DUKE POWER COMPANY
MCGUIRE NUCLEAR STATION

RESPONSE TO SUPPLEMENT 1 TO NUREG-0737
DOCUMENT REVISION TRANSMITTAL

Revision 2 Instructions

Remove Sections 4, 5, 6, and 7 (SPDS, Regulatory Guide 1.97, EP Upgrade Program, and Emergency Response Facility) and insert in newly provided Volume 2 binder.

Place new Volume 1 title inserts into present binders, discarding present title inserts.

Revise Volume 1 as described below:

Remove Title Page	Insert Volume 1 Title Page
Remove Table of Contents (Two Pages)	Insert Page i, Table of Contents, Rev. 2 Insert Page ii, Table of Contents, Rev. 2
Remove CRDR Tab	Insert Control Room Review Tab
	Insert 3.1 Control Room Review Status Tab before Page 3-1
	Insert 3.2 Control Room Review Plan Tab following Page 3-7
	Insert 3.3 Control Room Review Final Report and Tab following Appendix B of the Control Room Review Plan
	Insert 3.4 Control Room Review Supplemental Report, Units 1 and 2 and Tab following the Control Room Review Final Report

DUKE POWER COMPANY

RESPONSE TO SUPPLEMENT 1 TO NUREG-0737,

EMERGENCY RESPONSE CAPABILITY

FOR

MCGUIRE NUCLEAR STATION

VOLUME 1

MNS
Revision 2

DUKE POWER COMPANY

RESPONSE TO SUPPLEMENT 1 TO NUREG-0737,

EMERGENCY RESPONSE CAPABILITY

FOR

MCGUIRE NUCLEAR STATION

VOLUME 2

MNS
Revision 2

TABLE OF CONTENTS

VOLUME 1

SECTION		PAGE
1	INTRODUCTION	1-1
	1.1 Purpose	1-1
	1.2 Scope	1-1
	1.3 Background	1-3
	1.4 Definitions	1-4
2	INTEGRATED IMPLEMENTATION PLAN AND SCHEDULE	2-1
	2.1 Overview	2-1
	2.2 Integrated Schedule	2-5
3	CONTROL ROOM REVIEW	3-1
	3.1 Control Room Review Status (Through April 1, 1983)	3-1
	3.2 Duke Power Nuclear Stations Control Room Review Plan	Tab 3.2
	3.3 Control Room Review Final Report	Tab 3.3
	3.4 Control Room Review Supplemental Report, Units 1 and 2	Tab 3.4

VOLUME 2

4	SAFETY PARAMETER DISPLAY SYSTEM (SPDS)	4-1
	4.0 Introduction	4-1
	4.1 SPDS Implementation Plan	4-1
	4.2 SPDS System Description	4-6
	4.3 SPDS Safety Analysis	4-14
	4.4 SPDS Current Status	4-15

TABLE OF CONTENTS

SECTION		PAGE
5	REGULATORY GUIDE 1.97	5-1
	5.1 Introduction	5-1
	5.2 Review	5-1
	5.3 Assessment	5-2
	5.4 Implementation	5-3
	5.5 Status	5-3
6	EMERGENCY OPERATING PROCEDURE UPGRADE PROGRAM	6-1
	6.1 Introduction	6-1
	6.2 Plant Specific Technical Guidelines And Emergency Procedure Development Process	6-1
	6.3 Writer's Guide For Emergency And Abnormal Procedures	6-3
	6.4 Emergency Procedure Verification Program	6-4
	6.5 Emergency Procedure Validation Program	6-5
	6.6 Emergency Procedure Training Program Description	6-6
	6.7 Emergency Procedure Upgrade Program Status	6-7

