June 1984
Rev. 1

Detailed Control Room Design Review

Program Plan

Pilgrim Station

BOSTON EDISON

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REVISION LOG

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DETAILED CONTROL ROOM DESIGN REVIEW PROGRAM PLAN

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Appendix A Qualification of Management Review Team and Design Review Team Members

ACRONYMS AND ABBREVIATIONS
LISTED ALPHABETICALLY BY ACRONYMS

A	Area
AC	Alternating Current
ADS	Automatic Depressurization System
ANALOG	Input Cabinet
ANN	Annunciator
AO	Auxiliary Operator
AOG	Augmented Off-Gas
APRM	Average Power Range Monitor
ASSOC	Associated
ASST	Assistant
ATF	Above Top of Active Fuel
ATWS	Anticipated Transient Without Scram
AUX	Auxiliary
BOP	Balance-of-Plant
BWROG	Boiling Water Reactor Owners Group
CAT	Category
CCI	Containment Cooling & Isolation
CM	Color Monitor
COND	Condenser, Condensate
CONT	Control
CPC	Central Processor Cabinet
CR	Control Room
CRD	Control Rod Drive
CRP	Control Rod Position
CRT	Cathode Ray Tube
CSCS	Core Standby Cooling Systems
CSS	Core Spray System
CWS	Circulating Water System
DC	Direct Current
DCRDR	Detailed Control Room Design Review

DI/OC	Digital Input/Output Cabinet
DRT	Design Review Team
DWS	Drywell Sump
ECCS	Emergency Core Cooling System
EES	Emergency Event Sequences
EOF	Emergency Operating Facility
EPRI	Electric Power Research Institute
ES	Electrical System
ESF	Engineered Safety Feature(s)
EST	Estimate(d)
EXPER	Experience
FSAR	Final Safety Analysis Report
FW	Feedwater
FW&R	Feedwater and Recirculation
HE	Human Engineering
HED	Human Engineering Discrepancy
HEO	Human Engineering Observation
HPCIS	High Pressure Coolant Injection System
HVACS	Heating, Ventilation and Air Conditioning System
I&C	Instruments and Controls
INPO	Institute of Nuclear Power Operators
INSTR	Instrument; Instrumentation
I/O	Input/Output
IRM	Intermediate Range Monitor
JP	Jet Pump
LDR	Leader
LOCA	Loss of Coolant Accident
LPCIS	Low Pressure Coolant Injection System
LPRM	Local Power Range Monitor
LTOGS	Low Temperature Off-Gas System
MCP	Main Control Panel
MG	Motor Generator
M/M	Man/Machine
MON	Monitor

MSIV	Mainsteam Isolation Valve
MT	Management Team
MW(e)	Megawatts (electric)
NMS	Neutron Monitoring System
NOS	Numbers
NPO	Nuclear Plant Operator
NRC	Nuclear Regulatory Commission
OC	Operator Console
OER	Operating Experience Review
OSC	Operational Support Center
PCIS	
PCRVICS	Primary Containment and Reactor Vessel Isolation Control System
PNPS	Pilgrim Nuclear Power Station
PROC	Process
PS	Power Supply
PSAR	Preliminary Safety Analysis Report
RAS	Recirculation Actuation Signal
RBCCW	Reactor Building Closed Cooling Water System
RBM	Rod Block Monitor
RCB	Reactor Containment Building
RCICS	Reactor Core Isolation Cooling System
RECIRC	Recirculating
REQ'D	Required
RHRS	Residual Heat Removal System
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
RM	Radiation Monitor
RNMC	Reactor Neutron Mapping control
RO	Reactor Operator
RRP	Reactor Recirculation Pump
RRS	Reactor Recirculation System
RWCU	Reactor Water Clean-Up
RWCUS	Reactor Water Clean-Up System

RWST	Refueling Water Storage Tank
RX	Reactor
SBGTS	Standby Gas Treatment System
SIS	Safety Injection System
SLCS	Standby Liquid Control System
SOE	Selected Operational Event(s)
SP	Suppression Pool
SPDS	Safety Parameter Display System
SRM	Startup Range Monitor
SRO	Senior Reactor Operator
SRV	Safety/Relief Valve
SS	Subsystem
ST	Steam
STAT	System Task Analysis Team
SUPVR	Supervisor
SW	Switch
SYS	System
T&M	Test and Monitoring
TBS	Turbine Bypass System
TEMP	Temperature
TG	Turbine Generator
TMI	Three-Mile Island
TP	Tape Punch
TR	Tape Reader
TS	Turbine Supervisory
TSC	Technical Support Center

ACRONYMS AND ABBREVIATIONS
LISTED ALPHABETICALLY BY DEFINITION

Alternating Current	AC
Annunciator	ANN
Anticipated Trip without Scram	ATWS
Area	A
Associated	ASSOC
Assistant	ASST
Augmented Off-Gas	AOG
Automatic Depressurization System	ADS
Auxiliary	AUX
Auxiliary Operator	AO
Average Power Range Monitor	APRM
Balance-of-Plant	BOP
Category	CAT
Cathode Ray Tube	CRT
Central Processor Cabinet	CPC
Circulating Water System	CWS
Color Monitor	CM
Condenser, Condensate	COND
Containment Cooling & Isolation	CCI
Control	CONT
Control Rod Drive	CRD
Control Rod Position	CRP
Control Room	CR
Core Spray System	CSS
Core Standby Cooling Systems	CSCS
Detailed Control Room Design Review	DCRDR
Digital Input/Output Cabinet	DI/OC
Direct Current	DC
Drywell Sump	DWS
Electric Power Research Institute	EPRI

Electrical System	ES
Emergency Core Cooling System	ECCS
Emergency Event Sequences	EES
Emergency Operating Facility	EOF
Engineered Safety Feature(s)	ESF
Estimate(d)	EST
Experience	EXPER
Feedwater	FW
Feedwater and Recirculation	FW&R
Final Safety Analysis Report	FSAR
Heating, Ventilation and Air Conditioning System	HVACS
High Pressure Coolant Injection System	HPCIS
Human Engineering	HE
Human Engineering Discrepancy	HED
Human Engineering Observation	HEO
Input Cabinet	ANALOG
Input/Output	I/O
Institute of Nuclear Power Operators	INPO
Instrument; Instrumentation	INSTR
Instruments and Controls	I&C
Intermediate Range Monitor	IRM
Jet Pump	JP
Leader	LDR
Local Power Range Monitor	LPRM
Loss of Coolant Accident	LOCA
Low Pressure Coolant Injection System	LPCIS
Low Temperature Off Gas System	LTOGS
Main Control Panel	MCP
Mainstream Isolation Valve	MSIV
Management Team	MT
Man/Machine	M/M
Megawatts (electric)	MW(e)
Monitor	MON
Motor Generator	MG
Neutron Monitoring System	NMS

Nuclear Regulatory Commission	NRC
Numbers	NOS
Operating Experience Review	OER
Operational Support Center	OSC
Operator Console	OC
Power Supply	PS
Preliminary Safety Analysis Report	PSAR
Primary Containment and Reactor Vessel Isolation Control	PCRVIC
Process	PROC
Project Review Team	PRT
Radiation Monitor	RM
Reactor	RX
Reactor Building Closed Cooling Water System	RBCCW
Reactor Containment Building	RCB
Reactor Core Isolation Cooling System	RCICS
Reactor Neutron Mapping control	RNMC
Reactor Operator	RO
Reactor Pressure Vessel	RPV
Reactor Protection System	RPS
Reactor Recirculation Pump	RRP
Reactor Recirculation System	RRS
Reactor Water Clean-Up	RWCU
Reactor Water Clean-Up System	RWCUS
Recirculating	RECIRC
Recirculation Actuation Signal	RAS
Refueling Water Storage Tank	RWST
Required	REQ'D
Residual Heat Removal System	RHRS
Rod Block Monitor	RBM
Safety Injection System	SIS
Safety Parameter Display System	SPDS
Safety/Relief Valve	SRV
Selected Operational Event(s)	SOE
Senior Reactor Operator	SRO

Standby Gas Treatment System	SGTS
Standby Liquid Control System	SLCS
Startup Range Monitor	SRM
Steam	ST
Subsystem	SS
Supervisor	SUPVR
Suppression Pool	SP
Switch	SW
System Task Analysis Team	STAT
System	SYS
Tape Punch	TP
Tape Reader	TR
Technical Support Center	TSC
Temperature	TEMP
Test and Monitoring	T&M
Three-Mile Island	TMI
Turbine Bypass System	TBS
Turbine Generator	TG
Turbine Supervisory	TS

1.0 INTRODUCTION

1.1 GENERAL COMMENTS

This report describes the Boston Edison Company's plan to perform a detailed control room design review (DCRDR) of its Pilgrim Nuclear Power Station. The purpose of this DCRDR is to identify and implement control room design improvements that offer a high probability for meeting plant safety and availability objectives.

The need for control room design reviews has been well documented by the NRC as a result of the investigations of the Three Mile Island accident. The principal areas of concern identified were: non-compliance of control room facilities with human factors principles, deficiencies in operator presented information, and inadequate operating procedures.

This is part of an integrated plan covering TMI-related actions referenced in the TMI-2 Action Plan, NUREG-0660 and will consider the relationship of the DCRDR with NUREG-0737, Supplement 1: "Requirements for Emergency Response Capability (Generic Letter No. 82-33)" dated 12/17/82 and "NRC staff review of the BWR Owners Group (BWROG) Control Room Program," (Generic Letter 83-18) dated 4/19/83 including:

- o Establishment of a qualified multi-disciplinary review team.
- o Function and task analysis to identify control room operator tasks and information and control requirements during emergency operations.
- o A comparison of display and control requirements with a control room inventory.
- o A control room survey to identify deviations from acceptable human factors principles.

- Assessment of Human Engineering Discrepancies (HEDs) to determine which HEDs are significant and should be corrected.

- Selection of design improvements.

- Verification that selected design improvements will provide the necessary correction.

- Verification that improvements will not introduce new HEDs.

- Coordination of control room improvements with changes from other programs such as Safety Parameter Display System (SPDS), operator training, Regulatory Guide 1.97 instrumentation and upgraded emergency operating procedures.

Figure 1-1 is a block diagram showing the relationship of the NUREG-0660 Task Action items Boston Edison Company is addressing.

This plan was prepared to be consistent with and responsive to the guidelines provided in NUREG-0700 and NUREG-0801 as directly applicable to the design and status of the Pilgrim Nuclear Power Station and good human factors principles.

The Pilgrim Station has already received an intensive review by the BWR Owners Group Control Room Improvement Committee with an associated review by Dr. T. Sheridan and Dr. D. Lanning, human factors consultants of the MIT Group. The results of this review will be used in this program.

This report is in compliance with Generic Letter 83-18 which notes:

"Since the BWROG survey program addresses only the planning and review phases of DCRDR, you are expected to complete the following tasks:

"a. Submit an individual program plan to the NRC referencing the BWROG Generic Program Plan. The plant-specific submittal should:

i. Document the qualifications of survey team members, and number and extent of plant personnel participation.

ii. Identify portions of the plant's DCRDR not performed in accordance with the methodology specified in the BWROG Program Plan.

iii. Discuss your program for prioritization of HEDs, reporting of DCRDR results, and implementation of control room enhancements.

"b. Complete the BWROG control room survey Checklist Supplement.

"c. Prioritize HEDs, determine corrective actions, develop an implementation schedule, and report the results of the DCRDR to the NRC.

"d. Repeat portions of the task analysis using updated plant specific emergency operating procedures to account for differences in the new procedures.

"e. Update operating experience review."

The Boston Edison Company is committed to this program for identifying and implementing changes to the plant man/machine interfaces that can reduce the probability of operator error thus resulting in an overall improvement in plant safety and reliability. To this end, Boston Edison Company has committed the necessary resources, including knowledgeable management, technical personnel, and technical specialists from its human factors consultant, Torrey Pines Technology, to effect the program defined herein.

1.2 OBJECTIVES

Boston Edison Company intends to complete this review in a timely and cost-effective manner to:

- Determine whether the control room provides the system status information, control capabilities, feedback, and analytical aids necessary for control room operators to accomplish their functions in an effective, safe and reliable manner.

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

- Analyze and evaluate potential problems that could arise from this review.

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

- Integrate the DCRDR review with other areas of human factors inquiries identified in the NRC Task Action Plan.

1.3 PLANT DESCRIPTION

The Pilgrim Nuclear Power Station is located on the western shore of Cape Cod Bay in the Town of Plymouth, Plymouth County, Massachusetts. It is 38 miles Southeast of Boston, Massachusetts. Bechtel Corporation was the architect/engineer and constructor of the station. The station consists of one 670 MW(e) (nominal) unit. It is powered by a single cycle, forced circulation General Electric Boiling Water Reactor producing steam for direct use in the General Electric 1,800 RPM tandem compound, four flow, nonreheat turbine generator. Commercial operation of the unit began in December 1972. A photograph of the plant is shown in Figure 1-2.

1.4 DEFINITION OF CONTROL ROOM

The control room is defined as the following consoles, bench boards and panels including the SPDS displays which are used by the operators for normal and emergency plant operations:

FRONT PANELS

903	Reactor & Containment Cooling & Isolation Bench Board
904	Reactor Water Clean-up & Recirculation Bench Board
905	Reactor Control Bench Board
C-2	Turbine Bench Board
C-1	Feedwater & Condensate Bench Board
C-3	345 K.V., Generator Auxiliary Power Bench Board
C-170	Post Accident Monitoring Panel, Train A
C-171	Post Accident Monitoring Panel, Train B
CP-600	H_2 Recombiner Panel

BACK PANELS

902	Area & Process Radiation Recorder Vertical Board
910	Process Radiation Monitoring Vertical Board
911	Area Radiation Monitoring Cabinet
C-4	Feedwater Heaters Control Vertical Board
C-7	Containment Ventilation, Isolation & Gas Treatment Vertical Board

The DCRDR will extend to other Man/Machine interfaces identified as a result of the analysis of selected events during the System Function and Task Analysis Activity.

1.5 CONTROL ROOM STATUS AND PLANNING

The Pilgrim Station control room has been in operation since December 1972 and the obvious human engineering discrepancies have been found and corrected. However, we are willing to implement this control room design review to assure that Boston Edison Company has provided a control room whose design and environment adequately supports the operators' abilities to cope with normal operations and degraded conditions.

We have participated actively on the BWROG control room design review committee. A BWROG control room survey has been performed at Pilgrim Station and will serve as the basis of our program. The following improvements are planned for the control room.

- <u>IMPLEMENTATION OF REGULATORY GUIDE 1.97, REV. 2</u>

  In order to provide a comprehensive implementation schedule, Boston Edison Company expects to approach the Pilgrim Nuclear Power Station/Regulatory Guide 1.97 analysis in a two-phase manner. The first phase would be to compare the Pilgrim Station design base to Regulatory Guide 1.97 criteria, and if modifications are required, provide an implementation schedule that will be consistent with Boston Edison Company's proposed Long Term Program.

  Boston Edison Company intends to do an item-by-item comparison between all the requirements of Regulatory Guide 1.97, Rev. 2 and the applicable systems and components of Pilgrim Station. Any deviations found will be systematically evaluated and documented to determine if the deviation is justifiable due to plant-specific design, original design bases, supportive operational requirements, etc. Any deviations not found to be justifiable will be evaluated to determine what modifications, if any, are needed to conform to Regulatory Guide 1.97, Rev. 2.

- REPLACEMENT OF EXISTING PLANT COMPUTER

  Boston Edison Company is planning to replace its existing plant computer to improve the present acquisition/distribution of information in order to effectively support the operator and enhance the Emergency Response Facilities. We intend to consider the various guidance documents such as NUREG-0696, Regulatory Guide 1.97 (Rev. 2), BWROG Graphic Display System (GDS) evaluation, and the INPO guidelines for an effective SPDS implementation. We believe the best approach to incorporating the suggested guidance is to base the objective for the SPDS on operator information requirements and augment the Emergency Operating Procedures. This integrated approach is essential to ensure the final product provides reliable, accurate and, more importantly, usable information for the control room personnel.

  Our plan involves the installation of a SPDS that is convenient to the control room operator. The system will display the information from which the plant safety status can be readily and reliably assessed by control room personnel who are responsible for avoiding degraded conditions. The SPDS display will be designed to incorporate accepted human factors principles.

- UPGRADED EMERGENCY OPERATING PROCEDURES (EOPs)

  Our Emergency Response Capabilities Program is based on the EOPs developed from the BWROG Emergency Procedure Guidelines (EPGs). We are in the process of preparing plant-specific symptom-based EOPs. These EOPs will be available for use for the DCRDR.

- CONTROL ROOM SIMULATOR

  We are planning on purchasing a full-scale simulator to aid in training operators. This simulator will be located in the new training facility now under construction in Chiltonville, Massachusetts.

