		CRITERIA	POSITIONS	RESP. TIME	TYPE	COMMENTS
1. Verify equipment status: Valves that are required to be open to provide SI flow to the RCS are open. (E-0 Background Document, Section 4, SDT for Step 11)	P	open	open	NA	Discrete	
	G	open	open	NA	Discrete	
2.	P					
	G					

Characteristics Table

Figure 4-9

CHARACTERISTICS COMPARISON SUMMARY TABLE

INSTRUMENTATION		RANGE	ACCURACY	RESOL	UNITS	RESP	TYPE	COMMENTS
1. RCS Pressure	P	0-2750	300 A	20	PSIG	10 sec.	C, T, D	
	G	NA	NA	NA	PSIG	NA	C, T, D	
2. Pressurizer Level	P	0-100	10 A, 5 N	5	%	5 sec.	C, T	
	G	NA	NA	NA	%	NA	C, T	
3. PRZR Pressure	P	1700-2500	80 A, 10 N	20	PSIG	5 sec.	C, T, D	
	G	NA	NA	NA	PSIG	NA	C, T, D	
4. SG Narrow Range Level	P	0-100	25 A, 5 N	5	%	5 sec.	C, T, D	
	G	NA	NA	NA	%	NA	C, T	

Characteristics Summary Table

Figure 4-10

CHARACTERISTICS COMPARISON SUMMARY TABLE

CONTROLS / INDICATION		POSITIONS	RESP. TIME	TYPE	COMMENTS
1. SI Pump Discharge Valves	P	open,closed	60 secs.	Discrete	
	G	open,closed	NA	Discrete	
2.	P				
	G				
3.	P				
	G				
4.	P				
	G				

Characteristics Summary Table

Figure 4-11

INSTRUMENTATION REQUIREMENTS TABLE

SYSTEM: Reactor Coolant

INSTRUMENTATION: RCS Pressure (NPS-121,122)

UNITS: PSIG

RANGE: 0 TO 2750

RESOLUTION: 20

ACCURACY: 100 (normal containment); 300 (adverse containment)

RESPONSE TIME: 10 seconds

TYPE: Continuous; trending; discrete

CRITERIA REQUIREMENTS	PROCEDURE	STEP
1. Less than 1630 psig	E-0	10
2. Less than 300 psig	E-0	10 35C
3. Less than 1250 psig	E-0 E-1 E-3	21 1 1
4. Stable or increasing	E-0	25 35
	E-1	6 9
	ES-1.1	5 9
	ES-1.2 E-3	5 2
5. Greater than 300 psig	E-0 E-1	35 9 14
	ES-1.2 E-3	5 12C 12

Figure 4-12

CONTROL/INDICATION REQUIREMENTS TABLE

SYSTEM: Emergency Core Cooling

CONTROL/INDICATION: SI Pump Discharge Valves Control and Status (ICM-260, 265)

POSITIONS: Open/Close

RESPONSE TIME: 10 seconds

TYPE: Discrete

CRITERIA REQUIREMENTS	PROCEDURE	STEP
Open/Close	E-0	11
	FR-C.1	16
		23
	FR-H.1	11

Figure 4-13

4.1.4 Summary of Task Analysis Documentation

The documentation resulting from the SRTA program consisted of the following:

- o Element Tables

  The element tables identify the operator actions necessary for response to emergency transients, including identification of specific instrumentation and control requirements necessary for implementation of operator actions. These tables were developed in Phase 1 of the SRTA program.

- o Instrumentation and Control Requirements Tables

  The Requirements Tables compile the specific criteria and characteristic requirements for instrumentation and controls necessary for implementation of operator actions. These tables were developed and specific criteria was identified in Phase 1 of the SRTA program. Characteristics were identified in Phase 2 and added to the subject tables. Separate tables were provided for each instrument or control.

- o System Sequence Matrice

  The System Sequence Matrices identify the sequence in which the operator uses plant systems in response to emergency transients. Separate matrices were provided for each selected EOP that was task analyzed. These matrices were developed in Phase 1 of the SRTA program.

4.1.5 Use of Task Analysis Documentation in Verification of Operator Task Performance Capability

4.1.5.1 The objective of Verification of Operator Task Performance capability is to assure that operator tasks can be performed in the existing control room with minimum potential for human error. Verification evaluates task execution at each work station and consists of:

- o Verification of Availability

  Verification of the presence (or absence) of instruments and equipment that provide the information and control capabilities necessary to implement operator actions.

- o Verification of Suitability

  Verification that the man-machine interfaces provided by the displays controls and other control room features are effectively designed to support operator actions.

4.1.5.2 The task analysis documentation was structured to support a Verification process consisting of verification of operator action performance capability and verification of instrumentation and control characteristics. The following subsection describe the use of the task analysis documentation in supporting these two activities of the verification process.

4.1.5.2.1 <u>Verification of Operator Action Performance Capability</u>

The verification activity consists of evaluating the availability and suitability of control room instrumentation and controls to support performance of operator actions. The Element Tables are used for this activity. These tables present the operator actions and associated instrumentation and control requirements identified in Phase 1 of the task analysis program.

For each Element Table, the multidisciplinary DCRDR review team systematically reviewed the operator actions itemized under the ACTIONS heading. As each action was reviewed, the DCRDR team located the instrumentation and controls in the control room necessary to support the operator actions. Having located the instrumentation and controls, the team evaluated the suitability of the instrumentation and controls for performing the operator actions. The suitability evaluation was structured to evaluate the specific operator action criteria (e.g., greater than 1500 psig, less than 700^{o}F, etc.) upon which operator actions are based. The team utilized the information under the INSTRUMENTATION and the CONTROLS headings to identify criteria requirements. In working through each Element Table, the team evaluated all entrees under the ACTIONS, INSTRUMENTATION and CONTROLS headings to ensure that the task analysis documentation is complete and self-consistent.

4.1.6 <u>Use of Task Analysis Documentation in Validation of Operator Functions</u>

The objective of Validation of Control Room Functions is to determine whether the functions of the control room operating crew can be accomplished effectively within (1) the structure of defined emergency operating procedures, and (2) the design of the control room as it exists. Validation evaluates operator function execution within the integrated control room configuration and consists of walk and talk-throughs of selected event sequences with control room personnel.

The emergency operating procedures are the appropriate documents for use by the control room personnel in directing their response to the selected event sequences. Although not specifically developed or needed for Validation, the Element Tables of the SRTA program were used by the DCRDR team as a source document with which to observe the response of the operators to the event sequences. Since the Element Tables were developed based on the procedures, these tables itemize detailed operator actions and associated instrumentation and control requirements necessary for proper response to emergency transients. Through comparing the actions in the Element Tables with the operator walk-through actions, discrepancies were noted and discussed in the talk-through portion of the validation.

4.1.7 Program Control

The D. C. Cook SRTA program was structured with appropriate provisions for management, staffing (including qualifications), and documentation control. These provisions are discussed below.

Program Management and Staffing

Technical management of the SRTA Program was performed by Westinghouse Nuclear Technology Division (NTD) engineering personnel responsible for development of the Westinghouse Owners Group Emergency Response Guideline (ERG) program (including generic guideline basis documentation and System Review and Task Analysis (SRTA) documentation) and plant-specific Emergency Operating Procedure (EOP) Development Programs (including the EOP Upgrade Program for the D. C. Cook Plant). Personnel staffing the program was drawn from functional groups within Westinghouse NTD which had experience in the WOG programs, development of plant specific EOPs and system review and task analysis documentation, definition of Regulatory Guide 1.97 functional requirements and characteristics, and licensing activities related to these areas.

The Westinghouse NTD management interface for this program was Mr. Ralph Surman and the lead technical interface was Mr. Robert Orendi. Mr. Surman has had management responsibility with the WOG ERG and SRTA programs and has participated in WOG meetings with the NRC directed toward clarifying NRC requirements in this program area. Mr. Orendi has participated in the WOG programs and had lead responsibility for the development of the upgraded D. C. Cook EOPs. Mr. Orendi directed Phases 1 and 2 of the D. C. Cook SRTA program.

As an organization and individuals, Westinghouse and Westinghouse personnel have expertise and experience in all areas related to this program, having performed emergency response capability services for both the WOG and a number of individual utilities. Westinghouse NTD experience includes EOP development programs for D. C. Cook and support of the D. C. Cook control Room Design Review in the operations area of verification and validation.

Coordination of Program Documentation

The program documentation was developed in two phases as described in Paragraph 4.1.1.2. Mr. Orendi was responsible for assignment and coordination of the various activities and documents that comprise the Task Analysis Program. Mr. Orendi and Mr. Surman had responsibility to review all program documentation to ensure consistency, correctness and compliance with the requirements of the Task Analysis Program.

Control of Program Documentation

The program documentation was used in the Verification and Validation Phases of the D. C. Cook Control Room Design Review Program, as described in Paragraph 4.1.5. Use of Task Analysis Documentation in Verification, and Paragraph 4.1.6. Use of Task Analysis Documentation in Validation.

Prior to each activity, the requisite documentation was developed. Following Verification and Validation, the documentation was revised to incorporate any comments and observations that result from the activity. At the completion of the Verification and Validation activities, the documentation was finalized and issued as the initial version (Issue 0) of the completed program documentation. Any subsequent revision to program documentation can be issued as Revisions to the associated documentation sections (i.e., Revision 1, Revision 2, etc.).

4.1.8 References

1) Westinghouse Owners Group, Emergency Response Guidelines System Review and Task Analysis, Volumes 1,2A, 2B and 3, April 1, 1983.

2) NRC Memorandum from H. Brent Clayton to Dennis L. Ziemann, Meeting Summary-Task Analysis Requirements of Supplement 1 to NUREG-0737, March 29, 1984. Meeting with Westinghouse Owners Group (WOG) Procedures Subcommittee and Other Interested Persons, April 5, 1984.

4.2 Verification of Task Performance Capabilities

The verification of task performance capabilities was accomplished in accordance with the guidelines in NUREG-0700 and verification task program plan.

4.2.1 Methodology

The verification of task performance capabilities was divided into two parts: Verification of Availability and Verification of Suitability.

- Verification of Availability

  Each operator need (control, indication and instrument) identified in the System Review and Task Analysis element tables for emergency operating procedures was listed on a control/indication requirements table and an instrumentation requirements table. DCRDR review team members then compared the control/indication and instrumentation requirements tables with the control board mockup and the control room inventory to verify the availability. Any missing devices were recorded on a Checklist Observation Report.

- Verification of Suitability

  As was done for the verification of availability, DCRDR review team members compared the control/indication and instrumentation characteristics and criteria with the control board mockup and the control room inventory to ensure that the devices on the main control board have the characteristics (range, precision, positions, etc.) to support each operator task. All discrepancies were recorded on Checklist Observation Reports.

4.2.2 Staffing

The Design Review Team for the Verification Task was as follows:

NAME	FUNCTION	PARTICIPATION
R. F. Shoemaker	I&C Engineer (AEPSC)	30%
R. G. Orendi	Plant Operations & Evaluation (W)	100%
R. C. Hines	Plant Operations & Evaluation (W)	50%
C. R. Sterrett	Plant Operations & Evaluation (W)	50%
J. D. Young	Control Board Design (W)	100%
T. J. Voss	Human Factors Essex Corp.	On Call
T. R. Stephens	Plant Operations (I&M Co.)	On Call

4.2.3 Findings

The Verification of Task Performance Capabilities resulted in the identification of sixty-eight discrepancies. Checklist Observation Reports V1-1 through V1-68 were written to record these discrepancies. Table 4.3 lists these discrepancies.

TABLE 4.3

VERIFICATION TASK FINDINGS

CLO #	DESCRIPTION	NUREG-0700 PARAGRAPH #
V1-1	Part Length Rod Control System	6.4.1.1b & 6.5.1.1c
V1-2	Bus Voltmeter Scale Range	6.5.1.2d(1)
V1-3	Steamline Pressure Indicator Scale Units	6.5.1.5d
V1-4	Steamline Delta-P Indicator	6.5.1.1b
V1-5	Steamline Flow Indicator Scale Units	6.5.1.2b
V1-6	Containment Pressure Indicator Scale Graduations	6.5.1.2b
V1-7	Pressurizer pressure Indicator Scale Graduations	6.5.1.2b
V1-8	S/G FRV Isolation Values Control Arrangement	6.8.1.1b
V1-9	AFP Steam Supply Values Control Location	6.8.2.1a
V1-10	Total Auxiliary Feedwater Flow Indicator (None)	6.5.1.1b
V1-11	SI Pump Indicator Scales Difference	6.5.1.5d
V1-12	Containment Isolation-Phase A Indication	6.5.1.1e
V1-13	Containment Vent Fans Indication Labels	6.6.3.3c
V1-14	Steamline Radiation Monitor (Missing)	6.5.1.1b
V1-15	Sampleline Radiation Monitor (Missing)	6.5.1.1b
V1-16	Steam Generator Pressure Recorder (Missing)	6.5.1.1b
V1-17	H2 Igniters Switch Location	6.1.1.1b
V1-18	RHR Flow Indicators (Mirror Image)	6.8.3.3
V1-19	S/G PORV Controller Setpoint	6.4.1.1a(2)
V1-20	Steamline Pressure SI Block Indication	6.5.1.1
V1-21	Containment Ambient Temperature (Missing)	6.5.1.1a & b
V1-22	Feedpump Warming Controls (Not Needed)	6.7.1.1b & 6.5.1.1c
V1-23	Feedpump Hydraulic Couplings Controls (Not Needed	6.4.1.1b & 6.5.1.1c
V1-24	Feedwater Isolation Status (Missing)	6.1.1.1a
V1-25	SI Pumps Discharge Flow (Scale Markings)	6.5.1.2a
V1-26	Boron Injection Tank Indicator (Scale Markings)	6.5.1.2a
V1-27	Boron Injection Tank Header Pressure (Scale Markings)	6.5.1.2d
V1-28	Power Range Neutron Flux Recorders (Paper Scale)	6.5.4.1b & c
V1-29	Nuclear Recorder Scale Range	6.5.4.1c
V1-30	Spray Additive Tank Pressure (Scale Range)	6.5.1.2d(1)
V1-31	RCS Pressure Range Resolution	6.5.1.2a
V1-32	RCS Average Temperature Range	6.5.1.2d(3)

TABLE 4.3

(Continued)

VERIFICATION TASK FINDINGS

CLO #	DESCRIPTION	NUREG-0700 PARAGRAPH #
V1-33	RCS Subcooling Monitor Scale Units	6.5.1.1b
V1-34	RCS Hot & Cold Leg Temperature Recorders Scale Resolution	6.5.1.1.2d
V1-35	Pressurizer Relief Tank Temperature (Engraving)	6.6.3.1a
V1-36	RCS Loop Flow Indication (Scale Resolution)	6.5.1.2d
V1-37	RCP Seal Injection Flow Indication (Scale Range)	6.5.1.2a & d
V1-38	Reactor Letdown Flow Indicator Scale	6.5.1.2a & d
V1-39	Excess Letdown Pressure Indicator Engraving	6.5.1.4d
V1-40	Plant Air Header Pressure Indicator Scale Units	6.5.1.1b
V1-41	Control Air Pressure Indicators (Not Consistent)	6.5.1.4
V1-42	S/G Pressure Indicators (Resolution)	6.5.1.2a & d
V1-43	Steamline Flow Indicator Units	6.5.1.4
V1-44	Turb Driven Auxiliary Feedpump Speed Indicator Scale	6.5.1.5c
V1-45	Diesel Generator Kilowatt Meter Marking	6.5.1.5c
V1-46	Diesel Generator Trip Annunciators Location	6.3.3.3d(2)
V1-47	Core Exit T/C Indicator Scale Range	6.5.1.2d
V1-48	PRT Pressure Indicator Resolution	6.5.1.2d
V1-49	RCP CCW Upper Bearing Flow (Engraving)	6.6.3.2f
V1-50	Excess Condensate Letdown Flow Recorder Scale Units Missing	6.5.1.1b
V1-51	S/G Narrow Range Level Indicators (Identification)	6.6.3.1a
V1-52	Calibration Label Placement	6.6.2.4a
V1-53	MD Feedpumps Control Switches & Ammeter Location	6.8.2.3
V1-54	AFW Pumps Discharge Pressure Indicator Scale Range	6.5.1.2d(1)
V1-55	Transformer Ammeter Scale Markings	6.5.1.5c
V1-56	Backup Heating Boiler Status Missing	6.1.1.1a
V1-57	Switch Position Convention	6.4.2.1
V1-58	Safety Train Designation Not Identified	6.6.1.1
V1-59	Reactor & Pressurizer Head Vent Valves Nameplates	6.6.3.3b
V1-60	Switches Not In Main Control Room	6.1.1.1a(2)
V1-61	Switch Position Labels Do Not Agree With EOPs	6.6.3.3c
V1-62	Control Switch Type Not As Expected	6.4.1.1c(2) & 6.6.3.3c
V1-63	Value Nameplate Colors Varies For Same Function	6.5.1.6
V1-64	Value Numerical Order Not Consistent	6.8.2.2a
V1-65	Containment Purge Fans Switch Location Arrangement	6.8.2.2c
V1-66	Main Feed Pumps Trip & Trip Reset Switches Engraving	6.6.3.4c
V1-67	AFW Flow Control Valves Engraving	6.6.4.1a(2)
V1-68	Switch Type Different For Same Function	6.4.1.1c(2)

4.3 Validation of Control Room Functions

The validation of control room functions was accomplished in accordance with the guidelines of NUREG-0700 and the validation task program plan.

4.3.1 Methodology

Validation of Control Room Functions was performed at the D. C. Cook Unit 1 control room mockup. Operators performed walk-throughs of the following validation scenarios, developed from the system function review and task analysis and composed of the D. C. Cook Emergency Operating Procedures.

Validation Scenarios

NUMBER	TITLE
A-1	Reactor Trip
A-2	Anticipated Transient Without Scram (ATWS) from full power following loss of off site power
A-3	Loss of All Feedwater
A-4	Secondary Break Outside Containment
A-5	Steam Generator Tube Rupture in Different Steam Generators, plus Cooldown
A-6	Design Base Accident Loss of Coolant Accident (DBA LOCA) with Switchover
A-7	Intermediate LOCA - Post LOCA Cooldown
A-8	Steam Generator tube Leak Plus Spurious Safety Injection (SI)
A-9	Inadequate Core Cooling
A-10	Secondary Break - All S/G Stop Valves Fail to Close
B-4	Loss of All A.C. Power
C-1	Reactor Start Up from Hot Standby

4.3.1 Methodology

During the walk-through discrepancies were noted in three ways: by individual design review team members comparing the walk-through actions with NUREG-0700 Section 6 guidelines; by operator comments on operational difficulties, discrepancies or inconsistencies and by design review team members observations of operational difficulties.

Each of the walk-throughs were recorded on tape (both video and audio) for later use by the design review team and as part of the control room validation documentation. The tapings were performed with two cameras. One camera with wide angle view of the control room operating area and one close-up camera with a zoom lens to follow each operator action and permit the recording of the main control board device and control location.

Following each of the walk-throughs the operating crew was debriefed by the review team while viewing the tape from the zoom lens camera. The debriefing sessions were also video/audio taped. all discrepancies noted during the walk-through were discussed. A review team member recorded the discrepancies on a Talk-Through Problem Report Form for later analysis by the review team.

4.3.2 Staffing

The Design Review Team for the Validation Task was as follows:

NAME	FUNCTION	PARTICIPATION
R. F. Shoemaker	I&C Engineer (AEPSC)	100%
T. R. Stephens	Plant Operations (I&MECo)	60%
T. J. Voss	Human Factors (Essex Corp.)	50%
M. N. Francher	Human Factors (Essex Corp.)	100%
R. G. Orendi	Plant Operations & Evaluation (W)	100%
R. C. Hine	Plant Operations & Evaluation (W)	100%
J. D. Young	Control Board Design (W)	100%
W. R. Young	Control Board Design (W)	60%

4.3.3 Findings

The walk-through, talk-through sessions resulted in forty-seven talk-through problem reports being written. Sixteen of the talk-through problem reports were determined to be procedure problems. They were identified to the Procedure Validation Team for resolution. Six of the talk-through problems reports were identified as Checklist Observation Reports from the Human Factors Surveys and the Verification of Control Room Functions. Checklist Observation Reports V2-1 through V2-25 were written for the remaining twenty-five talk-through problem reports. Table 4.4 lists these discrepancies.

Seven additional CLOs identified during the Control Room Operating Personnel Interviews (CROPs) and during the Control Room Human Factors Surveys were determined to be part of the Validation Task. These additional CLOs are also listed in Table 4.4.

TABLE 4.4

VALIDATION TASK FINDINGS

CLO #	DESCRIPTION	NUREG-0700 PARAGRAPH #
V2-1	Mimic Bus Color Coding	6.6.6.4a &
V2-2	Turbine Load Limiter Control Label Missing	6.4.1.1.1
V2-3	Boron Injection Tank Flow Indicator Scale Range	6.5.1.5e
V2-4	Pressurizer Pressure Indicator Spacing	6.9.1.2
V2-5	Containment Pressure Relief Controls Location	6.6.6.1
V2-6	Steam Generator PORVs Indicating Lights (Missing)	6.4.4.5d
V2-7	FW Isolation Valve Controls Note Sequential	6.9.2.1 & 6.9.2.2
V2-8	Reactor Trip Backup Controls	6.4.1.1
V2-9	Generator Voltage Regulator Switch Position Label	6.6.3.2a
V2-10	Unit Auxiliary Power Transfer	--------
V2-11	Condensate Storage Tank Level Recorder Units	6.5.1.5d
V2-12	Containment Isolation Phase A Indicating Lights	6.5.1.1b
V2-13	Low Pressure Water Source Listing	6.1.1.1a
V2-14	RCS-Wide Range Pressure Channels	6.5.1.1b
V2-15	Indicator Color Coding Convention	6.5.1.6d
V2-16	Isolation Phase A Value Controls Locations	6.8.1.2 & 6.8.1.1a
V2-17	Pressurize Spray Valves Position Indication	6.4.4.5d
V2-18	Indicating Light Function (White or Amber Lights)	6.5.3.2a
V2-19	Indicators/Recorders Layout Convention	6.8.2.2a
V2-10	Control Switches Numeric Arrangement	6.8.2.2a
V2-21	Sampling Isolation Valves Indicating Lamps Test Capability	6.5.3.1a
V2-22	Instrument Room Exhaust Fans Indication	6.5.1.1b
V2-23	S/G Stop Valves Dump Valves Trip Position	6.4.1.1c(1)
V2-24	Dual Scale Indicator (Single Pointer)	6.5.1.5f
V2-25	Auxiliary Building Radiation Monitor (No Specific Monitor)	6.5.1.1b
9.1-1	No Administrative Procedures Controlling Use of Shared Equipment	6.1.3.1e(5)
9.1-2	Visual Displays Not Provided to Meet All Task Requirements	6.5.1.1b
9.1.3	Unnecessary Information Displayed in Control Room	6.5.1.1c
9.1-4	Control/Display Integration is Poor	6.9.1.2a 6.9.1.1c
9.1-5	Operator Must Convert Display Values	6.5.1.2b
9.1-6	Displays Not Located Above Associated Controls	6.9.2.2a(1)
9.1-7	Control Position Sequence Not Same as Display	6.8.2.2a&b 6.9.1.2c1&c2

5.0 CLO/HED ASSESSMENT

5.1 Assessment Overview

NUREG-0700 defines a Human Engineering Discrepancy or HED as "a departure from some benchmark of system design suitability for the roles and capabilities of the human operator." Section 6 of NUREG-0700 contains these design benchmarks or guidelines. While it can be expected that the DCRDR process will produce reports of Human Engineering Discrepancies, it does not follow that all discrepancies will necessarily degrade operator performance to the point that safety and plant operations would be affected.