TABLE OF CONTENTS

VOLUME 1

SECTION		PAGE
1	INTRODUCTION	1-1
	1.1 Purpose	1-1
	1.2 Scope	1-1
	1.3 Background	1-3
	1.4 Definitions	1-4
2	INTEGRATED IMPLEMENTATION PLAN AND SCHEDULE	2-1
	2.1 Overview	2-1
	2.2 Integrated Schedule	2-5
3	CONTROL ROOM REVIEW	3-1
	3.1 Control Room Review Status (Through April 1, 1983)	3-1
	3.2 Duke Power Nuclear Stations Control Room Review Plan	Tab 3.2
	3.3 Control Room Review Final Report	Tab 3.3
	3.4 Control Room Review Supplemental Report, Units 1 and 2	Tab 3.4

VOLUME 2

SECTION		PAGE
4	SAFETY PARAMETER DISPLAY SYSTEM (SPDS)	4-1
	4.0 Introduction	4-1
	4.1 SPDS Implementation Plan	4-1
	4.2 SPDS System Description	4-6
	4.3 SPDS Safety Analysis	4-14
	4.4 SPDS Current Status	4-15

TABLE OF CONTENTS

SECTION		PAGE
5	REGULATORY GUIDE 1.97	5-1
	5.1 Introduction	5-1
	5.2 Review	5-1
	5.3 Assessment	5-2
	5.4 Implementation	5-3
	5.5 Status	5-3
6	EMERGENCY OPERATING PROCEDURE UPGRADE PROGRAM	6-1
	6.1 Introduction	6-1
	6.2 Plant Specific Technical Guidelines And Emergency Procedure Development Process	6-1
	6.3 Writer's Guide For Emergency And Abnormal Procedures	6-3
	6.4 Emergency Procedure Verification Program	6-4
	6.5 Emergency Procedure Validation Program	6-5
	6.6 Emergency Procedure Training Program Description	6-6
	6.7 Emergency Procedure Upgrade Program Status	6-7

DUKE POWER COMPANY

CONTROL ROOM REVIEW

FINAL REPORT

Foreward

This Final Report of the Duke Power Control Room Review together with the companion Supplement for a specific nuclear unit constitutes the complete "Summary Report" required by Supplement 1 to NUREG-0737.

TABLE OF CONTENTS

Section		Page
1.0	Overview	1
	1.1 Introduction	1
	1.2 Objective	1
	1.3 Definition of Physical Review Area	2
	1.4 General Description of the Control Room Review	8
2.0	Control Room Review Organization	13
	2.1 Introduction	13
	2.2 Steering Committee	15
	2.3 Review Team	15
	2.4 Orientation and Training	18
3.0	Documentation	20
4.0	Review Phase	22
	4.1 Overview	22
	4.2 Categorization of Guidelines	22
	4.3 Control Room Survey Activity	26
	4.4 Operating Experience Review Activity	40
	4.5 Task Analysis Activity	50
5.0	Assessment Phase	63
	5.1 Overview	63
	5.2 General Description of Criteria/Methods	64
6.0	Implementation Phase	68
7.0	Future Control Room Modifications	69

Appendix: A Workplan for the BioTechnology Contract to Support Duke Power Company

1.0 Overview

1.1 Introduction

In light of the many post TMI modifications and considerations, Duke Power elected to begin a detailed integrated Control Room review for each of its three nuclear stations - Oconee, McGuire and Catawba. An inter-disciplinary management Steering Committee was established in October 1981, and a Review Team was selected in February 1982. A formal review plan was written and a human factors consultant selected. After initial preparations, which included the development of a detailed work plan, the development of appropriate review methodologies, and construction of full-scale photo-mosaic mock-ups of each nuclear unit control board, and after necessary training of personnel, the detailed review activities began in September 1982.

The review was completed in approximately one year. A separate review was performed for each unit; however, generic reviews were performed whenever applicable, such as a study of the environment in a two unit Control Room. Full advantage was also taken of previous work in such areas.

This report discusses the objective and organization of the review. It also describes the review and assessment activities, the methodologies used in the review activities, documentation methods, and the means for implementation of necessary corrections. A companion supplement for each station describes the plant-specific review processes and results, including a station implementation schedule plan.

1.2 Objective

The primary objective of the Control Room Review was to identify cost effective improvements which will strengthen the man-machine interface. Although primary emphasis was placed on improving emergency response capability, problem areas in normal operation were also examined.