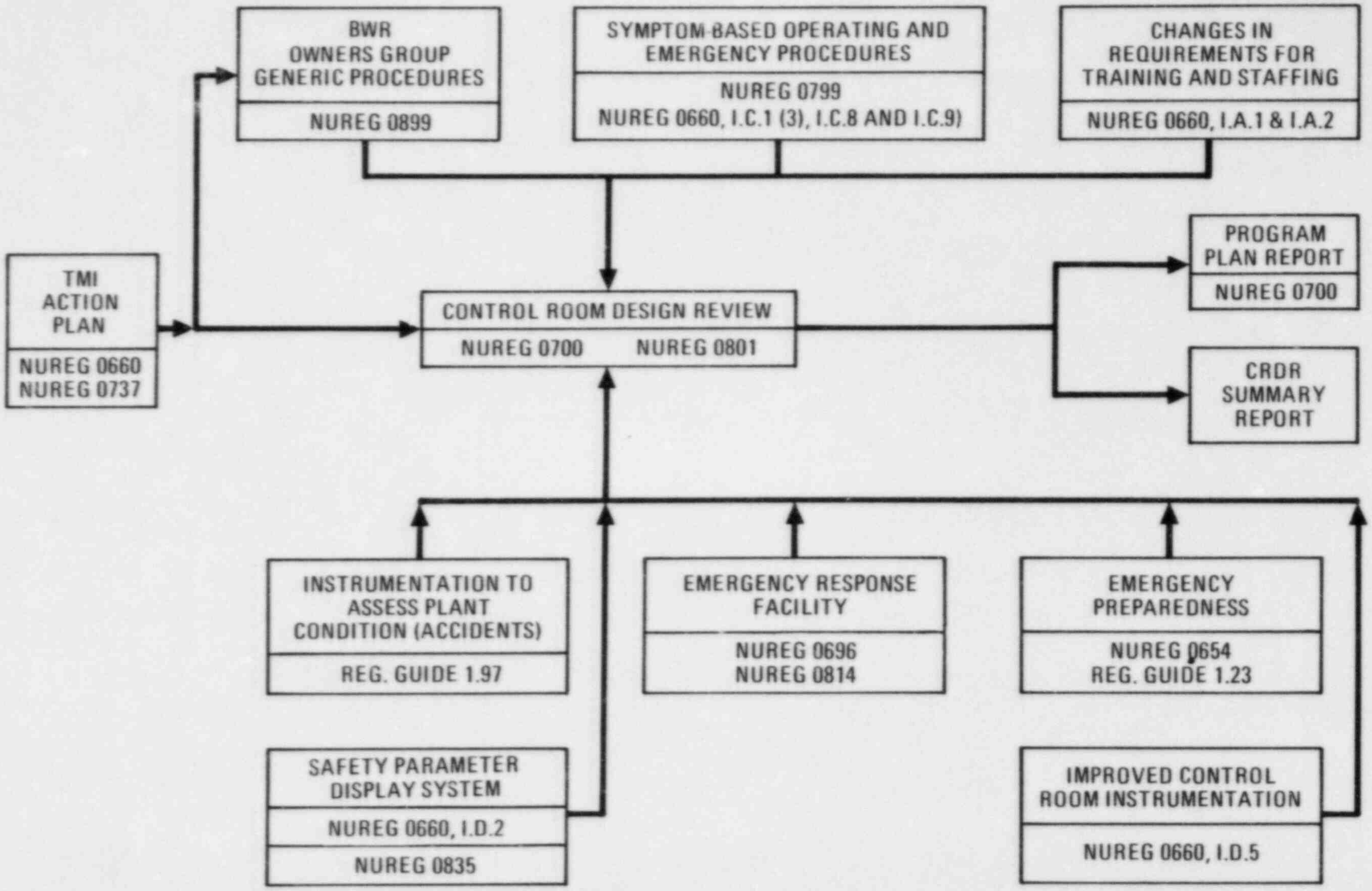

Figure 1-1. Relationship of NUREG-0660 Task Action Items to be Addressed

Figure 1-2. Boston Edison Company - Pilgrim Nuclear Power Station

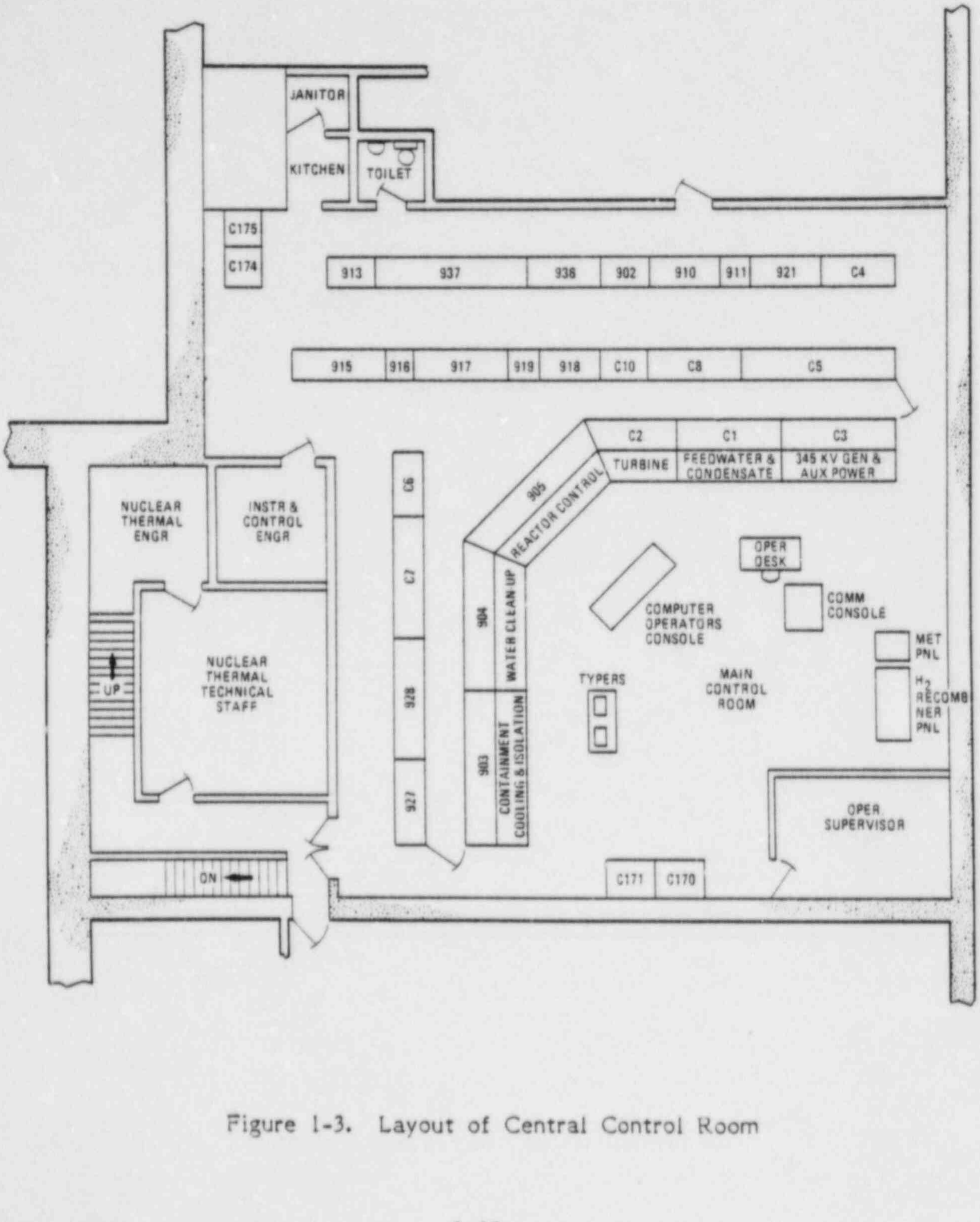

Figure 1-3. Layout of Central Control Room

2.0 CONTROL ROOM DESIGN REVIEW PLAN

2.1 GENERAL COMMENTS

The DCRDR will be conducted principally as recommended by NUREG-0700, NUREG-0801, and Generic Letters 82-33 and 83-18. It will consider the integration of related project requirements that may affect control room human factors discrepancies. The following related activities and documents will be coordinated with the DCRDR:

- o Development of emergency operating procedures (reference item I.C.1(3), I.C.8, and I.C.9 of NUREG-0660).

- o Development of a safety parameter display system, (reference Item I.D.2 of NUREG-0660; also NUREG-0696, Functional Criteria for Emergency Response Facilities).

- o Upgrading of emergency support facilities (reference Item III.A.1.2 of NUREG-0660 and NUREG-0696, Functional Criteria for Emergency Response Facilities).

- o Development of improved control room instrumentation (reference Item I.D.5 of NUREG-0660).

- o Changes in requirements for training and staffing (reference Items I.A.1 and I.A.2 of NUREG-0660).

- o Implementation of Regulatory Guide 1.97, Revision 2.

- o Evaluation criteria for DCRDRs (NUREG-0801).

- o Methodology for evaluation of emergency response facilities (NUREG-0814).

- o Human factors acceptance criteria for SPDS (NUREG-0835).

The overview of the DCRDR processes is shown in Figure 2-1 which is a copy of Exhibit 3-1 of (NUREG-0700). This Program Plan describes the following:

- o Planning (Section 2.2)
- o Review (Section 2.3)
- o Management and Staffing (Section 3.0)
- o Assessment and Implementation (Section 4.0)
- o Documentation and Document Control (Section 5.0)

2.2 PLANNING

The planning phase covers relevant actions completed to date or planned as noted herein.

Boston Edison Company organized an Executive Team to guide, monitor and implement this program. The Executive Team has made provisions for designated alternates to key positions. The functions of this team correspond to those recommended for management in NUREG-0700. They are to:

- o Assure proper relationships and awareness between this project and other NUREG-0660 efforts.
- o Assignment of key Management and Design Review Team personnel (see Figure 2-2).
- o Approve detailed program plan.
- o Provide resources required to carry out the Program Plan.
- o Identify and assure that plant operational constraints and project requirements are properly coordinated.
- o Monitor DCRDR progress.

- o Review and approve control room improvement recommendations.
- o Establish and initiate the control room improvement program.

A management review team has been established to monitor and approve the results of the Design Review Team. All assessemnt and implementation recommendations will be approved by the management review team. A senior human factors specialist will assist the management review team in executing its function. Table 2-1 shows the composition of the management review team.

The Management Team has analyzed NUREG-0700 in relation to this plant facility and resources and has defined the program described herein. The major activities are shown in Figure 2-3. The planning activity includes, in addition to the above items, the following:

- o Definition of all man/machine interfaces and related activities to be reviewed.
- o Definition of objectives.
- o Definition of Management Team role.
- o Formulation of the task structure for the program (see Figure 2-3) and corresponding personnel assignment (See Table 2-2).
- o Development of administrative procedures to govern this review.

To facilitate this review, project management authorized the construction of a full scale, realistic mock-up for an extensive review by human factors and systems specialists.

Boston Edison Company has assigned engineering and operations specialists to the Design Review Team that has the responsibility for the technical scope of the DCRDR. Lead members of this Team and the tasks to which they are assigned are shown in Table 2-2. This table indicates the strong participation of human factors specialists in all major talks and participation of the key Design Review Team members in most activities.

2.3 REVIEW

The review phase is basically the investigative phase. This effort is organized into specialty task groups per Figure 2-3. Specialized personnel are selected as required for each task group from Boston Edison Company and Torrey Pines Technology. Human factors specialists will provide a major role in all tasks and assignments will be made for cross fertilization of the various functional task groups. This concept will be extended into the management review team and accordingly the project engineer will be assigned to the Management Team. If necessary, General Electric will be asked to provide system design criteria. Approximately 15 engineers and key operations personnel will participate in the detailed reviews and evaluations of the task groups.

The following types of personnel are included:

- Nuclear systems designers and analysts
- Human factors consultants
- Control board designers
- Instrumentation and control engineers
- Computer and data management engineers
- Plant operators
- Training personnel
- Licensing personnel

The levels of effort for the personnel relied upon most heavily for the DCRDR are summarized in Table 2-3.

2.3.1 Methodology

Each task team will initially develop guidelines and, where necessary, procedures for executing the task. These guidelines or procedures may be modified to optimize team operation. Each topical report covering the full scope of each task activity will include the guidelines and/or procedures used. In general, guidelines and/or procedures will consider the following as applicable:

- o Objectives
- o Team membership and assigned duties
- o Methodology, including flow chart of all activities required to complete the task objectives
- o List of constraints, (if any)
- o Reporting requirements
- o Special instructions.

2.3.1.1 Criteria

The Design Review Team will prepare a control room design review criteria which will be included in the Criteria Report. This effort will stress the human factors considerations and requirements for the control room. This document will describe the function of the control room and plant systems related to external communications. It will also address one of the major post-TMI-2 concerns, the systems and human factors features for Annunciator/Computer/Safety Equipment interfaces relative to prioritization, consistency, and overall integration.

The following topics will be included in this document.

A. Introduction

B. General

C. Control Room Layout and Features

D. Main Control Panels Layouts and Features

E. Human Engineering Guidelines (BWROG specific adaptations of NUREG-0700, Section 6, and other guidelines not covered in other major topics)

F. Special Guidelines Associated with the Application of Human Factors Engineering to Control Room Design

G. References

Criteria will be developed considering:

- o Those human factors engineering practices that have general industry acceptance and have resulted in proven performance.
- o Pertinent NUREG documents, BWROG documents and Regulatory Guides.
- o Established criteria from general industry, EPRI, INPO, government sources, Boston Edison Company conventions, standards and practices.

2.3.1.2 Operating Experience Review

The Operating Experience Review Task Team (OERT) will review pertinent operating experience documents and conduct a survey of control room operations personnel. In addition to typical human factors operator concerns, the OERT will emphasize systems operability. It is anticipated that valuable input will be developed for use by the other task groups, particularly the System Function and Task Analysis Team (STAT). Specific attention will be placed on those normal plant procedures that experienced operators identify as having the greatest potential for human factors engineering enhancements. This information will be used in the selection process for those events to be analyzed by the STAT.

A special meeting will be held to review the methodology used in the preparation of operating procedures. Sample procedures will be reviewed and comments submitted to the operations department. The OERT will perform the following:

A. Meet with key operations and training personnel to determine pertinent information on training, assigned duties, anticipated work scheduling, and the availability of the various classes of operations personnel.

B. Prepare questionnaires and interview forms. See Table 2-4.

C. Provide for review by the Management Review Team.

D. Evaluate the data obtained from completed questionnaires by operations

E. Interview plant personnel.

F. Evaluate and summarize observations, including human engineering observations (HEOs) with recommended corrections.

Interview sheets and questionnaires will be prepared considering a review of the results of the BWROG control room survey interviews, the special knowledge the control room operations personnel have concerning potential control room problems and positive features as determined by their experience.

The interviews will identify any aspects of the control room equipment layout and general design which are considered by the operators to provide opportunities for improvement relative to their decision-making processes. Questions will be focused on those details of the control room environment which are projected to indicate notable success, failure and near-miss situations based on past experiences.

The respondents will be advised that the information obtained will not be used for performance evaluation purposes. Project procedures will assure that comments by operations personnel will remain anonymous.

The respondents will be encouraged to speak openly about problems from their past experience or perceived potential problems and suggested solutions.

The following NUREG-0700 topics to be included in this operations personnel review are:

1. Workspace and Environment
2. Communications
3. Annunciator Warning Systems
4. Controls
5. Visual Displays
6. Labels and Location Aids
7. Process computers
8. Panel Layout
9. Control/Display Integration
10. Procedures, Manning and Training
11. Control Room Equipment and Storage.

Other kinds of human factors concerns such as those related to employee programs and other questionnaires developed by industry and research groups in previous projects.

The interviews will be structured to allow for additions of material developed during the interview.

Data evaluation will be done immediately following completion of the interview period to assure maximum benefit from the interview. The data evaluation results will be forwarded to the Management Review Team for review. The results of this work will be evaluated and summarized. A re-review of areas of significant changes may be required.

2.3.1.3 System Function and Task Analysis (SFTA)

The system function and task analysis (SFTA) will be a structured review and analysis conducted according to the guidelines presented in NUREG-0700 and will be performed by the SFTA team members identified in Table 2-1. The results of the review and analysis were assembled into data sheets and diagrams showing operator tasks, actions and movements required for use in the Verification and Validation phases of the DCRDR. This work will be done considering the following:

A. Document Review

The initial activity in the SFTA will be to review documents related to plant design and operations as they pertain to the DCRDR. The primary documents considered are:

- o FSAR
- o System Operating Procedures
- o Emergency Operating Procedures
- o Operating Procedures
- o Technical Specifications
- o P&IDs

The EOPs will be plant specific and symptom-oriented and will:

- o Adequately address basic plant safety functions.
- o Have a format adequate for defining operator tasks.
- o Have a format containing operator decision-points (See Figure 2-4).

B. System and EOP Data Collection

This activity will document the system and EOP information for use in the event selection process as well as for general use in the DCRDR. The format shown in Figure 2-5 will be used which contains the following characteristics:

- System - Identifies major systems presented in the FSAR.
- EOP - Identifies system addressed in the EOPs that required some form of operator attention related to that plant basic safety function.
- SOE - Identifies systems ultimately addressed in the Selected Operating Event.

C. Selection of Events (SOEs) for Analysis

To select the events for analysis, the following criteria will be considered by the SFTA team:

- Utilize a broad range of control room functions.
- Require time-dependent action by the operator.
- Require multisystem operation and interaction by the operator.
- Represent potentially high-stress situations for the operator.

The SFTA Team will use an iterative process involving Figure 2-5, the EOPs and selection criteria as follows:

- Select an initial set of Initiating Events using Figure 2-5 and selection criteria.
- Determine the EOP flow-paths for each Initiating Event.
- Evaluate systems addressed on each EOP flow-path against selection criteria and revise the initiating event and/or the EOP flow path accordingly.
- Evaluate operator decision-points on each EOP flow-path against the selection criteria and add to each initiating event the assumption of system failures as necessary.

D. SOE Data Collection

In this activity, the SOE-specific data will be collected for input to the data base. This will consist of the following major activities:

- o Operator Task Data - formulation of task description, requirements and alternate tasks from the EOP flow-paths for each SOE.
- o Operator Step Data - formulation of step description and identification of control room devices that the operator could use for each step on the EOP flow-path for each SOE and an estimate of related system status based on an estimate of SOE elapsed-time.
- o Operator Area of Responsibility.

The photomosaic mockup of the control room will be used for the collection of operator step data.

E. SOE Data Sheets

Samples of the data sheets to be used are shown in Figures 2-6, 2-7 and 2-8.

2.3.1.4 Control Room Inventory

An inventory of controls, instrumentation, displays and other equipment on the control room man/machine interfaces will be performed. This inventory will establish a reference data base for comparison with the requirements established by operator task analysis.

The following will be done in performing the inventory:

- **Line Number**

  A unique sequential line number will be arbitrarily assigned to each item (or collection of items treated as a unit) on the panels to facilitate accountability and quality in compiling the inventory. These same numbers will also be on labels affixed to the full-scale mock-up. These line numbers will be unique and as such will be used exclusively with the Control Room Survey and Systems Function and Task Analysis. The line number will be used to identify instruments not complying with NUREG-0700 Section 6 guidelines and will be listed in any HEOs generated. The SFTA task will also use these numbers to outline the operator steps.

- **Instrument Numbers**

  Instrument numbers will be assigned to the majority of the items in the inventory in order to identify the type of instrument in question.

- **Service Description**

  Information will be included in order to either create a non-existent label or to render more definitive the information given in the label; P&IDs/the Instrument Index/FSAR/GE documents will be consulted at various times for more definitive information.

- **System Number**

  System numbers will be assigned based on a use of the Pilgrim Nuclear Power Station System MR Index.

- **Manufacturer/Model**

  This data will be collected if available.

- **Range Units**

  These values will be used during the SFTA and validation effort of the DCRDR.

- **Minimum Scale Increment**

  These values will be used during the SFTA and validation effort of the DCRDR.

- **Board Number**

  The numbers will be equivalent to the panel numbers.

- **Panel ID**

  The mock-up will be divided into sections, and the location of the line numbers will be noted to facilitate location of instruments at a later date.

An example of an inventory sheet is shown in Figure 2-9.

2.3.1.5 Control Room Survey

A survey of the full scale mock-up and the Pilgrim Station Control Room will be performed to document compliance with the human factors criteria document. The use of a realistic mock-up will permit completion of the bulk of the checklist items developed. Those items that cannot be checked, on the mock-up such as control room workspace, voice-assisting communication devices, control room noise, illumination, use of protective clothing and other environmental considerations, will be completed using the control room in actual service conditions.

The objectives of the Control Room Survey will be to:

- Identify characteristics of the control room instrumentation and physical arrangements that may impact operator performance.

- Determine whether the control room provides the system status information, control capabilities, feedback, and analytical aids necessary for effective plant operation.

- Provide recommendations for correcting observations based on good human factors principles.

The Control Room Survey will be conducted using nine checklists to be developed from the Criteria Report (essentially to Section 6, NUREG-0700 Reference 6). The checklists to be developed will cover:

- 6.1 Control Room Workspace
- 6.2 Communications
- 6.3 Annunciator Warning Systems
- 6.4 Controls
- 6.5 Visual Displays
- 6.6 Labels and Location Aids
- 6.7 Process Computers
- 6.8 Panel Layouts
- 6.9 Control-Display Integration

and will use the same number and title contained in NUREG-0700, Section 6.

Each checklist will contain a title page, a detailed description of the criteria and a reference/comment form to allow the observer to expand on any potential deficiencies discovered in the survey. See Figure 2-10 and 2-11. The basis for each criteria judgement will be established in the Criteria Report. The Criteria Report will identify NUREG-0700, BWROG or INPO guideline criteria used for this survey. By performing the Control Room Survey in this fashion, every item addressed in Section 6 of NUREG-0700 will be addressed.