During DCRDR data collection activities, control room (CR) design features were reviewed to identify deviations from NUREG-0700 guidance. The CR features which were felt to deviate from guidance were documented as Checklist Observation Reports (CLOs). The assessment process began with a discussion of whether or not a given CLO was an HED. The rational used to make this judgment was different than that described in the D.C. Cook DCRDR program plan report. According to the program plan, a judgment was to be made as to whether the CLO increased potential for operator error in any way and, if so, the CLO would become an HED. In actual practice, the Assessment Team instead decided whether the CLO represented an actual deviation from guidelines, and, if so, the CLO became an HED. The modification was made to ensure that all D.C. Cook design features that did not comply with NUREG-0700 guidelines would be subjected to the full assessment process. It was felt that a preliminary consideration of potential for error should not be the rational for eliminating a CLO from further consideration. Rather, a consideration of potential for error was more properly (and thoroughly) conducted after the CLO was judged to be an HED, i.e., found to represent an actual deviation from guidelines.

The remainder of the assessment approach followed the assessment methodology described in the D.C. Cook DCRDR program plan report. Each HED was analyzed to determine its significance in terms of safety and plant operations. The analysis separated those HEDs that are unlikely to degrade performance from those that may degrade performance and it provided a categorization of HEDs according to overall importance from a human factors perspective.

5.1.1 Preliminary Assessment

To provide a structured starting point for the first Assessment Team meeting, Essex conducted a preliminary assessment of the 294 CLOs resulting from the operator interviews and control room surveys. The 93 CLOs from the SRTA (Verification/Validation) were not included, since they were not yet written.

During the preliminary assessment process each of the 294 CLOs was assigned a tentative category using the same method as used in later assessment activities. The method used is described in the pages which follow. The categories assigned were "tentative" in that the Assessment Team later had to thoroughly discuss each CLO and decide whether to accept or modify the preliminary assessments.

The Essex personnel involved in preliminary assessment included two human factors specialists and one senior operations specialist. The human factors specialists both have masters degrees in human factors and experience in several DCRDRs. The senior operations specialist is a former nuclear plant shift supervisor with 20 years experience in the electric power industry. These individuals were not involved in later assessment activities. However, preliminary assessment categorizations were subsequently reviewed by another Essex human factors specialist who did participate in later assessment activities.

Preliminary assessment did provide a structured starting point for the actual assessment meetings such that other team members could become familiar with both the CLOs and the preliminary categorizations. As a result of Assessment Team discussions, categories for some CLOs were raised or lowered. In some instances, the Assessment Team decided that a given CLO was not an HED (preliminary assessments were made on the assumption that all CLOs represented valid HEDs). The process by which it was decided that a given HED is or is not an HED is described in section 5.2.1.

5.1.2 The Assessment Process

Each of the 387 CLOs which resulted from DCRDR data collection activities (294 from interviews and surveys, 93 from V&V) was evaluated by the Assessment Team. If during the assessment process, any disagreement occurred between Assessment Team members, discussion was continued until a consensus was obtained. The assessment process entailed the following activities:

- o Determine if the CLO is an HED
- o If so, determine if Potential for Error (PFE) is high, medium, or low
- o Determine if Consequence of Error (COE) is high, medium, or low
- o Based on the interaction of PFE and COE assign an HED category (from I to IV).

The first step in the assessment process was to determine if the CLO is an HED, that is, if the CLO represented any departure from CRDR guidelines. If so, the Assessment Team considered potential for inducing error and consequences of induced error. Cumulative and interactive effects of HEDs can increase either potential for error or consequence of error. Therefore, a consideration of cumulative and interactive effects of HEDs was an important determinant of the PFE and COE ratings. For HEDs which might have cumulative and interactive effects, higher ratings of PFE and/or COE, as appropriate, were given. The assessment process yielded a cross-classification of the two rating factors such that HEDs were assessed into four categories, Category I being the highest priority and IV the lowest.

Assessment activities were conducted in a room with a full scale photo-mosaic of the main control boards for D. C. Cook, Unit 1, so that most individual HF concerns could be visually appraised. Assessment Team meetings were multidisciplinary and well attended with eight to twelve participants at each meeting. This included the AEPSC representatives identified in the program plan as well as D. C. Cook management and operations (SRO) representatives. Also included were one or more human factors representatives from Essex Corporation. Representatives of Westinghouse Corporation were also involved in meetings as needed.

For each HED assessed, an Assessment Record Form was completed (Figure 5-1). The form contains a section for rating both potential for error and consequences of error "High", "Medium" or "Low". It also contains a diagram which illustrates how PFE and COE interact to establish the four HED categories as well as a key which defines each of the categories. Spaces for recording the HED number and the resulting assessment category are provided.

5.1.2.1 Determine If the CLO Is an HED

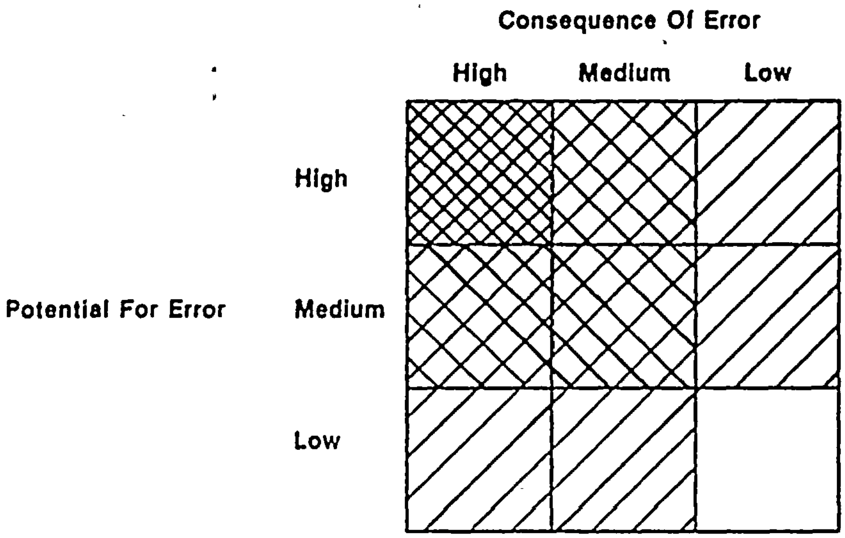
As defined above, an HED is a departure from the human factors guidance contained in appropriate benchmarks of human factors design such as NUREG-0700. As a first step in the assessment process, a determination was made as to whether or not a CLO did, in fact, represent such a departure. If, in the considered judgment of the assessment team, a CLO was determined to represent an actual deviation, the remaining steps in the assessment process were carried out. If not, the reason for ending consideration of the CLO was recorded and the CLO was retained in the data files.

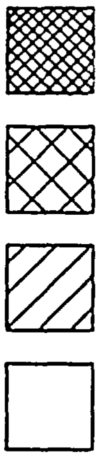
CLO/HED#

ASSESSMENT RECORD

POTENTIAL FOR ERROR (PFE) HIGH MEDIUM LOW

CONSEQUENCE OF ERROR (COE) HIGH MEDIUM LOW





Category I -- High priority; corrective action should be taken.

Category II -- Medium priority; corrective action is highly recommended.

Category III -- Low priority; corrective action is recommended.

Category IV -- No corrective action necessary, but should be considered.

ASSESSMENT CATEGORY ______

Figure 5-1
HED ASSESSMENT RECORD FORM

Reasons why nondiscrepant items were occasionally documented as CLOs include:

- o Misinterpretation of interview/questionnaire items by respondents
- o Misinterpretation of operator responses by interviewers
- o Plant issues that are out of scope of the CRDR (referred to appropriate plant groups)
- o Misunderstanding by reviewers of control room composition or of the way components or systems function
- o Issues that have been corrected during the period between data collection and assessment.
- o Duplicates another CLO.

Before ending consideration of each CLO, efforts were made to ensure that the Assessment Team understood the issue involved. For example, this might have entailed checking an ambiguous interview response. A few duplicate CLOs were also eliminated from further consideration as HEDs. Each of these was found to be redundant to an assessed HED.

5.1.2.2 Assess Potential for Error (PFE)

An assessment of the potential of the HED to induce error was generated by reference to the criteria shown in Table 5.1, "Potential for Error Assessment Criteria." The criteria were applied by Assessment Team members to achieve a rating of PFE as "High," "Medium," or "Low." As stated above, possible cumulative and interactive effects of the given HED with other HEDs were also taken into account in rating PFE. In rating PFE the judgments of the human factors specialists and the operations personnel were given greater emphasis. This is because the HF specialist has had more formal training in human performance while the operator is more knowledgeable about those aspects of the control room that have been troublesome.

Several of the potential for error assessment criteria listed in Table 5.1 are related to the safety significance of the HED. These include the effect of the discrepancy upon the operator's ability to see and hear, the likelihood of causing confusion or distraction, the effect upon the operator's ability to perform required actions, and conditions of stress which may exist when associated tasks are performed. Therefore, an understanding of a given HED's potential to induce error was considered an important aspect of determining which HEDs have potential to significantly impact safety.

Table 5.1

POTENTIAL FOR ERROR ASSESSMENT CRITERIA

The following criteria will be considered in assigning the Potential for Error (PFE) rating:

1. The nature of discrepancy, including the following factors:

   (a) The impact of the discrepancy upon the operator's ability to perceive and discriminate input information. Considerations include:
   - Whether required information is provided.
   - The effect of the discrepancy upon the operator's ability to locate, read, and interpret displays of interests.
   - The effect of the discrepancy upon the operator's ability to see and hear.

   (b) The impact of the discrepancy upon the operator's ability to process information. Considerations include:
   - The likelihood of exceeding the operator's information processing capability.
   - The likelihood of causing confusion or distraction.
   - Operator fatigue or discomfort which may be introduced by the discrepancy.

   (c) The effect of the discrepancy upon the operator's ability to perform required actions. Considerations include:
   - Whether required controls are provided.
   - The effect of the discrepancy upon the operator's ability to locate the control.
   - The effect of the discrepancy upon the operator's ability to use the control.

2. Conditions of stress which may exist when associated tasks are performed.

3. The past occurrence of errors as a result of discrepancy.

4. The degree and prevalence of the deviation.

5. The familiarity of the components and systems involved.

6. The frequency with which the associated components and systems are used.

5.1.2.3 Assess Consequence of Error (COE)

The consequence of the hypothesized error on plant operations and safety was assessed as "High," "Medium," or "Low" using the criteria shown in Table 5.2, Consequence of Error Assessment Criteria." In applying the criteria to assess error consequence, the collective judgment of the Assessment Team members was used. In rating COE, possible cumulative and interactive effects of the given HED with other HEDs were also taken into consideration. Discussion was continued until a consensus was achieved.

For COE, the judgments of the operations' representatives and the engineering staff were given greater emphasis. Licensed operators best understand day-to-day plant operations, and they also receive extensive training on plant safety systems and how to respond to emergency situations. The engineering staff better understands the design basis of the plant and how individual plant components were designed to support plant operations and safety functions.

Almost all of the consequence of error assessment criteria listed in Table 5.2 are related to the safety significance of the HED. This is especially true for the first two items which are the risk of injury to the public and the risk of injury to plant personnel. Therefore, an understanding of the consequences of hypothesized error produced by a given HED was considered the most important aspect of determining which HEDs have potential to significantly impact safety.

5.1.2.4 Assign HED Category

The diagram on the Assessment Record (see Figure 5-1) illustrates how assessments of error potential and error consequence were integrated to produce four prioritized categories as follows:

Category I - High priority; HEDs with a high PFE rating and a high COE rating. Some form of corrective action should be implemented at earliest opportunity.

Category II - Medium priority; HEDs with (1) a medium PFE rating and a high or medium COE rating or (2) a medium COE rating and high or medium PFE rating. Implementation of some form of corrective action is highly recommended in a timely fashion.

Category III - Low priority; HEDs with (1) a low PFE rating and high or medium COE rating or (2) a low COE rating and a high or medium PFE rating. Implementation of corrective action is recommended.

Category IV - HEDs with a low PFE rating and a low COE rating. No corrective action is necessary, but should be considered.

Table 5.2

CONSEQUENCE OF ERROR ASSESSMENT CRITERIA

The following criteria will be considered in assigning the Consequence of Error (COE) rating:

1. The risk of injury to the public.
2. The risk of injury to plant personnel.
3. The potential effect of the error upon operating margins to safety limits.
4. The importance of the components and systems involved.
5. The availability of alternate systems and components.
6. The ability of automatic protective features to compensate for the error.
7. The ability of the operator to detect the error.
8. The ability of the operator to recover from the error.
9. The potential for the error causing additional errors.
10. The risk of equipment damage.

A consideration of error consequence and error potential also determined the safety significance of the HED. Several criteria used to judge PFE and almost all of the criteria used to judge COE are related to safety significance. PFE and COE were deemed to interact such that if potential for error was at least moderate with consequence of error also at least moderate, then the HED would have potential to significantly jeopardize safety. Therefore, all HEDs with medium or higher PFE ratings combined with medium or higher COE ratings are considered safety significant. That is, all Category I and Category II HEDs were considered to be safety significant. Additionally, it was recognized that consequence of error was the more important determinant of safety significance, since almost all of the criteria for COE are related to safety significance. Therefore, it was decided that any HED with a high COE would also be considered safety significant. This means that, in additional to all Category I and II HEDs, any Category III HED with a high COE was also considered to be safety significant. Category III HEDs of safety significance are identified as III-S in the CLO/HED Assessment Summary Tables (Section 5.2.4).

The four prioritized categories were used to rate each HED in terms of overall importance from a human factors perspective regarding its potential effects on plant operations and safety. Category I HEDs (high PFE and high COE) are the most important to resolve and should generally be scheduled for resolution before those with lower ratings.

5.1.3 Assessment Results

A total of 387 Checklist Observation Reports resulted from the CRDR data collection process: Of these, the Assessment Team decided that 14 (4%) did not warrant further consideration as HEDs. Five were CLOs that were redundant with assessed HEDs. The 14 CLOs include (a redundant CLO is indicated by an asterisk):

- o Emergency Equipment — 1.3-9
- o Annunciators — 3.1-14
- o Controls — 4.1-11
- o Displays — 5.1-16*, 5.1-23, 5.1-25*
- o Conventions — 8.1-9*
- o Verification— V1-15, V1-20, V1-48
- o Validation — V2-3*, V2-7*, V2-8, V2-24

Explanations for the decisions are given in the CLO/HED Disposition Summary Tables in Section 5.2.4

Since 14 CLOs were eliminated from further consideration, the total number of HEDs assessed was 373. These HEDs were assessed into categories as shown in Table 5.3.

Table 5.3

HEDs BY ASSESSMENT CATEGORY

Category	Number	Percent
I	7	2
II	95	25
III	171	46
IV	100	27
Total	373	100

As can be seen from Table 5.3, about one quarter of the HEDs were judged to be of a high or medium priority such that corrective action is at least highly recommended by the Assessment Team. About half the HEDs were judged to be of low priority, but important enough so that corrective action is recommended by the team. The remaining HEDs were assessed such that no corrective action is required but should be considered in order to enhance control room operability.

A breakdown of assessment decisions by CRDR review area is provided in Table 5.4. Several aspects of the data are worthy of note. The greatest percentage of higher priority HEDs is in the areas of communications and the annunciator review. Most of the other review areas seem to show a representative mixture of higher and lower priority items, except for the validation and verification (V&V), and the plant computer review. The results for the plant computer review are fairly easily understood, since the plant computer is, in general, considered to be a backup system.

The verification and validation results are more surprising, since V&V efforts are normally expected to produce a larger percentage of high priority HEDs. Verification and validation are concerned with whether or not CR features support tasks and functions necessary for emergency operations. However, the results are easily explained in that

Table 5.4
ASSESSMENT DECISIONS BY REVIEW AREA

	Review Area	Total	CLOs Not HEDs	Total HEDs	Category I	Category II	Category III	Category IV
1.1	Workspace	15	0	15	0	3	7	5
1.2	Anthropometrics	2	0	2	0	2	0	0
1.3	Emergency Equipment	9	1	8	1	7	0	0
1.4	HVAC	2	0	2	0	0	1	1
1.5	Illumination	7	0	7	0	4	3	0
1.6	Noise	3	0	3	0	0	3	0
1.7	Maintainability	7	0	7	0	1	6	0
2.1	Communications	16	0	16	1	7	8	0
3.1	Annunciators	33	1	32	1	16	10	5
4.1	Controls	24	1	23	0	7	12	4
5.1	Displays	54	3	51	0	6	26	19
6.1	Labels	71	0	71	1	23	43	4
7.1	Computer	31	0	31	0	2	23	6
8.1	Conventions	13	1	12	0	2	8	2
9.1	Information/Integration	7	0	7	1	4	1	1
V-1	Verification	68	3	65	2	5	15	43
V-2	Validation	25	4	21	0	6	5	10
	Totals	387	14	373	7	95	171	100

many of the V&V HEDs were not based upon a failure to meet information/action requirements, or due to a failure of control room design features to support CR functions. Rather, many of the HEDs resulted from less important issues that were noted coincidentally with verification and validation activities. This explanation is supported by the description and priority given for each HED in the CLO/HED Assessment Summary Tables, Section 5.2.4. It should be noted that several V&V HEDs did receive high categorizations.

The number of HEDs classified as safety significant was 152 (41% of the total number of HEDs). This includes all of the 102 Category I and II HEDs as well as 50 additional Category III HEDs that have a high consequence of error. As explained above, these have been classified as safety significant even though their potential for error is low. In the CLO/HED Disposition Summary Tables (Section 5.2.4) the Category III safety significant HEDs have been identified as III-S to distinguish them from other Category III HEDs. The number of safety significant HEDs within each assessment category is shown in Table 5.5.

Table 5.5

SAFETY SIGNIFICANT HEDs BY CATEGORY

Category	Number	Percent
I	7	5
II	95	62
III-S	50	33
Total	152	100

From Table 5.5 it is apparent that Category I and II HEDs, which were at least highly recommended for corrective action, comprise about two-thirds of the safety significant HEDs. The remaining one-third is comprised of the Category III-S HEDs which are of lower priority but also recommended for corrective action. The category for each safety significant HED is given in the CLO/HED Assessment Summary Tables in Section 5.2.4.

5.2 DISPOSITION OF HEDs

As part of the assessment process, a disposition was recommended for each HED by the Assessment Team. The goal was to resolve HEDs, especially those of high priority, such that control room design would be in compliance with guidelines wherever feasible.

Suggested corrective actions included design modifications and surface enhancements. Surface enhancements include such techniques as application of demarcation lines and mimics, color coding, and modification of labels. In some instances, suggested corrective actions involved revisions to written procedures or operator training. Factors which were considered in selecting the appropriate solution included the effectiveness of recommended solutions, the feasibility of any required design modification, and the impact of any change on plant operations and operator training. In some cases engineering studies were conducted to assess the feasibility of recommended corrections. For some recommendations a cost/benefits analysis was also necessary.

The Project Review Team, whose members are identified in the program plan approved, disapproved, or modified and justified the recommended dispositions. This review process was iterative; any HED disposition that was denied approval by the Project Review Team was returned to the Assessment Team for further consideration. The Assessment Team would then reach a consensus in terms of concurrence with management recommendations, reiteration of the original recommendation, or development of an alternative recommendation.

5.2.1 Detailed Methodology for HED Disposition

The Evaluation and Disposition Record (Figure 5-2) was used to track pending assessment actions and to record the disposition of the HEDs. This form was also used to evaluate whether or not the planned resolution would bring the HED into compliance with guidelines. Further, for each CLO/HED the form was used to record one of the following: a brief explanation of the planned correction, a justification for those HEDs which would not be corrected, or the reason for determining why a given CLO was not an HED.

The method by which planned resolutions were evaluated involved a reapplication of NUREG-0700 guidance to determine whether or not each recommended correction would satisfactorily resolve the existing discrepancy and to ensure that it would not introduce new discrepances. Following Assessment Team agreement on the recommended resolutions, a brief explanation of the resolution was entered on the Evaluation and Disposition

CLO/HED#

EVALUATION AND DISPOSITION RECORD

ASSESSMENT/REVIEW ACTIONS

PENDING | DATE

☐ FURTHER REVIEW BY ____________________ ________

☐ FURTHER REVIEW BY ____________________ ________

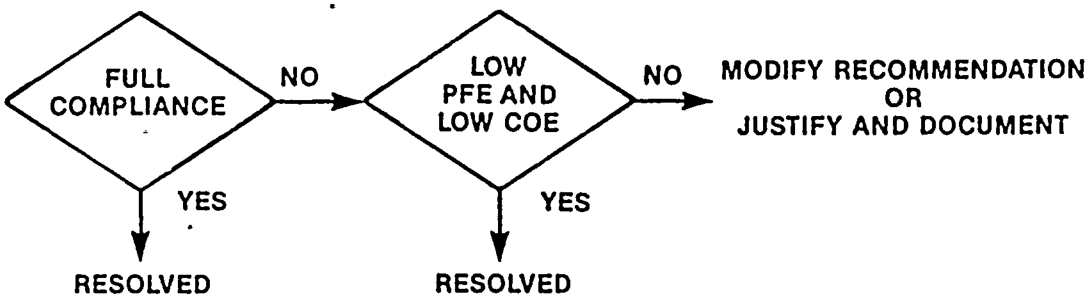
☐ FURTHER REVIEW BY ____________________ ________

DISPOSITION

☐ APPROVED ☐ PARTIALLY APPROVED ☐ NO ACTION ☐ OTHER

EVALUATION

FULL COMPLIANCE WITH GUIDELINES	NO		YES
POTENTIAL FOR ERROR (PFE)	HIGH	MEDIUM	LOW
CONSEQUENCE OF ERROR (COE)	HIGH	MEDIUM	LOW



EXPLANATION OR JUSTIFICATION ____________________

____

____

____

SIGNOFF

H.F. CONSULTANT (ESSEX) ____________________ DATE ________

AEPSC PROGRAM LEAD ENGINEER ____________________ DATE ________

Figure 5-2

EVALUATION AND DISPOSITION RECORD FORM

Record. Then, using the "Evaluation" section of the form an assessment was performed for each of the recommended corrections (see Figure 5-2). Each recommended correction was first assessed for full compliance with guidelines. If it was judged that the correction would yield full compliance, then the HED was considered resolved. If not, the planned correction was further assessed to determine potential for error and consequence of error ("High", "Medium", or "Low"). If both PFE and COE were rated low, then the HED was again considered resolved. If either PFE or COE were judged to be other than low, then the HED was discussed further and a decision was made by the team to either modify the recommendation so that the HED could be considered resolved or to justify not achieving satisfactory resolution of the HED.

As mentioned above, if full correction was not to be achieved or a CLO was determined not to be an HED, a justification was recorded on the Evaluation and Disposition Record. If appropriate, justifications were supplied by the Assessment Team based upon human factors principles and practices. If not, justifications were supplied by the Project Review Team based upon a consideration of engineering constraints and the cost-effectiveness of providing a correction. Due to the iterative nature of the disposition and reassessment process, Evaluation and Disposition Records were modified or replaced as appropriate.

5.2.2 Further Evaluation of Corrective Actions

To further ensure that modifications would provide correction and not result in new HEDs, modifications were designed with input from engineering, human factors, and D. C. Cook operations personnel. Applicable human factors literature, such as NUREG-0700, Section 6, was used for guidance.

The assessment and disposition of HEDs took place over a one and one-half year period. During this time, it was possible to complete several engineering studies and design many of the topical enhancements. Planned surface enhancements and some of the more complex design modifications were illustrated on the full-scale photomosaic in the assessment meeting room. Various approaches to corrective actions were tried, and human factors specialists reviewed and critiqued planned corrections so the best overall solutions could be achieved.

In addition, once preliminary design work had been completed and the corrections were shown on the photomosaic, five D. C. Cook operating crews comprising 31 operators (over half of the licensed D.C. Cook operators) were brought to Columbus to review the photomosaics and comment on the planned changes. The planned modifications included

demarcation, component labeling, summary labeling and other enhancements, as well as proposed design modifications such as rearrangement of the Steam Generator Panel. Operators were asked to complete a questionnaire which pertained to the modifications and make any suggestions for improvement. The results of the questionnaire were analyzed and appropriate modifications were made. A human factors specialist from Essex attended one of the review sessions to elicit operator responses, review the planned modifications from an HF perspective, and provide feedback to AEPSC. At a later meeting both of the Essex HF specialists who had participated in Assessment Team meetings reviewed and criticized all planned corrective actions.