The objective was accomplished by identifying HEDs (human engineering discrepancies) in the man-machine interfaces in the Control Room, determining the extent and importance of the HEDs, developing modification and training solutions as necessary to resolve significant discrepancies, developing an implementation plan for these solutions, and establishing a working interface with the SPDS, Emergency Procedure Upgrade and Post Accident Monitoring Assessment efforts (See Figure 1-1).

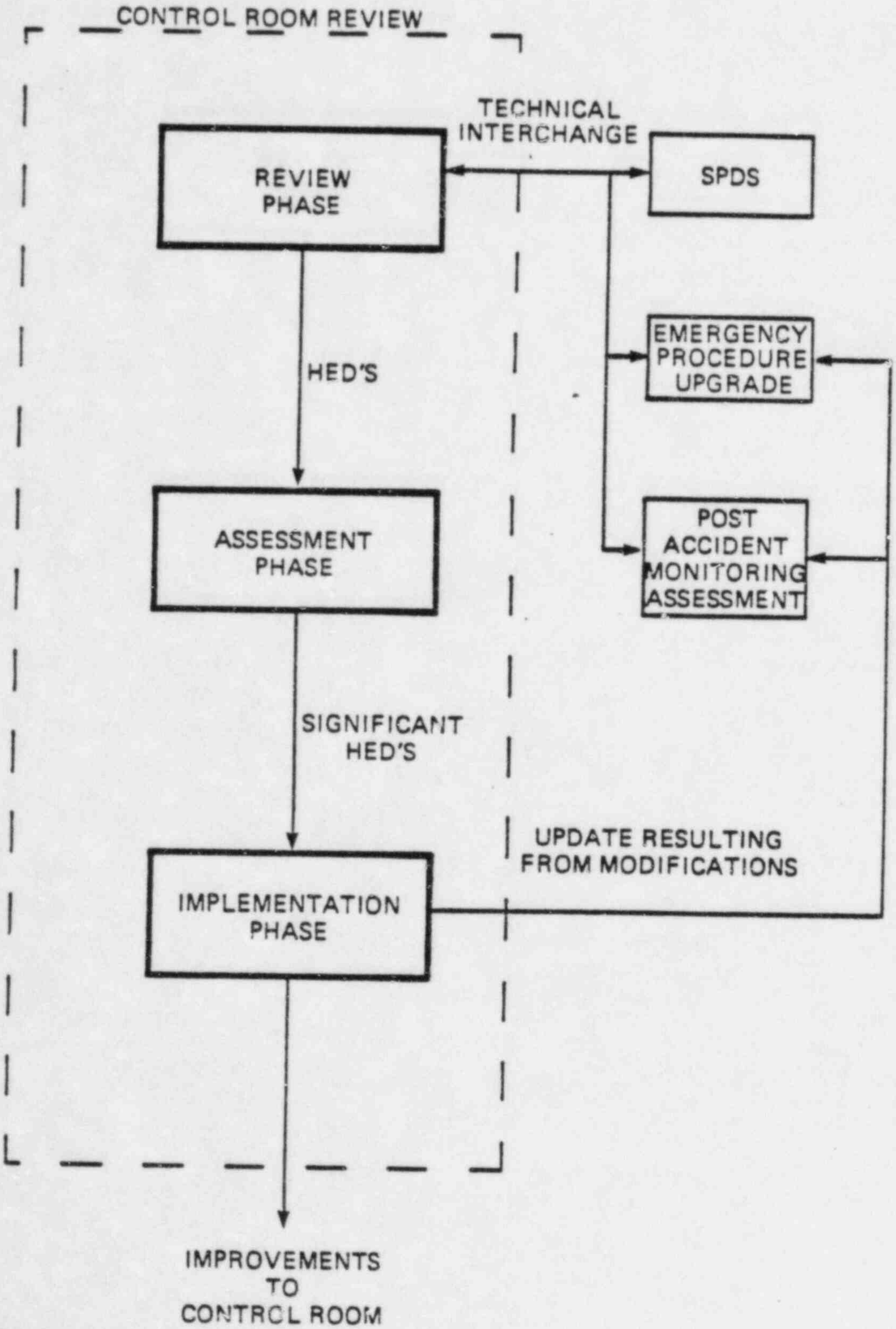
The term human engineering discrepancy (HED) has been "defined" in NUREG-0700 as "a departure from some benchmark in system design suitability for the roles and capabilities of the human operator." The benchmarks used in the Duke Control Room Review to identify discrepancies consisted of human engineering principles, guidelines, and checklists developed specifically for each review activity after