Any items identified as not meeting the guideline criteria will be documented as Human Engineering Observations (HEOs). Each HEO will contain a brief description of the observation, the potential operator error and a recommended good human factors engineering fix.

An identifying system will be adopted to assist separating the HEOs by checklist item. The first numbers or letters before the dash will identify the checklist or DCRDR task. The last three numbers are arbitrary, sequential numbers. If the last three numbers are followed by an A, B, or C, it means that this is a continuation of the HEO description.

The procedure for processing the HEOs generated by the Control Room Survey is discussed in Section 4.0.

A computer program will be developed using a data base management system for storing, reporting and sorting of the HEOs. The program will produce individual forms as shown in Figure 4-1 for each HEO generated. It can also sort on any of the categories or words within a category. For instance, if it is desirable to search for all of the HEOs regarding a given instrument, the program can search in the "HEO Description" section for the instrument in question and then link it to the HEO number or any other item of interest.

2.3.1.6 Verification of Task Performance Capabilities

A. Verification of Availability/Accessibility

The verification of the availability and accessibility of control room controls and displays will be accomplished by comparing the list of devices required in the SFTA with the list of available devices in the control room inventory. The criteria considered in this evaluation is from Accessibility of Instrumentation/Equipment, Section 6.1.1.1 of NUREG-0700.

The SFTA data will be compared with the control room inventory using the file linking option of the DBMS. This allows a direct comparison of the required devices for the SFTA versus the available devices from the inventory for the evaluation of availability.

A listing of all devices that are located outside the primary operating area will be obtained from the DBMS for the evaluation of accessibility. All items not satisfying the above criteria will be recorded as HEOs.

B. Verification of Suitability

The verification of the suitability of control room controls and displays will be accomplished by comparing the requirements for the devices used in the SFTA with the devices specifications from the control room inventory. The criteria considered in this evaluation is from Section 6.5.1.1. Information to be Displayed and Section 6.5.1.2 Useability of Displayed Values of NUREG-0700.

The SFTA control and display requirements will be compared to the inventory control and display specifications (e.g. switch positions, instrument range, minimum scale increment, etc.) by using the file linking option of the DBMS. All devices not satisfying the evaluation criteria above will be documented as HEOs.

C. Verification of Function/Task Grouping

Prior to evaluating the diagrams, an initial evaluation will be made to determine if controls and devices are grouped by task, by function, and by importance or frequency of use.

The major criteria considered in this evaluation is from Section 6.8.1.1 and 6.8.2.1 of NUREG-0700.

The data sorted by operator step will be used to perform this evaluation. From a DBMS listing of the sorted data, all the tasks that are performed on more than one control panel and all functions that are performed on more than one panel will be recorded. Also, any frequently occurring operator tasks and steps will be recorded. A review and evaluation will be made of all the items recorded and will consider the following:

a. Steps which occur near the boundary line between the two panels may be within the same workspace (devices may be on separate panels but still grouped together).

b. For overall system monitoring tasks it is considered acceptable for the steps to occur on more than one panel.

c. Non-emergency SOEs (plant startup) are not constrained by time or stress as is the case for emergency events. Grouping of tasks on two adjacent panels may be considered acceptable for non-emergency SOEs.

d. Tasks or functions occurring on more than one panel may be acceptable if more than one operator is involved.

e. Tasks or functions occurring on two or more adjacent panels may be acceptable if one or more of the panels is a very small or short panel.

f. Tasks which have steps that occur on both a console and the corresponding but separate vertical panel are acceptable if the vertical panel step is an observation of an instrument or status light that can easily be seen from the console position.

All items still not satisfying the panel contents criteria after considering the above allowances will be recorded as HEDs.

D. Verification of Layout Arrangement

The traffic link diagrams provide a comprehensive visual review of the panel device layout (and to some extent the operating procedures) with regard to efficiency of movement for the operators. The major criteria considered in this evaluation are from Section 6.8.1.1 of NUREG-0700.

Traffic link diagrams will be prepared (See Figure 2-12). From these diagrams, the traffic paths showing high number of operator trips will be identified for review. These are indications of devices that are not located on panels to minimize operator movement from panel to panel. Also to be identified are the traffic paths showing long distances traveled by the operators. These are indications of devices that are not located for efficient control panel operation and minimum operator movement.

The selection of high frequency or long distance paths from the link diagrams is primarily a matter of judgement and depends on the SOE. Guidelines will be established to identify high frequency paths:

E. Verification of Panel Contents

The operational sequence diagrams provide a visual method of evaluating the operator movement within the control panels. The major criteria considered in this evaluation is from Section 6.8.2.1 of NUREG-0700.

Operational sequence diagrams will be prepared as shown in Figure 2-13. The diagrams for each SOE will be reviewed with regard to the selected criteria.

2.3.1.7 Validation of Control Room Function

A validation will be performed as part of the SFTA activity to determine whether the control room operating crew can perform allocated functions within defined procedures. The bulk of this effort will be performed on the mock-up using walk-through/talk-through techniques. Scenarios will be devised using the plant-specific, symptom-based EOPs that were used in the SFTA effort. The tasks to be performed will be directed by the SFTA specialist and monitored by the SFTA specialist and a television camera. Data gathered during this phase will be compared to a Validation/Verification checklist to determine if any HEOs exist.

TABLE 2-1

DCRDR Management Review Team and Advisory Committee

Management Review Team

W. J. Armstrong

R. E. Grazio

S. Dasgupta

Advisory Committee

P. Mastrangelo

J. W. Ashkar

TABLE 2-2

DCRDR Design Review Team Members and Associated Task Assignments

C. H. Minott
Project Manager

W. Babcock, Jr.
Principal Investigator

S. F. Luna
Project Engineer
Sr. Human Factors Specialist

Planning

C. H. Minott
W. Babcock, Jr.
S. F. Luna
R. Sabeh

Operating Experience Review

W. Babcock, Jr.
K. N. Taylor
S. F. Luna
R. Sabeh

Control Room Survey

W. Babcock, Jr.
S. F. Luna
R. Sabeh
W. Welch
E. P. Gagnon
W. Arnold

Control Room Inventory

W. Babcock, Jr.
F. Scaletta
E. P. Gagnon

System Function and Task Analysis

W. Babcock, Jr.
D. Hughes
J. L. Rogers
C. S. Brennion
K. N. Taylor
W. Olson
E. P. Gagnon
S. F. Luna
W. R. Arnold
R. C. Potter
F. Scaletta

Verification

E. P. Gagnon
F. Scaletta
W. R. Arnold

Validation

W. Babcock, Jr.
W. Olson
D. Hughes
E. P. Gagnon

TABLE 2-2
(continued)

DCRDR Design Review Team Members
and Associated Task Assignments

Assessment	Documentation
W. Babcock, Jr.	C. H. Minott
D. Hughes	W. Babcock, Jr.
C. S. Brennion	E. P. Gagnon
S. F. Luna	S. F. Luna
R. Sabeh	R. Sabeh
W. R. Arnold	
E. P. Gagnon	

Table 2-3.
LEVELS OF EFFORT

DCRDR PHASE/TASK	HUMAN FACTORS ENGINEER	REACTOR OPERATORS	I & C ENGINEERS	NUCLEAR SYSTEMS ENGINEERS
Planning	220		100	120
Review:				
Operating Experience Review	220	120	40	40
Control Room Survey	200			40
Task Analysis	40	80	160	660
Assessment	120	80	160	
Correction/Effectiveness	120	80	160	40
Documentation	40		100	100
Project Meetings	80	20	20	40

TABLE 2-4
QUESTIONNAIRE AND INTERVIEW SHEET REFERENCE TOPICS

The following will be covered in the interview sheets and questionnaires to determine positive and negative features and suggestions for improvements:

- o The role of the operations personnel in emergency situations.
- o Those normal functions and tasks that the respondents consider should be included in the system function and task analysis.
- o Major concerns and strengths of related plant operations.
- o Techniques for maintenance of high vigilance. How boredom will be prevented. How proficiency will be maintained.
- o Views of engineering and engineered product necessary for plant operation.
- o Overall management policies - how perceived by interviewees.
- o Views of projected job assignments (work loading - too much, too little?).
- o Views of job satisfaction or dissatisfaction (long-range job objectives).
- o Views of personal training received to date - adequate? Suggestions for improvements.
- o Views of the control center complex - strengths and weaknesses.
- o Views of the control room complex in the general areas noted in NUREG-0700 Appendix C and Section 3.3.2.2 for normal and abnormal situations.

TABLE 2-4 (continued)

- o Discussion of emergencies.
- o Discussion to determine special techniques useful in plant control.
- o Views of the engineering of the products required for plant operations.
- o Views of external elements - NRC and press.
- o Views of projected shift staffing.
- o Relationship with fellow workers, maintenance, and other associates.
- o Discussion of main concerns, major strengths or weaknesses, and improvements that are most sought for.
- o View of projected workload and difficulties in performing assignments.
- o Views of projected relationship with other groups that effect overall plant operations.
- o Views of training.
- o Views of administrative procedures.