When the modifications are installed in the control room, further evaluations will be undertaken to ensure their acceptability. Suggestions for potential revisions or future improvements may be obtained by operator comment or by a more formal operator questionnaire/interview process. These suggestions will be evaluated using similar guidelines, criteria and procedures established for use in the DCRDR program.

5.2.3 Disposition Results

DCRDR assessment activities resulted in a categorization of 373 HEDs according to their overall importance from a human factors perspective. Of these HEDs, 152 were classified as safety significant. An appropriate disposition was selected for each of the 373 HEDs with particular emphasis given to those considered safety significant. Of the total, 290 (78%) have been selected for full correction, and 37 (10%) for partial correction. In addition, no action will be taken to correct 46 HEDs (12%). Table 5.6 contains a listing of HED dispositions by review area. Table 5.7 provides a listing of HED disposition decisions by assessment category. The CLO/HED Assessment Summary Tables in Section 5.2.4 contain a brief explanation of the disposition for each HED. Of the 152 safety significant HEDs, 134 (88%) have been selected for correction, 14 (9%) for partial correction, and 4 (3%) will receive no corrective action. Table 5.8 provides a listing of disposition decisions for safety significant HEDs by assessment category.

5.2.3.1 HEDs to be Corrected

In all, 290 (78%) of the 373 HEDs will be brought into compliance with guidelines. The 290 HEDS to be corrected included: 6 (86%) of the Category I HEDs, 81 (85%) of the Category II HEDs, 150 (88%) of the Category III HEDs, and 53 (53%) of the Category IV HEDs. The HEDs in all categories except for Category IV have a very high percentage of correction. The Category IV HEDs are those with low consequence of error and low

Table 5.6

HED DISPOSITION BY REVIEW AREA

Review Area	Total HEDs	Correction	Partial Correction	No Action
1.1 Workspace	15	10	1	4
1.2 Anthropometrics	2	0	2	0
1.3 Emergency Equipment	8	7	1	0
1.4 Hvac	2	2	0	0
1.5 Illumination	7	7	0	0
1.6 Noise	3	3	0	0
1.7 Maintainability	7	5	2	0
2.1 Communications	16	16	0	0
3.1 Annunciators	32	19	5	8
4.1 Controls	23	13	7	3
5.1 Displays	51	31	9	11
6.1 Labels	71	66	3	2
7.1 Computer	31	30	1	0
8.1 Conventions	12	9	2	1
9.1 Information/Integration	7	4	3	0
V1 Verification	65	53	0	12
V2 Validation	21	15	1	5
Totals	373	290	37	46

Table 5.7

HED DISPOSITION BY ASSESSMENT CATEGORY

Category	Total HEDs	Correction	Partial Correction	No Action
I	7	6	1	0
II	95	81	12	2
III	171	150	15	6
IV	100	53	9	38
Totals	373	290	37	46

Table 5.8

SAFETY SIGNIFICANT HED DISPOSITION BY CATEGORY

Category	Total HEDs	Correction	Partial Correction	No Action
I	7	6	1	0
II	95	81	12	2
III-S	50	47	1	2
Totals	152	134	14	4

potential for error such that correction is discretionary. However, over half of the Category IV HEDs were selected for correction.

Of the 152 safety significant HEDs, 134 (88%) were selected for correction. This includes the 87 Category I and II HEDs mentioned above as well as 47 (94%) of the 50 Category III-S HEDs. In general for safety significant HEDs, if corrective action was deemed at all feasible, then such action was recommended. See Section 5.2.4 for a listing of the individual HEDs and a description of the individual actions to be taken.

5.2.3.2 HEDS to be Partially Corrected

Thirty-seven (10%) of the 373 HEDs will receive partial correction. Of the 37 HEDs, 14 (38%) were classified as safety significant. HEDs which will be partially corrected are usually of two types. The first type consists of HEDs on which several similar or related problems were identified. For some of these, AEPSC found it was not feasible to correct all of the problems listed or elected not to correct the less important (especially non-safety significant) items listed on the HED. The second type of "partial corrections" involve those HEDs relating to design features for which full compliance with guidelines is not feasible. For these HEDs some enhancement or partial design improvement will be undertaken to ameliorate the effects of the HED. The individual HEDs and brief descriptions of the actions which will be taken are contained in the CLO/HED Assessment Summary Tables in Section 5.2.4. More detailed explanations for the safety significant HEDs are given in Section 5.2.3.3.

The HEDs which will be partially corrected include (safety significant HEDs are indicated by an asterisk):

- Workspace — 1.1-12
- Anthropometrics — 1.2-1*, 1.2-2*
- Emergency Equipment — 1.3-8*
- Maintainability — 1.7-5, 1.7-6
- Annunciators — 3.1-5*, 3.1-12, 3.1-21*, 3.1-24*,3.1-30*
- Controls — 4.1-1*, 4.1-8*, 4.1-9*, 4.1-16, 4.1-17, 4.1-18, 4.1-24
- Displays — 5.1-4*, 5.1-8*, 5.1-26, 5.1-27, 5.1-28, 5.1-38, 5.1-41, 5.1-45, 5.1-51
- Labels — 6.1-26, 6.1-45, 6.1-52
- Computer — 7.1-8
- Conventions— 8.1-2, 8.1-4
- Integration — 9.1-4*, 9.1-5, 9.1-6*
- Validation — V2-20

5.2.3.3. Justifications for Safety Significant "Partial Correction" HEDs

As mentioned in the preceding section, 14 (9%) of the 152 safety significant HEDs were selected for partial correction. Detailed explanations for the 14 HEDs are given below.

5.2.3.3.1 HED #1.2-1, Controls are Located Too High or Too Low (Category II)

Several controls were identified by operator interviews and observation as outside the height restrictions of guideline 6.1.2.5a. All of the controls identified were reviewed for criticality, need for precision, and frequency of use. All D.C. Cook panels are vertical. Since there are no benchboards, the area to which guidelines restrict location of controls is limited to only 38% of available area. It is not physically possible to locate all controls within the area recommended by guidelines since 80% of the available area is actually used. However, some improvements are possible. Therefore, appropriate rearrangements of the Steam Generator, Containment Spray, Boric Acid, Component Cooling Water, and H_2 recombiner controls are being designed. The remaining controls do not warrant relocation based on the above mentioned considerations. In all, it is not feasible to relocate other controls since more important controls are already located in the panel areas recommended by guidelines.

5.2.3.3.2 HED #1.2-2, Displays are Located Too High or Too Low (Category II)

Many displays were identified by operator interviews and observation as being outside the height restrictions of guideline 6.1.2.5b. Rearrangement was considered for the more critical displays but this was found to be infeasible due to lack of room on the vertical panels. The area between 41 and 70 inches is already used by critical controls and annunciators. D.C. Cook operators are accustomed to finding indicators at the top of panels. The most frequently used displays, i.e., those in the horseshoe at the front of the control room, are tilted down approximately 15^{o} for better visibility and in several instances oversized indicators are used. The readability of displays will be improved by replacing scales, improving lighting, and coding operating bands. In addition, scales with tinted covers will be changed to white with black lettering, and parameter bands will be color coded light green, blue or pink with black lettering of good contrast.

5.2.3.3.3 HED #1.3-8, Lack of Written Instructions for Operator Protective Equipment (Category II)

By observation and operator interview response, it was noted that there are no posted instructions for the donning and doffing of operator protective equipment. However, the plant will continue to ensure that operators are well trained in the use of protective equipment. Operators now receive twice yearly radiological retraining and they dress out frequently. As such, there is no need to post written instructions for protective equipment.

5.2.3.3.4 HED #3.1-5, Multi-input Alarms do not have Reflash Capability (Category II)

One operator responded in the interview that some multiple input alarms do not have reflash capability. However, no information was given as which specific alarms were problematic. AEPSC has subsequently reviewed all multiple input drops and is planning to provide separate dedicated alarms in the control room for the more important containment alarms which are now located in the plant on the CAS panel and for the RCP Oil Pot Alarms which are also local at present. It is felt that other alarms do not require reflash, since similar local action would be required for each. That is, an operator would be dispatched to the local panel to identify and take action on any specific drop or drops in alarm. For the remainder of the multiple input alarms, lack of reflash does not significantly effect the nature of the response or the time required to implement the corrective action in response to the alarm condition.

5.2.3.3.5 HED #3.1-21, No Demarcation Lines on Annunciators Panels (Category II)

During checklist activities it was observed that demarcation lines are not used to enclose functionally related annunciator tiles. Some annunciator boxes have as many as 100 windows. However, the D.C. Cook annunciator system is unique in that it uses individual legend push buttons in annunciator arrays which are located at eye level. To acknowledge an alarm the operator has to push the individual button in alarm. Recognizing the individual tile in alarm is not, therefore, a problem since the operator must walk within arm's length to acknowledge it. Alarms will be rearranged on a basis of functional groups and will be color coded for priority. AEPSC investigated the possibility of demarcation; however, individual pushbuttons are small and close together, and due to the narrowness of space between alarms demarcation would only result in visual clutter.

5.2.3.3.6 HED #3.1-24, Number of Annunciator Tiles per Panel Exceeds 50 (Category II)

Since there are 1500 drops in the D.C. Cook annunciator system, it is reasonable that some banks would contain more than 50 drops. Dividing each 100 drop annunciator bank into two 50 drop banks would be very costly and would not result in marked improvement. Panel space is at a premium, so the two 50 drop banks would no doubt be mounted almost exactly in the same location as the present 100 drop bank. Demarcation was considered, but rejected due to the limited space between tiles. However, priority coding and functional grouping are being investigated as a means of improving the operator's ability to locate or recognize specific tiles.

5.2.3.3.7 HED #3.1-30, Defeatable Annunciator Controls (Category I)

Any annunciator system can be defeated in some way; therefore, operator training and administrative controls are necessary to prevent unauthorized defeating of annunciators. Such training and administrative controls are in place at D.C. Cook. However, on an annunciator system of this size and complexity, nuisance and problem alarms do occur. As such, a carefully controlled and highly visable defeating (pegging) of alarms method has been implemented. Pegged alarms are administratively controlled by logging and all pegged alarms are checked at shift turnover. There is an ongoing program to fix problem and nuisance alarms. Over 200 alarms have already been fixed. Due to this program the need for pegging should be virtually eliminated.

5.2.3.3.8 HED #4.1-1, Critical Controls Do Not Have Movable Guards (Category II)

Operator interview responses and observations during checklisting identified several critical controls that do not have movable guards. These include the safety injection actuation switches, reactor trip switches, turbine trip, PZR SI reset, generator output breakers, the diesel generator test bank selector, and the cold overpressure controls. The last mentioned switches have had their handles removed to prevent accidental activation. Handles are available in the control room for rapid installation should control activation be necessary. Activation of these controls is not time critical. The other switches will be enhanced by such techniques as shape coding of handles, demarcation, and labels with red backgrounds to lessen the possibility of accidental activation. For some functions such as safety injection actuation, reactor trip and turbine trip it was felt that physical guards might introduce unnecessary time delays.

5.2.3.3.9 HED #4.1-8, Controls are Difficult to Adjust to the Precise Level Required (Category III-S)

Several controls were identified by operator interview responses as difficult to adjust. The Assessment Team discussed each item listed and actions are being taken to correct all but the following two items. The pistol grip controls for the turbine on Unit 2 are more difficult to use than the Unit I controls. However, they are usable with a sufficient range of control and replacement would necessitate replacing the entire control system which is not feasible. The component cooling water Heat Exchanger Valve controls were discussed by the Assessment Team and, after input from the operations specialists at the meeting, were not found difficult to operate. As such, it is felt that no change is needed for the valve controls.

5.2.3.3.10 HED #4.1-9, Control Movement is Backwards (Category II)

Many controllers turn counter-clockwise to open (i.e. increase flow). AEPSC has investigated reversing both pneumatic and electronic controllers which work backwards. However, reversing the controllers is not feasible, since failure mode determines the direction in which the controllers turn to open. However, distinctive, shape-coded handles are being installed for backwards acting controllers and highly visible arrows for direction to open are being added.

5.2.3.3.11 HED #5.1-4, No Verification that Meters Fail Off Scale (Category II)

An engineering review was done to identify which meters fail off-scale and to investigate which meters should have a live zero. As a result, a live zero is being developed for ECCS and auxiliary feedwater flow meters. In all, there are about 450 electronic or pneumatic meters which would fail to less than minimum scale upon input signal loss. However, there are approximately 150 electrical ammeters, voltmeters, wattmeters, etc. that are powered by the electrical circuit they monitor. If the circuit is dead, they can only indicate zero. Readings on these meters are usually fairly static, so a failure should be readily detected. However, several other types of failures are possible such as stuck indicator mechanisms or stuck transmitters. As such there is no way to guarantee off-scale failure in all cases. Therefore, D.C. Cook operators are trained to check redundant or verifying displays against each other for accuracy and failure checks.

5.2.3.3.12 HED #5.1-8, Recorders Not Located in Primary Work Area (Category II)

Operator interviews identified several recorders that respondents felt should be available in the primary operating area. These include recorders for Containment Sump Flow, Meterological data, Steam Generator Wide Range Level, Plant Vent Flow, Containment Vent Flow, Containment Leak Detector, Plant Air Header Flow, Gland Seal Flow, Screen House Level, and Containment Temperature Recorder. The Assessment Team reviewed the recorders listed and only the Containment Sump Recorder required further review for possible relocation into the CR. This review determined relocation was not necessary. The Containment Temperature Recorder has already been moved into the CR. In addition, design is in process to move several of the more important Containment Alarms into the control room (refer to HED #3.1-11). It is felt that the remainder of the recorders, which for the most part are near the primary working area on back panels or behind the main CR panels, are not of sufficient importance to move into the main control room area.

5.2.3.3.13 HED #9.1-4, Control/Display Integration is Poor (Category II)

Operator interview responses indicated that control/display integration could be improved in many areas. The human factors recommendation for correction was to review the problems in light of the task analysis, verification, and validation results and to improve the component relationships as required. Improvements can be accomplished either by surface enhancement or in severe cases by relocation of components. As per recommendations, all items were checked against SRTA results and those identified as important in SRTA have been given appropriate attention. Specifics are given in the Information/Integration portion of the CLO/HED Assessment Summary Tables (Section 5.2.4). The other issues listed were not identified as important to emergency tasks in the SRTA. However, many of these issues are addressed in other HEDs. Topical enhancements, such as demarcation, summary labeling, and revised color coding are being applied to the control panels. This should result in an overall improvement in control/display integration.

5.2.3.3.14 HED #9.1-6, A Few Displays are Not Located Above Associated Controls (Category II)

Checklist observations revealed that several displays are not located above their associated controls. The items identified include controls and displays for (1) screen speed, (2) PZR level, (3) PZR recorders, (4) vibration, and (5) Delta T. For items (2) & (3)

corrections are being designed. For the other three items the control/display relationships are readily apparent. The screen indicators are master indicators for all 7 screens and are located directly above the controls. The vibration indicator is located directly to the side of the controls. The association is good and no change is needed. The Delta T controls are located directly above the recorder. This association is good and no change is needed.

5.2.3.4 HEDs With No Corrective Action

No action will be taken to correct 46 (12%) of the 373 HEDs. Of the 46 HEDs which will receive no corrective action, 38 (84%) were classified as Category IV and 4 (9%) as safety significant. The individual HEDs and the reasons for not correcting them are listed in the CLO/HED Assessment Summary Tables in Section 5.2.4. More detailed explanations for the safety significant HEDs are given in Section 5.2.3.5. The HEDs which will not be corrected include (safety significant HEDs are indicated by an asterisk):

- Workspace — 1.1-4, 1.1-6, 1.1-7. 1.1-14
- Annunciators — 3.1-1, 3.1-16, 3.1-17*, 3.1-18, 3.1-19*, 3.1-25, 3.1-28, 3.1-29
- Controls — 4.1-3*, 4.1-14*, 4.1-15
- Displays — 5.1-9, 5.1-10, 5.1-14, 5.1-22, 5.1-32, 5.1-35, 5.1-36, 5.1-37, 5.1-39, 5.1-43, 5.1-54
- Labels — 6.1-17, 6.1-28
- Conventions — 8.1-7
- Verification — V1-10, V1-14, V1-17, V1-21, V1-29, V1-30, V1-36, V1-37, V1-38, V1-54, V1-60, V1-64
- Validation — V2-4, V2-14, V2-21, V2-22, V2-23

5.2.3.5 Justifications for Safety Significant "No Action" HEDs

As mentioned in the preceding section, 4 (3%) of the 152 safety significant HEDs will receive no corrective action. Detailed explanations for the 4 HEDs are given below.

5.2.3.5.1 HED #3.1-17, Alarm Does Not Specify Condition or Unit (Category II)

This HED was based upon the interview response of one operator who felt that the annunciator alarms for high Pressurizer pressure were somehow not specific enough. It was decided that operations and AEPSC engineering should evaluate the alarms to

determine if more specific information was required or appropriate for a better understanding of the out-of-tolerance condition. Perhaps there were multiple conditions which could be alarmed in a different manner. Both plant operations and AEPSC engineering reviewed the PZR alarms and could not find any basis for a problem. The Assessment Team could not identify a problem either. Therefore, no change was recommended.

5.2.3.5.2 HED #3.1-19, Multi-input Annunciators Do Not Provide Alarm Printout (Category III-S)

Some multiple input annunciators have no alarm print-out which describes the alarm specifics. AEPSC has reviewed all multiple input drops and has found that additional print outs are not needed. The D.C. Cook annunciator system has many more alarms than most other plants (about 1500 per control room) and it is not necessary to print out all alarms. The most significant alarms have been provided with print outs and the process computer is not capable of handling more alarms. For many of the alarms in question, an alarm print out is not needed, since the operator's initial response would be the same. That is, an operator would be dispatched to the local panel to investigate and take action. The local panel annunciator bank has all the needed alarm information. Some of the multiple input alarms are those with interlocks to prevent them from coming in during inappropriate plant conditions. It is not useful to the operator to print out the interlocking inputs.

5.2.3.5.3 HED #4.1-3, Controls Have No Interlocking Devices (Category II)

Three operator interview responses pertained to controls which might require mechanical interlocking devices to prevent switches from passing through a position when a strict sequential activation is necessary. Included were controls for Purge Supply and Exhaust, Charging Pump Recirculation and Suction, and RHR Pumps and Suction flow path. The Assessment Team recommended that a study be done to investigate the need for additional interlocks. AEPSC engineering reviewed the electrical interlocks already provided on the controls and found they were adequate to prevent costly damage. The operations members of the Assessment Team agreed that further interlocks are not required. It was concluded that these items may have been identified because the respondents mistook the intent of the question or because they judged that a mistake on these controls would be costly.

5.2.3.5.4 HED #4.1-14, Plastic Ties Used to Lock Hinged Pushbutton Barriers (Category III-S)

It was observed that plastic ties are used to lock some guards for reset pushbuttons. Included are reset pushbuttons for Safety Injection, Phase A Isolation, Phase B Isolation, Containment Ventilation Isolation, Alarm Reset Spray, and Feedwater Isolation Train A and B. The guards in question are hinged on the bottom and the ties not only lock the guard but hold it closed. Since these are reset pushbuttons, pushing them is not time critical. These reset pushbuttons would be used only when RCS cool down is well underway and the transient is under control such that engineered safety systems are no longer required. A slight delay in pushing the buttons would have no detrimental results. The plastic ties were added to achieve administrative control of resetting or stopping critical automatic functions. The control was implemented because the guarded pushbuttons have been erroneously activated in the past. AEPSC has decided that the plastic ties should be retained to ensure that operators will not reset functions without prior approval. The time delay for removing plastic ties is insignificant compared to the operations and management review of the initiating event.

5.2.4 CLO/HED Assessment Summary Tables

The tables at the end of the present section summarize the results of the assessment and disposition process. Each table is titled by review area, i.e., Workspace, Anthropometrics, ...Validation, and CLO/HEDs are presented in numerical order within tables. A brief description of the subject matter of each CLO/HED is given as is a code for the data collection method (I,O,M,D). Concerning the data collection codes, "I" stands for interview, "O" for observation, "M" for measurement, and "D" for document review. A NUREG-0700 guideline reference is also given along with the assessment category (I-IV). The assessment category identifies the priority of the HED. All other aspects being equal, a Category I HED should be corrected before a Category II HED, etc. All Category I and II HEDs plus HEDs identified as III-S are considered to be safety significant. The Category III-S HEDs are those with a high consequence of error but low potential for error. It is felt that corrections for these should be scheduled to be concurrent with other Category III HED corrections since fixing them does not produce much improvement in terms of reducing potential for error. That is, no matter what is done to correct these HEDs, potential for error is not much reduced since it was low initially.

The assessment summary tables further provide a brief explanation of the disposition for each CLO/HED. Corrective actions are described and justifications are given if

less than full correction is to be achieved. Finally, the tables give the status of the HEDs as of report writing. At present, about 150 HEDs either have already been corrected or are being corrected. Many of the enhancements have been designed and are now being applied to the control panels.

WORKSPACE
CLO/HED ASSESSMENT SUMMARY

Note: All Category I, II, and III-S HEDs are considered safety significant.

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.1-1	Too many non-essential people in primary area of control room	I	6117	III	Administrative controls are in place. Unit supervisor who is in the CR during a given shift can clear CR of all non-essential personnel. Administrative controls will be enforced and upgraded.	Corrected
1.1-2	CR floor tiles are too hard & cause fatigue	I	6157a5	III	Carpeting was installed in early '86.	Corrected
1.1-3	Access to rest room is limited; none for women in CR area	I	6157b1,2,3	III	A PA speaker will be installed in the rest room. A door lock and dead bolt will be installed so restrooms can be used by male or female operators. Room will be restricted for use by only operators.	To be corrected
1.1-4	There are two access doors between CR area and shift supervisor's office	I&O	6116a 6131b	IV	There is a dedicated communications link between CR & SS office. SS has a key to bypass locked door. Any delay would be minimal. Unit supervisor is always on shift in the CR.	No action needed
1.1-5	Personnel tripping hazards	O	6121b5 6113c1	II	The metal plates have been recessed flush with floor, box has been replaced with table, cords do not hang on floor & are not a problem, mats have been replaced with carpeting.	Corrected
1.1-6	Inadequate knee room - computer console	M	6127d6	IV	Operators do not need to sit close-in to console, no modification recommended by HF consultant.	No action needed
1.1-7	Inadequate separation of furnishings	M	6113e1	IV	Distance is 5" less than recommended 36", but is adequate given the limited periods of time for which computer operators' console is used.	No action needed

WORKSPACE (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.1-8	Unwanted panel and equipment openings	O	6113g	III	Holes from removed equipment have been covered and doors will be replaced on trend recorders. A cover will be considered for keyboard, especially for noise abatement. Communication & test jacks not considered a problem on vertical panels, i.e., not a violation of guidelines.	Being corrected
1.1-9	Inadequately stored reference materials	O	6114a2	II	New EOPs & AOPs have been put on a roll around cart. Other reference materials have been labeled and stored in a permanent place.	Corrected
1.1-10	Some reference documents do not have clearly visible titles	O	6114b1	II	Documents will be appropriately labeled.	Being corrected
1.1-11	Improperly bound documents	O	6114c2	III	Storage space has been doubled, procedures now bound fairly loosely. Bookmarks have been provided to prevent loss of place for those items which have to be accessed rapidly.	Corrected
1.1-12	Unprotected documents	O	6114d	III	Documents are replaced frequently so they do not become loose, dog-eared or dirty.	Partially corrected
1.1-13	CR chairs lack proper footrests	O	6128g	IV	Chairs adjust to 17" above floor. New chairs to be bought within 2 years will comply with guideline - will have footrest if not adjustable to within 18" above floor.	To be corrected

WORKSPACE (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.1-14	Lack of armrests	O	6128c	IV	Only unit supervisor's chair has armrests. Armrests are considered a potential hazard for accidental activation. Would prefer not to have any chairs with armrests.	No action needed
1.1-15	Inadequate seat adjustability	M	6128f	III	Plant will buy one chair adjustable down to 15" for each CR and next time (within 2 years) chairs are replaced, they will comply with guideline recommendations.	To be corrected

ANTHROPOMETRICS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.2-1	Controls are located too high or too low	I & O	6125a1,2	II	All identified controls were considered for criticality, frequency of use, and need for precision. Appropriate arrangements of SG, SPY, RHR, BA, VS & IV controls are being designed. It is not necessary or not feasible to rearrange the remaining controls. See detailed explanation in Section 5.2.3.3.1.	To be partially corrected.
1.2-2	Displays are located too high or too low	I&O	6125h1,2	II	The critical displays were considered for rearrangement, but this was found to be infeasible due to lack of room. Usability of displays will be improved by replacing scales, improving lighting and coding operating bands. The most frequently used displays are tilted forward at 15 deg angle and in several places oversized indicators are used. See detailed explanation in Section 5.2.3.3.2.	To be partially corrected.