a careful and systematic review of NUREG-0700 and other human engineering criteria.

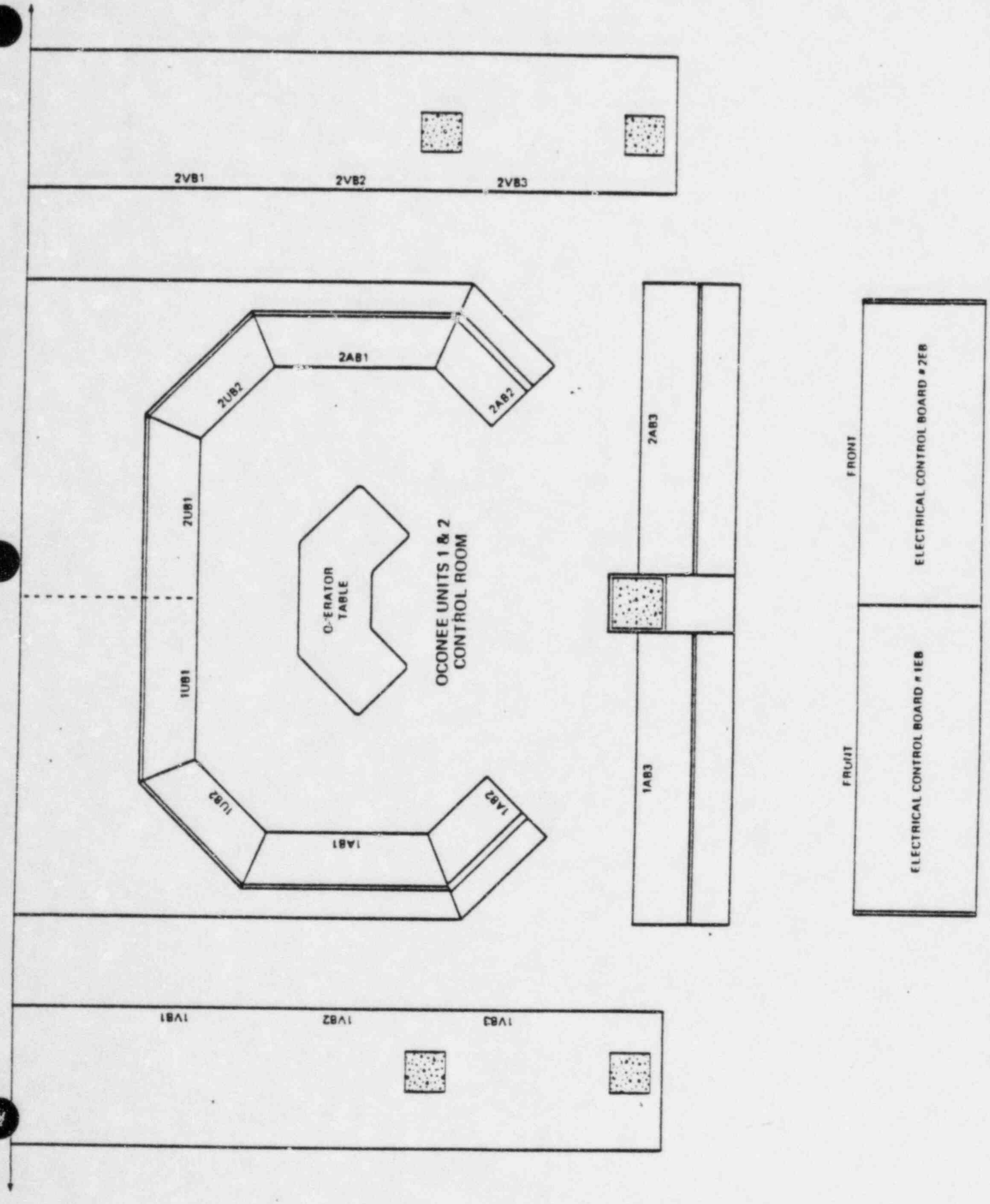
1.3 Definition of the Physical Review Area