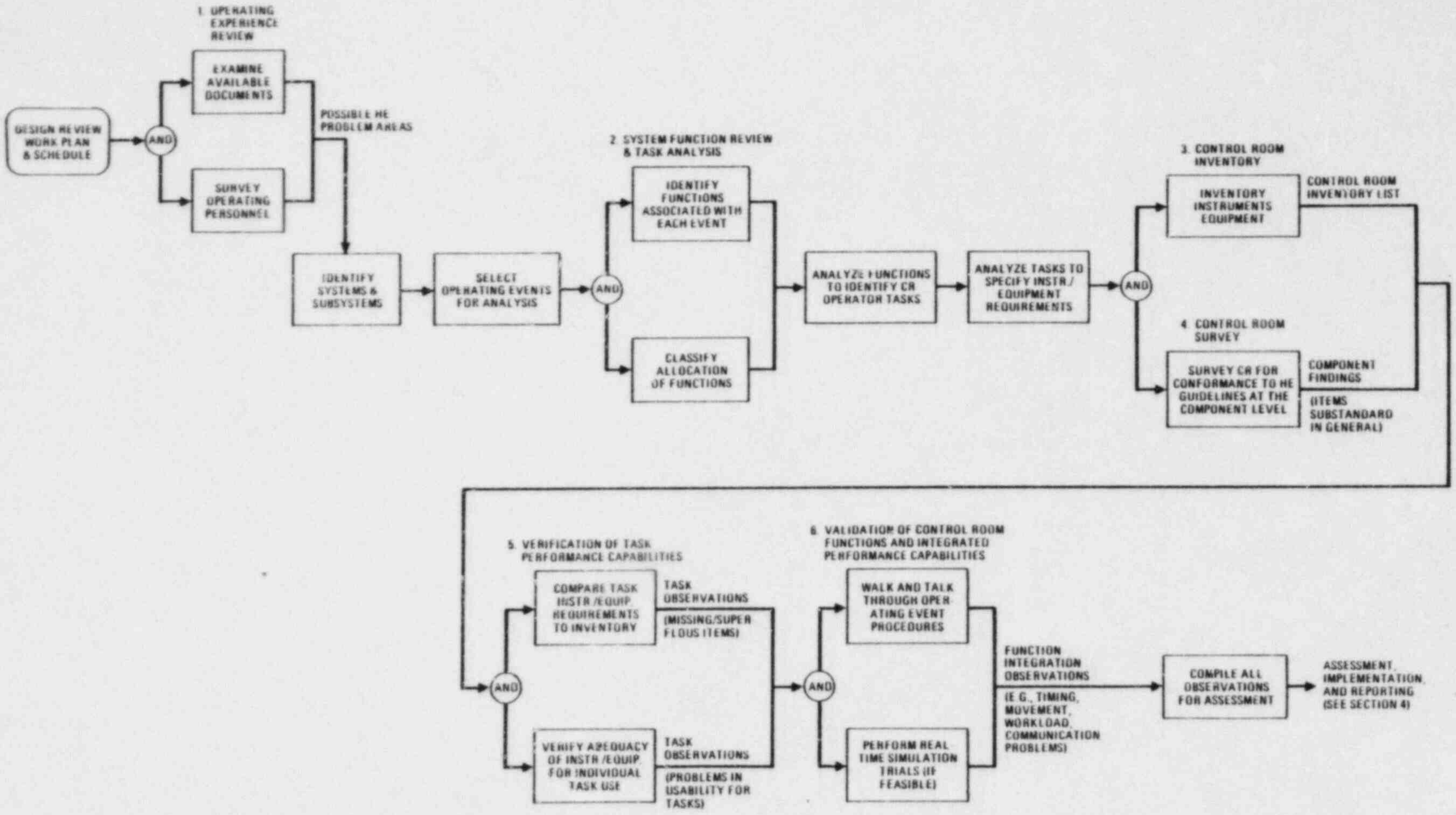

Figure 2-1. Overview of the DCRDR Process

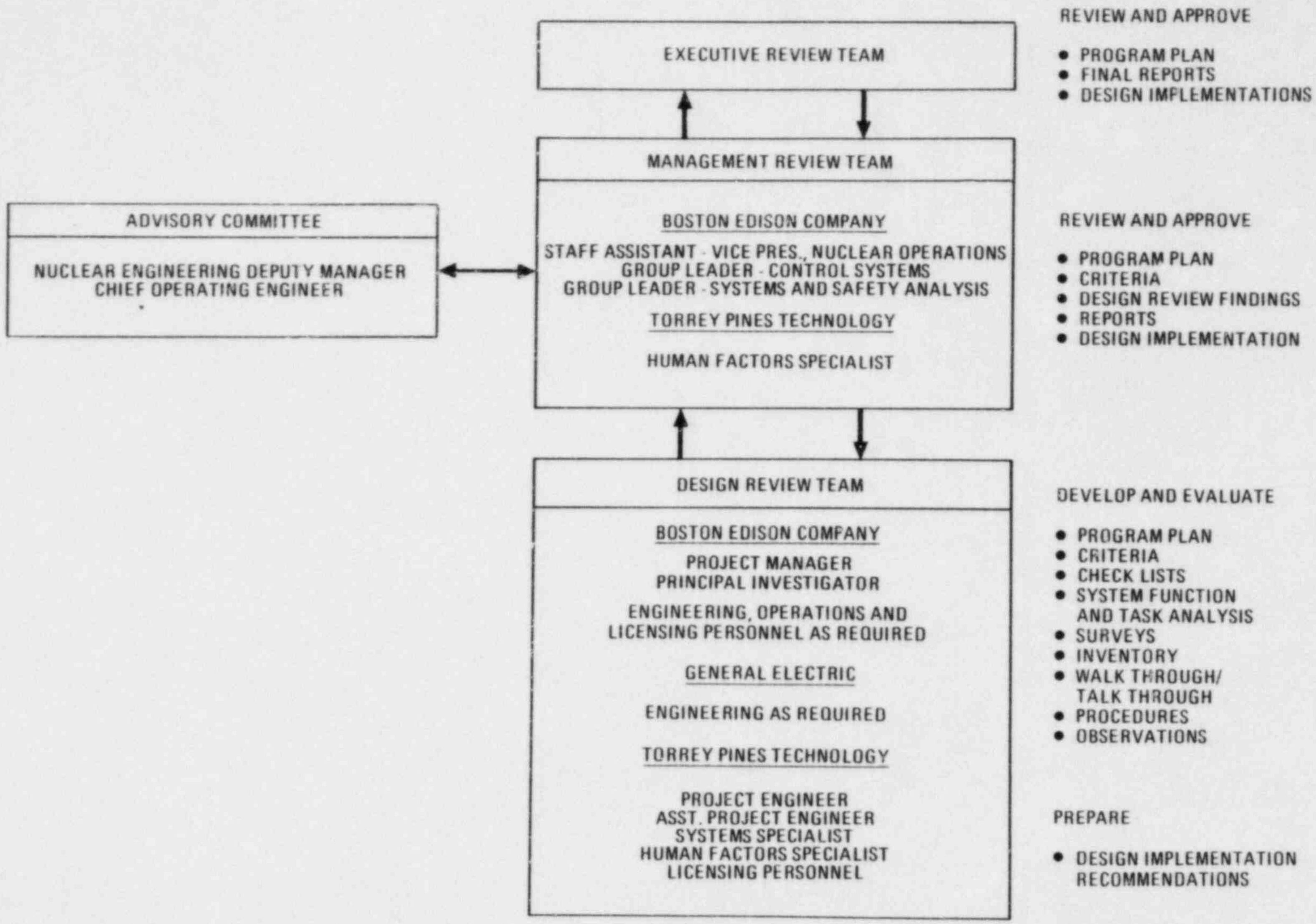

Figure 2-2. DCRDR Review Teams

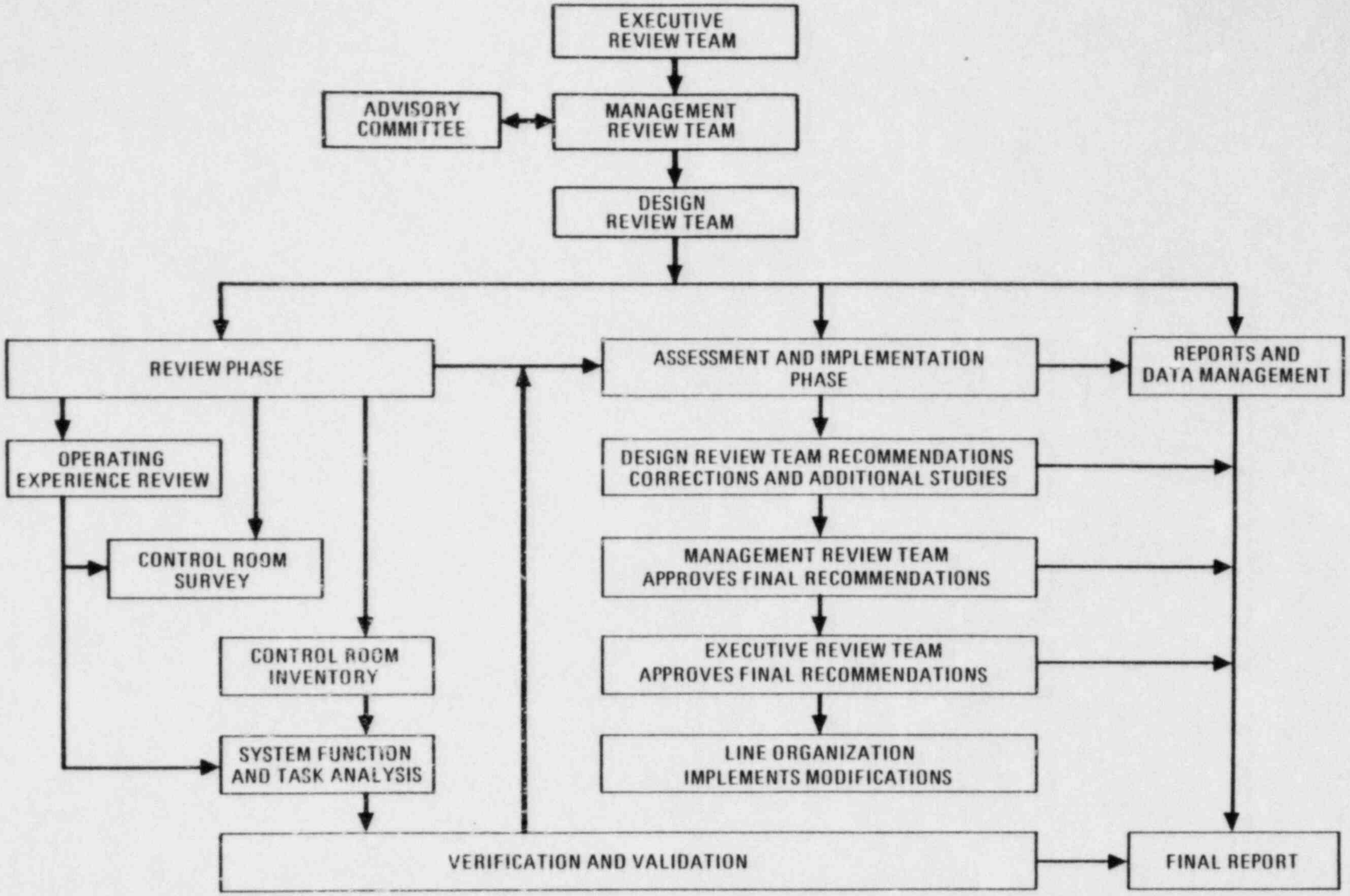

Figure 2-3 Formulation of the DCRDR Task Structure

III. OPERATOR ACTIONS (Continued)

B. INITIATE action as indicated

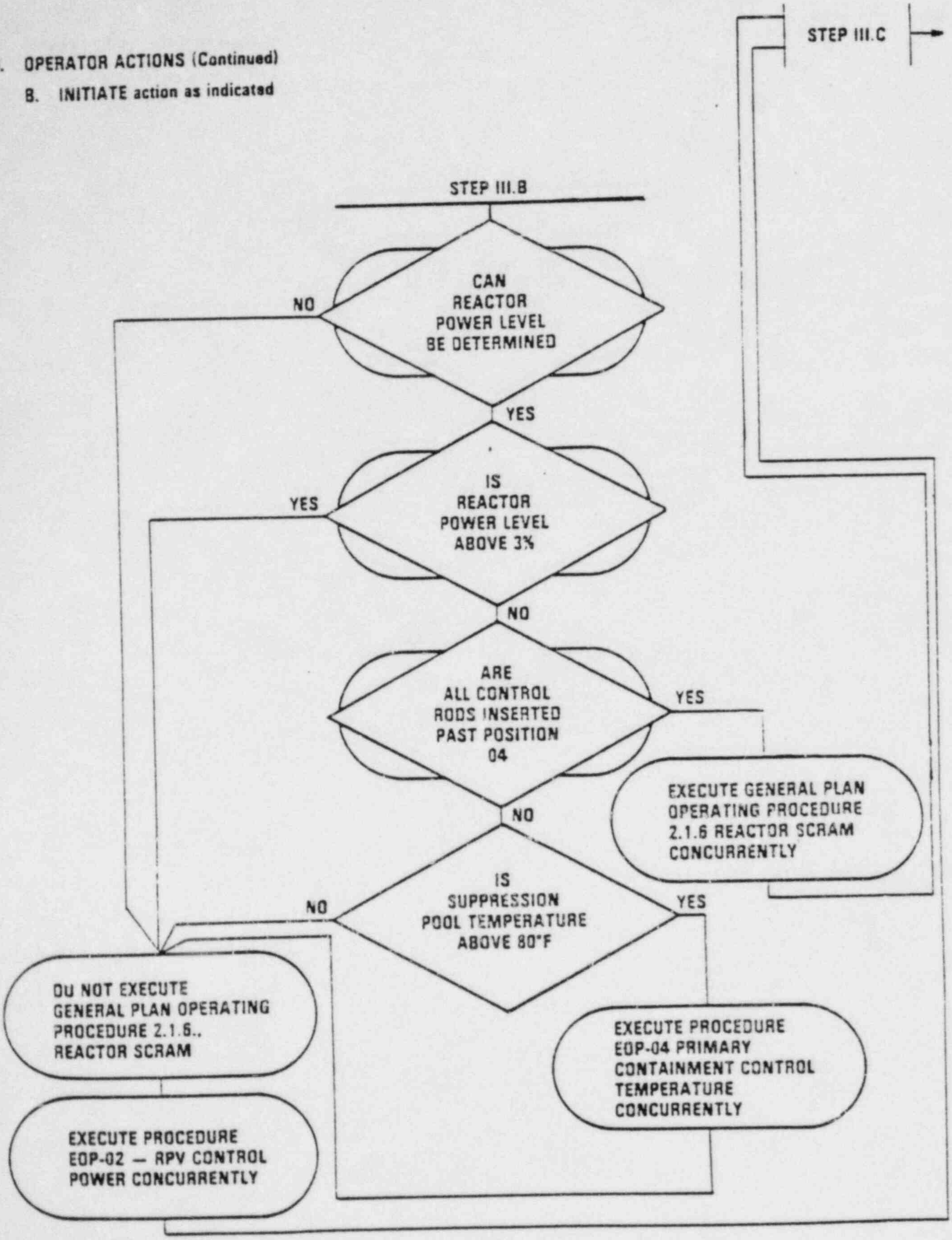

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Figure 2-4. Example of Functional (Decision-Action) Flow Diagram

	EOP								SOE				
System No.	01	02	03	04	05	06	07	08	1	2	3	4	5
1	X	X					X		X		X	X	
2			X		X					X			X
3						X		X					
4		X		X						X			
5					X								
6									X				
etc.													

Figure 2-5. Sample for Pilgrim System Cross Referenced with the Plant EOPs and SOE.

PILGRIM NUCLEAR POWER STATION
DCRDR - SFTA
SOE4: LARGE BREAK LOCA IN PRIMARY CONTAINMENT WITH LOSP
DATA SHEET #1: OPERATOR PRIMARY & ALTERNATE TASKS

SOE	PROC	OPER STEP	TASK or STEP DESCRIPTION	TASK or STEP REQUIREMENT	ALTERNATE TASK DESCRIPTION
4		.10	T: Monitor/adjust plant parameters during normal plant operation @ 100% power		
4	-	1.00	T: Respond to numerous alarms and systems auto actions for EOP entry conditions	See subtasks	See subtasks
4		1.05	ST: Determine RPV water level	RPV water level	Initiate RPV flooding (EOP-07)
4		1.20	ST: Determine DW pressure and temperature	DW pressure & temperature	Assume DW press & temp entry conditions exist
4		1.50	ST: Determine SP level	SP level	Assume SP level entry conditions exist
4	EOP-01	2.00	T: Verify Reactor scram	Rod position & scram system status	Initiate reactor power control thru RPV water level(EOP-02) & boron injection(EOP-08)
4	EOP-01	3.00	T: Verify reactor power indication	Reactor power, full,intermed. & lo range	Initiate reactor power control thru RPV water level(EOP-02) & boron injection(EOP-08)
4	EOP-01	4.00	T: Verify control rod position	Control rod position	Initiate reactor power control thru RPV water level(EOP-02) & boron injection(EOP-08)

Figure 2-6. SFTA Data Sheet #1

PILGRIM NUCLEAR POWER STATION
DCRDR - SFTA
SOE4: LARGE BREAK LOCA IN PRIMARY CONTAINMENT WITH LOSP
DATA SHEET #2: OPERATOR STEPS IN TASK SEQUENCE

SOE	PROC	OPER STEP	TASK or STEP DESCRIPTION	TASK or STEP REQUIREMENT	DEVICE USED	ALTERNATE TASK or STEP DESCRIPTION	SYSTEM NO	BOARD NO	PANEL NO	OPER
4		.10	T: Monitor/adjust plant parameters during normal plant operation @ 100% power		0					
4	-	1.00	T: Respond to numerous alarms and systems auto actions for EOP entry conditions	See subtasks	0	See subtasks				
4		1.05	ST: Determine RPV water level	RPV water level	0	Initiate RPV flooding (EOP-07)				
4		1.07	Observe RPV water level	< 136 INCHES above TAF	1174		45	905	3-3	OP1
4		1.09	Observe RPV water level	< 136 inches above TAF	1173		45	905	3-3	OP1
4		1.11	Observe RPV water level	< 136 INCHES above TAF	1332		9	C171	B	OP2
4		1.13	Observe RPV water level	< 136 INCHES above TAF	439		9	C170	B	OP2
4		1.20	ST: Determine DW pressure and temperature	DW pressure & temperature	0	Assume DW press & temp entry conditions exist				

Figure 2-6. SFTA Data Sheet #2

SOE	PROC	OPER STEP	TASK or STEP DESCRIPTION	TASK or STEP REQUIREMENT	DEVICE USED	SERVICE DESCRIPTION, RANGE,UNITS	MIN SCALE INCR	SYSTEM NO	BOARD NO	PANEL NO	OPER
4		.10	T: Monitor/adjust plant parameters during normal plant operation @ 100% power								
4	-	1.00	T: Respond to numerous alarms and systems auto actions for EOP entry conditions	See subtasks							
4		1.05	ST: Determine RPV water level	RPV water level							
4		1.07	Observe RPV water level	< 136 INCHES above TAF	1174.	REACTOR WATER LEVEL (INDIC) + LABELS FOR VARIOUS REF LEVELS -50 TO +50 INCH(ZERO @ 127 INCH ATF @ RATED PWR&TEMP	10	45	905	3-3	OP1
4		1.09	Observe RPV water level	< 136 inches above TAF	1173.	REACTOR WATER LEVEL (INDIC)+LABELS FOR VARIOUS REF LEVELS -50 TO +50 INCH(ZERO @ 127 INCH ATF @ RATED PWR&TEMP	10	45	905	3-3	OP1
4		1.11	Observe RPV water level	< 136 INCHES above TAF	1332.	TORUS LEVEL(/FUEL ZONE/LONG RANGE RECORDER)NOTE:ZERO OF INSTR @ 77.5 INCH ATF TL,R:0-300/FZ,BLU:-150 TO +150/LR,G:-50 TO+50 INCHES	5/5/5	9	C171	B	OP2
4		1.13	Observe RPV water level	< 136 INCHES above TAF	439.	TORUS LEVEL (/FUEL ZONE/LONG RANGE RECORDER)NOTE:ZERO OF INSTR @ 77.5 INCH ATF TL,R:0-300/FZ,BLU:-150 TO +150/LR,G:-50 TO+50 INCHES	5/5/5	9	C170	B	OP2
4		1.20	ST: Determine DW pressure and temperature	DW pressure & temperature							

Figure 2-8. SFTA Data Sheet #3

LINE NO	INSTRUMENT NUMBER	SERVICE DESCRIPTION	SYSTEM NUMBER	MANUFACTURER MODEL	RANGE UNITS	MIN SCALE INCR	BOARD NUMBER	PANEL ID
128.	XAN-3	(TURBINE BENCH BOARD C2 ANNUNCIATORS)	42	PANALARM	-	-	C2	1A/1B
129.	ZI-3022	BYPASS VLVS OPENING JACK POS	51	FOXBORO	0-100 PERCENT	2	C2	1A
130.	ZI-3021	MECH PRESS REG HND WHEEL POS	51		150-1050	50	C2	1A
131.	ZI-3020	MECH PRESS REG RELAY PISTON POS	51	FOXBORO	0-100 PERCENT	2	C2	1A
132.	ZI-3014	ELECT PRESS REG SERVO MTR POS	51	FOXBORO	0-100 PERCENT	2	C2	1A
133.	ZI-3013	PRESS CONTROL POS	51		910-1010 PSI	2	C2	1A
134.	ZI-3023	LOAD LIMIT PISTON POS	51	FOXBORO	0-100 PERCENT	2	C2	1A
135.	ZI-3024	SPEED & LOAD CHANGER POS	51	FOXBORO	0-100 PERCENT	2	C2	1B
136.	PI-3049	STEAM CHEST PRESS	1	FOXBORO	0-2 PSIG X 1000	0.05	C2	1B
137.	PI-3052	TURB 1ST STAGE PRESS	1		0-900 PSIG	25	C2	1B
138.	XZI-8	NO. 1 CNTR VLV ABOVE SEAT DRAIN	1		G-R LITES	-	C2	1B
139.	XZI-9	NO. 2 CNTR VLV ABOVE SEAT DRAIN	1		G-R LITES	-	C2	1B
140.	XZI-10	NO. 3 CNTR VLV ABOVE SEAT DRAIN	1		G-R LITES	-	C2	1B

Figure 2-9. Sample Inventory List

GUIDELINE

6.2.1.1 GENERAL REQUIREMENTS FOR VOICE COMMUNICATION SYSTEMS

Generally there are six varieties of voice communication systems found in control rooms: Conventional-powered telephones, sound-powered telephones, walkie-talkie radio transceivers, fixed-band UHF transceivers, announcing systems, and point-to-point intercom systems. Human factors requirements specific to each type of voice communication system will be considered individually in Guidelines 6.2.1.2 through 6.2.1.7 while 6.2.1.8 will address voice communication by the operator wearing an emergency mask. The following requirements are relevant to communication systems in general.

a. INSTRUCTIONS—Instructions should be provided for use of each communication system, including suggested alternatives if a system becomes inoperable.

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.

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.

(2) INCOMING—Procedures should be established for handling communications during an emergency and these procedures must be known by all operators.

COMPLIANCE CHECKLIST

N/A	Yes	No	Reference/Comment

Figure 2-10. Sample Compliance Checklist

Figure 2-11.

BOSTON EDISON

DETAILED CONTROL ROOM DESIGN REVIEW
CONTROL ROOM SURVEY
REFERENCE/COMMENT FORM

OBSERVER: ______________________ DATE: __________ PAGE ___OF ____

LOCATION: ______________________

GUIDELINE CRITERIA ITEM NO.: ______________ HEO REFERENCE NO.: __________

CRITERIA ELEMENT NO.	PANEL/ CONSOLE NO.	SUBPANEL	REFERENCE/COMMENT
DIAGRAM/PHOTO NO.:			

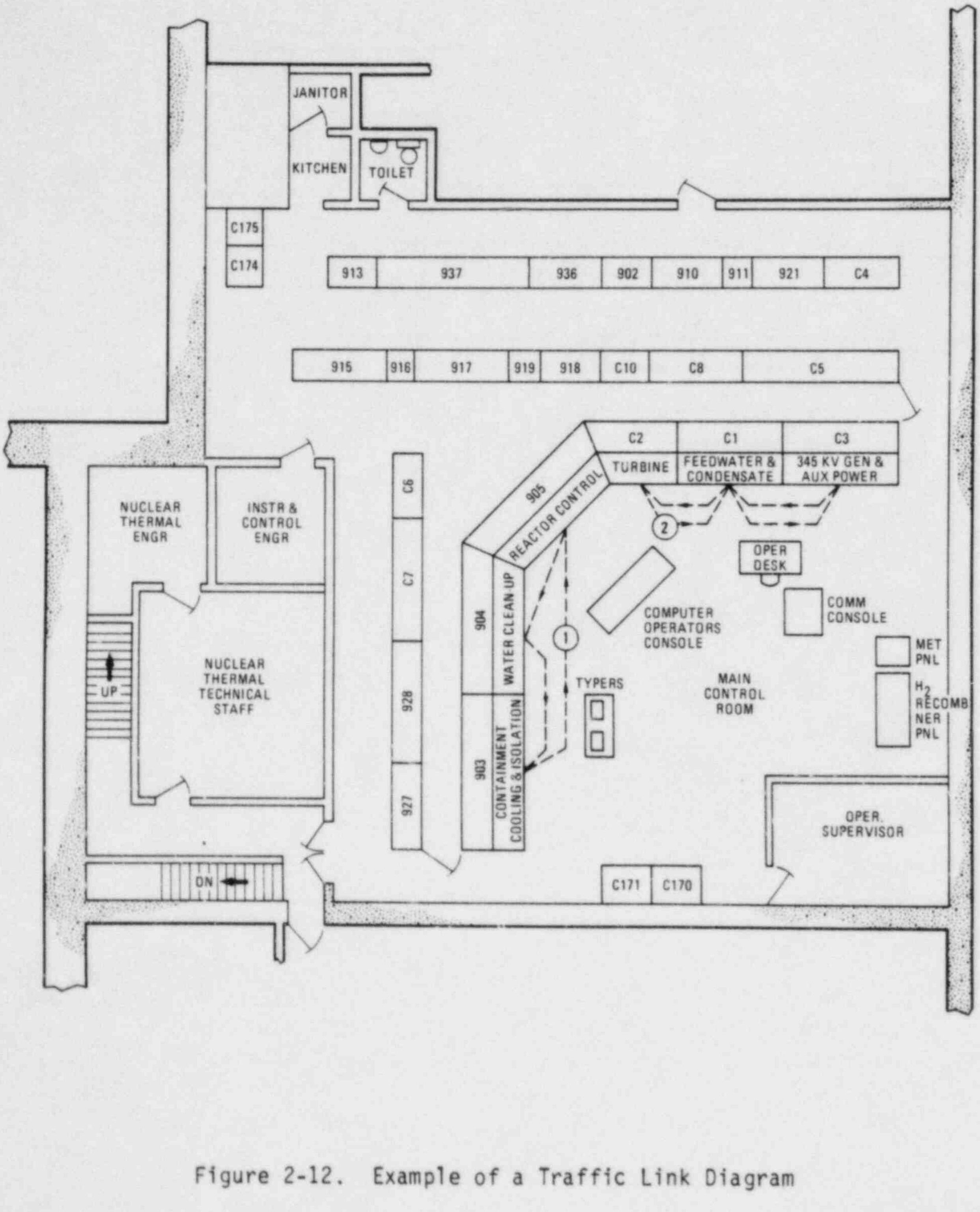


Figure 2-12. Example of a Traffic Link Diagram

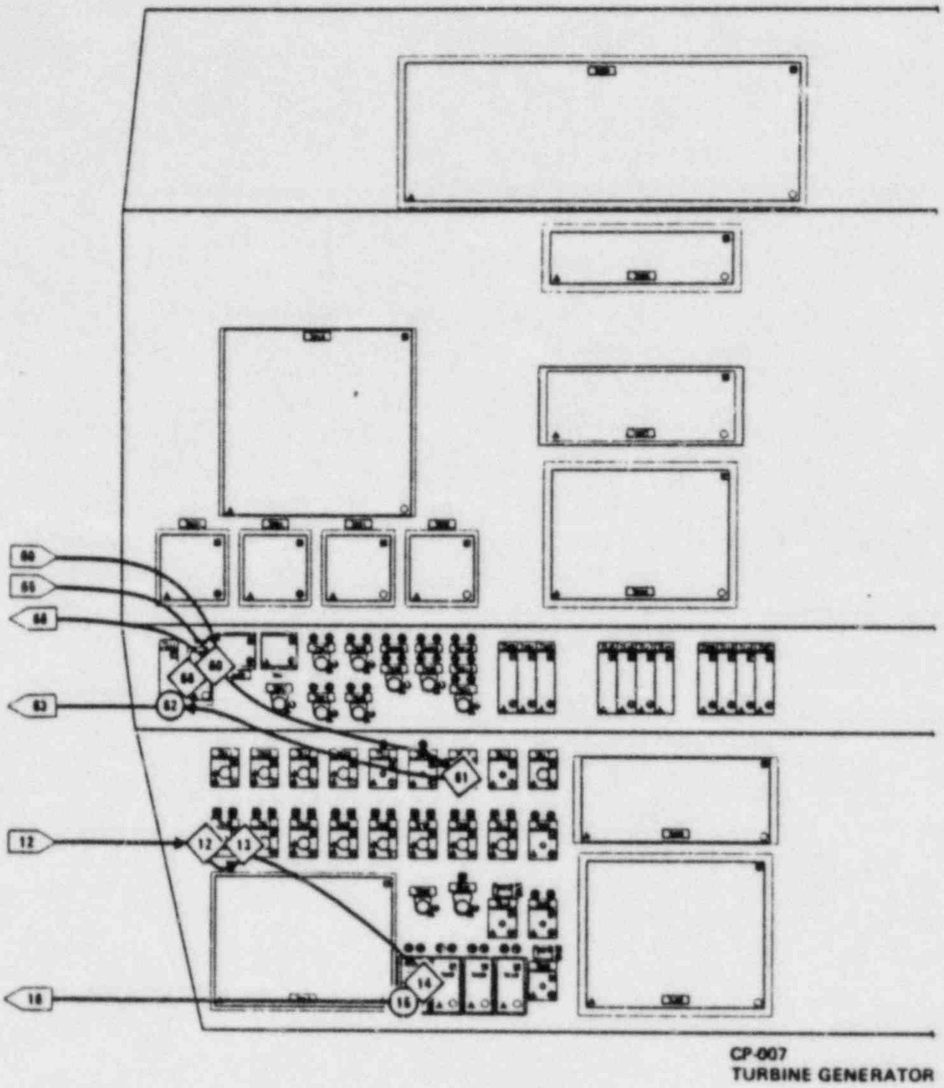


Figure 2-13. Operational Sequence Diagram

3.0 MANAGEMENT AND STAFFING

3.1 DETAILED CONTROL ROOM DESIGN REVIEW MANAGEMENT PROCEDURE

- o The management planning activity is described in Section 2.2.
- o The basic organization and functions are shown in Figure 2-2.
- o The Management Review Team will meet throughout the program as required to perform its basic functions. Meetings will be called by the Principal Investigator, and directed by Boston Edison Company. In addition, it may be necessary to hold special meetings to meet scheduled requirements.
- o The DCRDR consultant will be available for these meetings as needed to facilitate completion of meeting agenda items.
- o Minutes of all meetings will be taken and recorded.