EMERGENCY EQUIPMENT
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.3-1	Emergency equipment not stored in nor accessible to CR	I	6143a	II	Plant security requires that doors fail closed, however, several keys are readily available, including ones in SS office and CR. Sufficient Scott Air packs and emergency equipment for operating crew are now in CR area, the rest are located right outside CR security door.	Corrected
1.3-2	Protective equipment sizes are limited	I	6141d	II	Eight sets of radiation/emergency equipment are now stored in CR area. In case of fire, CR operators would evacuate area & go to hot shutdown panel. CR operators are not on fire brigade. Shoe covers come in only one size, which is large enough to fit everyone.	Corrected
1.3-3	Operators get no practice in performing CR tasks while wearing protective equipment	I	6141h	II	Training and practice will be conducted when simulator is set up.	To be corrected
1.3-4	Face masks have no mouth pieces - cannot communicate verbally	I	6141b 6218b 6154c	II	Capabilities for emergency communications are being reviewed and will be upgraded as necessary. Verbal communications in face masks are included in the consideration.	Being corrected
1.3-5	Radiation equipment not easily & readily accessible	II	6152b	II	Eight sets of equipment are now stored in CR area, the rest will be stored right outside CR area door. Eight sets are sufficient for CR operating crew.	Corrected
1.3-6	Emergency communication links are unreliable	I	6218a	I	Emergency communications equipment is being reviewed for needed improvement so that reliable communication will be ensured. A new wireless radio system with low wattage antennas giving full plant coverage is being designed. PA System and Walkie-Talkie maintenance has been improved.	Being corrected

EMERGENCY EQUIPMENT (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.3-7	Lack of periodic operator protective equipment checks	I	6141c	II	Equipment will be periodically checked via an inventory list.	Being corrected
1.3-8	Lack of written instructions for operator protective equipment	I&O	6141i	II	Operators are well trained in the use of protective equip. They receive semi-annual radiological retraining & are well practiced. Written instructions for protective gear is not needed. See detailed explanation in Section 5.2.3.3.3.	Partially corrected
1.3-9	Lack of written procedures covering environmental emergencies	I&O	6142d	None	CLO is incorrect, there are written procedures which cover environmental emergencies.	Not an HED

HVAC
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.4-1	CR temp not maintained within comfort zone	M	6151a	III-S	Design and procurement is underway for obtaining separate air conditioning unit for computer room. This will allow CR thermostats to be set within guideline recommendations.	To be corrected
1.4-2	There are some CR areas in which noticable drafts exist	M	6152b	IV	Will look into readjusting dampers for Unit 1 so that air velocities are within guideline maximum of 45 FPM given the pressurization limits of CR Ventilation System. Also operators now have uniforms that are warmer than previous CR attire. Velocities are not significantly higher than G/L, damper adjustment also must consider air flow balances and CR pressurization for 3 modes of operation.	To be corrected

ILLUMINATION
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.5-1	CR lighting inadequate for task performance in some areas	I	6153d	III	Administrative controls will be established over replacement of bulbs so that bulbs will be replaced as needed.	Being corrected
1.5-2	Displays are hard to see because of glare	I&O	6153f	II	CR lighting, including emergency lighting, is being evaluated by EED. Parabolic wedge diffusers or other appropriate modifications are being tested to reduce glare.	Being corrected
1.5-3	Colors not recognizable under emergency lighting	I	6153h	II	During emergency lighting the front of the CR is too dark (the sides are acceptable). Another string of emergency lighting is being considered for the front of the CR.	Being corrected
1.5-4	Recommended illumination levels are exceeded at various CR areas	M	6153a	II	To achieve satisfactory lighting levels, AEPSC is testing diffusers, carpeting the CR and trying other means as necessary. EED is evaluating lighting for improvements.	Being corrected
1.5-5	Some surfaces within the CR have abnormal light reflectance levels	M	6153g	III	Some desk tops have been modified to a darker surface to reduce reflectance. Carpeting has been installed and has markedly reduced glare from lower board areas.	Corrected
1.5-6	Non-uniform illumination	O	6153b	III	CR lighting is currently being evaluated for appropriate modifications by EED. Appropriate methods for increasing uniformity and diffusing light are being considered and tested.	Being corrected
1.5-7	Shadowed labels	I&O	6153e2	II	EED is evaluating CR lighting for improvements, reduction in shadows and more uniform level of lighting on the boards. Burned out bulbs are to be replaced as required.	Being corrected

NOISE
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.6-1	Verbal communications - front to back of CR	I	6155a	III	Carpet has been installed and dramatically attenuates noise. Telephone links are available between front and rear of panels. Administrative controls over non-essential people in CR are to be enforced (see HED #1.1).	Corrected
1.6-2	Operator's verbal communication impaired by noise in CR	I	6155d	III	PA system has been modified and is no longer a source of noise distraction in CR. The RMS printer is being replaced. The two-tone phone is within noise limitations. Maintenance will look into reducing ventilation noise. Carpeting has been installed and does attenuate noise.	Being corrected
1.6-3	Too many people in CR on day shift	I	6155	III-S	Addresses same problem as HED #1.1-1. Administrative Control over non-essential people in CR has been upgraded and is being enforced.	Corrected

MAINTAINABILITY
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.7-1	Inadequate supply of fuses, bulbs and resistors in CR	I	6115a	III	SS has key to storeroom so that operations personnel can get supplies at any time. Administrative controls will be established to ensure proper supplies are in storeroom.	Being corrected
1.7-2	Replacement tools not available to install expendable/spare parts	I	6115c 6331c3 6531a3	II	Bulb and resistor pullers have been supplied to CR personnel.	Corrected
1.7-3	Expendable & spare parts organized poorly	I	6115e	III	Appropriately organized storage areas will be set up and maintained.	To be corrected
1.7-4	Bulb replacement requires removal of non-coded tiles	I	6331c1 6433c4 6531c2	III-S	Administrative control over tile removal and replacement has been established to ensure that only one tile is removed and replaced at a time.	Corrected
1.7-5	Dual bulbs not replaced until both burned out	I	6433c1	III	All alarms are tested twice at each shift change and a once per week check is made for sockets with one bulb burned out. The possibility of changing incandescent bulbs to LED bulbs for greater reliability is also being evaluated. Also an adequate and accessible supply of bulbs is ensured (see 1.7-1 to 1.7-3).	Partially corrected

CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
1.7-6	Simple indicator lights have neither dual bulbs nor test capability	I	6531a1,2	III	Bulb test is not advisable since it would compromise control and display circuit reliability. Dual filament bulbs are not available that are compatible with fixtures and voltages. However, operators are trained to test for and readily recognize bulb failures. One or both lamps on at all times informs the operator of lamp failure. Normally racked out (NRO) lamps will have identifier labels and it may be feasible to replace incandescent lamps with LED bulbs.	To be partially corrected
1.7-7	Lack of periodic maintenance tests	O	6211b	III-S	All emergency communication systems are tested frequently. Other Systems are tested by constant use. The PA system now has 2 maintenance people assigned full time. The process computer screens have been changed and are checked periodically.	Corrected

COMMUNICATIONS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
2.1-1	Cannot hear phone calls in noisy areas of plant	I	6212	II	More and improved "Hear-Here" boxes are being considered and maintenance has been improved. A study will be undertaken to review and upgrade plant communications systems.	To be corrected
2.1-2	Headsets with microphones poorly maintained, not enough jacks, only one channel	I	6213	II	Maintenance has been improved for head-set system which is to be used primarily for surveillance testing. A new wireless radio system with low wattage antennas giving full plant coverage is being designed. This will reduce demand on old system.	Being corrected
2.1-3	Walkie-talkies poorly maintained and do not work in dead areas	I	6214a,b	II	PA and walkie-talkie system maintenance have been improved. A study has been undertaken to review and upgrade plant communications systems for full plant coverage.	Being corrected
2.1-4	PA system is malfunctioning and is poorly maintained.	I	6216	II	PA system maintenance has been improved. Two workers are assigned full-time to PA maintenance. A study has been undertaken to review and upgrade plant communications systems including the installation of variable gain speakers in high noise areas.	Being corrected
2.1-5	PA station in CR is too loud	I	6216c1	II	PA stations in CR have been adjusted. Further consideration of PA stations will be given in communications study.	Corrected
2.1-6	Back up communications equipment inadequate for emergencies	I	6218a	II	A study has been undertaken to review and upgrade plant communications systems, especially in terms of needs to support EOPs.	To be corrected

COMMUNICATIONS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
2.1-7	Communications system disrupts local instrumentation in plant areas	I	6218a 6214b	I	A study has been undertaken to review and upgrade plant communications systems. Disruption problem will be considered as part of study.	To be corrected
2.1-8	Lack of instructions for communications system use	O&D	62119	III	Needed instructions have been provided as part of communications study and upgrade efforts.	Corrected
2.1-9	Lack of priority procedures for emergency messages	O&D	6211c1,2	III-S	Priority for emergency messages is being considered as part of the communications upgrade study. Priority procedures are being written.	Being corrected
2.1-10	Improperly designed vertical handset mounts	O	6212b6	III	Handset mounts will be considered as part of the communications system review and upgrade study.	To be corrected
2.1-11	Uncomfortable headsets	O	6213b2	III	Replacing headsets to increase comfort in the CR is being included as part of the communications system review and upgrade study. However, the heavier muffling type headsets are required for noisy areas out in the plant.	To be corrected
2.1-12	Inadequate headset storage	O	6213b6	III	Proper storage of headsets is being implemented as part of communications systems review and upgrade efforts.	To be corrected
2.1-13	Lack of walkie-talkie battery maintenance	O	6214c	II	Walkie-talkie battery maintenance is being improved as part of communications systems review and upgrade efforts. Battery radios are now being used which require less battery maintenance.	Being corrected

COMMUNICATIONS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
2.1-14	UHF radio gain limits too low	O	6215b	III	Limiting volume adjustment of UHF radio will be considered as part of communications systems review and upgrade efforts.	To be corrected
2.1-15	No procedures for UHF radio use	O&D	6215c	III	Procedure for UHF radio use is being developed as part of communications system review and upgrade efforts.	To be corrected
2.1-16	Lack of announcing system priority coding	O	6216f	III	PA system priority stations are being designed as part of the communications systems review and upgrade efforts.	To be corrected

ANNUNCIATORS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
3.1-1	No first out panel for reactor system & turbine generator system	I	6313a1,3 6313b	IV	No backfit was recommended by HFS. Operators have access to a sequence of events monitor and the P250 prints out alarm sequences. Identification of initiating events is readily available.	No action needed
3.1-2	Annunciator system is not visually or audibly priority coded	I	6314b1,2	II	An annunciator system study and upgrade program has been initiated. Windows are being evaluated for color coding to indicate priority. Other changes being considered include re-engraving messages, rearrangement of alarm drops, elimination of nuisance alarms (over 200 fixed thus far) and review of Annunciator Response Procedures (ARPs).	Being corrected
3.1-3	Alarm signals startle and/or irritate operators	I	631c	II	An annunciator system study and upgrade program has been initiated. Over two hundred nuisance alarms have been corrected to date. Alarms will be adjusted and RMS alarms will be included in nuisance alarm study.	Being corrected
3.1-4	Tiles are illuminated when no alarm is indicated	I	6332e	II	Problem tiles (those marked with "P") are being evaluated and modified on an individual basis. Present program will continue to resolve problem and "normally on" annunciators.	Being corrected

ANNUNCIATORS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
3.1-5	Multi-input alarms do not have reflash capability	I	6312c3	II	AEPSC has reviewed all multiple input drops and dedicated alarms are being evaluated for important CAS drops (see 3.1-11) and RCP Oil Pots (see 3.1-15). Other alarms do not require reflash, since similar local action would be required for each. See detailed explanation in Section 5.2.3.3.4.	To be partially corrected
3.1-6	Tiles illuminated over extended durations not coded	I	6332f1	III-S	Plant personnel are developing a method to code annunciators which are on for extended periods for repair of equipment. A color dot or similar means will be used. Administrative controls will be in place for adding & removing dots.	To be corrected
3.1-7	No way to tell if annunciator tile is out of service	I	6333c	II	Preventative maintenance program has been started so that all bulbs are tested weekly and any annunciators with one bulb out have burned-out bulb replaced. This is in addition to testing twice at shift change.	Corrected
3.1-8	Alarms occur so frequently that they are considered a nuisance.	I	6312a1	II	An annunciator system study and upgrade program has been initiated. Over two hundred nuisance alarms corrcted to date.	Being corrected
3.1-9	Alarms do not allow enough time to respond	I	6312a2	III-S	Engineering review has been undertaken to determine appropriateness of set points and to adjust accordingly. T_{ave} and seismic monitor alarms cannot be modified due to nature of alarm, e.g., cannot give earlier warning of an earthquake (seismic event).	To be corrected

ANNUNCIATORS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref *	Assessment Category	Review Disposition	Status/ Remarks
3.1-10	Alarms and associated components not grouped well	I	6331a	III-S	An annunciator system study and upgrade program has been initiated. Windows are being evaluated for color coding to indicate priority. Other changes being considered include re-engraving messages, rearrangement of alarm drops, elimination of nuisance alarms and review of ARPs.	To be corrected
3.1-11	Alarms requiring information outside CR do not allow ample time to respond	I	6312b2	II	Engineering is reviewing alarm set points to determine if local operator action is needed and if there is enough time to respond to each alarm. Have also looked at CAS alarms to determine which should be in the CR.	To be corrected
3.1-12	Individual alarm tiles contain dual messages	I&O	6334c	III	All dual messages were reviewed & RCP oil level alarms will be split out per HED 3.1-15. No other changes are deemed necessary. For all alarms, whether single or dual (such as high/low) the operator is trained to verify the alarm condition by checking appropriate indicators. Therefore, dual alarms do not cause unnecessary checking and separate windows are not needed.	To be partially corrected
3.1-13	Annunciator response book available, but not adequate for use by operators	I	6343a	II	Annunciator Response Procedures are undergoing bi-annual review and will be revised appropriately.	Being corrected
3.1-14	Potential for personal injury to AO when responding to alarm	I	6312b2	None	Not a CRDR issue, has been referred to plant as an industrial safety issue.	Not an HED, referred to plant for action

ANNUNCIATORS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
3.1-15	Tile contains dual message but only one is apparent	I	6334c	III-S	Splitting out alarms (by upper & lower pots and according to reservoir) and installing local indications is being evaluated.	To be corrected
3.1-16	Alarm reset function not consistent throughout CR	I	6341c	IV	Seal-in type alarms are used in applications where the initiating signal is momentary and operator would not have time to react were it not seal-in. The alarms are coded with a black band and a special reset is provided.	No action needed
3.1-17	Alarm does not specify condition or unit	I	6334a	II	AEPSC engineering and operations reviewed PZR annunciator alarms and neither could find any basis for a problem. Assessment Team concurred, therefore, no change is recommended. See detailed explanation in Section 5.2.3.5.1.	No action needed
3.1-18	No coding of alarms for stations outside primary area	I	6322a1	IV	There are separations for front, left and right portions of CR. In addition "bulls eye" lights up on the individual matrix containing alarming window. CW annunciator matrix has a bulls eye on plant service panel which is easily viewed from front of CR. See detailed explanation in Section 2.3.5.2.	No action needed
3.1-19	Multi-input annunciators do not provide alarm printout	I	6312c2	III-S	AEPSC has reviewed all multiple input drops and has found no additional print outs to be needed. CR has about 1500 alarms and it is not necessary to print out all alarms. Some multiple input alarms are those with interlocks to prevent them from coming in during inappropriate plant conditions. See detailed explanation in Section 5.2.3.5.2.	No action needed

ANNUNCIATORS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
3.1-20	Character tile consistency	O	6335b1,2 6335a2	II	An annunciator system study and upgrade program has been initiated. Windows are being evaluated for color coding to indicate priority. Other changes being considered include: re-engraving messages, rearrangement of alarm drops, elimination of nuisance alarms and review of ARPs.	Being corrected
3.1-21	No demarcation lines	O	6662a1	II	Some annunciator arrays do have 100 windows, however, to acknowledge alarm operator has to push the individual button in alarm. Alarms will be color coded and rearrangement is being reviewed, but demarcation is not recommended due to narrowness of space between alarms and high probability of visual clutter. See detailed explanation in Section 5.2.3.3.5.	To be partially corrected
3.1-22	Tile legend message	O	6334a	II	Tiles are to be reengraved using standard abbreviations so they are more concise and fit on 3 lines. To be included in the annunciator study.	Being corrected
3.1-23	Many handwritten/typewritten annunciator legends contain lower-case lettering	O	6335b3	II	An annunciator system study and upgrade program has been initiated. Windows are being evaluated for color coding to indicate priority. Other changes being considered include: re-engraving messages, rearrangement of alarm drops, elimination of nuisance alarms and review of ARPs.	Being corrected
3.1-24	Number of annunciator tiles per panel exceeds 50	O	6333d1	II	The 100 drop annunciator banks will be retained, but alarms are being evaluated for rearrangement and color coding according to priority. See detailed explanation in Section 5.2.3.3.6	To be partially corrected

ANNUNCIATORS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
3.1-25	A few workstations do not have an auditory alert system	O	6321f	IV	There are 3 tones which focus operators' attention to front, left or right. Each annunciator matrix has a "bulls eye" light to further focus operators' attention. The "bulls eye" for the CW panel annunciators which are normally out of view is located in view on the plant service panel (see 3.1-18).	No action needed
3.1-26	One annunciator alarm speaker's output exceeds the other's.	M	6321d	III-S	Speaker output has been adjusted similar to other annunciator speakers in compliance with NUREG-0700 guidelines.	Corrected
3.1-27	Some annunciator tile legends are not engraved	O	6335c1	II	An annunciator system study and upgrade program has been initiated. Windows are being evaluated for color coding to indicate priority. Other changes being considered include: re-engraving messages, rearrangement of alarm drops, elimination of nuisance alarms and review of ARPs.	Being corrected
3.1-28	Vertical and horizontal axes of ALBs are not labeled	O	6333c1,c2 6832d1	IV	No backfit recommended by HF specialist. D.C. Cook annunciator boxes are much smaller than other plants. So, labels would clutter displays. Labeling axis would also interfere with current numbering system used.	No action needed
3.1-29	Cleared annunciators are not visually coded	O	6315b	III	Once acknowledged, all alarms must be pressed to clear. A cleared alarm would then be dark, if lit, it is a new alarm. Therefore, the operator knows if an alarm is new or cleared as soon as the button is pushed.	No action needed

ANNUNCIATORS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
3.1-30	Defeatable annunciator control	I&O	6342c	I	There is an ongoing program to fix problem and nuisance alarms. The need for pegging will be nearly eliminated. All pegging is controlled administratively and is properly logged. See detailed explanation in Section 5.2.3.3.7.	To be partially corrected
3.1-31	Annunciators - Spacing & dimensions	M	6335d	III-S	Annunciator systems study and upgrade program has been initiated. Windows are being evaluated for color coding to indicate priority. Other changes being considered include re-engraving messages, rearrangement of alarm drops, elimination of nuisance alarms (over 200 fixed thus far) and review of ARPs.	Being corrected
3.1-32	Annunciator - tile grouping	O	6333d2	II	Same as 3.1-31	To be corrected
3.1-33	Inconsistent/incorrect annunciator colors	I&O	6516c1,2	III-S	Same as 3.1-31	Being corrected

CONTROLS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
4.1-1	Critical controls do not have movable guards	I&O	6412c1 6412a	II	Cold overpressure controls have had handles removed to prevent accidental activation. Unit 2 Main Turbine Valve Reset Switch has had handle shape and demarcation enhanced. Other switches will be enhanced by shape coding of handles, demarcation and labels with red background where applicable. See detailed explanation in Section 5.2.3.3.8.	To be partially corrected
4.1-2	Pushbuttons should be replaced with other type of control switches	I	6412g	III	The actual problem is that operators have pushed the alarm buttons rather than test buttons. The problem will be solved by guarding the alarm pushbutton with an extender tube.	To be corrected
4.1-3	Controls have no interlocking devices	I	6412f	II	Controls have been reviewed for interlock necessity and it was found that mechanical interlocks (as recommended in the guideline) are not necessary since the electrical interlocks on these switches are adequate. See detailed explanation in Section 5.2.3.5.3.	No action needed
4.1-4	Controls & displays that operator is never required to use	I	6411b1	III-S	Controls were reviewed and the following are not necessary: part length rod controls, generator load frequency controls, feed pump warming line controls, MFW pumps hydraulic coupling controls, loose parts monitor and FW chemical controls. These already have been removed or will be considered for removal.	To be corrected

CONTROLS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
4.1-5	Control configurations not expected type	I	6411c2	II	The actual problem is that the labeling (i.e., Block/Reset) is confusing, since an actual reset does not occur. Therefore, labeling will be changed to unblock/block. Also the throw action of the switches will be tightened and Cold Overpressure switch position labels will be corrected.	Being corrected
4.1-6	Controls provide no sensory feedback when activated	I	6411c3	III	Turbine adj. pot. & lube oil temp are process controllers which have indicator scales to provide feedback. The controllers will be looked at for maintenance problems. As per HED #4.1-6, the SG & PRZ SI Block switches are being adjusted so that throw action is tighter.	Being corrected
4.1-7	Controls are too hard to turn	I	6411c3	III	Switches are being checked for maintenance problems, and for PULL-TO-LOCK switches torques are being adjusted and handles replaced if needed. Torque adjustment and lubrication of knurled knob switches are being done as needed.	Being corrected
4.1-8	Controls are difficult to adjust to the precise level required	I	6411a	III-S	The Assessment Team discussed each control type listed and resolved each as follows: 1. Aux feedwater reg. valve controls will be changed so that pull-to-lock is reserved only for overriding auto signal when necessary. 2. Several controllers were listed; if broken a work requisition has been issued, otherwise the problem is not with the controllers, the process itself is difficult (i.e., equipment out in plant is difficult in response). Included are NIS 10 Turn Pots, Hotwell Level Makeup & Letdown, Condensate Makeup & Letdown, Train Controls, SG Level, & Charging Flow.	Being partially corrected

CONTROLS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
4.1-8 (Cont'd)					3. The turbine adj. pots have been investigated for repair per HED #4.1-6. 4. The pistol grip turbine controls on Unit 2 are more difficult to use than those on Unit 1, but replacement would necessitate replacing entire system which is not feasible. Controls are usable as is and do provide a sufficient range of control. 5. RHR Flow controls are difficult to use due to a problem with the RHR valves themselves. The RHR valves may be replaced for other reasons. 6. CCW Heat Exchanger Valve controls were not deemed difficult to operate after input from operations specialists and discussion by Assessment Team. 7. The Bailey FW Heater controls and the Auto turbine roll control will be fixed or adjusted by plant personnel, as necessary. See detailed explanation in Section 5.2.3.3.9.	
4.1-9	Control movement is backwards	I&O	6421	II	Some controllers are pneumatic and some are electronic, but it is not feasible to modify either to work in the reverse direction. However, shape coded handles are being installed as are arrows for direction to open. See detailed explanation in Section 5.2.3.3.10.	To be partially corrected