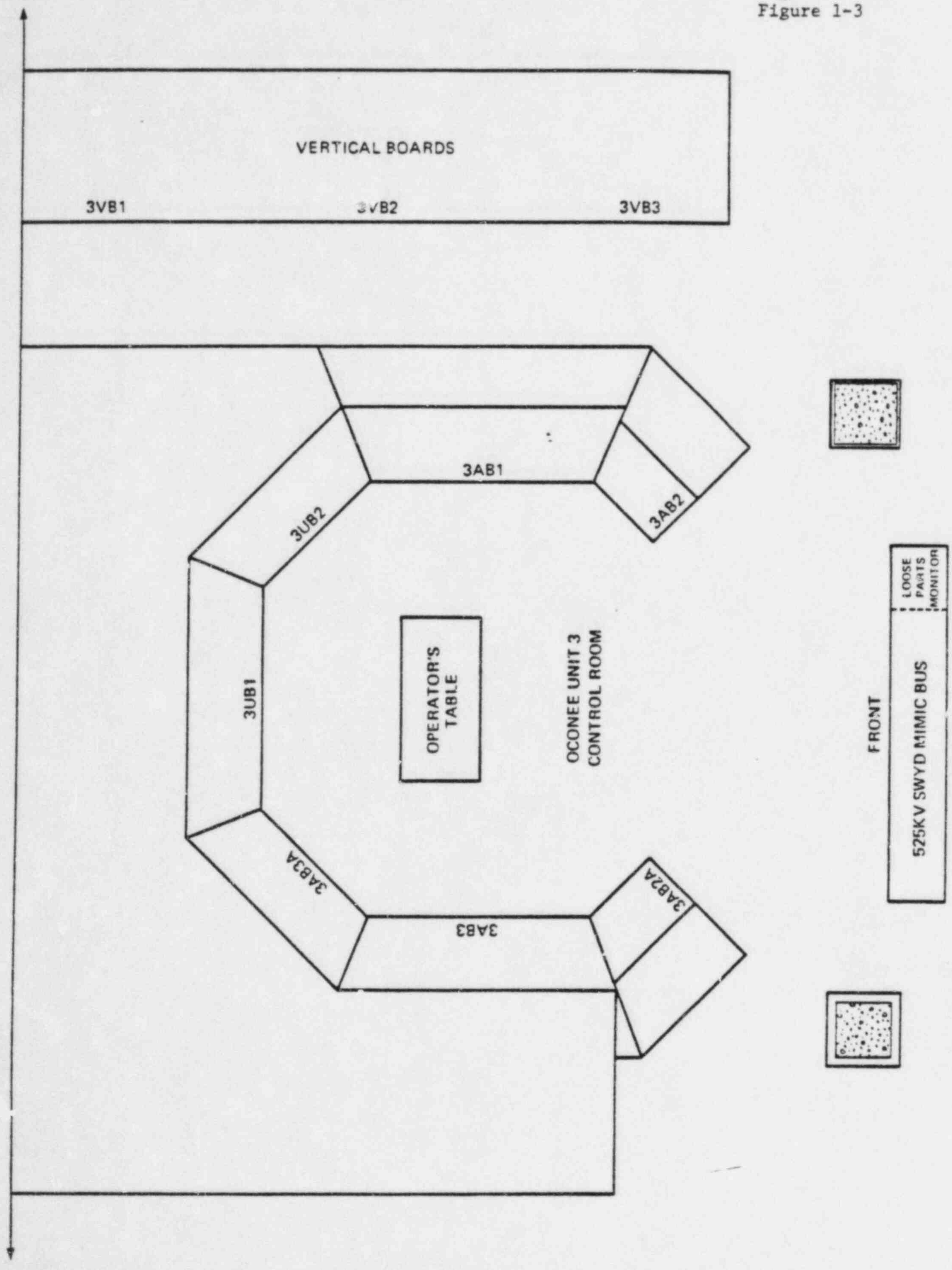
The physical area for Control Room Review activities is shown in Figures 1-2, 1-3, 1-4 and 1-5, and will include all of the identified control panels. The Auxiliary Shutdown Panels at all three stations were also included in the review.