3.2 INTEGRATION OF DCRDR WITH OTHER HUMAN FACTORS PROJECTS

The overall relationship of NUREG-0660 task action items are shown in Figure 1-1. The human factors aspect of the basic activities shown in Figure 1-1 will be reviewed by the Management Review Team working with the Boston Edison Company licensing group.

3.3 DCRDR TEAM STRUCTURE AND PERSONNEL

The basic DCRDR team structure and personnel are defined in Figure 2-2 and Tables 2-1 and 2-2. Resumes of assigned personnel are included in Appendix A and are consistent with the review criteria of NUREG-0801.

4.0 DCRDR ASSESSMENT AND IMPLEMENTATION

4.1 OBJECTIVE

The objective of the Assessment and Implementation Task (AIT) will be to evaluate the HEOs resulting from the program, assign categories, recommend appropriate corrective actions and methods for verifying and validating corrective actions, and document the process.

4.2 TASKS

The following Tasks will be done by members of the Assessment Team:

- o Develop background information for this task from a review of the pertinent NRC documentation, NUREG-0737 Supplement 1, NUREG-0700 and NUREG-0801, this Program Plan, all summary reports issued by the Design Review Team and all the HEOs submitted to the AIT group for review. Other references such as EPRI NP-2411, Human Engineering Guide for Enhancing Nuclear Control Rooms will be reviewed. In addition, the following information is required during the assessment meetings:

  1. Technical Specification Safety Limits
  2. Operating Limits
  3. Limiting Conditions for Operations
  4. LERs.

- o Prepare criteria for this task.

- o Compile all HEOs (computer printouts) by subject and by category in descending order, e.g., all work space and environment with Category A, B, C and D, etc.

- o Review the HEO writeups, evaluate and categorize the HEOs, and choose the implementation recommendation.

- o Determine the methodology for the verification and validation of the significant HEOs, using the verification and validation procedure.

- o Process the HEO/HEDs and documentation associated with this task. Team members will initial and date the HED.

- o Review, comment and sign-off of each HEO/HED by the Management Review Team.

4.3 CRITERIA FOR CLASSIFYING HEOs

The DCRDR process encourages the reporting of all observations, recognizing that the AIT team will be staffed with personnel qualified to assess the significance of each observation. Assessment will be based on an analysis of the impact of each observation on operating crew performance (workload) and overall plant safety and reliability. Those observations that are judged to have a high potential impact on plant safety and reliability will be categorized as HEDs per the classification rated below and the non-significant observations will be classified as HEOs.

The four categories used in the categorization process are defined below:

1. **Category A** - HEOs Associated with Documented or Potential Errors.

   Category A includes HEOs which are known to have previously caused or contributed to an operating error as documented in a Licensee Event Report (LER) or other historical record, or as established by the interview (or questionnaire) responses of operations personnel, or which have the potential to cause an error of high safety consequence.

2. **Category B** - HEOs Associated with Safety Condiderations.

   Category B includes those HEOs determined by documentation or by potential to be of low safety consequence or to cause an unsafe condition.

3. **Category C** - HEOs Associated with Availability or Reliability Considerations.

   Category C includes HEOs which have been assessed and determined to have minimal potential for causing or contributing to a human error but impact electrical generating capabilities.

4. **Category D** - HEOs that are Minor or Non-Significant.

   Category D includes any observation that has been evaluated and determined neither to increase the potential for causing or contributing to a human error nor to have adverse safety consequences.

4.4 METHODOLOGY

The following describes the general approach for performing the tasks listed in Section 4.2.

4.4.1 Meetings

The AIT team leader will schedule meetings consistent with the overall DCRDR schedule. Figure 4-1 shows the HEO report format. The left half will be completed by the Design Review Task Teams with an initial HEO category to facilitate the assessment process. It is recognized that the initial categorization will be made without an analysis and is provided strictly to assist the AIT team.

Each HEO will be reviewed and evaluated. The team leader will be responsible for recording the results of the review and evaluation on the right side of the HEO.

Any member may include a dissenting opinion as an attachment to an HEO.

4.4.2 HEO/HED Categorization

Figures 4-2 through 4-6 graphically show this process. The following describes this process:

1. The team will review the entire HEO as presented followed by an open discussion to assure complete understanding of the observation. The Human Factors Specialist will be available to answer questions during this phase of the assessment. In this process, the team may request clarification of the wording of the HEO description. This will be covered in the comment section with reference to an attached rewording.

2. The team will then determine which of the four categories (A through D) to assign the HEO under review. The process to be used is shown typically in Figure 4-3.

Figure 4-3 includes a branch where HEOs may be reconsidered due to the cumulative or interactive effects of multiple HEOs. Otherwise, HEOs could be discounted as non-significant and dropped out of the assessment and improvement process. Effects of combined Category HEOs will be considered during the selection of a correction method. Category D HEOs are optional and may be corrected at Boston Edison's prerogative and will not be ignored.

3. The next step is to log the HEO/HED. Those observations that are categorized A through C will be assigned an HED number to be logged on a master log sheet (see Figure 4-4). All HEDs in Category A will be numbered consecutively, i.e., A001, A002, etc., to facilitate collation of data and final DCRDR reporting. All observations classified as HEDs by both the AIT Team and the Management Team must be included in the improvement process.

   HED numbers will be assigned based upon an alpha-numeric code, with the first digit being keyed to the NUREG-0700, Section 6 topic; i.e., Workspace = 1, Communications = 2, Annunciator = 3, etc. The next letter designates the category (A through D) and the last three digits are assigned in sequence within each of the four categories.

4.4.3 Corrective Actions

The team will then review the suggested corrective action noted in each HED. Again, the Human Factors Specialist will be available to clarify, if necessary. The team will then select a correction method. See Figures 4-5 and 4-6.

1. Selection of Correction Method

Four possible correction methods are available to the review team: enhancement, design changes, design improvement studies, and procedure changes. Each HED will first be screened for further action as follows:

a. Enhancement
b. Design Change
c. Design Improvement Study
d. Operating Procedure Change
e. Administrative Procedure Change.

To select enhancement when a design change is more appropriate will not be critical. Should either enhancement, design change or improvement study, or a combination of methods prove inadequate or inappropriate, procedure changes may be chosen for correcting or mitigating HEDs.

During the selection of a correction method, the review team will consider all correction methods. Where several methods are proposed, the reasons for selecting a particular method will be documented. This documentation will be attached to the basic HEO/HED form.

While a particular correction method for an individual HED may appear appropriate, an alternative correction method may be more appropriate when the HEDs are grouped. After all HEDs have been analyzed for correction, the review team will re-evaluate all similar HEDs selected for a particular correction method, to ensure that the method chosen is appropriate.

HED correction by enhancement, design change, design study, or procedure changes is described below. In each case, analysis will be weighted towards using the judgement of the review team members in developing recommendations. Any special analyses employed in the development of recommendations will be documented as identified by an attachment. It should be noted that Boston Edison Company training department reviews all plant changes per requirements of 10CFR50.

The following approaches will be considered:

- Enhancement Corrections

  Development of enhancements will proceed soon after completion of the selection process, since an enhancement typically provides a significant improvement quickly at low cost. In some cases, the enhancement may be implemented as an interim solution while a long-term design solution is being developed. In this way, the dilemma of providing a near-term solution as well as an integrated control room design in the long-term will be resolved. Figure 4-6 gives some examples of types of enhancements.

- Design Corrections

  Design corrections are those corrections developed through planned design efforts. The AIT's responsibilities will be to produce preliminary conceptual design recommendations. The specificity of a recommendation will vary with the type and extent of the HED. A recommendation will specify:

  - Problem Statement
  - Scope of Work
  - Design Objectives.

Recommendations will be based on preliminary design analyses performed by the AIT. Analyses may include alternate solution identification, comparison and selection for the case of a simple, isolated HED. Preliminary analysis will provide a preliminary conceptual design requiring further design analyses and engineering.

o Design Improvement Studies

The correct resolution to some HEDs may require correlation with other HEDs to assure an integrated correction. (For instance labeling color, type size, wording, location, etc.) In these instances, a design improvement is the corrective method to assure that all parameters are included in the solution, and the AIT will recommend that a study be done.

o Procedure Correction

Changes to existing procedures will be considered as a possible means of correcting an HED. Indeed, the source of the HED may be found in the way the procedure was originally written. Correction of an HED by enhancement or redesign of the panels to conform to a procedure could introduce other potential errors.

Procedure revisions may also be very effective for correcting HEDs where the procedure is not the root cause of the HED. Design limitations may dictate using less than optimal type of control (or placement of a control) to accomplish a particular function, resulting in an HED. Procedures may then be used to compensate for the control's deficiency.

The types of procedure changes chosen to correct or mitigate the effects of an HED may include, but are not limited to:

1. A change in procedure format
2. Improved quality of reproduction
3. Larger or more legible type
4. Inclusion of cautionary statements
5. Re-ordering operator tasks.

The AIT team will recommend changes to procedures. The actual changes will be made in accordance with Boston Edison Company Procedures.

2. **Management Team Review and Sign-Off**

After each HEO/HED has been reviewed by the AIT with recommendations/revisions and the appropriate priorities and HED numbers assigned, the management review team will review each HEO/HED. This review will provide management input into the DCRDR and assure overall coordination of the various segments of the corrective actions suggested by the AIT.

Management Review Team members may request clarification, change priorities, categories or implementation schedules. It is recommended that the Principal Investigator be present for this review.

Any revision to the HEO/HED category will require a new HED number, and will be recorded by the "REV:" entry on the HEO assessment format, with a "1" and the date, indicating that a first revision has been made, etc., and that a new HED number has been assigned. For record purposes, the original HEO/HED will have the new number recorded under the Management Review section, as "See new HED #_______." The original HEO/HED will then be attached to the revised HED, and the "Support Material Attached" box on the revised HED.

When the team has finished all discussion/revision of the HED, the chairman will sign and date the form. Implementation of the corrective actions agreed upon then takes place through normal plant change routines.

3. **Results**

The results of the HEO Assessment and HED Improvement process will be recommendations for changes to the control room design or to the operating procedures intended to reduce the potential for operator error. HEDs recommended for study will be closed out when the implementation study results are complete.

There will be two types of design recommendations. One type will be detailed enhancement correction recommendations for surface treatments requiring limited financial and time resources. The second type will be design correction recommendations for the implementation of a systems engineering design project to develop detailed design corrections; i.e., corrections requiring more significant financial and time resources.

Further studies may result in significant evaluation, analysis, and firm designs to resolve the deficiency prior to implementation.

Where the design approach would be inappropriate for correcting a given HED, recommendations for changes to procedures may be made. These recommendations may include substantive changes in the procedures and/or simple modifications to the format.

Recommendations for improvement will be supported by documents produced throughout the assessment process. This information may be useful in prioritizing implementation of recommendations or to justify a decision not to implement the recommendations.

4.4.4 Verification and Validation

The approach used to verify and validate the design corrections will be that described in the verification and validation procedure.

4.4.5 Documentation

Documentation of the assessment and improvement process will be consistent with procedures and will include records of HED/HEO assessment. The records will be necessary for historical purposes and will be required for subsequent steps in the process; particularly correction method selection.

Correction analysis will be documented in the form of design recommendations, design improvement studies or procedure changes. The recommendations will be supported by engineering drawings, photos, conceptual sketches, calculations, or other suitable materials, as necessary.

Special emphasis will be placed on documenting justifications not to correct a significant HED and to record dissenting opinions, including the Human Factors Specialist.

HUMAN ENGINEERING OBSERVATION ASSESSMENT

OBSERVATION

PLANT: Pilgrim NPS | R. Sabeh EVALUATOR | HED#: 1B001

TASK: Control Room Survey | ________ | HEO#: 6.1.001

CL: 6.1 CL ITEM: 6.1.1.1b DATE: 2-10-84 REV:

CL TITLE: Control Room Workspace HED CATEGORY: B

BOARD TITLE: Cntmt Vent. BOARD#: C7, 915 & 917

HEO DESCRIPTION

GUIDELINE- ACCESSIBILITY OF INSTRUMENT/EQUIPMENT
Instrumentation requiring continuous monitoring by operators during emergency operations: Panel C7: Drywell temperatures, #1358, 1361 Containment purge and vent control, #1412,1413, 1447,1448,1449,1450,1451,1452,1453,1454,1455,1453, 1472,1473 Torus temperature, #1427,1428
Panels 915,917: Scram solenoid lights
Overhead monitor - cannot be conveniently viewed by the panel 905 operator. This observation is supported by OER-001 and OER-002

[ ] SUPPORT MATERIAL ATTACHED

POTENTIAL OPERATOR ERROR(S)

Excessive operator movement results in a delay to respond to an emergency.

RECOMMENDED REVISION

Relocate the instruments and controls to the front panels.
Adjust overhead monitor for convenient operator viewing.

RECOMMENDED IMPLEMENTATION

[ ] PRIOR TO OR AT NEXT REFUELING
[ ] AT CONVENIENT OUTAGE
[ ] AT EARLIEST OPPORTUNITY
[ ] NON-MANDATORY

TECHNICAL REVIEW

CHAIRMAN ________ DATE ________

[ ] Concur.

[ ] Concur With Comment/Note.

[ ] Reevaluate & Resubmit for Following Reason:

Comment/Note/Reason: ________

MANAGEMENT REVIEW

CHAIRMAN ________ DATE ________

[ ] Concur.

[ ] Concur With Comment/Note.

[ ] Reevaluate & Resubmit for Following Reason:

Comment/Note/Reason: ________

Figure 4-1. Sample HEO Assessment Form

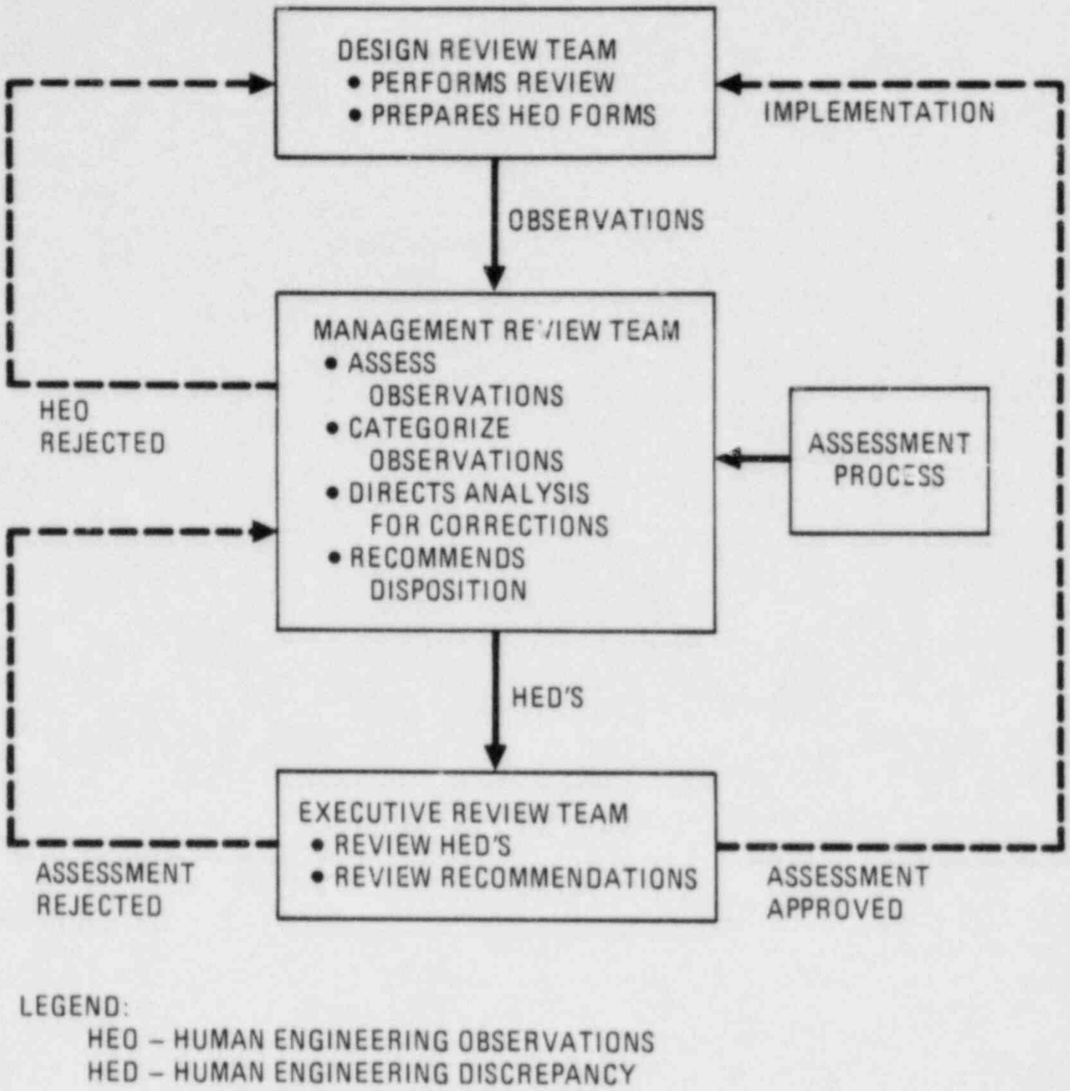
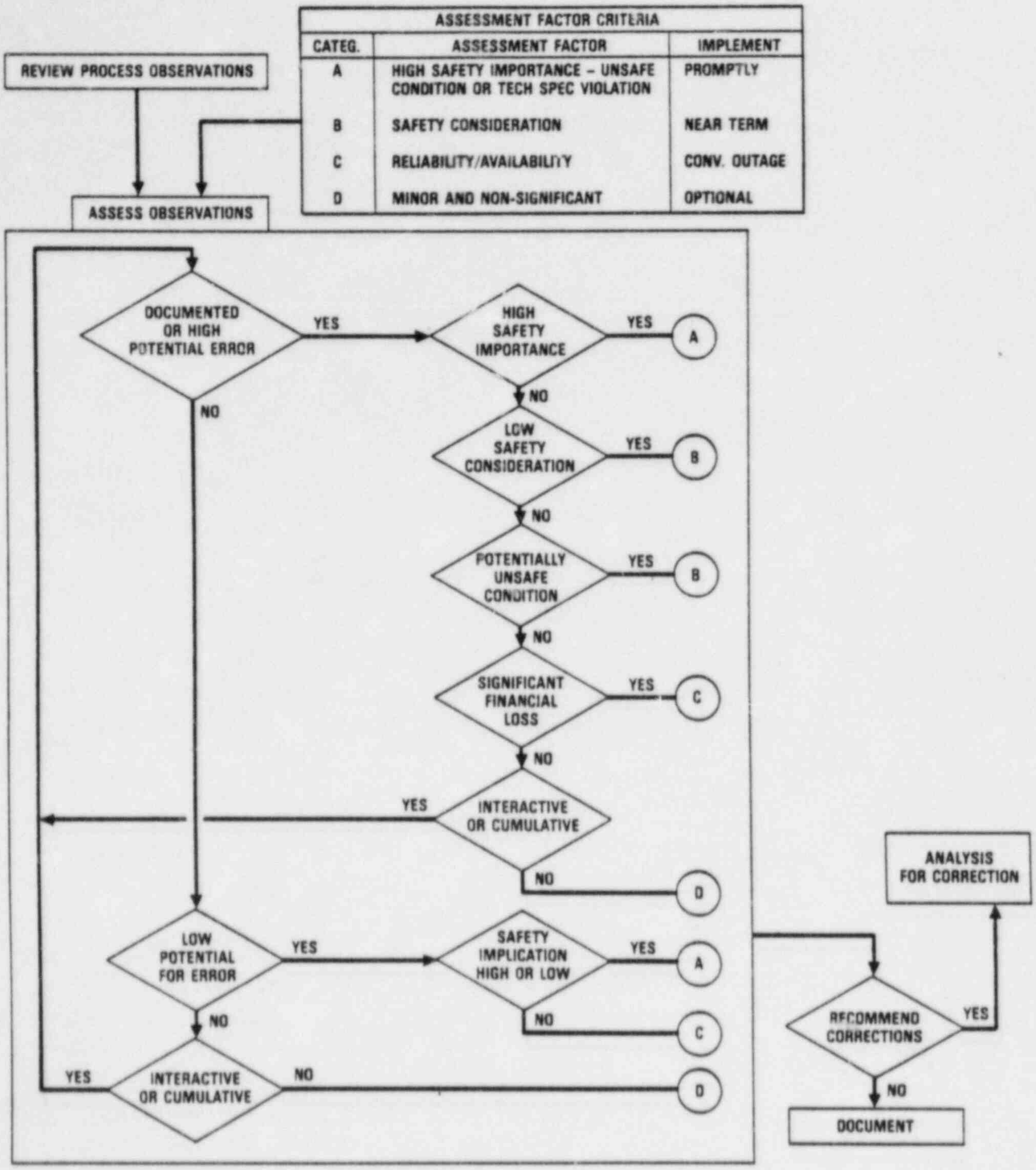