CONTROLS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
4.1-10	Location coding is inaccurate	I&D	6422b	II	MSR components will be rearranged so they are all in East/West order and will be relabeled accordingly. CCW valve controls are already in the best location, since the outlet crosstie controls requires precise adjustment and would be too low for precise adjustment if moved down.	To be corrected
4.1-11	Rotary selector switch not used when 3 positions required.	I	6445a	None	CLO is incorrect, there is a three position switch used for turbine load change.	Not an HED
4.1-12	There are some access doors that have unnecessary key locks	O	6443a 6541f	IV	Locks are unlocked and have been disabled by discarding the keys.	Corrected
4.1-13	Some moving scale and fixed pointer rotaries do not have intact scales	O	6411c1	III-S	Scales will be replaced and maintained intact.	To be corrected
4.1-14	Plastic ties used to lock hinged pushbutton barrier	O	6412c2	III-S	Plastic ties were added to implement administrative control to prevent accidental activation. Pushing buttons is <u>not</u> time critical and since guarded buttons have been activated in past, AEPSC feels it is necessary to maintain plastic ties to prevent future incidents. See detailed explanation in Section 5.2.3.5.4.	No action needed
4.1-15	Barriers are not always used when legend pushbuttons are contiguous	O	6433d1	IV	The bank selected/bank sequence buttons do have barriers. Operators report no problem with the pushbuttons on the FCC panel. Therefore, no change is needed.	No action needed

CONTROLS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
4.1-16	Some control movements do not conform to population stereotypes	O	6421	III	Each of the items listed was discussed and the significant ones will be modified to conform to population stereotypes: the 8 J-handle rotaries on the VS panel will be considered for correction; HP-520-IL is easy understood and will not be modified; FRV-267 & FRV-266 are being evaluated for removal from the panels; FRV-252 & FRV-254 are being evaluated for modification to "CLOSED-AUTO-OPEN"; labeling on ORV-302 will be modified to "VCT-DEMIN"; the remaining items are of low criticality, not used by operators, are easily recovered from, or are regulated automatically so that modifications are not warranted.	To be partially corrected
4.1-17	Some rotary control settings do not increase in value with clockwise rotation	O	6441a	III	Eight controls on VS panel are to be considered for correction per 4.1-16. The remaining controls do not require any modification since they are easily understood, non-critical in nature, not backwards from an operations viewpoint, not used by operators, or are being replaced.	To be partially corrected
4.1-18	Some rotary controls have a fixed pointer and moving scale	O	6445c	IV	Foxboro H/A and Manual Stations do have fixed pointers with moving scales, however, the knobs can be easily and accurately set with minimum operator hesitation or mistakes. Markings are such that status can be read from a distance. Stations are to be enhanced by adding arrows for direction of increase.	To be partially corrected

CONTROLS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
4.1-19	A few color coded controls do not contrast adequately with their background	O	6422f3	III	Color coding of pushbuttons will be checked for adequate contrast, especially blue and green lights will be changed to white. Also see 5.1-24.	To be corrected
4.1-20	Control surfaces cause injury	O	6411e1	II	Plant maintenance has replaced burred screws and instructed personnel as suggested.	Corrected
4.1-21	Controls not intact	O	6411e1	III	Plant maintenance has repaired or replaced items listed.	Corrected
4.1-22	Unlabeled key operated switches	O	6443f	II	A new keyboard has been installed on RMS alarm printer.	Corrected
4.1-23	Lack of thumbwheel coding	O	6451b	III	Thumbwheel directions are being labeled, i.e., "INCREASE-DECREASE" or "RAISE-LOWER".	Being corrected
4.1-24	Control dimensions not as recommended	M	6445e 6451d2	IV	All controls will be relabeled so they can be located for timely activation. Other CLOs identify controls which operators find difficult to turn or adjust as necessary. Refer to 4.1-5, 4.1-7 & 4.1-8 for actions to be taken.	To be partially corrected

DISPLAYS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-1	Status inferred by absence of illumination	I	6531c1	III	All status lights were reviewed and all legends are true when lit, except for annunciator voltage failure lights. These will be re-engraved "VOLTAGE AVAILABLE."	Being corrected
5.1-2	Scale ranges too wide for maximum displayed values	I	6512d1	III	All scales listed were reviewed and modifications will be done as appropriate. 1. An engineering review will determine the correct range for Steam Packing Exhaust Pressure, Boric Acid Flow, and SI Pump Flow (i.e., ECCS Discharge Pumps). 2. The BIT is being considered for elimination; if not eliminated then changes to scale will be considered (either square root extractor or decrease in range with 0-135 required). 3. Modifications to Air Ejector-Air Flow-Off Gas recorder scale has been approved. 4. Steam and Feed Flow scales are correct as presently scaled, since valves can go to 85% of scale. 5. Aux. Feedwater scale range is needed to 200,000 lb/hr and minimum flow during startup is easily read on scale. 6. Turbine Vibration has been measured at 20.5 previously, so present 0-30 scale is needed in case of an abnormal transient (more precise equipment is used for calibration). Turbine Vibration must be wide enough to measure excursions.	To be corrected
5.1-3	Maximum values are too large for scales	I	6512d3	III-S	All scales listed were reviewed and modifications will be done as appropriate:	To be corrected

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-3 (Cont'd)					1. An engineering review will determine the correct range for Condensate Letdown and Makeup Flow Recorders, CCW Reactor Support Cooling Flow, CCW to & from Excess Letdown Heat Exchangers, and RC pressure High Range Recorder. 2. The Containment Spray Educator Flow indicator is being considered for removal from CR. If not removed, modifications to scale will be considered. 3. SG Steam and Feed Flows are correct, the maximum scale value is 3.6×10^6 and scales go to 4×10^6. 4. Aux Feedwater Flow indicators are presently correct, the maximum value for EOPs is 200,000 lb/hr and scale goes to 250,000 lb/hr. 5. For RCS Pressure, wide range indicators (0-3000) are nearby on both the Main Control Boards and the Hot Shut-down Panel. 6. For Main Steam Flow, the problem is with the transmitters which are being replaced. The indicator scales are correct (4×10^6). 7. The scales on the RCP High Range Recorder and charging Hdr Press are correct (0-3000); RV press rating is 2,500. 8. RCS Wide Range Temp. Indication is provided, recorders go to 700^o and WR thermocouple readings are available in the CR computer systems. 9. The RHR total flow indicator scale has recently been improved. The maximum flow is 6,000 and meter now goes to 7,000.	

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-4	No verification that meters fail off-scale	I	6511f	II	An engineering review was done and a live zero is being developed for ECCS and Aux FW flow meters. To deal with stuck mechanisms, operators are trained to check redundant or verifying displays against each other. See detailed explanation in Section 5.2.3.3.11.	To be partially corrected
5.1-5	Multiscale displays do not benefit operators, and are confusing to read	I	6515f 6541c	III	There are no single pointer, multiple scale displays listed on this HED. However, all displays listed have been reviewed and scales will be made to agree with chart paper. AEPSC will correct scales where appropriate.	To be corrected
5.1-6	No zone coding used where needed	I&O	6523	II	Zone coding study to be undertaken by AEPSC. Appropriate zone coding will be applied to indicators.	To be corrected
5.1-7	Poor contrast between pointers and background	I	6522c	III	Indicator scales will be changed to white background with black pointers and numbering. Narrow band for parameter labeling will be color coded according to parameter type (level, press, temp).	To be corrected
5.1-8	Recorders not located in primary work area	I	6541h	II	Containment Sump Recorder will be reviewed for possible relocation into CR. Containment Temperature Recorder is now available in rear of CR. Other recorders listed are not of sufficient importance to move into CR. See detailed explanation in Section 5.2.3.3.12.	To be partially corrected
5.1-9	Recorders do not have paper speed adjustment	I	6541i	IV	Paper speed adjustment is a convenience, but not a necessity for efficient reading and changing of charts. The inconvenience does not warrant recorder replacement.	No action needed

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-10	Data cannot be read through window without opening door	I	6541k	IV	It is not necessary to open doors to determine trends. The present value can be read by looking at the pointer. The trend can be determined by looking at the values on the chart paper and comparing them to the present reading. Also, the only listed recorder used in EOPs is NR-45 and its data can be read on indicators.	No action needed
5.1-11	Ink clogs pens or smudges paper on graphic recorders	I&O	6541a	II	Cartridge, felt tip pens will be installed on recorders where available, otherwise maintenance of refillable mechanisms will be improved.	To be corrected
5.1-12	Recorders are driven to maximum, then they hang up	I	6542b1	III	Plant maintenance will ensure recorders do not hang up; will fix the stops if needed. The Vibration Recorder has already been modified.	Being corrected
5.1-13	Display too slow after channel selection	I	6542b4	IV	The process recorder is being considered for replacement within five years.	To be corrected
5.1-14	Some recorders not provided with paper takeup spool	I	6541d	IV	Takeup spool and paper cutoff edge are conveniences. Operators are able to efficiently change or cut charts without them. A lack of these does not warrant recorder replacement. Many recorders in the CR use "fan fold" paper and this guideline is not appropriate to them (paper is easily detached).	No action needed

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-15	Pink (red) windows over vertical displays	O	6513c1	III	Indicator scale backgrounds are to be changed to white, except narrow band (without numbers) which will be color coded for parameters.	To be corrected
5.1-16	Indicator light brightness	O	6532a1	None	CLO is redundant, see 5.1-53 since it contains all pertinent information.	Not an HED, combined with 5.1-53.
5.1-17	Indicator light color meaning is not clear	O	6532a1	II	Labeling will be added to explain white lights. Consistency of other applications will be ensured. On vendor supplied panels, lenses will be changed if appropriate color lenses are available. APDMS is not used by operators and is being considered for removal from CR.	Being corrected
5.1-18	Legend light lettering	O	6533b2	III-S	Legend lights will be re-engraved in compliance with NUREG-0700 guidelines concerning use of capital letters and correct font style.	Being corrected
5.1-19	Meanings of symbols/punctuation marks are not always clear when applied to legends	O	6533b3	III-S	Legend lights are to be re-engraved in compliance with NUREG-0700 guidelines concerning symbols and punctuations marks.	Being corrected
5.1-20	Four lines of text on legend lights	O	6533b3	III	Legend lights are to be re-engraved using standard abbreviations so they are more concise and fit on 3 lines.	Being corrected
5.1-21	Meter multipliers	O	6512e	IV	Meter scale will be replaced so that multiplier is no longer confusing.	To be corrected

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-22	Meaning of numbers on scale is unclear	O	6512c	IV	The numbers in question are used by C&I technicians to calibrate the meters. Operators are aware that the markings are not for their use. The markings are quite small, out of the way, and do not interfere with scale readability.	No action needed
5.1-23	Inconsistent scale graduations between meters.	O	6515d	None	CLO is not an HED, since the two indicators mentioned are for different parameters with different ranges.	Not an HED
5.1-24	A few legend indicator lights have legends that do not have adequate contrast	O	6533a2,3	III	Blue or green legend indicator lights will be changed to white. Refer to 4.1-19.	To be corrected
5.1-25	Scale numbers not vertical	O	6524a	None	CLO is redundant, see 5.1-51.	Not an HED, combined with 5.1-51.
5.1-26	More than nine graduations separating scale numerals	O	6515a1	IV	Many indicator scales are to be changed due to other HEDs. When the scales are changed the guideline cited in the present HED will be followed.	To be partially corrected
5.1-27	Scale value decreases with upward movement	O	6521h	IV	Indicators are within conventions used and understood at D.C. Cook. Operators are well trained and know that as inches of mercury decrease from 30 at scale bottom to 0 at scale top absolute pressure increases. Labeling enhancements will improve operator comprehension.	To be partially corrected
5.1-28	Irregular meter pointer tips	O	6522a1	IV	All of the meters listed can be easily read without confusion or hesitancy. Should any of the displays require replacement for other reasons, the recommended pointer design will be considered.	To be partially corrected

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-29	Inadequate zone markings	O	6523c	III	AEPSC will undertake zone coding study and correct indicator zone coding as appropriate.	To be corrected
5.1-30	Improper placement of meter zone markings	O	6523b	III	AEPSC will undertake zone coding study and correct indicator zone coding as appropriate.	To be corrected
5.1-31	Flag indicators for J-handle rotaries are difficult to differentiate from one another	O	6516c13	IV	Plant maintenance is making effort to repaint and keep flag indicators clean.	Being corrected
5.1-32	Moving scale/fixed pointer	O	6525	IV	The Fischer H/A stations occasionally function as moving scale/fixed pointer. They are not confusing to operators. The use of the scales will be improved when direction of motion is labeled as suggested in HED 6.1-42. Also see HED 4.1-18.	No action needed
5.1-33	Color windows on vertical displays	O	6513c1	III	Windows will be clear, scales will have white background, except for narrow band (without numbers) that will be color coded for parameter.	To be corrected
5.1-34	Scales on paper vs on recorder	O	6541b	III	Recorder paper will be changed to match scales and maintained as such.	To be corrected
5.1-35	All drum counters have white numerals on a black background	O	6551a4	IV	The contrast of the white numbers on black background is good, all counters are easily read.	No action needed
5.1-36	A few drum counters are not mounted perpendicular to operator's line of sight	O	6551b1	IV	All counters are easily read, the numbers are large enough to compensate for the somewhat off perpendicular mounting.	No action needed

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-37	Most electronic counters have slanted characters	O	6552a2	IV	All counters are easily read, the characters are more than large enough to compensate for the slant.	No action needed
5.1-38	Major intermediate & minor graduation marks not used when necessary	O	6515a3 6541c	IV	Many scales are being changed due to other HEDs. When changed they will be designed to NUREG-0700 guidelines with consideration given to appropriate use of major, intermediate and minor graduations.	To be partially corrected
5.1-39	Inadequate distance between some pointer tips and smallest scale graduation marks	O	6522b1 6522a2	IV	All of the displays referred to can be easily read to the required accuracy of the application without confusion or hesitancy.	No action needed
5.1-40	Some displays have pointers that contrast inadequately with background	O	6522c	III	For indicators, black pointers on white scale faces will be used. Process controller pointers have good contrast, they do not need any improvement. Note: narrow band on vertical indicators will be color coded for parameters.	To be corrected
5.1-41	Unnecessary use of scale multiplier labels	O	6514f	IV	Many indicator scales will be replaced due to other HEDs. When scales are changed multipliers will be eliminated such that only 10^3 and 10^6 will be used whenever possible.	To be partially corrected
5.1-42	A few drum counters have more than 4 digits not grouped	O	6551a3	III	Decimals and commas will be added where appropriate.	To be corrected

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-43	Some displays have pointers that conceal scale numerals/graduation marks	O	6522a2	IV	Pointer sizes relative to the size of numbers is not excessive, the operators' recognition of the numerals is not hindered. In some cases portions of graduation marks are covered, but recognition of the location of the marks and pointer tip are not compromised.	No action needed
5.1-44	Colors used for display zone coding do not always color recommendations	O	6516c2 6523c	III-S	AEPSC will undertake a zone coding study and ensure colors used for display zone coding are appropriate.	To be corrected
5.1-45	Some meters and recorders use scale graduations not recommended by guideline	O	6515c 6541c	III	The scales will be reviewed and replaced as necessary. Most of the scales listed will be replaced, however, some electrical meter scales will be maintained to appropriate electrical meter conventions.	To be partially corrected
5.1-46	Zone markings/setpoints designs are confusing	O	6523a	II	AEPSC will undertake a zone coding study to ensure indicator zone coding is appropriately applied.	To be corrected
5.1-47	Most zone markings used are not conspicuous and distinctly different zones	O	6523a 6516a	III	AEPSC will undertake a zone coding study and will modify zone codes as appropriate so that codes are distinct for different zones.	To be corrected
5.1-48	Non-standard and inconsistent abbreviations are used for legend lights	O	6533b6	III-S	Legend lights will be re-engraved using correct abbreviations.	Being corrected

DISPLAYS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
5.1-49	All scale multiplier labels are not clearly designed & conspicuously located	O	6512e 6514f 6541c	III	Many scales are to be replaced, where possible only 10^3 and 10^6 will be used.	To be corrected
5.1-50	Printing on display faces	O&D	6514c,d,e	III-S	Messages will be modified using standard abbreviations and bolder engraving.	To be corrected
5.1-51	Non-vertical display numerals	O	6524a 6521b	III	Boron Injection Tank Temperature is to be corrected. Hydrogen Recombiner Temp. meters are easily read. No change is needed.	To be partially corrected
5.1-52	Inadequate display contrast/channel identification	O	6513c1 6542b2 6715a	III	Identified scales will be replaced; indicator lights will be cleaned and lettering repaired; and bulbs and/or light circuits will be repaired as needed.	Being corrected
5.1-53	Non-legend indicator lights too dim	M&O	6532b 6531b	III	Plant maintenance will investigate too dim lights for correction. Ground detector bulbs glow in proportion to amount of current. These only need to be seen when glowing brightly, should be dim normally. There is an administrative procedure by which operators walk boards to check for loose bulbs.	Being corrected
5.1-54	Some non-legend indicator lights alert operator to unfavorable status	O	6531d	IV	First item listed is a light for the Oil Heater which indicates heater is on. This is not an unfavorable status. The remainder of the status lights listed are alarmed on the annunciator system.	No action needed

LABELS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-1	Components not labeled clearly nor appropriately	I	6611 6635 6632b,c	II	AEPSC has initiated a labeling, demarcation, and mimic study. The study will include relabeling of components, hierarchical labels, addition of demarcation lines and corrections to mimics. The present discrepancy is being included as part of the study.	Being corrected
6.1-2	Position labels not visible during control actuation	I&O	6621c 6624c 6638c	III-S	Discrepancy is included as part of the labeling study.	To be corrected
6.1-3	Labels do not describe equipment functions	I	6631a	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-4	Labels do not specify what action is intended	I	6632a	III-S	Discrepancy is included as part of the labeling study.	Being corrected
6.1-5	Unconventional color coding used on indicators	I	651bc1,2	II	A study will be performed of color coding used throughout both control rooms to match colors with appropriate usage meanings. To be included as part of labeling, demarcation, and mimic study.	To be corrected
6.1-6	Terms & abbreviations used in labeling are not standardized	I	6632d	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-7	Inadequate labeling on REG null meter	O	6631a	II	Discrepancy is included as part of the labeling study.	To be corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-8	Some displays do not have a parameter and/or units label	I&O	6611	III-S	Discrepancy is included as part of the labeling study.	To be corrected
6.1-9	Inconsistent recorder channel identification methods	I&O	6611	III	Discrepancy is included as part of the labeling study.	Being corrected
6.1-10	There are some related components that use labels with dissimilar contents	O	6611 6633b	III	Discrepancy is included as part of the labeling study.	Being corrected
6.1-11	Most major systems/operator workstations are not labeled	O	6612a1	III-S	Major systems/work stations will be labeled as part of CR relabeling, demarcation and mimic study.	Corrected
6.1-12	Most subsystems or functional groups not labeled	O	6612a2	III-S	Subsystems and/or functional groups will be labeled, as appropriate, as part of overall CR relabeling, demarcation, and mimic study.	Corrected
6.1-13	Label letter sizes are not always graduated according to hierarchical levels	M&O	6612b	III-S	Label letters and numbers will be resized according to guideline recommendations (part of CR relabeling effort). Include in labeling, demarcation, and mimic study.	Being corrected
6.1-14	Component labels are not placed above the panel element they describe	O	6621AB	III-S	AEPSC has initiated a labeling, demarcation, and mimic study. The study will include relabeling of components, hierarchical labels, addition of demarcation lines and corrections to mimics. The present discrepancy is being included as part of the study, labels will be placed above panel elements as space permits and unless labels would be more difficult to see because of height of components.	Being corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-15	A few adjacent labels not separated by sufficient space	O	6621f 6642d2	III	Discrepancy is included as part of the labeling study.	Being corrected
6.1-16	Some labels not adequately mounted to panels/component surfaces	O	6622a	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-17	Curved labeling sometimes used	O	6623b	IV	All labeling in question is easily read and most of this nature would be very difficult to change without ordering new components or component scale faces and escutcheons. All were carefully reviewed to ensure they could be read easily.	No action needed
6.1-18	Mimic lines covered/obscured by J-handles	O	6624b	IV	Discrepancy is included as part of the labeling study.	Corrected
6.1-19	Some labels are obscured/hidden by components	O	6624b	III	Discrepancy is included as part of the labeling study.	Being corrected
6.1-20	A few label messages are not direct	O	6632c 6433b4	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-21	Labels are inconsistent in their use of words, acronyms and abbreviations	O	6633b	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-22	Symbols are not consistently used across and within panels	O	6633b	III-S	Discrepancy is included as part of the labeling study.	Being corrected
6.1-23	Some functional control switch positions are not labeled	O	6638a	II	Discrepancy is included as part of the labeling study.	To be corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-24	Some component labels have misspelled words/misprinted numerals	O	6632f	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-25	Character heights are not same size for all labels within same hierarchical levels.	O	6641a2	III	Character heights will be the same for all labels within the same hierarchical level, space permitting. Included as part of labeling, demarcation, and mimic study.	Being corrected
6.1-26	Various labels use light characters on a dark background	O	6641b1	III	AEPSC will relabel the control room, but is going to continue the use of black labels with white characters as is the convention for all their plants. The label material purchased is more readable and is not likely to fill with dirt on vertical panels, since it uses a much thinner black veneer than previously used material.	Being partially corrected
6.1-27	A few labels do not have all capital letters	O	6642a1	III-S	Discrepancy is included as part of the labeling study.	Being corrected
6.1-28	A few mimics do not have their flow directions indicated	O	6664b3	IV	On RHR panel that which is depicted is not a true mimic, lines merely indicate interconnectedness, there is no actual flow. Also, on electric mimics flow can go in either directions, so direction of flow lines are not appropriate.	No action needed
6.1-29	Temporary labels are used as permanent labels	O	6651a	III	Discrepancy is included as part of the labeling study.	Being corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-30	Temporary labels do not conform to human engineering principals	O	6651b	III	Discrepancy is included as part of the labeling study.	Being corrected
6.1-31	Tag-outs sometimes are not securely mounted	O	6651e	II	Administrative controls are now in place and will be enforced to ensure secure attachment of tags.	Being corrected
6.1-32	Tag-outs sometimes obscure adjacent devices or their associated labels	O	6651h	III-S	Tags are now smaller with instructions on installation provided. To prevent obscuring, the method of securing tags was changed so they do not hang down as far as before.	Corrected
6.1-33	Demarcation lines seldom used	O	6662a	III	Discrepancy is included as part of the labeling study.	Corrected
6.1-34	Some mimic line colors do not conform to those recommended by guideline	O	6664a1	III	Discrepancy is included as part of the labeling study.	Corrected
6.1-35	Some mimic line colors are not discriminably different from others	O	6664a2	II	Discrepancy is included as part of the labeling study.	Corrected
6.1-36	Inadequate contrast between panel and panel mimic lines	O	6664a3	III	Discrepancy is included as part of the labeling study.	Corrected
6.1-37	Some mimic lines are not consistently color coded	O	6664a4	II	Discrepancy is included as part of the labeling study.	Corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-38	Mimic line widths have no consistent meaning	O	6664b1	III	Discrepancy is included as part of the labeling study.	Corrected
6.1-39	Some mimic lines do not fully extend to components	O	6664b5	III-S	Discrepancy is included as part of the labeling study.	Corrected
6.1-40	Some mimic beginning & end points are not identified	O	6664b4 6664b5	II	Discrepancy is included as part of the labeling study.	Corrected
6.1-41	Demarcation not used to subdivide large component matrices	O	6832d2	III	Discrepancy is being included as part of the labeling study.	Corrected
6.1-42	Some continuous rotary controls do not have direction of motion indicated	O	6638b	III-S	The direction for the valve opening is to be given on valve controls. Labels were applied to indicate direction of control motion to open valve.	Corrected
6.1-43	Some labels are not placed close to related components	O	6621d	II	Discrepancy is being included as part of the labeling study.	Being corrected
6.1-44	Some displays have worn surfaces	I&O	6611	II	Plant maintenance is to address this problem by repairing or replacing worn surfaces as needed.	To be corrected
6.1-45	Various types of labels are vertical	O	6623a2	IV	Vertical labels will be reviewed and corrected as possible. The labeling on J-handle rotarys and on process controllers is readable, but these will be reviewed further for possible improvements in labeling study.	To be partially corrected
6.1-46	Some labels located above eye level are not clearly visible	O	6621c	II	Discrepancy is included as part of the labeling study.	Being corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-47	Some components do not have labels that describe their function clearly	O	6631a	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-48	Parameter/units labels detract from or obscure display scales	O	6624a	III	Display scales will be replaced such that scale numbers are not obscured. Parameter/unit designations will be considered in labeling, demarcation, and mimic study.	To be corrected
6.1-49	Several components do not have a component label	O	6612a3	I	Discrepancy is included as part of the labeling study.	Being corrected
6.1-50	Some labels and display legends use roman numerals	O	6634e	III	Discrepancy is included as part of the labeling study.	To be corrected
6.1-51	Some displays have parameter/unit labels that are difficult to read or recognize	O	6611 6641a1	III-S	Discrepancy is included as part of the labeling study.	To be corrected
6.1-52	Some redundant labels used	O	6612a4	III	Summary labels will be added and components will be relabeled, but slight redundancy will be maintained. On vertical panels where summary label is at top, it is more likely summary label will become disassociated from component label. Also some redundancy reduces negative transfer and makes it easier to match control board labels with written procedures.	To be partially corrected
6.1-53	Some labels have insufficient spacing between words	M&O	6642d2	III-S	Discrepancy is included as part of the labeling study.	Being corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-54	Labels obscure/detract from information sources	O	6624a,b	III	Discrepancy is included as part of the labeling study.	To be corrected
6.1-55	Some labels do not have sufficient spacing between characters	M&O	6642d1	III-S	Discrepancy is included as part of the labeling study.	Being corrected
6.1-56	There is insufficient space between lines of some labels	M&O	6642d3	III	Discrepancy is included as part of the labeling study.	Being corrected
6.1-57	Some labels have insufficient character height based upon viewing distance	M&O	6641a1	II	Discrepancy is included as part of the labeling study.	Being corrected
6.1-58	Some labels are not visible to operator during control use	I&O	6624c 6445d2	III	The examples given only appear to be a problem due to photomosaic photo angle, but the CR will be reviewed for others with a problem. Will be included in labeling, demarcation & mimic study.	To be corrected
6.1-59	Functionally grouped component groups are seldom labeled for identification	O	6637a	III-S	Discrepancy is included as part of the labeling study.	Corrected
6.1-60	Danger, safety and warning labels do not conform to standards	O	6639b	II	Information labels are to be reviewed and danger, safety & warning labels replaced with labels that are in accordance with human engineering and safety standards.	Being corrected
6.1-61	Tag-outs do not always clearly identify components	O	6651d	II	Administrative procedure is now in place to ensure proper use of labels/tags.	Corrected
6.1-62	Various types of labels do not follow good HFE principles	O	6611	III-S	Discrepancy is included as part of the labeling study.	Being corrected