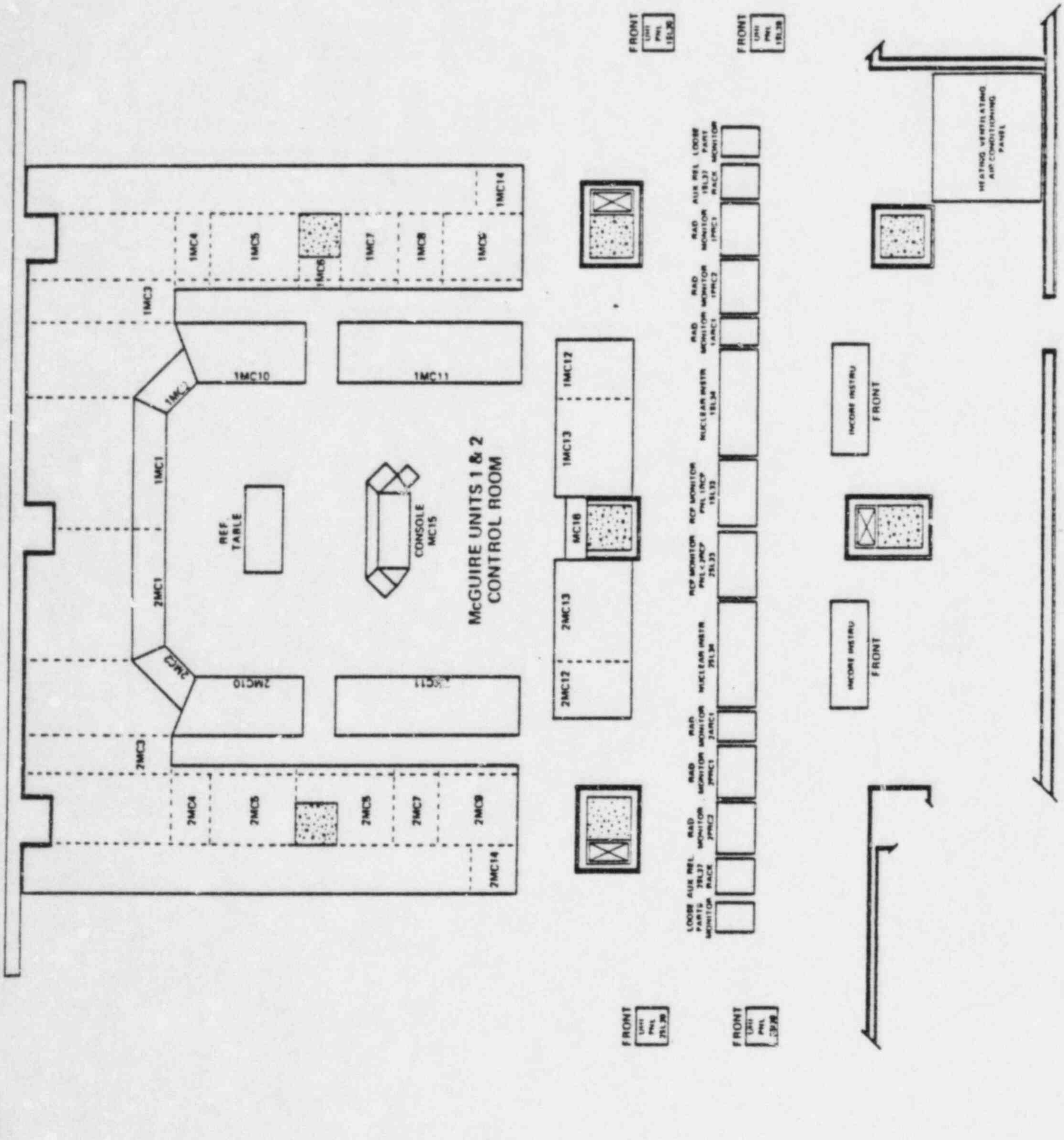
DUKE POWER COMPANY
CONTROL ROOM REVIEW PROCESS