Figure 4-2. Assessment and Implementation Methodology



ASSESSMENT FACTOR CRITERIA		
CATEG.	ASSESSMENT FACTOR	IMPLEMENT
A	HIGH SAFETY IMPORTANCE – UNSAFE CONDITION OR TECH SPEC VIOLATION	PROMPTLY
B	SAFETY CONSIDERATION	NEAR TERM
C	RELIABILITY/AVAILABILITY	CONV. OUTAGE
D	MINOR AND NON-SIGNIFICANT	OPTIONAL

Figure 4-3. HEO Processing

DCRDR HEO DISPOSITION LOG

HEO	CL ITEMS	BOARD NO.	CATEGORY NO.	COMMENTS

ASSESSMENT TEAM LEADER____________________________ DATE___________ Pg ___ of ___

Figure 4-4. Sample Master Log Sheet

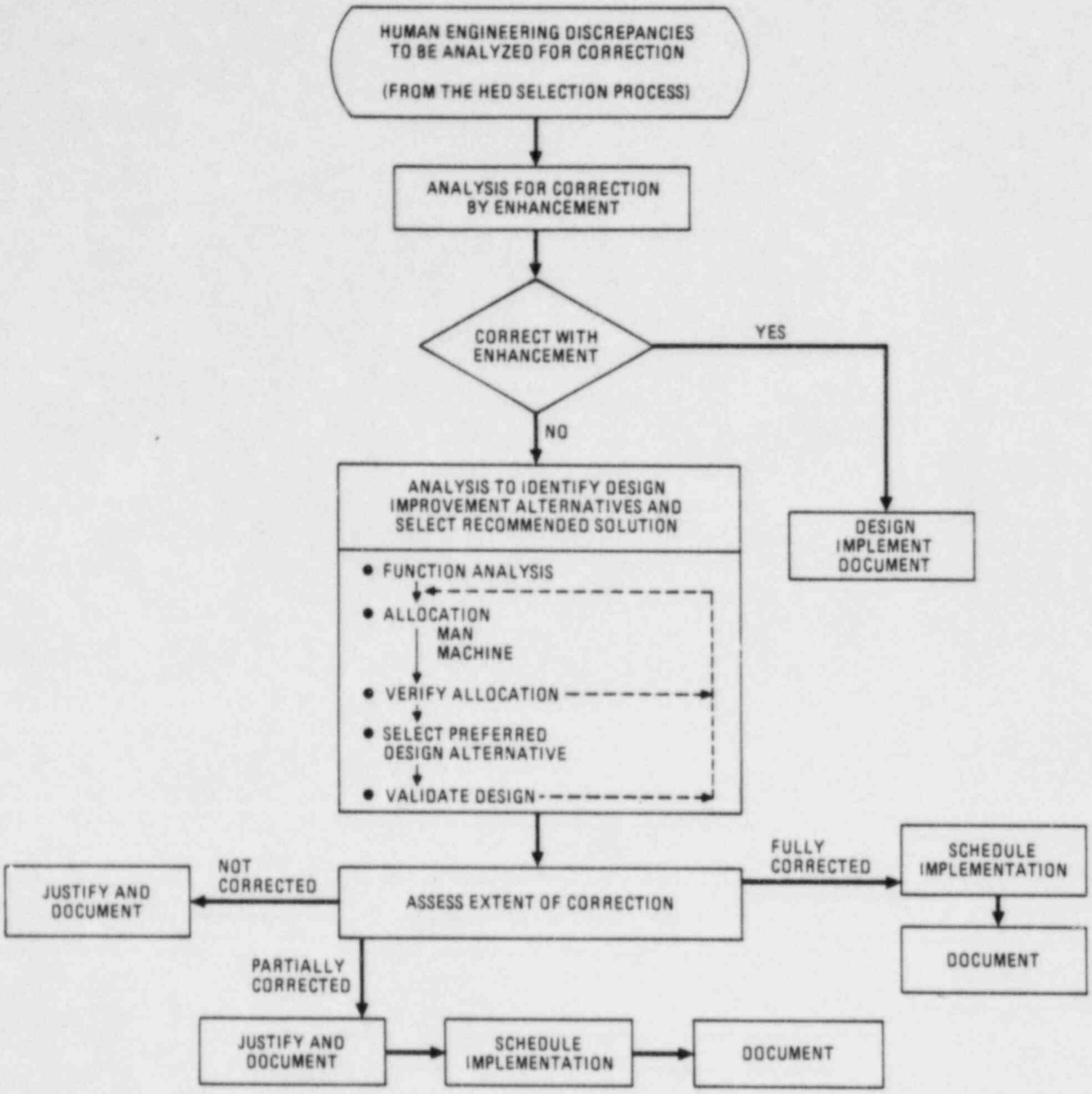


Figure 4-5. Selection of Design Improvements

ENHANCEMENT:

DEFINITION -CONTROL ROOM IMPROVEMENT BY SURFACE TREATMENT TECHNIQUES.

ACTION WORDS - ADD, REMOVE, REPLACE, RE-LOCATE, MODIFY, ADJUST, ORGANIZE.

EXAMPLES:

- LABELS:
  - CONTROLS
  - DISPLAYS
  - SYSTEMS
  - FUNCTIONS
  - ANNUNCIATOR TITLES
- DEMARCATION & MIMICS:
  - LINES
  - SYMBOLS
  - ZONES
  - CODING (COLOR, SHAPE, ETC)
- ENVIRONMENT:
  - FURNISHINGS
  - ROOM COLOR(S)
  - CABINET COLOR(S)
  - TEMPERATURE
  - VENTILATION
  - LIGHTING
  - NOISE LEVEL
  - TRAFFIC PATTERN(S)
  - FURNITURE LOCATION
- DISPLAYS:
  - RECORDER PAPER & SCALE
  - INDICATOR SCALES
- PROCEDURES VOLUMES:
  - ORGANIZATION
  - LABELING
  - COLOR CODING
- HARDWARE:
  - HANDLES
  - KNOBS
  - METER FACES

Figure 4-6.
Sample Enhancement Suitability Checklist

5.0 DOCUMENTATION AND DOCUMENT CONTROL

5.1 DOCUMENTATION USED TO SUPPORT THE DCRDR

- Boston Edison Company has established a library to assist the Design Review Team. The documents contained therein are the latest plant construction documents consistent with Section 2.4.1 of NUREG-0700.

- The consultant has also established a reference library of pertinent human factors documents including many of those listed in NUREG-0700, as well as relevant documents generated in other DCRDRs and relevant EPRI and INPO documents.

5.2 DOCUMENTATION GENERATED BY THE DCRDR PROCESS

The following basic documents will be submitted to the NRC for approval in this review:

- Program Plan Report (this document).

- Executive Summary Report, which will address methodology, review findings, and implementation.

The following documents will be generated in support of the review.

- Criteria Report
- OER Report
- SFTA Report
- CRS Report
- Inventory Report
- Compilation of Observations & HEDs

The following format is proposed for the Executive Summary Report:

DETAILED CONTROL ROOM DESIGN REVIEW
PILGRIM STATION

1.0 INTRODUCTION

1.1 General Comments

1.2 DCRDR Purpose and Objectives

1.3 Plant Description

1.4 Definition of Control Room

2.0 DCRDR PLANNING, METHODOLOGY

2.1 Planning

- Summarize from Program Plan.

- Include Management, Staffing & Documentation

2.2 Methodology

2.2.1 General

- As required---

2.2.2 Criteria Development

- Summary info mainly from Criteria Report.

- Describe NUREG-0700, BWROG & INPO guidelines review.

2.2.3 Data Base Management System

- Describe use, specific data bases & interactions.

- Some info from Program Plan.

2.2.4 Operating Experience Review

- Summarize info from Operating Experience Review Report

-Describe interactions with other DCRDR tasks.

2.2.5 Control Room Survey

- Summarize from Control Room Survey Report

- Use of mock-up.

2.2.6 Control Room Inventory

- Summarize info from Inventory Report.

- Use of mock-up.

- Describe data base record definition.

2.2.7 System Function & Task Analysis

- Identify plant-specific, symptom-oriented EOPs per basic EPG safety functions:
  - Reactivity control
  - Core heat removal
  - Containment integrity
  - Fission Product control

- Identify plant systems (per FSAR) covered by EOPs.

- Describe SOE selection criteria & SOEs selected (iterative process wtih EOPs).

- Identify plant systems (per FSAR) covered by SOEs.

- Describe SOE data collection & data base use & record definition.

- Describe SOE selection criteria & SOEs selected (iterative process with EOPs).

- Identify plant systems (per FSAR) covered by SOEs.

- Describe SOE data collection & data base use & record definition.

- Describe data sheets & diagrams (SFTA output) used for analysis, Verification & Validation:
  - Data sheets 1 thru 5.
  - Traffic link diagrams.
  - Operational sequence diagrams.

- Some info from Program Plan.

- Use of mock-up.

2.2.8 Verification

- Some info from Program Plan.

- Describe interaction of:
    - Control room survey checklists
    - SFTA data sheets & diagrams.
    - Criteria matrix.

- Use of control room inventory.

- Describe interaction with Validation on task basis.

2.2.9 Validation

- Some info from Program Plan.

- Describe method:
    - Walk/talk-through used.
    - Task bases using SFTA data sheets.
    - SOEs & selected tasks evaluated.
    - Limited to primary operating area (mockup).
    - Recorded on Video.

- Describe operators involved.

2.2.10 Assessment

- Summarize info from Program Plan.

- Use of moc'up.

3.0 DCRDR RESULTS

3.1 Human Engineering Observation Summary

- Describe HEOs by task, checklist, assessment action & category.

- Show cross-reference to BWROG HEOs.

- Identify separate DCRDR task reports.

3.2 Human Engineering Discrepancy Summary

- Describe HEDs by HEO category.

- Describe significant HEDs.

4.0 DCRDR CONCLUSIONS

4.1 HED Corrective Actions & Schedule

- Describe corrective actions to be taken & schedule.
- Describe studies to be conducted to determine corrective action & schedule.

4.2 Remaining Work

- Describe task data base status.
- Describe remaining work for:
  - All DCRDR tasks.
  - Integration plan covering NUREG-0737, Supplement 1.

4.3 Methodology of procedure for future changes

5.3 DOCUMENTATION SYSTEM AND CONTROL

The Design Review Team will develop a data base which will be reviewed by the Management Review Team. This data base will consist of computerized printouts and hard copy files of cross-referenced information including:

- o Listings of reference plant documents used.
- o Listing of human factors referenced documents used.
- o The program plan report (this document).
- o Pertinent documents defining requirements for the DCRDR.
- o The control room criteria report.
- o The outputs of the individual task groups (see Figure 2-3).
- o Minutes of meetings.
- o All findings, HEDs, and dispositions as processed.
- o Executive Summary Report.
- o Topical DCRDR Reports.
- o Pertinent correspondence.

6.0 SUMMARY

The Boston Edison Company considers that this program plan for the control room design review of the Pilgrim Station is extensive, complete and consistent with the pertinent document noted herein.

The program is in progress and it is our intention to comply with the content of this Program Plan. The Boston Edison Company reserves the right to make changes in its best interest and will notify the NRC of all planned or executed deviations.

APPENDIX A

Qualification of Management Review Team and

Design Review Team Members

WILLIAM R. ARNOLD
STAFF ENGINEER
TORREY PINES TECHNOLOGY
MEMBER DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

Reactor protection and instrumentation systems: design and analysis, operation, startup, trouble shooting, and equipment qualification.

EDUCATION

BSEE, University of Texas, 1958.
Graduate Courses, Electrical and Nuclear Engineering.

EXPERIENCE

Work on the control room design review for the South Texas Project Nuclear Generating Station. Participated in all phases of the review including control room survey, system function and task analysis, and annunciator review. Also, participated in subsequent redesign of control panel layouts for this project.

Review of qualification data for safety-related equipment for PWR projects. Responsible for assuring that the data packages met the general requirements of NUREG-0588 and the specific requirements referenced and that the equipment represented is satisfactory for use in a harsh environment.

Review of safety-related plant control and protection system logic and operation to confirm that components important to safety are properly classified for PWR projects at Bechtel.

Field investigation and solution of reactor protection system trips and transients during startup of Fort St. Vrain station. Liaison on operational and licensing aspects with utility operations and with NRC.

Field engineer in successful construction and startup of all internal and adjacent external reactor instruments, pressure test and hot flow test support, and control rod drive checkout for Fort St. Vrain station.

Completed design and documentation for licensing of reactor plant protection systems. Accomplishments included logic design, cabling, customer liaison and review of specifications and layout for compliance with applicable NRC design criteria.

Electrical design of aerospace launch control hardware and systems.

PROFESSIONAL ASSOCIATIONS

Registered Control Systems Engineer, California, 1975.

WILLIAM J. ARMSTRONG
STAFF ASSISTANT - OPERATIONS
BOSTON EDISON COMPANY
MEMBER MANAGEMENT REVIEW TEAM

EDUCATION

Dorchester High School - 1948
Wentworth Institute - 1957-1958
Peterson School of Steam Engineering - Various time periods in preparation for Mass 1st Class Engineer's License.
Penn State Triga Facility - Two-week course - Completed 16-week Nuclear Power Preparatory Training Course - 5-week BWR.
Technology course, 12-week BWR Simulator course, and 3-month observation period, including 2 months at Millstone during power test program.

Mass License - 1st Class Fireman - 1957
Mass License - 3rd Class Fireman - 1957
Mass License - 2nd Class Engineer - 1961
Mass License - 1st Class Engineer - 1961
NRC SRO License - 1971-1976
Mass Nuclear Power Plant Senior Supervising Engineer - 1972-Present

WORK EXPERIENCE

6/1/83 - Present Boston Edison Company - Staff Assistant - Operations

As Staff Assistant - Operations, responsible for assisting Vice President-Nuclear Operations in developing and implementing policies governing station performance and keeping the Vice President cognizant of the status of plant operations. Also responsible for ensuring the necessary support for plant operations through coordinating communications between Nuclear Operations, Nuclear Engineering, and Quality Assurance, other Company organizations, contractors and vendors. Advising the Vice President-Nuclear Operations on all significant issues and representing him at meetings, conferences, etc., as necessary.

9/82 - 5/83 Boston Edison Company - Special Projects Manager, Pilgrim Nuclear Power Station

As Special Projects Manager, responsible for various problems that need to be corrected in order to improve the overall efficient operation of the plant. These include development and implementation of tasks such as:

(a) Salt Service Water and Condenser Sea Water Mussel Control Program

(b) Overall radwaste process refurbishment

(c) Removal off site of various amounts of radwaste sludge

(d) Development of an on-site Dry Waste Treatment Facility to reduce volume of low specific activity material

9/82 - 5/83 (cont'd)

(e) As a member of NEPEX Nuclear Dispatch Task Force have the responsibility of resolving ongoing problems that exist between the operating nuclear units and NEPEX present day procedures

6/81 - 9/82 Boston Edison Company - Deputy Manager, Pilgrim Nuclear Power Station

As Deputy Manager, responsible for the Technical, Radiological and Radwaste Operations Groups.

Continued involvement with boiling water reactor Owner's Group pertaining to Control Room issues. Also was a member of INPO Committee on control room review. These committees are involved with:

- Safety Parameter Display System (SPDS)
- Control Room review
- Emergency Operating Procedure guidelines
- Implementation of NRC document SECY 82-111B

9/80 - 6/81 As Deputy Manager, responsible for plant operation, maintenance, security and fire protection.

10/77 - 9/80 Boston Edison Company, Staff Assistant to the Manager of Nuclear Operations

As Staff Assistant, have been responsible for the following:

Member of Company Central Safety Committee

Nuclear Operations Department representative in the Company Blackout Study Committee

Developed the Planning & Scheduling of Refueling and Maintenance Outage No. 3

Directly involved in the Group establishing the Company's position regarding "Fire Protection Review A.P.C.S.B.9.5.1.