LABELS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
6.1-63	Color coding scheme of labeling is not consistent	I&O	6663	II	Discrepancy is included as part of the labeling study.	To be corrected
6.1-64	Inconsistent position labeling	O	6611	II	Discrepancy is included as part of the labeling study.	To be corrected
6.1-65	Labels not periodically cleaned	I&O	6624d	III	Labels are clean after ten years. Operations will review this and take appropriate action to ensure that labels remain clean.	To be corrected
6.1-66	Procedures and labels do not use consistent nomenclature	O	6633c	III-S	Discrepancy is included as part of the labeling study.	Being corrected
6.1-67	Some labels have improper character width-to-height ratio	M&O	6642b	III-S	Discrepancy is included as part of the labeling study.	Being corrected
6.1-68	Some label characters have improper stroke width-to-height ratio	M&O	6642c	III	Discrepancy is included as part of the labeling study.	Being corrected
6.1-69	Temporary labels obscure permanent labels	O	6651c	III-S	Discrepancy is included as part of the labeling study.	To be corrected
6.1-70	Tag-outs sometimes obscure labels	O	6651f	III-S	Tag-outs are now smaller. See HED #6.1-32.	Corrected
6.1-71	Lack of administrative and review procedures for temporary label control	D	6652a,b	III-S	Uncontrolled temporary labels are to be removed and replaced with permanent labels where appropriate. Operations standing order #36 has been written for administrative control of temporary labels.	Being corrected

COMPUTER
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
7.1-1	Computer response too slow	I&O	6717	II	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including increased rapidity of responses.	To be corrected
7.1-2	Paper jams & ribbon bunches up or comes loose on computer printer	I&O	6731c	IV	Printers have been changed, are now high speed with print balls. Instructions for other expendables will be provided (see HED #7.1-19).	Corrected
7.1-3	3 RMS CRTs are too slow and one unit ties up the other unit	I&O	6717a	II	Present plans are to replace RMS CRTs in 1987.	To be corrected
7.1-4	Keyboards too slow and don't always accept signals	I	6714	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including increased rapidity of responses.	To be corrected
7.1-5	Cannot match associated annunciators with computer alarms	I&O	6732f1	III	Alarm message wording is to be considered during computer replacement, to be scheduled within 5 years. It is not feasible to modify message on present system due to limited memory capacity.	To be corrected
7.1-6	Computer dialogue difficult to learn	I&O	6712a2	III	Reference materials will be reviewed for improvements.	To be corrected
7.1-7	Computer system procedures too complex & operator training is inadequate	I&O	6718	III	Reference materials will be reviewed for improvements.	To be corrected

COMPUTER (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
7.1-8	Computer audible alarm not used because its annoying	I&O	6725k1	III	Audible alarm is not essential because computer is a duplicate or backup to alarms that are on the annunciators or sequence of events recorder. All essential alarms are on the annun. system (1500 drops). Plant will investigate permanently disabling audible computer alarm, since some plant setpoints have changed and the P-250 has limited capability to accept changes.	To be partially corrected
7.1-9	RMS CRT screen glare	O	6721a,b	III	CR lighting is to be modified per HED #1.5-2 to reduce glare. This should also reduce glare on the CRTs.	Being corrected
7.1-10	CRT dislay controls are insufficient	O	6721h	IV	Engineering review is in progress to replace equipment in 1987.	To be corrected
7.1-11	CRT display lacks punctuation marks (periods)	O	6724k	III	Engineering review is in progress to replace equipment in 1987.	To be corrected
7.1-12	Use of non-standard fields	O	6724l	III	Engineering review is in progress to replace equipment in 1987.	To be corrected
7.1-13	CRT - incomplete error messages	O	6726g	III	Engineering review is in progress to replace equipment in 1987.	To be corrected
7.1-14	CRT - activity completion feedback	O	6726l	III-S	Engineering review is in progress to replace equipment in 1987.	To be corrected
7.1-15	CRT - non-standard color code	O	6727k1 6727l	III	Engineering review is in progress to replace equipment in 1987.	To be corrected

COMPUTER (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
7.1-16	Process computer - inconsistent color code	O	6516d2	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including color coding of indicator lights and pushbuttons on the console as well as in displays (if color is used in displays).	To be corrected
7.1-17	Inadequate software security	I&O	6711a	III	To prevent inadvertent software changes, operator training will be improved. Computer group has backup software so it can be replaced if deleted from P-250.	To be partially corrected
7.1-18	RMS CRT - hardcopy capability	O	6731b1	III	The feasibility of installing hardcopy capability has been investigated and plans call for hardcopy capability in 1987 replacement.	To be corrected
7.1-19	Lack of instructions for replacing computer printer expendables	O	6731e3	III	As suggested instructions will be provided for replacing computer printer expendables. Also see HED #7.1-2.	To be corrected
7.1-20	Data point indices	D	67181c,d	III-S	A cross index of frequently used and rapidly needed parameters will be provided in a condensed form.	To be corrected
7.1-21	Obscured computer printouts	O	6731f4	IV	Cover cleaning is now included in general CR and recorder cleaning program which is currently in force. Printer covers are not used for storage. The occasional book is easily removed.	Corrected

COMPUTER (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
7.1-22	Computer inabiity to record all annunciator alarms	O	6732a2	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered. Plant also has a dedicated trip sequence recorder. The present P-250 is used to duplicate and compliment many of the trip sequence recorders.	To be corrected
7.1-23	Lack of provisions for computer printout requests by alarm groups	O	6732c	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including provisions for computer printouts by alarm group.	To be corrected
7.1-24	Printout columns not separated into groups	O	6733d2	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including separating printout columns into groups of five.	To be corrected
7.1-25	Computer error correction	O	6713d	IV	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including correction of individual keystroke without affecting valid entries.	To be corrected
7.1-26	Shifted special function keyboard keys	O	6715d5	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including separate keys for numerical entry vs. special functions.	To be corrected

COMPUTER (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
7.1-27	Output text uses abbreviations and contractions	O	6712c3 6731c	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including those restricting use of abbreviations and contractions.	To be corrected
7.1-28	Computer lacks visual feedback	O	6714h	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including the addition of a CRT for visual feedback of keystrokes.	To be corrected
7.1-29	Printout tables not always clearly readable	O	6733d1	IV	Printout section shown on HED is an anomaly. The trend & log are shown on the same printout. This only happens if one printer fails which is a rare occurrence. However, readability & clarity of dislays will be considered when P-250 is due for replacement.	To be corrected
7.1-30	Use of non-relevant keyboard keys	I&O	6714i	IV	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including keyboard design. However, keys not used by operators on present P-250 are used by the computer specialists.	To be corrected
7.1-31	Lack of prompting feature for operator requests	O	6713a,b	III	The P-250 Process Computer plans call for replacement within 5 years. When replaced, all applicable guidelines will be considered including those regarding prompting features.	To be corrected

CONVENTIONS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
8.1-1	Consistent and distinctive enhancement techniques are not always used to code emergency controls	O	6813d	II	The Part Length Rod Stop is no longer used and is being considered for removal. For the rest of the items listed consistent and distinctive enhancements will be applied as needed.	Being corrected
8.1-2	Some recurring functional component groups are mirror-imaged	O	6823a,b	III	The selector switches on the SG panel have been rearranged and relabeled. The remaining components were reviewed for criticality of use and as to whether an improved layout was feasible. It was determined that criticality of components is low and that any feasible rearrangements would be more misleading than present layouts, e.g., by introducing such problems as partial mirror image.	To be partially corrected
8.1-3	Indicator lights are not readily distinguishable from pushbuttons	O	6433a	III	At D.C. Cook the functional labels identify whether lights are pushbuttons. Functional labels will be reviewed and modified to clarify if individual items have pushbutton functions.	To be corrected
8.1-4	Various components are not laid out in a logical left-to-right or top-to-bottom order	O	6822a	III	The Assessment Team discussed each item listed and resolved them as follows: 1. The selector switches on the SG panel have been rearranged as appropriate. 2. The 4 controls on the SG panel will be reviewed for rearrangement as appropriate. 3. The 4 controls on the Hot Shutdown panel will be reviewed for rearrangement as appropriate.	To be partially corrected

CONVENTIONS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
8.1-4 (Cont'd)					4. An engineering review will determine rearrangement and/or relabeling, probably to East/West as per functionally related components. 5. For the remainder of the items listed, criticality was low and either they already were laid out in appropriate functional or stereotypic fashion or rearrangement was not feasible.	
8.1-5	Sometimes more than five similar components are laid out in an unbroken row or column	O	6832c1,2	IV	Row or columns of components will be separated by demarcation where desirable and appropriate.	Corrected
8.1-6	Red, green and amber (yellow) are not always used in accordance with guideline recommendations	O	6516c2	III-S	Color coding in the CR will be reviewed and hardware changed where practical and necessary.	Being corrected
8.1-7	All annunciator response controls are not adequately coded	O	6342b	IV	To silence alarms the operator must press the individual alarm windows. The Reset and Test buttons are prominently and consistently located (coded by position) on each of the Annun. panels. Each is clearly labeled "RESET" or "TEST". Possibility of error is extremely low.	No action needed
8.1-8	Sometimes color coding is used in which case color does not provide redundant information	O	6516a	III	Color coding in the CR will be reviewed and hardware modified where practical and necessary.	Being corrected
8.1-9	Inconsistent meaning of colors	O	6516d	None	CLO is redundant, see 8.1-11 which contains all pertinent information.	Not an HED, combined with 8.1-11

CONVENTIONS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
8.1-10	A few controls lack control coding consistency	O&D	6422	III-S	Color coding in the CR will be reviewed and hardware modified where practical and necessary.	To be corrected
8.1-11	Some colors are used that do not have narrowly defined/consistent meanings	O	6516c1d 6422f	III	Color coding in the CR will be reviewed and hardware modified where practical and necessary.	Being corrected
8.1-12	Label contents not administratively controlled	D	6633a	III-S	A list of standardized names, acronyms, abbreviations, and part/system numbers is now available and controlled by AEPSC engineering, and is in use at the plant for CR relabeling.	Corrected
8.1-13	Control room abbreviations and acronyms are not standardized	O	6334d 6712c3	II	CR nameplates, annunciator tiles and information labels are to be replaced with ones which use correct abbreviations and acronyms. Software modification will be considered in P-250 replacement. EOPs will reflect control board labels.	Being corrected

INFORMATION/INTEGRATION
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
9.1-1	No administrative procedures controlling use of shared equipment	I	6131e5	II	There is no longer any shared equipment controlled from both CRs. Analyses will be conducted to assess Appendix R equipment of major safety importance. Administrative procedures will be written as necessary.	To be corrected
9.1-2	Visual dislays not provided to meet all task requirements	I	6511b	I	An SRTA has been performed. Information requirements were identified and those requirements were compared to the CR displays to determine if task requirements are met for emergency situations (See V1 and V2 series HEDs). Containment spray indication was reviewed in the SRTA and was found to be adequate.	To be corrected
9.1-3	Unnecessary information displayed in CR	I	6511c	III	An SRTA has been performed and unnecessary displays identified (see HEDs V1-22 and V1-23, also see 4.1-4). %MW Demand and %MW are required for normal operations.	To be corrected
9.1-4	Control/display integration is poor	I&O	6912a 6911c	II	As per HF recommendations all items listed were checked against SRTA results and those identified as important in SRTA were given appropriate attention. All critical items listed on this HED were found to be covered by verification and validation HEDs (V1 and V2 series HEDs) as follows: 1. 101 switches and associated gauges on RHR panel (see V1-18, 64). 2. Aux. Feed Pump controls and associated indicators (see V1-53, 54, 67). 3. Letdown Isolation valve controls (see V2-20).	To be partially corrected

INFORMATION/INTEGRATION (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
9.1-4 (Cont'd)					4. Aux Feed Valve control & associated flow meter (see V1-53, 67, 10). 5. Circuit breakers for 600V bus crosstie (see V2-1, V1-2, 45, 46). 6. Heat Exchanger Outlet Valve Controls & RHR Flow Indicators, Pump Amp Indicators & associated alarms (see V1-18). 7. Containment Spray components (see V1-64). 8. RHR Letdown valve control & Letdown flow, pressure indication (see V1-18). 9. Synchronizing busses (see V2-1). 10. Isolation switches SG 1, 2, 3, 4 (see V1-8, V2-7). 11. SG feedvalves & associated displays (see V1-44, 67). 12. Pull-to-stop reg. valves & level indicator (see V1-53, 67). 13. Heat exchanger valve & bypass valve (see V1-64). 14. CNTMT Purge Supply & Exhaust (see V1-60). The other issues listed were not identified as important to emergency tasks in the SRTA. However, many of these issues are addressed on other HEDs. See additional explanation in Section 5.2.3.3.13.	

INFORMATION/INTEGRATION (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
9.1-5	Operators must convert displayed values	I	6512b	IV	Accumulator level indicators, tech. spec. and procedures are now all in Cubic feet, so conversion is no longer required. Engineering review of Steam Packing Condenser indicator for Unit 2 is underway to eliminate conversion. Elevation to pressure conversion is a simple calculation with no time constraints, there is no need to modify forebay indicator.	To be partially corrected
9.1-6	A few displays are not located above associated controls	O	6922a1	II	1. Screen indicators are master indicators for all 7 screens and they are located directly above controls. 2&3. Operations and engineering will review swapping PZR level control and recorder selectors. 4. Vibration indicator is located to the side of the controls, the association is good and no change is needed. 5. Delta T controls are located directly above the recorder, the association is good and no change is needed. See detailed explanation in Section 5.2.3.3.14.	To be partially corrected
9.1-7	Control position sequence not same as display	O	6822a,b 6912c1,2	II	The controls and displays listed will be modified so position sequences match.	To be corrected

VERIFICATION OF TASK PERFORMANCE CAPABILITY
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
VI-1	Part length rod control system is no longer used	O	6411b 6511c	IV	Part length rod control removal under consideration.	To be corrected
VI-2	Bus voltmeters for 4KV Bus 1A, 1B, 1C, 1D have inappropriate scale range	O	6512d1	IV	Scale changes under consideration.	To be corrected
VI-3	Steamline pressure indicator scale units are in PSID. Units should be PSIG.	O	6515d	IV	Scales will be changed.	To be corrected
VI-4	No steamline differential pressure indicator	O	6511b	II	Have status lights with lamp test to light at 100 psid. Will re-engrave windows, using approved acronyms and abbreviations, to clarify functions.	Being corrected
VI-5	Operators cannot read steamline flow value requested in procedure	O	6512b	III	AEPSC will change procedure so operator is directed to look at status light "STEAM FLOW HI-HI" so operator has appropriate guidance.	Being corrected
VI-6	Containment pressure indicator scale does not provide required precision	O	6512b	IV	Recorders provide adequate readings. They are located in same area at eye height. Meters will be zone coded for necessary values.	To be corrected
VI-7	Pressurizer pressure indicator scale does not provide adequate precision	O	6512b	III	Zone coding will be applied on meters where appropriate.	To be corrected
VI-8	SG FRV isolation valve controls do not line up with their respective Steam Generators	O	6811b	III	FW isolation valve control switch rearrangement design is in progress.	To be corrected

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-9	AFP steam supply valve controls not located with AFP controls	O	6821a	III	Valve controls are on the correct panel, controls will be highlighted so they can be located easily. Also see CLO V2-20.	To be corrected
V1-10	No flow indicator for total Aux feedwater flow	O	6511b	III	Operator is only looking for approximate value, if error occurs recovery is easy. A total Aux FW flow indicator is not needed for safe operation.	No action needed
V1-11	SI pumps discharge pressure indicator scales not identical	O	6515d	III	AEPSC will replace scales with ones having proper markings.	To be corrected
V1-12	No status indication for containment isolation Phase A actuation	O	6511e	III	Status lights are being considered to provide indication of Phase A isolation signal. Note: this is the same as V2-12.	To be corrected
V1-13	Labels for containment ventilation fan control switches are incorrect	O	6633c	IV	Labels will be replaced as part of label enhancement program.	Being corrected
V1-14	Steam line radiation monitors indication not in control room	O	6511b	III	As per ERG background document for plants without steam line rad monitors, levels will be checked locally. There are other indications of SGTR available. Operator procedure being reviewed for correctness and training will cover this.	No action needed
V1-15	Steam Generator blowdown sample line radiation monitor not in control room	O	6511b	None	CLO is incorrect. There is appropriate indication in the control room.	Not an HED

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-16	No steam generator pressure recorders in the control room	O	6511b	II	Consideration is being given to adding a steam generator pressure recording, possibly by adding a pen to SG level recorder.	To be corrected
V1-17	Hydrogen ignitor switches are located on back panels	O	611b	IV	Action to turn on ignitors is not time critical. Three operators are in control room and action only requires a few seconds. Controls are on panels A7 and A8 on side of back panels and can be readily accessed.	No action needed
V1-18	RHR flow indicators are mirror imaged	O	6833	III	AEPSC plans to rearrange indicators to remove mirror image.	To be corrected
V1-19	SG PORV controller setpoint setting of 1005 psig cannot be determined	O	6411a2	III	AEPSC will change scale to 0-1200 psig and install marks on scale for normal and emergency settings.	To be corrected
V1-20	Steam line pressure SI block status indication not in control room	O	6511	None	CLO is incorrect, there is a status light which provides steam line pressure/SI block reset status.	Not an HED
V1-21	Containment ambient temperature indication not available in the control room	O	6511a 6511b	IV	This is not the primary means, but is one of four means of detecting leakage. Containment temperature is available on side of back panels and can be easily accessed. Other means are readily available.	No action needed
V1-22	Feed pump warming controls no longer used	O	6411b 6511c	IV	Unused controls are being reviewed. Those that have no impending use are being considered for removal. Also see CLO 4.1-4.	To be corrected

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-23	Feed pump hydraulic couplings no longer used	O	6411b 6511c	IV	Unused controls are being reviewed. Those that have no impending use are being considered for removal. Also see CLO 4.1-4.	To be corrected
V1-24	Feedwater isolation status indication not available in control room	O	6111a	IV	AEPSC will review adding status light.	To be corrected
V1-25	SI pump discharge flow. Operator cannot read 49 or 715 gpm as required	O	6512a	I	AEPSC is reviewing installing square root extractors SI flow signals and linear scales or indicators to provide appropriate reading resolution.	To be corrected
V1-26	Boron injection tank flow indication cannot be determined during low flow conditions	O	6512a	I	AEPSC is reviewing adding square root extractors to BIT flow signals and linear scales to indicators.	To be corrected
V1-27	BIT header pressure indicator scale range, 0-2500 psig, is not adequate	O	6512d	IV	Actual instrument range is 0-2800 psig, but scale marking is misleading. Maximum pressure capacity is 2586. Scale will be modified so it is marked 0-2800 psig.	To be corrected
V1-28	Power range neutron flux recorders scales are 0-100. Instrument requirements table call for scale to be 0-120%.	O	6541b 6541c	III	Recorder charts and scales are being reviewed and will be modified as is appropriate.	To be corrected
V1-29	Nuclear recorder NR-45 required scale is 10^0 to 10^6. Recorder does not go full scale at 10^6	O	6541c	IV	Usable scale, i.e., up to 10^6, is 8" long and is easily read.	No action needed
V1-30	Spray additive tank pressure indicator scale is 0-10 psig. Instrument requirements table calls for scale to be 0-12 psig.	O	6512d1	IV	The emergency response requirement that the criteria is based upon only requires verification that pressure is decreasing.	No action needed

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-31	RCS pressure indicator scale precision does not meet criteria requirements	O	6512a	IV	These values are nominal guidelines taken from setpoint documents. Operator is trained as to the acceptable region and as to where action should be taken. Zone coding will be applied on meters where applicable.	To be corrected
V1-32	RCS average temperature scale range does not comply with requirements	O	6512d3	IV	All required readings can be read on RCS Temperature recorders. Procedure has been changed to reference recorders.	Corrected
V1-33	RCS subcooling monitor has no engineering units displayed	O	6511b	III	AEPSC will add appropriate units on indicator.	To be corrected
V1-34	RCS hot and cold leg temperature recorders scales do not provide required precision	O	6512d	IV	Values are nominal guidelines taken from setpoint documents. Operator is trained as to the acceptable region and as to when action should be taken. Zone coding will be applied on meters where applicable.	To be corrected
V1-35	PRT temperature indicator does not have the word temperature on the indicator engraving or the indicator nameplate	O	6631a	IV	Indicators all have ^{O}F or Deg F printed on scale. If scales are changed for other reasons, then "Temp" will be added to noun name and "DEG F" to scale portion.	To be corrected
V1-36	RCS Loop flow indication cannot be read accurately at upper and lower ends of the scale	O	6512d	IV	0-110% square root scale is adequate. 100% is normal reading. Trip occurs at 90%, there is no reason to read 40% or below accurately.	No action needed
V1-37	RCP seal injection flow rate cannot be determined below six gpm	O	6512a 6512d	IV	Specific readings below 6 gpm are not required. The emergency response guidelines that the criteria table is based upon only require readings of 6 gpm and above.	No action needed