Page 4
Figure 1-2




VERTICAL BOARDS
3VB1
3VB2
3VB3
3AB1
3AB2
3UB2
3UB1
OPERATOR'S TABLE
OCONEE UNIT 3 CONTROL ROOM
3AB3A
3AB3
3AB2A
LOOSE PARTS MONITOR
525KV SWYD MIMIC BUS
FRONT


McGUIRE UNITS 1 & 2
CONTROL ROOM
REF
TABLE
CONSOLE
MC15
1MC1
1MC2
1MC3
1MC4
1MC5
1MC6
1MC7
1MC8
1MC9
1MC10
1MC11
1MC12
1MC13
1MC14
MC16
2MC1
2MC2
2MC3
2MC4
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2MC6
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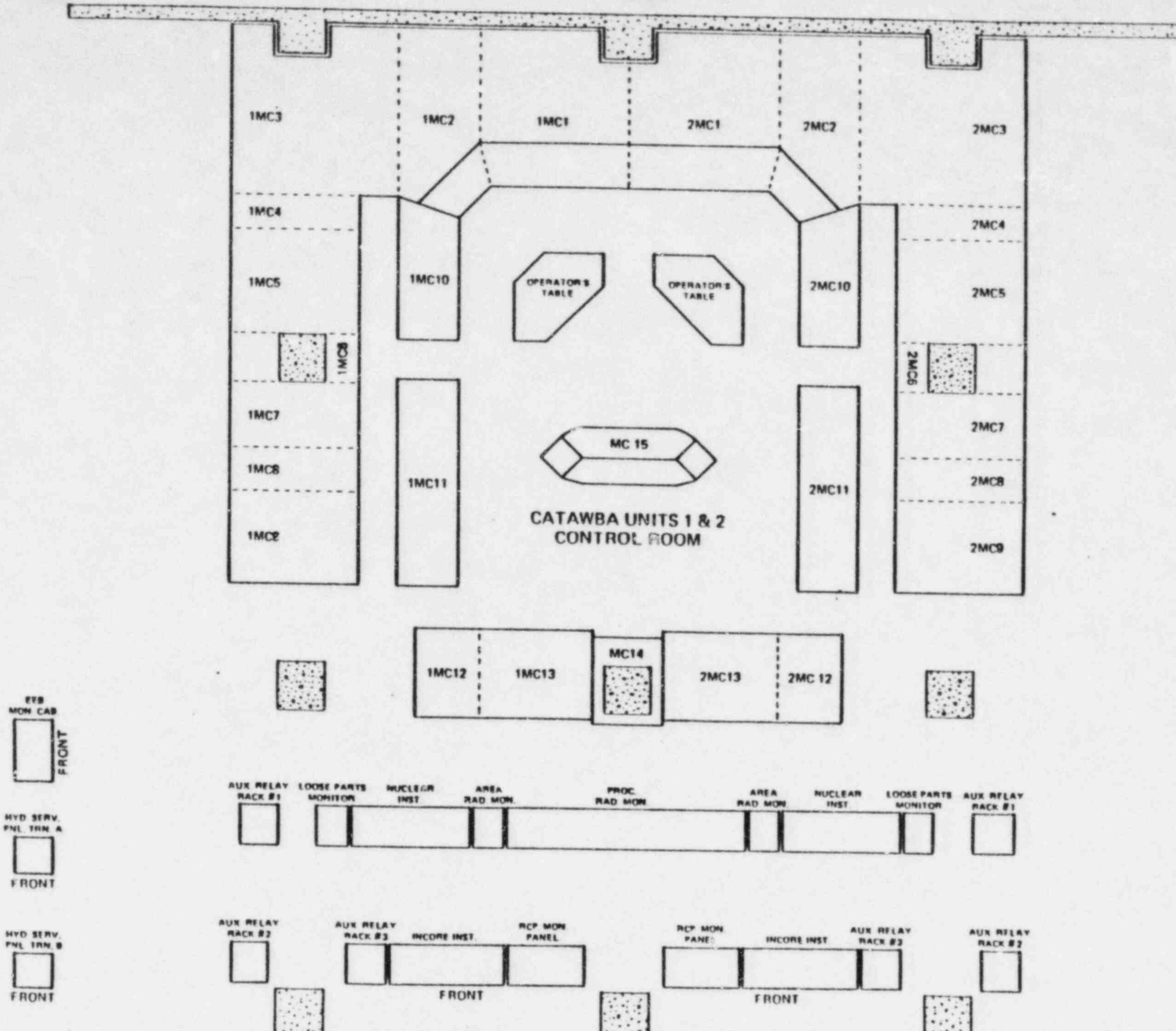