Member of the Bargaining Committee for the Company involving contract negotiations

Involved in all Nuclear Operations Department Union grievances as per Article XXXII 1 (b) of the Contract

Work directly with various members of the Nuclear Engineering Group in resolving various plant design and operational problems

Directly involved in coordinating efforts to update the plant to the changing requirements of the NRC regarding Fire Protection and Prevention per Branch Position 9.5.1.

Represent the Nuclear Operations Department or the Company's "Resource Conservation and Recovery" Task Force.

6/76 - 10/77 Boston Edison Company, Special Projects Coordinator

Staff Assistant to the Manager of Nuclear Operations, responsible for the following:

1. Design and implementation of various plant changes such as:

   A. Fuel pool cooling and residual heat removal system piping changes, to allow more flexibility in processing suppression chamber and reactor cavity water volume during refueling.

2. Design and installation of piping changes and the new "Cupco" Instrument Air Compressor.

3. Design of system changes and procedure revision necessary for unit cooldown after complete loss of screenhouse.

Assigned as an "Employee Discussion Group Leader" to discuss various questions involving the Company which were being voted on during the November elections.

Became involved in re-allocating available space in Unit #1 warehouse, to eliminate the need of establishing off-site storage facilities.

Actively involved in the planning and scheduling of Refueling & Maintenance Outage #3 which began August 3, 1977.

7/68 - 6/76 Boston Edison Company, Chief Operating Engineer, Pilgrim Station

The Chief Operating Engineer is responsible for fuel loading, startup and shutdown of the station and its equipment including:

1. System surveillance testing in accordance with requirements outlined in the Station Operations Manual.

2. Informing licensed operators and senior operators of facility design changes, facility license changes and station procedural changes which have an effect on the performance of their duties.

3. Maintenance of the special order book, for the implementation of special orders, for ensuring that all appropriate personnel are aware of the responsibilities assigned to them by the special orders, and for retiring special orders when they are no longer needed.

4. Maintenance of the control room files, training files for all individuals under his supervision.

In the event of any absence or unavailability of the Station Manager, the Chief Operating Engineer assumes responsibility for overall facility operation.

1/68 - 7/68 Boston Edison Company - Mystic Station - Watch Engineer

Responsible for the safe and efficient operation of the station.

1/65 - 1/68 Boston Edison Company - New Boston Station - Control Room Supervisor

Responsible for the initial startup and operation of two 400 MWe units.

7/61 - 12/64 Boston Edison Company - Mystic Station - Turbine Operator

Responsible under supervision for the operation of turbine generators and associated equipment.

1/61 - 7/61 Boston Edison Company - Various Stations - Fireman

Responsible for the operation, under supervision, of steam generators.

1/59 - 1/61 Boston Edison Company - Various stations - Auxiliary Tender

Basically this encompasses operation of auxiliary equipment in power stations.

JAMES W. ASHKAR
NUCLEAR ENGINEERING DEPUTY MANAGER
BOSTON EDISON COMPANY
MEMBER ADVISORY COMMITTEE

EDUCATION

Penn State - Master of Engineering, General Engineering
EPDA Fellowship for Engineering Education. (9/72 to 9/73)

University of Delaware-MBA Program (27 credits) no degree (9/69 to 12/71)

Penn State - B.S. Mechanical Engineering
Honors: Graduated with high distinction
Harding Loan Fund Award Recipient
Tau Beta Pi, member
Pi Tau Sigma, Chapter President

EXPERIENCE

Boston Edison Company

Assistant to Nuclear Engineering Manager (1/81 to present)
Responsible for planning and implementation of a Risk Management Program based on Probabilistic Risk Assessment, and implementation of a computer-based engineering work management system for all engineering activities.

Group Leader, Systems & Safety Analysis (8/79 to 1/81)
Managed a 10 member staff of engineers and analysts in performing nuclear power plant (BWR & PWR) system design assessment and specification. Methods included systems engineering, dynamic thermal/hydraulic analysis, reliability, FMEA, and sequence analysis. Administratively responsible for strategy planning, budgeting, staffing, and training.

Project Manager Fire Protection Modification (4/79 to 8/79)
Responsible for integrated planning (computer-based), budget preparation, licensing coordination. management reporting and direction of 5-member engineering team. Implemented major portions of a $5 million capital project.

Senior Systems Analysis Engineer (1/78 to 4/79)
Performed reliability and risk, cost/benefit and safety evaluations in specification and approval of nuclear power plant systems designs. Referenced engineering, economic and regulatory standards.

Systems Analysis Engineer (1/77 to 1/78)
Responsible for project engineering coordination, cost control, procedure development for state-of-the-art high density nuclear spent fuel storage racks. Also performed several discrete engineer system design reviews.

University of Nebraska, School of Engineering Technology, Omaha, NE.

Assistant Professor, Engineering Technology (9/73 to 12/76)
Developed and taught courses in Engineering Technology (mechanical systems, thermodynamics, servomechanisms, dynamics, and industrial engineering). Distinguished by the first annual Outstanding Teacher Award. Prepared 10-part videotaped maintenance training program for Northern Natural Gas Corp.

Gibbs-Hill, Incorporated, Omaha, NE.

Mechanical Engineer, Consultant (6/74 to 9/75)
Prepared systems descriptions and design calculations for coal-fired power plant design. Performed an alternate site evaluation for a nuclear power plant design. Performed an alternate site evaluation for a nuclear power plant project environmental report.

E.I. DuPont, Packaging Films Dept., Wilmington, DE.

Technical Representative Engineer (7/69 to 9/72)
Worked within a specialized marketing division to affect technical coordination between the manufacturing division and major clients.

Union Carbide, Plastics Division, Bound Brook, N.J.

Manufacturing Engineering (6/68 to 9/68, college summer)
Completed training projects at a manufacturing facility for vinyl resins.

PROFESSIONAL TRAINING/HONORS

Registered Professional Engineer, State of Massachusetts/State of Colorado
Technical Project Management Seminar, 7/81, AMR
Supervision of Engineering Professionals, 8/80, ANA
Probabilistic Risk Assessment Seminar, 2/80, JFB Assoc.
PWR Operator Simulator Training, 6/78, Combustion Engineering
Kempner Tregoe Decision Analysis Workshop, K-T, 4/78
Nuclear Safety Seminar, 8/78, MIT
Member, Boston Edison, Nuclear Safety Review & Audit Committee
Member, Atomic Industrial Forum, Probabilistic Risk Assessment Committee, 1980-81
Speaker, ASME JPC, "Utility Decision Analysis Perspective," 1981
Speaker, NRC Advisory Committee on Reatcor Safeguards Pilgrim-2 PRA/Design Verification Program, 1981
Member, ASME, 1968-81
Panelist, IEEE/ANS PRA Procedure Preparation Program, 1981

W. BABCOCK, JR.
SR. ELECTRONICS ENGINEER
BOSTON EDISON COMPANY
PRINCIPAL INVESTIGATOR OF
DESIGN REVIEW TEAM

EDUCATION

Bachelor of Science, Electrical Engineering, Brown University, 1968

Graduate Study, Industrial Engineering, Ohio University

PROFESSIONAL REGISTRATION

Control Systems Engineer,
State of California,
Certificate No. CS-3575

PROFESSIONAL EXPERIENCE

Boston Edison Company (1979 - Present)

Sr. Electronics Engineer, Control Systems Group, Nuclear Engineering Department

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

Recent Training in Human Factors Engineering:

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

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

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

EXPERIENCE (Continued)

Burns and Roe, Inc. (1977 - 1979)

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

Ebasco Services, Inc.

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

Cryogenic Technology, Inc.

Electrical Engineer, (1974)
Designed control systems and control panels for radioactive liquid and gas process systems. Designed, specified and tested control systems for large cryogenic gas liquefication systems.

Stone & Webster Engineering Corporation

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

Babcock & Wilcox Company

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

CARL STEPHEN BRENNION
SENIOR SYSTEMS ANALYSIS ENGINEER
BOSTON EDISON COMPANY
MEMBER OF DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

EDUCATION

B.S., Massachusetts Maritime Academy (Marine and Electrical Engineering), 1969
Peterson School of Steam Engineering, Boston, Mass., 1975.

EXPERIENCE

Boston Edison Company

Sr. Systems Analysis Engineer - Accountable for systems engineering and safety analysis of Pilgrim Station.

Sr. Instrument and Control Engineer - Accountable for providing engineering support to Pilgrim Station through design, analysis, and modification to pneumatic and electrical/electronic control systems.

Nuclear Operations Supervisor - Responsible for safe and efficient operations of Pilgrim Station on assigned shift in accordance with the requirements of station procedures and regulatory agencies.

Metcalf & Eddy, Inc.

Instrumentation and Control Systems Engineer involved with complete System Control for Municipal and Industrial water treatment, waste treatment and solid waste installations.

Responsibilities included the development of control concepts, piping and instrumentation diagrams, analog and digital logic diagrams, control panel arrangement and fabrication drawings, purchase requisitions and installation drawings, review of vendor shop drawings, plant system control write-ups, visits to plant sites for purpose of testing and checkouts, client to vendor contract negotiations, system controls and process simulation using programmable logic controllers.

Chas. T. Main, Inc.

Responsibilities included preparation and upkeep of computerized instrument and alarm lists, logic diagrams for plant systems, instrumenting piping and flow diagrams, installation drawings for panels and instrumentation, preparation of vendor bid summaries, letters of recommendation, supplements to purchase orders, review of all in-house and vendor equipment drawings for correct instrumentation, control functions and locations, and participation with mechanical and electrical groups in developing control concepts for Fossil Fuel and Pulp and Paper Power Plant Systems.

Stone & Webster Engineering Corp.

Assigned as Control Logic Engineer in the Control Systems Division preparing systems descriptions, logic diagrams and control check-off lists for Nuclear Power clients.

Responsibility included the functional display of control requirements for equipment and systems, step-by-step description of the logic diagram, control and monitoring device summary, and special operating precautions and notes.

Reynolds Metals Company

Third Assistant and Second Assistant Engineer responsible for operation of Turbo-Electric Propulsion as watch-standing Engineer.

Responsibilities included maintenance and upkeep of engine rooms and ship machinery, care and purification of lubricating oils systems, upkeep of turbine-driven generators, chemical analysis and treatment of high-pressure boilers, care of furnace side of boilers, internal and external fittings and supervision of lower classification personnel.

Grace Steamship Lines
Moore-McCormack Lines

Assigned as Third Assistant Engineer with responsibility for operation of turbine gear propulsion plant.

PROFESSIONAL ASSOCIATIONS

Instrument Society of America - Senior Member

SIBEN DASGUPTA
CONTROL SYSTEMS GROUP LEADER
BOSTON EDISON COMPANY
MEMBER OF MANAGEMENT REVIEW TEAM

EDUCATION

Northeastern University, Massachusetts, USA
"Electrical Engineer" Degree with Power Systems as major - 1979.

Northeastern University, Massachusetts, USA
M.S. in Engineering Management with Operations Research as a major - 1973.

Calcutta University, Bengal Engineering College, West Bengal, India; Master of Engineering in Electrical Engineering with Power Systems as a major - 1969.

Calcutta University, Bengal Engineering College, West Bengal, India; Bachelor of Engineering in Electrical Engineering with Power Systems as a major - 1967.

Registered Professional Engineer (Massachusetts).

TRAINING

Combustion Engineering Nuclear Power Plant Simulator - Training course in Nuclear Power Plant Operation.
Qualification of Safety-Related Equipment for Nuclear Power.
Generating Stations - Arranged jointly by Drexel University and IEEE.
Kepner-Tregoe Management Training Course.

PROFESSIONAL EXPERIENCE

Dec. 1981 to Present	Control Systems Group Leader Boston Edison Company, Nuclear Engineering Department
Oct. 1978 to Nov. 1981	Boston Edison Company, Boston, Massachusetts Senior Electrical Engineer, Nuclear Engineering Department
Oct. 1975 to Sept. 1978	Instrumentation and Control Engineer, Boston Edison Company, Nuclear Engineering Department
March 1973 to Sept. 1975	Stone and Webster Engineering Corp., Boston, Mass. Engineer, Control Systems Group, Advisory Operations Group.
Nov. 1970 to Feb. 1973	Bell & Howell Communications Company, Waltham, Mass. Engineer, Production Engineering Department

TEACHING AND RESEARCH EXPERIENCE

Sept. 1977 to present	Northeastern University, Boston, Mass. Lecturer, Graduate School of Engineering Assigned as a part-time lecturer in the Graduate School of Engineering
Oct. 1969 to Sept. 1970	Bengal Engineering College, Calcutta University Department of Electrical Engineering - West Bengal, India Senior Research Fellow under the Council of Scientific and Industrial Research, Govt. of India. Performed Post-Graduate Research work on "Transient Analysis of Three-Phase Induction Motors" and was assigned for light teaching load for undergraduate classes in electrical engineering.

PROFESSIONAL ASSOCIATIONS/HONORS

Member of Institute of Electrical and Electronics Engineers, USA.
Chairman, IEEE Educational Committee, Boston Chapter.
Member of the Working Group of IEEE Nuclear Power Engineering Committee, Section 4.7, Auxiliary Power Systems.

PUBLICATIONS

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

"Degraded or Loss of Voltage Protection of Class 1E Auxiliary Power Systems in a Nuclear Power Plant"; S. Dasgupta, J. J. Murphy; presented at the IEEE Nuclear Science Symposium, Oct. 1978. Published in the IEEE Nuclear Science Transactions, Feb., 1979.

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

ERROL P. GAGNON
STAFF LICENSING ENGINEER
TORREY PINES TECHNOLOGY
MEMBER OF DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

Nuclear Systems Engineering. Licensing, safety criteria and technical specification preparation and review.

EDUCATION

B.S., Engineering, San Diego State University, 1965

PROFESSIONAL EXPERIENCE AT GA TECHNOLOGIES INC. (Since 1969)

Assistant Project Engineer for the control room design review for the South Texas Project under contract to Bechtel Power Corp.

Chairman of the Results Review Committee of the Human Factors Evaluation program for the Palo Verde Nuclear Power Generating Station control room and responsible for coordination of the program tasks.

Developed safety/licensing positions and criteria for various applications of nuclear power plants.

Evaluated nuclear power plant systems and components to identify and prioritize technical, safety and licensing issues.

Developed nuclear power plant transient performance specifications.

Senior Technical Representative at Fort St. Vrain responsible for technical coordination and guidance on the conduct and evaluation of the startup test program.

Manager of the French Licensee Program responsible for the administrative and technical-transfer aspects of the nuclear power plant licensing agreements and contracts.

Performed simulation studies and evaluations of nuclear power plant transient performance/safety analyses, control systems, control room configurations and plant startup procedures.

OTHER PROFESSIONAL EXPERIENCE

General Dynamics Corporation (1965-1969). Performed dynamic analyses of missile control systems.

PROFESSIONAL ASSOCIATIONS/HONORS

Member, American Nuclear Society

ROBERT E. GRAZIO
GROUP LEADER SYSTEM AND SAFETY ANALYSIS
BOSTON EDISON COMPANY
MEMBER MANAGEMENT REVIEW TEAM

EDUCATION

Babson College, Wellesley, Mass.

MBA Program; 45/60 semester hours completed

Central New England College of Technology, Worcester, Mass.

B.S. Mechanical Engineering Technology
Graduated Summa Cum Laude

PROFESSIONAL EXPERIENCE

Boston Edison Company, Nuclear Engineering Department (June 1983 - Present)

Systems and Safety Analysis Group Leader
Responsible for directing the efforts of up to ten senior engineers/engineers in the performance of group functions in support of plant operations, major projects and regulatory activities. Responsible for technical completeness and correctness of all group outputs involving intersystems relationships, compliance with codes and standards and ability to perform intended functions, and impact evaluation of pending and new regulatory activities. Responsible for group administration such as formulation and adherance to capital and expense budgets and providing recommendations in all areas of personnel administration.

Boston Edison Company, Outage Management Group (Nov. 1982 - June 1983)

Senior Project Engineer
Responsible for the coordination of all Engineering inputs to the conduct of outages and assisting in the integration of these inputs with those of other departments. This responsiblity was performed in conjunction with the group charter of maintaining overall responsibility and accountability for the conduct of outages. Also responsible for the coordination of multiple department inputs to an organizational strategic plan as a supplementary assignment.

Boston Edison Company, Nuclear Engineering Department (March 1980 - Nov. 1982)

Senior System Analysis Engineer
Appointed to functional position of Project Engineer for a $14M multi-discipline project June 1981. Responsibilities included coordination of inputs of various engineering disciplines into an integrated package to meet technical licensing, schedule, and budget requirements.

Responsibilities as Senior Engineer in the System and Safety Analysis Group as outlined above. Special assignments included feasibility studies, conceptual designs, and operator training. Interfaced with a wide variety of organizations, including regulatory agencies, industry groups, vendors, consultants, and various in-house organizations.

Stone & Webster Engineering Corporation (July 1977 - March 1980)

Engineer
Maintained overall responsibility for several engineering retrofit tasks to solve operational problems of an operating power plant. Scope of responsibilities included coordination of the efforts of the required engineering aspects of the tasks and participation in equipment procurement including preparation of specifications, bid cycle activities, and recommendations. Task duration typically from problem identification and conceptual solutions to completion of system startup. Interfaced with client home office and site engineering, client operations, maintenance and construction, vendors and technical and non-technical support groups.

United States Navy (March 1969 - June 1977)

Served at various locations including Nuclear Power Training, Fleet Ballistic Missile (Polaris) Submarine, and Submarine Nuclear Repair Facility. Technical experience included assisting Lockheed shipbuilding engineers in the design of nuclear support facilities for a new class of submarine tender, design of fluid and process system modifications, craft supervision of operating submarine repair and modifications, all phases of power plant operation, shipyard overhaul, and pre-overhaul and post-overhaul testing of primary and secondary systems.

PROFESSIONAL TRAINING/HONORS

Engineer-in-Training, Massachusetts (June 1979)
Member ASME
Seminar Training - Battelle Project Management Seminar
W.P.I. Engineering Management Seminar
CE PWR Simulator,
M.I.T. Reactor Safety Course

PUBLICATIONS

"Operational Analysis" presented at August 1982/ANS/ENS meeting on Reactor Safety.

DERWOOD W. HUGHES, JR.
SENIOR NUCLEAR TRAINING SPECIALIST
BOSTON EDISON COMPANY
MEMBER OF DESIGN REVIEW TEAM

EDUCATION:

Braintree High School - 1949
Peterson's School of Steam Engineering, 1957 - 1069.

WORK EXPERIENCE:

1981 - Present — **Sr. Nuclear Training Specialist**

1976 - 1981 — **Boston Edison Company, Day Watch Engineer, Pilgrim Station**

The Day Watch Engineer is assigned the responsibility for the safe efficient operation of Pilgrim Station under the direction of the Chief Operating Engineer, in accordance with the requirements of station, procedures and regulatory agencies. Plans and directs the startup, normal operations and shutdown of the station within Technical Specifications and Operating Procedures.

In the absence or unavailability of the Chief Operating Engineer, the Day Watch Engineer will assume the duties and responsibilities of the Chief Operating Engineer.