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-38	RCS letdown flow indication below 50 gpm cannot be determined	O	6512a 6512d	IV	This requirement is to verify that letdown is in service, i.e., that there is some flow. No specific value has to be read.	No action needed
V1-39	Excess letdown pressure indicator engraving has the word "Excess" as "Exces".	O	6514d	IV	AEPSC will correct spelling.	To be corrected
V1-40	Plant air header pressure indicator PPI-10 has no engineering units shown	O	6511b	IV	Calibration sticker will be moved (covering part of markings). Operator aware of units from indicator mark number "PPI". Placement of calibration stickers by C&I technicians will be controlled by memo or training.	Being corrected
V1-41	Label units and units on control air pressure indicators are not consistent	O	6514	IV	Labeling will be changed (PSI vs PSIG) in scale modification program.	Being corrected
V1-42	Steam generator pressure indicator has a resolution of 10 psig. Instrument criterion calls for a resolution of 5.	O	6512a 6512d	II	Consideration is being given to adding a SG pressure recording (see V1-16) this would make possible determining safety valve opening points.	To be corrected
V1-43	Steamline flow indicator MFC 130 does not have engineering units engraved on indicator	O	6514	IV	AEPSC will add PPH to scales.	To be corrected
V1-44	Turbine driven aux feed pump speed indicator major scale markings are not consistent	O	6515c	IV	AEPSC will fix scale markings to conform to NUREG-0700 recommendations.	To be corrected
V1-45	Diesel generators kilowatt meter markings are not uniform	O	6515c	IV	AEPSC will fix scale markings to conform to NUREG-0700 recommendations.	To be corrected

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-46	Diesel generators A/B and C/D trips disabled annunciators are in different locations within its annunciator box	O	6333d2	IV	Rearrangement of annunciator group is under review.	To be corrected
V1-47	Core exit T/C indicator has a range of 0-700°F. Instrument requirements call for a range of 200-1200°F.	O	6512d	II	New recorders have been installed in unit 1 with range of 200-2300°F. Will be installed in unit 2 during 10 year outage. In meantime can read 700°F on process computer.	Being corrected
V1-48	PRT pressure indicator cannot be read to the degree of precision required	O	6512d	None	CLO is in error, actual resolution needed is 2.5; scale graduation marks are 5 and as such resolution is 2.5.	Not an HED
V1-49	RCP CCW upper bearing flow nameplate has a word mispelled	O	6632	IV	AEPSC will correct, i.e., change "FOLW" to "FLOW".	To be corrected
V1-50	Excess condensate letdown flow recorder MR-26 does not have the units listed on the recorder	O	6511b	IV	AEPSC is reviewing recorder labeling and will fix as appropriate, i.e., add units.	Being corrected
V1-51	Steam generator narrow range level indicators are not identified as narrow range	O	6631a	IV	AEPSC will fix, i.e., label narrow range indicators "NR".	To be corrected
V1-52	Calibration labels are placed such that part of the recorder scale is covered	O	6624a	IV	AEPSC will control sticker placement (see CLO V1-40) by memo or training.	Being corrected
V1-53	The east and west MD auxiliary feedwater pump control switches and ammeters are at different elevations on the control boards	O	6823	IV	Rearrangement of this panel (SG) is under review.	To be corrected

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-54	AFW pumps discharge pressure indicators have a range of 0-1500 psig. Instrumentation requirement table calls for a range of 0 to 1760 psig.	O	6512d1	IV	Maximum possible pump pressure is 1580, not 1760 psig. Any reading above 1207 psig indicates that appropriate flow is not being delivered to steam generators which is what operator needs to know.	No action needed
V1-55	Emergency power ammeters do not have major and minor markings	O	6515c	III	Scales will be changed to comply with NUREG-0700 recommendations.	To be corrected
V1-56	Backup heating boiler status instrumentation requirement not met in control room	O	6111a	IV	Backup heating boiler no longer used; procedures are to be modified to eliminate reference to component.	Being corrected
V1-57	Low steamline pressure SI actuation signal block control switches do not follow normal convention	O	6421	II	AEPSC will modify position labeling to "unblock-block".	To be corrected
V1-58	Safety train designation (Train A or Train B) not shown on some switches	O	6611	IV	All are labeled by safety train at bottom of panel (Train A or B) except for FLX panel. These will have tape added below the NSO valve switches.	Corrected
V1-59	Reactor and pressurizer head vent valve nameplates have the word valve abbreviated VA. This is not consistent with other abbreviations	O	6633b	IV	AEPSC will change labeling so abbreviations are consistent.	Being corrected
V1-60	Switches not in main control room	O	6111a2	III	1. Status lights are not required for sump pumps to verify flow is isolated. However, a change to the pump running recorder was considered to facilitate leak monitoring and found to be unnecessary. 2. Reviewed adding switch to CR for plant lighting transformer and determined that it was not feasible.	No action needed

VERIFICATION OF TASK PERFORMANCE CAPABILITY (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V1-60 (Continued)					3. Have annunciator for purge supply and exhaust fans, (see CLO V2-22).	
V1-61	Engraved switch positions do not agree with those in the emergency procedures	O	6633c	IV	The EOPs have been revised to match switch position labeling and will be maintained as such.	Corrected
V1-62	Circuit breaker position engravings do not match the procedure call-outs	O	6411c2 6633c	IV	The EOPs have been revised to agree with switch position labeling and will be maintained as such.	Corrected
V1-63	Valve nameplate color scheme varies (white on black vs black on white)	O	6516	IV	AEPSC will change odd labels to white letters on black (see 6.1-26).	Being corrected
V1-64	Discharge valves for the west containment spray pump are not in numerical order	O	6822a	IV	Rearranging switches would result in partial mirror imaging and possible negative transfer of training.	No action needed
V1-65	Containment purge number 2 supply fan and number 2 exhaust fan controls are located at a different height than the number 1 fans	O	6822c	III	These switches are being reviewed for rearrangement.	To be corrected
V1-66	Nameplates for the east main feed pump trip and trip reset differ ("East" vs "E").	O	6634c	IV	Labels will be corrected to conform with NUREG-0700 recommendations.	Being corrected
V1-67	AFW flow control valve engravings differ in character height.	O	6641a2	IV	Labels will be corrected to have same size lettering.	Being corrected
V1-68	Control switch type different for same function.	O	6641c2	IV	AEPSC will change switches to be consistent, i.e., so that switches are all the same type.	To be corrected

VALIDATION OF CONTROL ROOM FUNCTIONS
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V2-1	Electric bus mimic color coding difficult to follow.	O	6664a	II	Electrical mimic lines and mimic labeling have been corrected.	Corrected
V2-2	Turbine load limiter control has no label.	O	6611	III	Label will be added as part of the labeling enhancement project.	Being corrected
V2-3	BIT flow indicator scale range is not appropriate.	O	6515e	None	CLO is redundant, see V1-26.	Not an HED, combined with V1-26
V2-4	One pressurizer pressure indicator is spaced apart from the 3 others.	O	6912	IV	The 3 indicators located together have related function (control channels); the other is protection channel only; i.e., indicators are separated for a purpose.	No action needed
V2-5	Containment pressure relief valves and containment fan control location	O	6661	II	Panel layout is under review with intent of relocating containment pressure controls. Panel will also be relabeled as part of label enhancement program.	To be corrected
V2-6	Steam generator PORVs have no position indicating lights on the valve controls	O	6445d	II	Addition of PORV position indicators is being considered.	To be corrected
V2-7	FW isolation valve controls are not sequential and do not line up with SGs.	O	6921 6922	None	CLO is redundant, see V1-8.	Not an HED, combined with V1-8
V2-8	No reactor trip breaker controls on main control boards	O	6411	None	CLO originator misinterpreted functional requirements. Reactor trip breakers are not required in CR.	Not an HED

VALIDATION OF CONTROL ROOM FUNCTIONS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V2-9	Voltage regulator switch positions are labeled "off-test-on." Should be labeled "Man-Test-Auto".	O	6632a	II	AEPSC will relabel switches, "Man-Test-Auto"	To be corrected
V2-10	Procedure calls for transfer of unit auxiliary power from "Normal" to "Reserve Supply", switches on control board are labeled "Main Feed" and "Reserve Feed".	O	6611	IV	Procedure has been changed to agree with panel nomenclature.	Corrected
V2-11	Condensate Storage Tank level recorder scale is 0 to 30 feet. Level indicator is in percent.	O	6515d	IV	AEPSC will make units agree among instruments and procedure.	To be corrected
V2-12	There is no indication for containment isolation phase A actuation.	O	6511b	III	Status lights are being considered to provide indication of Phase A isolation signal. Note: This is the same as V1-12.	To be corrected
V2-13	Available low pressure water sources not listed in procedure.	O	6111a	IV	AEPSC will add list of water sources to procedure.	To be corrected
V2-14	There are only two channels of RCS wide range pressure on the control boards.	O	6511a	IV	Two channels of RCS wide range pressure indication are appropriate and adequate.	No action needed
V2-15	Pressure indicators on CCW panel are not color coded to normal plant convention.	O	6516d	IV	If replacement scales are still available from instrument manufacturer, will replace.	To be corrected

VALIDATION OF CONTROL ROOM FUNCTIONS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V2-16	Isolation Phase A valve controls are difficult to locate.	O	6812 6811a	III	List of valves has been redone so operator is not required to move back and forth between panels. Panel locations have been added next to valve call-out on list. In addition, critical valves are paired so, if one fails, the other should be correctly positioned.	Corrected
V2-17	There is no indication of valve position for pressurizer spray valve NRV163 and NRV164.	O	6445d	II	Plans are underway to provide position indicating lights for spray valves.	To be corrected
V2-18	The center light (white or amber) on numerous control switches does not always have the same function.	O	6532a	II	The amber light only means intermediate position. White lights will be provided with engraved caps giving any other meaning.	Corrected
V2-19	RCS temperature indicators and recorders have two layout conventions.	O	6822a	III	Rearrangement of indicators is under consideration.	To be corrected
V2-20	Control switch numeric arrangement is not consistent.	O	6822a	III	The Assessment Team discussed the items listed and resolved each as follows (note that some individual items were rated Category IV):	To be partially corrected
				IV	1. Considering adding a status light panel for containment isolation valves with the same layout as control switches so that each valve doesn't have to be checked.	

VALIDATION OF CONTROL ROOM FUNCTIONS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V2-20 (Cont'd)						
				IV	2. Three valves are actually involved; 1-IRV-255 is also a part of the BIT recirc path and is located in the correct position, given its relative importance. Present layout is best given trade-offs.	
				IV	3. Present arrangement of Letdown valve switches has Train A on left which is in accordance with operator training and expectations.	
				IV	4. Rearrangement of spray pump discharge valves would change mirror image panel to a partial mirror image. Present layout is best given trade-offs.	
				III	5. MS to AFW isolation valves are more critical, therefore switches will be high lighted so they can be found more easily. Due to separation of train requirements locations cannot be switched.	
				III	6. Letdown isolation valve switches are being considered for relocation since these are severely dislocated from one another and are used in several evolutions.	
V2-21	Indicating lamps for hydrogen sampling and nuclear sampling do not have lamp test capability.	O	6531a	IV	One light should always be lit; if both are out then a bulb is burned out. Also see CLO 1.7-6 response.	No action needed

VALIDATION OF CONTROL ROOM FUNCTIONS (Continued)
CLO/HED ASSESSMENT SUMMARY

CLO/HED Number	Subject	Method	NUREG Ref	Assessment Category	Review Disposition	Status/ Remarks
V2-22	Instrument room exhaust and supply fan indication not available in the control room.	O	6511b	IV	Existing annunciator will alert operator to exhaust fan trip status.	No action needed
V2-23	SG stop valve and dump valve trip positions are to the left.	O	6411c1	IV	By D.C. Cook convention "trip" position is always to the left. For valves "trip" means "suddenly close"; i.e., turbine stop valves. Operators are thoroughly familiar with convention.	No action needed
V2-24	Hydrogen concentration meters are dual range instruments. Operator has no means of knowing which range is to be used other than confirmation by lab.	O	6515f	None	CLO is incorrect, instrument actually has two scales and two pointers. Only one pointer is on scale at a time. Operator reads whichever is on scale.	Not an HED
V2-25	Specific information not given for reading auxiliary building radiation.	O	6611b	IV	The procedure will identify the specific radiation monitors which should be checked.	Being corrected.

6.0 IMPLEMENTATION

The implementation of corrective action fixes for the D. C. Cook plant is currently under way. The following is a list of control room enhancements for each unit that has been installed or the installation is underway.

6.1 Completed or Started Improvements

A. Control room carpeting with satisfactory flame retardant anti-static and wear resistant properties was installed in February and March 1986 in both control rooms. A two-tone green color was selected to be compatible with the green control panels and other enhancements. A three foot wide dark green zone adjacent to the panels in the U-shaped control board area was installed to represent a restricted area for qualified personnel only.

B. Regulation Guide 1.97 (RG 1.97) Stickers, Post Accident Monitoring Instrumentation identifiers, were installed on approximately 350 main control room displays and indicating lamps on each unit prior to implementation of the new upgraded Emergency Operating Procedures in March 1986. The RG 1.97 stickers readily identify the displays intended for use by the operators during accidents, as well as the seismic and environmental qualifications status and requirements for each display.

C. Safety Train Tape identifying electrical and physical separated columns of control panel equipment were installed in May 1986, replacing existing identifiers. The new tape is larger, and in addition to being color coded like the old, identifies the safety train with large, easily readable legends.

D. New electrical bus mimic lines were installed during May and June 1986, to replace existing lines. The new lines standardize color and line widths, and employ voltage level identifiers.

E. Panel boundary lines and nameplates were installed during May 1986. Since the panel mounted equipment is basically arranged by system and sequence of operation, these 32 boundary lines and labels are really major system demarcation lines and labels.

F. Critical Controls Tape highlighting critical control equipment mounted on the main control room boards was installed April 1986. The red tape augments red labels and red handles already on or to be installed on critical equipment.

G. Instrument Mark No. Labels and Valve Mark No. Labels for hand/auto stations were installed in August 1986. The approximately 300 Instrument Mark No. Labels per unit give the unique identifier number for each control room parameter display. Some displays show a second less prominent Westinghouse Instrument Loop Number to help improve operator and technician interface during surveillance testing procedures. These labels replaced existing labels to standardize and expand the information displayed, for example the unit identifier number and the Westinghouse numbers employed on the new labels were not part of the old scheme. Annunciator status and monitor light nameplates were also installed during this period.

H. Engraved White Lamp Caps were installed on approximately 300 unlabeled white lamps per control room in July and August of 1986. This project is part of the color code convention standardization. White lamps as employed in the Cook control rooms, have numerous meanings and many did not have external labels because of space restrictions, particularly when employed with control switches.

I. Hand/Auto Station Stickers were installed on approximately 80 stations per control room in September 1986. These stickers identify the closed and open directions on the Foxboro and Bailey station indicating gages, knobs and switches.

J. Recorder Point/Pen Labels are planned to be installed on approximately 80 recorders per control room starting in November 1986. These new labels, which replace old ones, standardize the information display formats and improve readability.

K. Component Nameplates were being engraved and installed throughout the last four months of 1986. The approximately 1,000 nameplates per control room are bigger and much more readable than the old nameplates they replaced. They augment the inherent advantage of the vertical control board, that is, an operator can view all displays, controls, nameplates, etc. at normal to his plane of sight. The one quarter inch legends now employed versus the old one-eighth to three-sixteenths inch legends can be read from greater distances. Standardized abbreviations, acronyms and information formats are also part of the improvement. Hierarchical labeling criteria, where applicable, were also employed. This reduced label clutter and further improved readability.

L. System/Subsystem Demarcation Lines and Labels were installed the last four months of 1986 in conjunction with the Component Nameplates. These approximately 250 labels and boundary lines augment the beforementioned Panel Boundary Lines and Nameplates by further dividing the major systems into more minor/smaller common function groups. The large text used with this labeling scheme can be easily read from the center of the room, thus greatly improving the location aids/coding for the operators.

M. Annunciator window engraving and priority filters installation should start in late 1986. The new windows use three lines of text maximum, the old had many windows with four. Along with the use of standardized abbreviations, acronyms and information formats, the new windows are much less cluttered and more readable. The priority filters are a new visual priority coding scheme to highlight critical and important alarms from information type alarms. This effort involved approximately 1,400 windows per control room.

N. Status and Monitor Lights window engraving are being installed the last four months of 1986. The largest text that would fit on the windows and conform to the NUREG-0700 Guidelines was employed to improve readability. Again standardized abbreviations, acronyms and information formats were employed to further improve the new versus the old.

Each of the above improvements underwent control room operator and assessment team review of the design and mockup simulations of the proposed installation. Refinements to the designs were made where applicable and practical based upon these reviews before actual installation in the control rooms.

O. Information Labels engraving and installation has been proceeding since late 1985, and will continue through 1987. Basically, all labels on the main control room boards front panels, not included in beforementioned panel, system, subsystem and component labeling programs, are to either be engraved, installed and controlled to a standard format, or removed from the boards. Much of this labeling is presently on dymotape, and involves approximately 2,000 usually small labels per control room containing reference information.

P. Control room lighting improvements, involving reduction of normal lighting and increasing emergency lighting levels, employs bulb placement and wattage, diffusers and reflector techniques.

See Appendix J for photographs, samples and drawings of control room improvements.

6.2 Planned Improvements

The following control room improvements for each unit are presently in the planning or design stage of development:

A. Indicating display scale replacements and zone coding. Standardized scale multiplying factor, markings, graduations and color coding. Approximately 400 scales per unit will be replaced, and approximately 50 of these per unit require zone coding.

B. Recorder inking system upgrades involve employing cartridge/felt tip pen assemblies where available from the manufacturer.

C. P-250 Process Computer modifications include a main control panel mounted digital display and a dedicated alarm on an annunciator panel for computer failure. Also planned is improvement of operator instructions and reference materials.

D. Control switch rewires to improve controllability or conformity to standards include ten control switches per unit with elimination of open and close circuit seal in and two control switches per unit switch position configuration change. The elimination of open and close circuit sealings effectively convert a wide open or closed control to a more precise "jogging" control. Eight control switches on the Steam Generator/Auxiliary Feedpump panel for auxiliary feedwater to the steam generators regulation valves will be converted for more precise control, as well as two essential service water to component cooling water cooler valves on the ESW panel.

E. Indicating display rearrangements include eight loop temperature indicators, two moisture separator pressure indicators and two main and two feedpump turbine equipment pressure indicators. Several other indicators throughout the control room relocation as part of panel rearrangements described later. Emergency core cooling system and miscellaneous status and monitor lights are being reviewed for possible improvement through rearrangements.

F. Removal of unused control panel equipment includes Load Frequency Control, main feedpump warming and coupling, part length rods and feedwater chemical displays, controls, lamps and labels.

G. Control switch and pushbutton escutcheon plate upgrade involves replacement to correct incomplete or erroneous labeling, as well as standardized color codes for pushbuttons and escutcheons.

H. Beach Evacuation Alarm pushbutton guard to prevent inadvertent operation during testing.

I. Protective equipment face masks stored inside the control room for use by control room operators during emergencies with non-radio communications system to enhance voice communications while wearing face masks.

J. The control room restroom a public address system speaker installation so that control room operators will know if they are being paged. A new door lock installation so that the door may be locked from the inside for privacy.

K. Panel rearrangements of both controls and displays include the following panels:

(1) The Steam Generator/Auxiliary Feedwater panel relocation of 22 control switches, four pushbuttons, one control station and 26 indicators.

(2) The Containment Spray and Relief panel removal of two control stations, relocation of five control switches, two pushbuttons and ten indicators.

(3) The Residual Heat Removal panel relocation of two recorders to make room for the installation of the two control stations from the Containment Spray and Relief panel, rearrange two indicators and remove one control station.

(4) The CVCS Charging and Letdown panel relocation of one control switch and one control station to make room for the control station from the Residual Heat Removal panel.

(5) The Ventilations Systems panel control switches, pushbuttons and dial switches relocation.

(6) The Containment Isolation Valves panel relocation of 3 control switches, highlighting two control switches and the addition of a new Status Light panel indicating containment vent, phase A and phase B isolations demand and feedback signals.

L. New steam generator pressure recording in four pen analog recorders to replace the existing three pen recorders that presently record for each steam generator narrow range level, feedwater and steam flows.

M. Steam generator steam relief valve analog position indicators on the steam generator panel for each steam generator.

N. Pressurizer spray valves position indicating lamps on the Pressurizer panel.

O. A new wireless radio system with multiple antennas and new high power transmitters and receivers to achieve as close to full plant communications coverage as economically feasible under normal, abnormal and emergency conditions, including high noise areas and difficult to reach equipment.

P. Public address system modifications to include the following:

(1) Priority stations to allow control room operators to override or take over PA channels in emergencies.

(2) Auto gain speakers at strategic locations to improve communications both during high noise periods (unit in service) and quieter periods (unit out of service).

(3) Full size Hear-Here Booths to improve communications in high noise areas.

Q. The following improvements to the annunciator systems:

(1) Add individual alarm drops on main control room annunciator bank from containment alarms located at the CAS Subpanel.

(2) Relocate approximately 36 alarms from one annunciator bank to another. Relocate approximately 350 alarms within annunciator banks.

(3) Revise the reactor coolant pumps oil pots level alarms in the control room and add local panel indications.

(4) Add a feedwater isolation alarm.

R. Rearrange the following transmitters and the associated control room indicators:

(1) Component cooling water flow to/from reactor support coolers.

(2) Component cooling water flow to/from the excess letdown heat exchanger.

(3) Component cooling water flow to/from reactor coolant pumps.

(4) Unit Two boron injection tank flow to loops 1 through 4.

(5) Unit One main turbine gland steam exhauster pressure.

S. P-250 Process Computer Room ventilation/air conditioning system modifications.

T. Radiation Monitoring System CRT display replacements.

6.3 Implementation Schedule

The schedule for installing the planned enhancements and modifications described in sections 6.1 and 6.2 are shown on Tables 6.1 and 6.2 on pages 6-9, 6-10 and 6-11.

Basically, the schedule calls for implementing all planned corrective actions in two refueling outages per unit, Unit One spring 1987 refueling outage excluded. The reasoning for this exclusion is two-fold. First, we plan on the first installations of major panel modifications during the Unit Two steam generator replacement and refueling outage. This is a long outage that allows us to refine the installation techniques and have minimum impact on the outage length. What is learned on this outage can be used to install these major jobs more efficiently during the next Unit One refueling outage with the lowest potential for impacting outage length. That outage is the third Unit One refueling outage after submittal of the PSR in December 1986. Second, the first Unit One refueling outage scheduled after December 1986 is May 1987. This outage is too soon to complete design, procurement and installation plans for major modifications. However, we plan on installing all the minor modifications and related enhancements practical during this outage.

TABLE 6.1

D. C. COOK NUCLEAR PLANT

DCRDR ENHANCEMENTS IMPLEMENTATION SCHEDULE

TASK DESCRIPTION	ESTIMATED START DATE MONTH	YEAR	ESTIMATED COMPLETE DATE MONTH	YEAR
Control Room Rug	1	86	2	86
RG 1.97 Stickers	3	86	6	86
Critical Equipment Tape	4	86	4	86
Safety Train Tape	5	86	5	86
Mimic Lines	5	86	6	86
Panel Labels/Demarc Lines	3	86	5	86
Engraved White Lamp Caps	7	86	8	86
Valve Mark No. Labels	7	86	9	86
Instrument Mark No. Labels	7	86	8	86
Control Station Stickers	9	86	9	86
Recorder Point/Pen Labels	11	86	3	87
System/Subsys Labels & Demarc Lines	9	86	10	86
Component Nameplates	11	86	3	87
Annunciator Window Engraving	10	86	3	87
Annunciator Window Priority Coding	10	86	3	87
Status/Monitor Lights Window Engraving	12	86	3	87
Control Station Labels	11	86	12	86
Control Switch Escutcheon Plate Engraving	*		*	
Control Switch Handle Shape/Color Coding	*		*	
Control Station Handle Shape/Color Coding	*		*	
Indicating Displays Operating Zone Coding	*		*	
Information Labels	10	85	12	87
Plant Administrative	11	85	12	87
Plant Procedural	11	85	12	87
Plant Maintenance	11	85	12	87
Plant Other	11	85	12	87
Recorder Chart/Scale Revisions	12	86	12	87
Backlighted Pushbuttons Engraving	1	87	3	87
Indicating Lamp Color Codes	1	87	12	87
Drum Counter Stickers	12	86	3	87
Miscellaneous	6	87	12	87

* Unit One = Spring 1987 Refueling Outage
Unit Two = Late 1987/Early 1988 Refueling Outage

3-TT)

TABLE 6.2

D. C. COOK NUCLEAR PLANT

DCRDR MODIFICATIONS IMPLEMENTATION SCHEDULE

TASK DESCRIPTION	ESTIMATED DATE			
	UNIT ONE		UNIT TWO	
	START	COMPLETE	START	COMPLETE
Control Room Lighting	8-86	12-87	9-86	12-87
Indicating Scale Replacements	*	*	*	*
Control Switch Revisions - SG Panel	*	*	*	*
- ESW Panel	*	*	*	*
- FP Panel	*/	*/	*/	*/
Tavg & T Indicators Rearrangement	*/	*/	*/	*/
MSR Controls/Indic Rearrangement	*	*	*	*
SPC 400/402 Rearrangement	*/	*/	*/	*/
FPT Vlv Pos Indic Rearrangement (U1)	*	*		
Unused Equipment Removal				
Load Frequency Control	*/	*/	*/	*/
FP Warming & Coupling Controls	*/	*/	*/	*/
Part Length Rod Control/Indic	*/	*/	*/	*/
FW Chemical Control/Recorder	*/	*/	*/	*/
RMS Display Replacement	7-87	12-87	7-87	12-87
BIT & SI Flows Square Root Extractors	*	*	*	*
Motor Operated Valve Position Indicators	*/	*/	*	*
Annunciator Window Rearrangement	**	**	*	*
New Panel Equipment				
Cntmt Ph A/B/Vent Isol Status Lights	**	**	**	**
SG Stm Relief Valves Position Indic	**	***	*	**
PRZ Spray Valves Position Lamps	**	***	*	**
Recorder Inking Systems Revisions	4-87	12-87	4-87	12-87
P-250 Panel Indicator & Failure Alarm	*/	*/	*	*
CAS Panel Alarm Display	**	**	*	*
RCP Oil Pots Level Alarms Revisions	**	**	**	**
FW Isolation Alarm	**	**	*/	*/
Transmitter Rearranging - U1 Stm Pkg Exh Press	*/	*/		
- U2 BIT Flows			*	*
- CCW RX Support Flows	**	**	*	*
- CCW Excletdn HX Flows	**	**	*	*
- CCW RCP Coolers Flows	**	**	*	*

TABLE 6.2

D. C. COOK NUCLEAR PLANT

DCRDR MODIFICATIONS IMPLEMENTATION SCHEDULE

(Continued)

TASK DESCRIPTION	ESTIMATED DATE			
	UNIT ONE		UNIT TWO	
	START	COMPLETE	START	COMPLETE
Panel Painting	*/	***	* *	* *
Panel Rearrangements - SG Panel	***	***	* *	* *
- RHR Panel	***	***	* *	* *
- BA Panel	***	***	* *	* *
- SPY Panel	***	***	* *	* *
- IV Panel	* *	* *	* *	* *
- PRZ Panel	* *	* *	* *	* *
SG Pressure Recorders	***	***	* *	* *
New Wireless Radio System	9-87	12-89	9-87	12-89
PA Priority Stations	9-87	12-89	9-87	12-89
PA Auto Gain Speakers	9-87	12-89	9-87	12-89
PA Hear-Here Booths	9-87	12-89	9-87	12-89
Face Mask Communications	10-86	12-87	10-86	12-87
Miscellaneous	*	***	*	* *

* Unit One = Spring 1987, Refueling Outage

* Unit Two = Late 1987, Early 1988 Refueling Outage

*/ Unit One = Category III or IV fix scheduled for Spring 1987 Refueling Outage, manpower permitting

*/ Unit Two = Category III or IV fix scheduled for Late 1987, Early 1988 Refueling Outage, manpower permitting

* * Unit One = Early 1989, Refueling Outage

* * Unit Two = Stm Gen Replacement & Refueling Outage

*** Unit One = Late 1990, Early 1991 Refueling Outage

D. C. COOK NUCLEAR PLANT

DCRDR MODIFICATIONS IMPLEMENTATION SCHEDULE

(Continued)

TASK DESCRIPTION	ESTIMATED DATE			
	UNIT ONE		UNIT TWO	
	START	COMPLETE	START	COMPLETE
Panel Painting	*/	***	* *	* *
Panel Rearrangements - SG Panel	***	***	* *	* *
- RHR Panel	***	***	* *	* *
- BA Panel	***	***	* *	* *
- SPY Panel	***	***	* *	* *
- IV Panel	* *	* *	* *	* *
- PRZ Panel	* *	* *	* *	* *
SG Pressure Recorders	***	***	* *	* *
New Wireless Radio System	9-87	12-89	9-87	12-89
PA Priority Stations	9-87	12-89	9-87	12-89
PA Auto Gain Speakers	9-87	12-89	9-87	12-89
PA Hear-Here Booths	9-87	12-89	9-87	12-89
Face Mask Communications	10-86	12-87	10-86	12-87
Miscellaneous	*	***	*	* *

* Unit One = Spring 1987, Refueling Outage
* Unit Two = Late 1987, Early 1988 Refueling Outage

*/ Unit One = Category III or IV fix scheduled for Spring 1987 Refueling Outage, manpower permitting

*/ Unit Two = Category III or IV fix scheduled for Late 1987, Early 1988 Refueling Outage, manpower permitting

* * Unit One = Early 1989, Refueling Outage
* * Unit Two = Stm Gen Replacement & Refueling Outage
*** Unit One = Late 1990, Early 1991 Refueling Outage

7.0 COORDINATION WITH NUREG-0737, SUPPLEMENT 1, ACTIVITIES

In accordance with NUREG-0737, Supplement 1, American Electric Power Service Corporation (AEPSC) coordinated and integrated the emergency response capability activities (Reference Appendix D, Letter AEP:NRC:0773H, Attachment 3). The Activities coordinated with the DCRDR include the following:

Safety Parameter Display System (SPDS)
Upgraded Emergency Operating Procedures (EOPs)
Regulatory Guide 1.97 (RG 1.97)
Emergency Operating Facilities (EOF)
including the Technical Support Center (TSC)

K. J. Toth, Nuclear Operations Division, was appointed as the overall project coordinator, and each activity has a lead engineer. Refer to Figure 7.1. The lead engineers and coordinator, or designated alternates, form the Emergency Response Capabilities Council, which met at periodic intervals according to need. Plans and schedules were developed for each of the elements considering the needs or influences of the other interfacing elements. Refer to Figure 7.2. Each Lead Engineer was responsible for the scheduling and coordination of activities within their project, as well as the coordination of their project with the other emergency response capabilities projects. The overall coordinator was responsible for overall project schedules and supported and coordinated the interface activities of the lead engineers.

Figure 7.3 shows the various interfaces between the various emergency response capability activities. The numerous interfaces required considerable coordination effort which is discussed in the following element descriptions.

7.1 Upgraded Emergency Operating Procedures

The coordination of the DCRDR and the EOPs was accomplished in several areas. The needs of the control room operator for information and controls were determined by the System Function and Task Analysis - Instrumentation and Requirements Review.

7.1 Upgraded Emergency Operating Procedures (Cont'd)

These requirements were determined by an analysis of the EOPs, and were compared to the existing control room equipment with the DCRDR Control Room Inventory and Mockups. Validation of control room function with operator walk-talk thrus at the Cook Mockup, simulating various design accident and transient scenarios which employ selected and representative EOPs, were coordinated with the Cook Operations Dept. validation of all EOPs activity. The CLO/HEDs generated by these reviews were evaluated by the DCRDR Assessment Team, supported by the Cook Operations Dept. Procedures Coordinator (PC). The DCRDR Lead Engineer and I&C Engineers reviewed and commented on the EOPs to the PC on human factors practices and problems.

The PC incorporated EOP human factors improvements where applicable before the EOPs were implemented on April 1, 1986. Further improvements are under review by the PC. Future revisions of the EOPs by the PC for procedure to labeling consistency will be incorporated as required with the DCRDR component labeling upgrade.

The Unit Two Simulator, scheduled for implementation in 1988, will incorporate the control panel enhancements installed in 1986 and 1987 before training of operators begins. The simulator is contemplated as a valuable validation tool for the operators, panel equipment and procedures.

7.2 Safety Parameter Display System

The SPDS and DCRDR Lead Engineers, in cooperation with the SPDS vendor and the Cook Operations and Training Depts., implemented operator training for determining plant safety status both with and without the SPDS. The SPDS and DCRDR Lead Engineers, the overall project coordinator, Cook Operations, Training and Technical Depts. collaborate on SPDS operability definition and equipment required for implementation analysis.

The SPDS was implemented on April 1, 1986, along with the Upgraded EOPs. The DCRDR human factor survey of the SPDS was conducted in August and September, 1986. The SPDS validation of control room function review will be conducted after the first of 1987. It was not possible to fully assess and plan corrective actions prior to the submittal of this report.

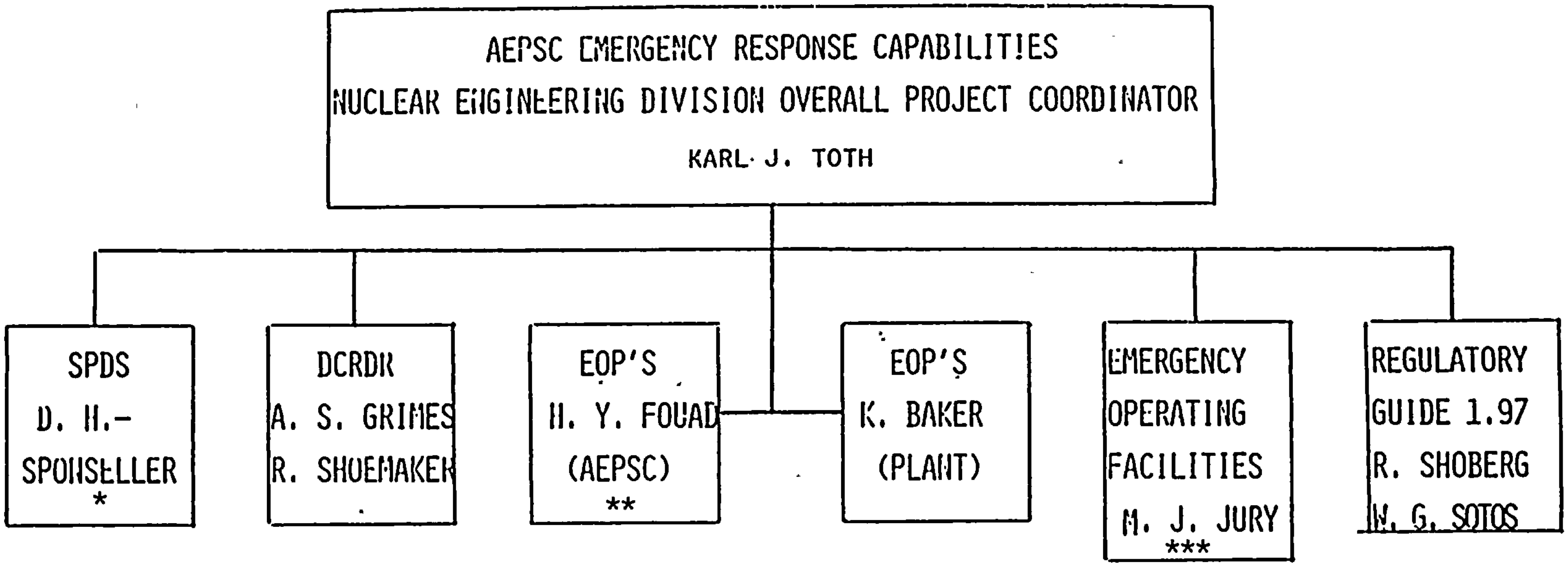
A preliminary assessment of the potential impact of the CLOs generated by the review show problems in four areas: Displays, keyboards, reference material and training. Reference material, operator training and maintenance of displays and keyboards can be resolved. However, problems involving software or computer design, such as response time, will require detailed analysis.

7.3 Reg. Guide 1.97

The DCRDR and RG 1.97 Lead Engineers collaborated on the identifiers for control panel instrumentation intended for use by the operator during accidents. RG 1.97 required revisions to control room instrumentation is an ongoing program. RG 1.97 proposed change drawings are routed through the DCRDR Lead Engineer for human factors comments. The lead engineers collaboration will continue throughout the RG 1.97 program to insure the instrumentation selected and installed meets the DCRDR requirements as well as RG 1.97, and the instrumentation identifiers are accurate and up to date.

7.4 Emergency Operating Facilities

The D. C. Cook Emergency Operating Facilities (EOF), including the Technical Support Center (TSC), plan and facilities have been tested and demonstrated to be functional. The AEPSC Quality Assurance Dept. conducted an audit of the emergency response facilities previous to implementation of the Upgraded EOPs. Basically, we believe the facilities to be complete except for those areas defined in our letter AEP:NRC:0773T, dated September 8, 1986.



* Replaced by D. J. Ruzicka in October 1985

** Replaced by J. Neito

*** Replaced by T. G. Harshbarger

FIGURE 7.1

AEPSC - D.C. COOK EMERGENCY RESPONSE CAPABILITIES FLOW CHART

FIGURE 7.2 PAGE 7-5

TI APERTURE CARD

8701070365-01

D

AEPSC - D. C. COOK
EMERGENCY RESPONSE INTERFACE

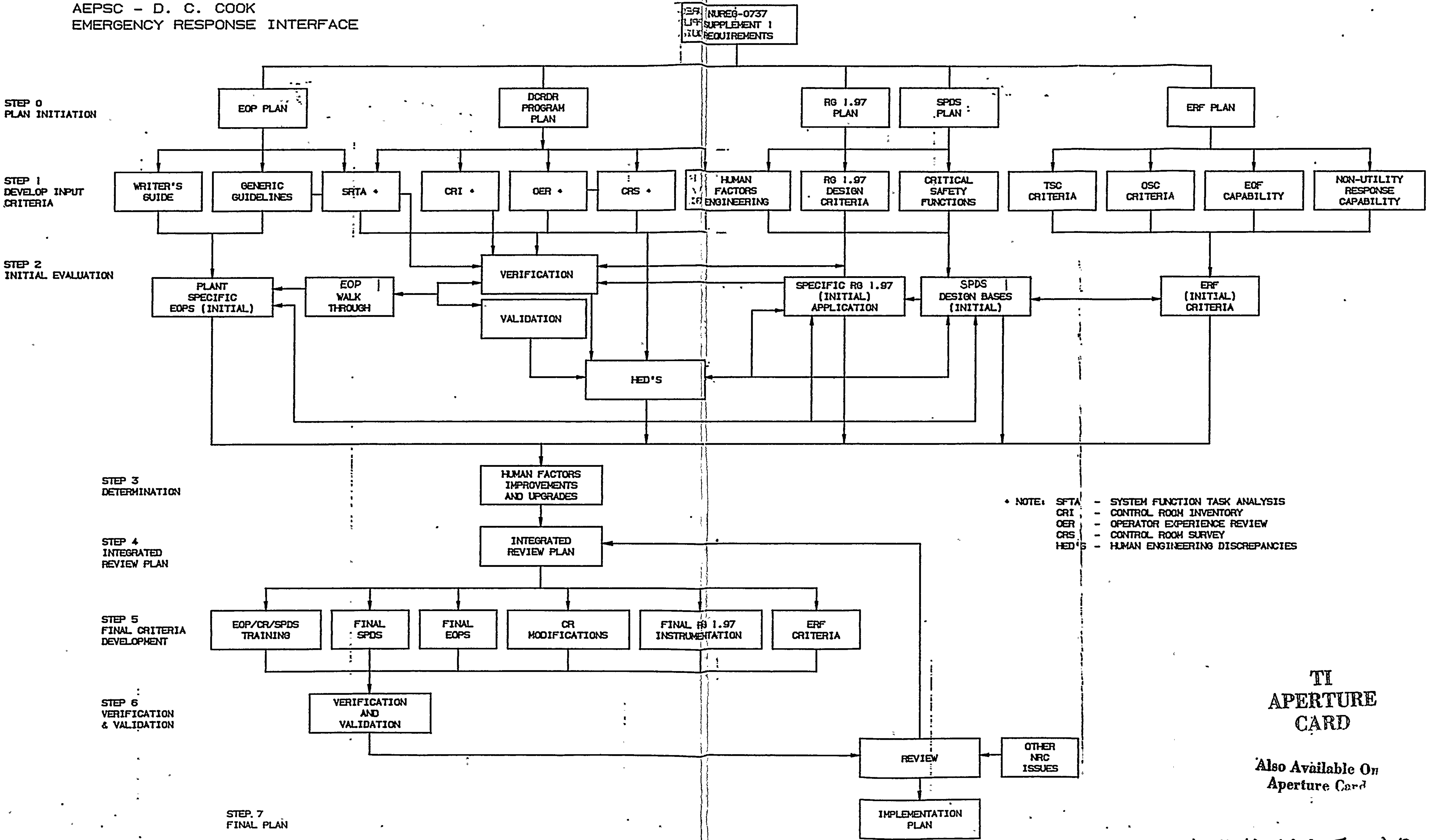


FIGURE 7-13

TI
APERTURE
CARD

Also Available On
Aperture Card

8701070365-02

8.0 CONCLUSIONS

The D. C. Cook DCRDR Program was conducted to ensure acceptable human engineering principles are employed on the main control room and hot shutdown panels. The applicable guidelines are contained in NUREG-0700.

Many of the human engineering principles found in NUREG-0700 were employed in the original design of the Cook control panels, although in some cases the methodologies may differ. Some techniques recommended by NUREG-0700 were not employed in the past, but will be where they have been determined to be beneficial, cost effective and applicable. AEP and I&MECo. recognized many CLO/HEDs documented deviations from our normal past practices and would be beneficial to correct. Several of these deviations involved equipment and alarms added after the original design. Many higher priority CLO/HEDs documented generic type problems. The corrective action plans included all similar equipment throughout the control room where applicable. These corrective actions should improve the operator, control panel and procedures interface during both normal and off-normal operating conditions, in both the primary and secondary side systems.

The overall corrective action plan augments the inherent advantages of the U-shaped vertical panel boards: All panels can be panoramically scanned and all components on the panels can be viewed at near normal to the operators plane of sight from the central areas within the U. New and improved location aids and coding techniques enhance rapid pattern recognition by the operator during panoramic scans. Individual work station organization, standardization, information and readability improvements enhance operator control actions as well as information transfer at both the work station and control room levels.

New system/subsystem labels and demarcation lines, as well as larger improved component labels, improved electrical mimic lines, visual annunciator color priority coding and indicating displays operating zone coding all reinforce the operators panoramic scanning capability. Hierarchical labeling, improved and expanded component labeling, engraved white indicating lamp caps, control switches and stations labeling upgrades, improved annunciator, status and monitor light window engraving and arrangements, new and better arranged displays and controls will improve the operators response at the individual work stations.

Numerous control room wide human factors problems were resolved with the corrective action plan. These tasks are listed below:

1) Illumination Levels

Excessive lighting levels reduced.
** Glare on dark red indicators will be reduced when replaced with white scales and light red noun name strips.
Glare from lower area of panels and light colored linoleum on floor reduced with installation of carpet.

2) Auditory Environment

Background noise reduced with installation of carpet and reduction of noise sources.

3) Annunciator Warning Systems

* Install new visual alarm priority system.
* Re-engrave all windows to 3 lines of test maximum to eliminate numerous 4 lines text windows; employ standard abbreviations and acronyms, employ same terminology for common equipment labeled elsewhere in control room, standardize legend size and style, reduce window text congestion, relabel annunciator bank control voltage windows.

4) Controls

Coding of critical controls with red demarcation lines, red component labels and handle/pushbutton shape/color coding.
** Coding of control functions with handle shape/color codes.
** Coding of continuous adjustment rotary controls & indicators for direction to open or energize with sticker, label and handle shape enhancements.
** Label all functional positions.

5) Displays

** Off scale indication of failure for critical indicators not used/in service/indicating under normal operating conditions.
** Install consistent scale conversion factors and graduation marks.
** Improve readability with black and white scales.
** Install consistent color codes versus parameter type, pressure, level, flow, temperature.

5) Displays (Cont'd)

- * Improve readability of parameter name and unique identifiers with hierarchical labeling techniques and character size, style and content standardization.
- ** Improve Zone Markings by standardizing color, shape, style and location as well as expanding the application.
- * Standardization of non-legend light indicator color codes where practical. In particular, required extensive use of engraved white lamp caps, limited use of engraved amber and red lamp caps.
- * Improve readability of legend light indicators with improved text size, style and content.
- * Improve readability of recorder scales, charts and labels.

6) Labels and Location Aids

- * Improve readability of component labels with improved text size, style and content and expansion of application.
- * Employ hierarchical labeling schemes where practical to improve location aid system, reduce operator search time and redundancy.
- ** Reduce and improve vertical labeling on edgewise indicators.
- * Employ standardized abbreviations, acronyms and part/system numbers, improve internal consistency of labels and consistency with procedures.
- * Identify functional groups of panel equipment with demarcation lines.

  Standardized and improved use of electrical mimic lines.

* Plans call for installation starting last quarter 1986, completion first quarter 1987

** Plans call for installation by first refueling outage

A great deal of effort and money will be expended to upgrade the Cook control rooms human engineering features up to the NUREG-0700 standards. AEP and I&MECo. plan on maintaining these standards in the future. The human engineering principles criteria, guidelines, specifications, descriptions and instructions developed during the DCRDR design and implementation efforts will be incorporated as standard engineering, design and installation practice in the future.

8.1 Control Room Design Improvements

Currently installed design improvements or near term improvements will resolve control room problems in illumination levels, auditory environment, annunciator warning systems, control codings and displays readability. Recommended improvements in the long term (later than first refueling), should reduce if not completely resolve the remaining problems.

8.2 Program Plan for Follow-Up Verification of Installed Design Improvements

Control room operators comments, complaints or suggestions on improvements installed to resolve human engineering discrepancies will be reviewed and evaluated by the Instrumentation and Control Section of the Mechanical Engineering Department of American Electric Power Service Corporation.

Comments will be evaluated for overall acceptance of the improvement by the operating crews. Suggestions or complaints will be evaluated for potential future improvements or revisions using similiar guidelines, criteria and procedures used in the DCRDR program.

Control room operator inputs may be obtained by any of the following methods:

1. DCRDR Plant Coordinator communications with the I&C section.
2. I&C section engineers interface with control room operators in the plant control rooms, simulator training sessions or in the control room mockup.
3. Control room operators interview or questionnaires.

   A questionnaire given to approximately 30 licensed operators at the Columbus Mockup in July and August 1986 (see Appendix I). Tabulated results from these questionnaires and discussions with the operators during these sessions were used as input to enhancement and modification design.

8.3 Continuing Human Factors Program

A human factors review has been incorporated into the AEPSC General Procedure for Design Changes. This will insure the human engineering properties of the control panels attained by the DCRDR Program will be maintained in the future. All future revisions or additions in the control rooms will be subjected to a review process using criteria developed during the DCRDR Program.