SAL F. LUNA
PROJECT ENGINEER
TORREY PINES TECHNOLOGY
MEMBER DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

Design and development, instrumentation and control; human factors

EDUCATION

B.S., Chemistry, Magna Cum Laude, Niagara University, 1947
Specialty courses: Seismic - Wyle Labs, Human Factors - University of Tennessee and Electric Power Research Institute.

EXPERIENCE

Project Engineer responsible for NUREG-0700 type design review of the South Texas Project control room.

Project Engineer responsible for Human Factors review of Palo Verde Nuclear Generating Station control rooms. Performed Annunciator Prioritization Study for same.

Directed design of advanced control room control consoles and unitized cabinets including: human factors engineering, full scale mock-ups, modular construction and seismic qualification.

Project Engineer responsible for Probabilistic Risk Assessment Study for Fire Protection Program Assessment of Northeast Utilities Nuclear Plants - Connecticut Yankee, Millstone 1, and Millstone 2.

Consultant, review of PG&E equipment qualification documents for NRC approval. Developed formats and organized walkdown teams for PP&L equipment qualification program.

Design of a wide variety of systems for advanced HTGR plants. Special studies for application of all technology for modernizing existing nuclear power plants featuring a "Diagnostic Console."

Directed development of in-core and ex-core instrumentation to study Fort St. Vrain core fluctuation phenomena.

Directed site engineering and craft effort to provide fire protection of critical Fort St. Vrain cabling.

Prepared specifications, designed special testing equipment conducted qualification tests, evaluated results and prepared reports for cabling and instrumentation for Fort St. Vrain equipment qualification program.

Managed a wide variety of instrumentational control and development groups at Westinghouse Electric Corp. for the nuclear navy and commercial nuclear programs. Cognizant engineer for Annunciator Systems for same.

Directed the design and development of a wide variety of processing plant instrumentation systems for Catalytic Construction Co.

PUBLICATIONS

Editor of Cassette Control Valve Training Program.
Author of chapter on Maintenance - ISA Control Valve Handbook.
Author of chapter on Liquid Level Measurement - ISA publication.
Also authored a wide variety of technical papers including methodology and results of human factors review of Palo Verde, and advanced control room design.

PROFESSIONAL ASSOCIATIONS

Registered Professional Engineer (control) California
Fellow Grade Member of ISA
Past Vice President Long Range Planning Department of ISA
Nuclear Power Plant Standards Committee of ISA
Member Human Factors Society

PAUL E. MASTRANGELO
CHIEF OPERATIONS ENGINEER
BOSTON EDISON COMPANY
MEMBER ADVISORY COMMITTEE

EDUCATION:

Somerville Trade School	Graduated	1956
New England Oil Heat Institute		1960-1961
Peterson School of Steam Engineering		1965

LICENSES:

Nuclear Power Plant Operating Supervisor Engineer (MA)	1982
NRC Senior Reactor Operator SOP 2004-4	1974
Nuclear Power Plant Operating Engineer (MA)	1973
NRC Reactor Operator	1972
2nd Class Fireman	1965
3rd Class Engineer	1969

SPECIAL COURSES:

Steam Eng International Correspondence School	1970 - I.C.S. Certificate
NUS Nuclear Prep Course	1971 - Certificate
Penn State Triga Reactor Training	1970

PRESENT POSITION TITLE: Chief Operations Engineer

EXPERIENCE:

Boston Edison Company:

9/1/82 to Present — Chief Operations Engineer - Pilgrim Nuclear Power Station(PNPS
Responsible for the safe and efficient operation of PNPS in accordance with NRC regulations and Station procedures under direction of the Station Manager and other regulatory agencies.

1/27/79 to 8/29/82 — Nuclear Watch Engineer - Pilgrim Nuclear Power Station
Responsible for all activities relating to Station safety and all operations of the Station including fuel loading, startup and shutdown in accordance with the requirements of the Operating License, Technical Specifications, approved operating procedures, regulatory agencies and other governing bodies.

5/16/78 to 1/26/79 — Nuclear Operating Supervisor - Pilgrim Nuclear Power Station
Responsible for supervising the Nuclear Plant Operators and implementing operating maneuvers in accordance with Station procedures and assist in training the NPOs in their skill and knowledge required to safely operate a nuclear facility.

1970 to May 1978 — Nuclear Plant Operator - Pilgrim Nuclear Power Station
Participated in fuel loading, pre-op testing, 20% power testing and operated all station equipment.

Boston Edison Company (cont)

1968 - 1970	<u>Boiler Operator - Mystic Station</u> Operate boilers, including responsibility for the feedwater driving turbines with a capacity of 150 MWE each.
1966 - 1968	<u>Fireman - Edgar Station and Kneeland Street</u> Operated boilers, under the direction of the Watch Engineer.
1965 - 1966	<u>Turbine Tender - L Street Station</u> Operated turbine and turbine equipment under the direction of the Watch Engineer.
1964 - 1965	<u>Auxiliary Operator - Mystic Station and Edgar Station</u> Operated boiler and turbine auxiliary equipment under the direction of the turbine operator and boiler operator.
1963 - 1964	<u>Auxiliary Tender - L Street Station and Kneeland Street Station</u> Operated boiler and turbine auxiliary equipment under the direction of the fireman, water tender and turbine tender.
1961 - 1962	<u>Station Cleaner</u> General housecleaning duties.

CHARLES H. MINOTT
PROJECT MANAGER
BOSTON EDISON COMPANY
MEMBER OF DESIGN REVIEW TEAM

EDUCATION

M. S. Civil Engineering: Project Management Program, M.I.T., 1974
B. S. Civil Engineering, University of Massachusetts, Amherst, MA., 1972.

EXPERIENCE

Project Manager, Nuclear Engineering Department, Boston Edison

Responsible for managing the following projects in support of Pilgrim Station:

Design/construction of a 130,000 s.f. administration/service building.

Renovation of a 30,000 s.f. building for a nuclear training center.

Design/construction of a facility for compaction/shipping of low level radioactive waste

Control room design review.

Upgrade of emergency response facilities.

Replacement of the plant computer and installation of an SPDS.

Project Engineer, Nuclear Projects Group, Boston Edison Company

9/81-9/82 Responsible for management of the architect/engineer's and turbine supplier's scope of work during close-out of the Pilgrim 2 Project including contract negotiation/settlement, protection of assests, and marketing/sale of assets. Responsible for a budget of $4 million.

Responsible for testifying at the Department of Public Utilities regarding Pilgrim 2 cost and contractual issues.

7/80-8/81 Responsible for shipping, receiving, storage and maintenance of all equipment manufactured for Pilgrim Unit #2; this equipment's value exceeded $!50 million and was stored in numerous states.

Responsible for developing work plans, assign work to other Boston Edison Departments and principal contractors and monitor progress on this work to assure the storage and maintenance program for the equipment was cost effective, technically correct and adhered to applicable codes.

EXPERIENCE (Continued)

Responsible for developing necessary control systems and insurance and audit programs. Directly responsible for a budget of $1 million per year.

Senior Cost Control Engineer, Boston Edison Co.

1/78-6/80 Prepared project procedures for the Pilgrim 2 Project in the following areas: engineering economics, accounting, insurance, tax and cost estimate preparation and reviews.

Cost Control Engineer

9/74-12/77 Developed a management control system for Nuclear Organization purchase orders. Reviewed architect-engineer's project cost estimate for Pilgrim 2; prepared and maintained the owner's scope portion of the cost estimate, prepared periodic cost reports and analyzed cost trends. Reviewed contractor bid analyses and developed recommendations for management approval.

Prepared other project cost estimates, insurance valuations, cost studies, cash flows, and economic analyses for executive management, other Edison departments, joint owners, and regulatory agencies. Developed and implemented a cost reporting system for a nuclear unit refueling outage. Coordinated the preparation of the Nuclear Organization capital and expense budgets.

Responsible for cost/schedule and contract management of two Unit 1 backfit projects. Represented Edison in the Electric Utility Cost Group.

(1972 - 1974) Massachusetts Institute of Technology

Research Assistant; worked under an NSF contract developing a cost estimating method incorporating risk analysis for use in the tunneling industry.

PROFESSIONAL ASSOCIATIONS/HONORS

Project Management Institute
Chi Epsilon (civil engineering)
Tau Beta Pi (engineering)
Alpha Phi Gamma (journalism)
Sigma Xi (research)

RICHARD C. POTTER
STAFF ENGINEER
TORREY PINES TECHNOLOGY
MEMBER OF DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

Power plant dynamic and steady-state systems design and analysis including large scale systems simulation.

EDUCATION

B.S., Mechanical Engineering, University of Minnesota
M.S., Mechanical Engineering, University of Southern California

EXPERIENCE

Mr. Potter is presently acting as consultant on the control room design review for the Palo Verde Nuclear Generating Station. He recently completed an assignment as Assistant Project Engineer on the control room design review of the South Texas Project Nuclear Generating Station where he performed system functions and task analysis, performed a control room survey, developed program plans and directed other engineers during the review.

Mr. Potter was responsible for a fire vulnerability study of three Northeast Utilities nuclear power plants. Study involved the use of probabilistic risk assessment techniques for predicting the shutdown capability of these plants in the event of a fire.

He also participated in a probabilistic risk assessment of the Fort St. Vrain plant to determine clean up costs versus probability for on-site contamination due to an interruption of cooling event.

On the Fort St. Vrain Nuclear Generating Station project responsible for: modifying and maintaining computer models for the simulation of steady-state and transient plant performance review which included data monitoring and analysis as required to ensure proper plant operation; and performing steady-state and dynamic analysis to support the plant startup testing program.

While assigned to the Gas Cooled Fast Reactor Project he performed a conceptual analysis of a natural convection, drum-type and condenser-type shutdown cooling system.

On the HTGR nuclear project he was responsible for the following: modifying and maintaining the steady-state and transient plant performance programs, the pipe rupture analysis program and the core afterheat analysis program; predicting power plant nominal, shutdown and refueling performance for use by design and analysis groups within the company and for use by the customers and performing parametric and application studies relating to the overall plant design and performance.

EXPERIENCE (Continued)

Prior to joining Torrey Pines Technology, he directed activities involving propulsion analyses, application studies and computer simulation work on large liquid rocket engines. He has also worked as a design engineer responsible for design and detailing of ground support equipment for rockets.

PROFESSIONAL ASSOCIATIONS

Professional Mechanical Engineer in State of California
Member of the American Society of Mechanical Engineers
Member of Pi Tau Sigma

JEFFREY L. ROGERS
SYSTEMS ANALYSIS ENGINEER
BOSTON EDISON COMPANY
MEMBER OF DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

Opportunity to utilize technical, supervisory and operational experience in the areas of systems analysis and reactor safety.

EDUCATION

Clarkson College of Technology, Potsdam, NY; 1975-1977 B.S. Degree, 1977; Mechanical Engineering

State University of New York at Albany, Albany, NY; 1973-1975 Majored in physics and mathematics

Intern Engineer Certificate, State of New York, 1977

EXPERIENCE

Boston Edison Company, Boston, MA.

Systems Analysis Engineer, (October 1981 to Present)
Accountable for providing nuclear safety evaluations consistent with industry standards and regulatory requirements. Responsibilities include the review and approval of safety evaluations/assessments of plant safety system designs, operating practices, system modifications, and Technical Specification changes; establishment, maintenance and approval of the Q-List; review of regulatory guides and information for PNPS applicability; establish criteria for system design; provide system engineering input to special projects; and perform systematic analysis of special events.

Operations Engineer, (June 1980 to October 1981)
Responsible for the timely and cost effective completion of design modification projects initiated internally by Boston Edison Company and externally by the Nuclear Regulatory Commission (NRC). Ensured on-going progress of corrective action through integration of corporate and plant work activities and monitoring work in accordance with plans, schedules and costs. Assisted in review of NRC documents to ensure operational compliance. Also responsible for providing operational engineering support to and analysis of the system of Pilgrim Station, Plymouth, MA.

EXPERIENCE (Continued)

Niagara Mohawk Power Corporation, Oswego, NY

Assistant Station shift Supervisor, (June 1978 to June 1980)
As leader of operations personnel, had responsibility and authority for the implementation, coordination and control of operating policies and practices used in the start-up of a 850 MW power plant. Actively involved in the creation of start-up, normal operation and shut-down procedures for plant equipment and systems; participated in completion of control and mechanical verification system start-up packages; and served as shift supervisor of operating crew during system start-up and full power operations.

Auxiliary Supervisory Development Course Trainee, (June 1977 to June 1978)
In training for ultimate assignment of a supervisory nature in the corporation. Acquired a knowledge of the objectives, functions, organization and key personnel of each department. Emphasis was placed on familiarization with power plant operation and maintenance.

RAYMOND SABEH
HUMAN FACTORS CONSULTANT
TORREY PINES TECHNOLOGY
MEMBER OF DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

Human Factors Engineering, Operations Research Analysis

EDUCATION

PH.D., (candidate), Experimental Psychology, Ohio State University
M.S., Industrial Psychology, Ohio University
B.A., General Psychology, Davis and Elkins College

EXPERIENCE

Responsible for Human Factors review of Corrective Enhancements, hierarchial labeling, and demarcation for the South Texas Project.

Responsible for special studies and operations personnel validation via operator questionnaire interview evaluations for the Palo Verde Plants.

Responsible for preparing and implementing the human factors portion of the NUREG-0700 plan for three NU nuclear operating plants and a fourth NTOL plant. Served as the human factors team member on the NU Safety Parameter Display System (SPDS) program that will be designed, developed, and implemented for as consortium of some 10 separate utility plants. Prepared Human Factors Engineering Orientation Course material used for instructing nuclear engineers and reactor operators.

Northeast Utilities - served as project leader and carried out nuclear operations analysis assignments concerning nuclear regulatory requirements to conduct human factors study, analysis and review of all activities affecting man-machine power plant design and operation. In this capacity was appointed as subcommittee chairman to technically monitor and direct the Westinghouse Corporation's efforts for developing a generic system function and task analysis on their PWR plants under contract to Westinghouse Owner's Group.

Consultant - responsible for human factors design of a control center for the storage and retrieval of nuclear waste. Currently compiling a handbook of human factors engineering design criteria.

Manager/man-machine analysis branch - performed human engineering analysis of the Automated Record Data System for the E4A Aircraft. Also performed a man-machine analysis of the FFGX-CIC space and work place design for SEAMOD, a ship-shore communications effectiveness study. Designed the operator interface for the Minimum Essential Emergency Communications Network Message Processing Mode including the development of computer simulation techniques to assess alternate operator interface designs.

EXPERIENCE (Continued)

Engineering Psychologist - initiated and coordinated research in development of methods and techniques used in human factors engineering system design and development. Technical leader of a communications effectiveness study effort and shipboard habitability programs.

Planned and technically directed the National Military Command System and Emergency Action Room study for the Defence Communcations Agency and World-Wide airborne command posts.

PROFESSIONAL ASSOCIATIONS

Human Factor Society
Operations Research Society of America
National Academy of Sciences Armed Forces-NTD Committee on Vision
Southeast Regional Director, Society for Information Displays

PUBLICATIONS

Human Factors Design Considerations for the Monitored Retrievable Storage System. Path Research Technical Document PR81001. June 1981.

MMPM Operator Interface Design (OID) Final Report. SEI Technical Document. December 1979.

Human Engineering Analysis of the Automated Record Data System for the E4A Aircraft. SEI Technical Document 0279-1. January 1978.

Human Engineering Analysis and Evaluation of the Integrated Record Data System for the EC-135 Aircraft. NOSC Technical Document 113. August 1977.

Profile for Open Ocean Crane Operators. NELC Technical Note 3209. August 1976.

Human Factors Analysis of the National Military Command System's Emergency Action Rooms. NELC Technical Note 3109. December 1975.

Preliminary Human Engineering Analysis of the Signal Intelligence Analysis System (SIAS). NELC Technical Note 2252. (U), January 1973.

Voice Traffic Analysis of LANTFLEX 66, Racer Run 68, and ROPEVAL 3-71 Exercises. NELC Technical Document 175. May 1972.

USS BLUE RIDGE (LCC 19) Communications Effectiveness Evaluation. NELC Technical Document 146. (U), October 1971.

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Comparison of a Single Operator's Performance with Team Performance on a Tracking Task. WADC Technical Note 55-362. July 1955.

KENNETH NORMAN TAYLOR
SENIOR REACTOR OPERATOR
BOSTON EDISON COMPANY
MEMBER DESIGN REVIEW TEAM

EDUCATION

Presently attending Northeastern University pursuing a degree in engineering.

Nuclear Power Training Unit, West Milton, NY - 1960

U.S. Navy Nuclear Power School, New London, Conn. (1959)
Machinist's Mate "A" School Great Lakes, IL - Cole Trade High School, Southbridge, MA

M.A., Nuclear Power Plant Operating Engineer (1978)
NRC Senior Reactor Opreator License S.O.P. 4065 (1977)
NRC Reactor Operator (1975)
M.A., License - 1st Fireman (1975)

EXPERIENCE

Boston Edision Company

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

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

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

OTHER EXPERIENCES

5/73 to 11/75
Served on U.S.S. Skipjack SS(N) 575 as Engineering Watch Supervisor

4/72 to 5/73
Served on staff at Engineering Repair Division, New London, Conn.

8/65 to 4/72
Served on U.S.S. Francis Scott Key SSB(N) 657 as Engineering Officer of the Watch

12/62 to 8/65
Served on U.S.S. Stonewall Jackson SSB(N) 634 as Engineering Watch Supervisor

1/61 to 12/62
Served on U.S.S. Ethan Allen SSB(N) 607 as Engine Room Supervisor

1/59 to 1/61
Received U.S. Naval Training at various schools

2/57 to 1/59
Served on U.S.S. Skate SS(N) 578 as Engine Room Operator

12/56 to 2/57
Served on U.S.S. Leyte C.V.S. 32 as Auxilary Operator

FREDERICK W. TODT
STAFF ENGINEER
TORREY PINES TECHNOLOGY
MEMBER DESIGN REVIEW TEAM

PROFESSIONAL SPECIALTY

Process computer systems conceptional design, configuration and application development.

EDUCATION

B.S., Physics, Wayne State University
Electronics School, U.S.M.C.

EXPERIENCE

Performed a control room survey of the plant computer for South Texas Project.

Coordinated proposal efforts to supply computer hardware and software for emergency response facilities for nuclear plants.

Implemented computer demonstration of plant disturbance detection concept.

Developed real time application programs to support start-up testing and reactor operation. Monitored system behavior during start-up, located deficiencies and made modifications as needed. Trained plant personnel to use computer facilities.

Section leader for large plant computer system application software development.

Specification writing for plant computer hardware and software and participation in the vendor evaluation process.

Performed nuclear design and analysis calculations associated with reactor power shaping, fuel cycles, control poison worth, and safety evaluations of HTGR and PWR reactors.

Developed methods and computer programs for nuclear fuel cycle studies, fuel cost analysis, and automation of reactor design parametric studies.

Performed nuclear design studies on small power, research, and space reactor concepts using a variety of fuels, moderators, and coolants.

Evaluated nuclear design calculation programs (computer codes) by comparison with critical experiments.

EXPERIENCE (Continued)

Performed laboratory work with radioactive isotopes including sample counting, dosage preparation, standardization. Calibrated x-ray machines and radiation measurement equipment. Performed radiation shielding surveys.

Installed, maintained, and repaired radio receivers, transmitters and telephone carrier equipment.

PROFESSIONAL ASSOCIATION

American Nuclear Society