1MC3
1MC2
1MC1
2MC1
2MC2
2MC3
1MC4
2MC4
1MC5
1MC10
OPERATOR'S TABLE
OPERATOR'S TABLE
2MC10
2MC5
1MC6
2MC6
1MC7
2MC7
MC 15
1MC8
1MC11
2MC11
2MC8
1MC9
2MC9
CATAWBA UNITS 1 & 2
CONTROL ROOM
1MC12
1MC13
MC14
2MC13
2MC 12
FRONT
AUX RELAY RACK #1
LOOSE PARTS MONITOR
NUCLEAR INST
AREA RAD MON.
PROC. RAD MON
AREA RAD MON
NUCLEAR INST
LOOSE PARTS MONITOR
AUX RELAY RACK #1
HYD SERV. PNL TRN A
FRONT
HYD SERV. PNL TRN A
FRONT
AUX RELAY RACK #2
AUX RELAY RACK #3
INCORE INST.
RCP MON PANEL
RCP MON PANEL
INCORE INST
AUX RELAY RACK #3
AUX RELAY RACK #2
HYD SERV. PNL TRN B
FRONT
FRONT
FRONT
HYD SERV. PNL TRN B
FRONT

Figure 1-5

1.4 General Description of the Control Room Review

The Control Room Review was conducted in three distinct phases as shown in Figure 1-1. These phases, in chronological order of accomplishment are:

- Review Phase
- Assessment Phase
- Implementation Phase

Review Phase

The Review Phase constituted the investigative portion of the Control Room Review. It was during this phase that HEDs were discovered and documented. Investigative activities included (1) a task analysis of emergency and selected normal operating sequences; (2) an examination of operating experience, including a review of plant operating history, and a survey of operating personnel through interviews and questionnaires; and (3) a survey of Control Room components and the environment to measure conformance with applicable human factors guidelines (See Figure 1-6).

Assessment Phase

During the Assessment Phase, all discrepancies identified in the investigative activities of the Review Phase were analyzed to determine the importance of each discrepancy to plant operation. A significance evaluation for each HED was performed which considered a combination of factors, including the potential for operator error, the potential for error detection and recovery, and the consequence of the error to plant operation and safety. Significant HEDs were then selected for resolution through Control Room modifications, surface enhancements to control boards, additional training, etc.

The modifications and other actions proposed to resolve significant HEDs were then analyzed for impact and effect upon operation; and an integrated set of Control Room improvements was developed.

Implementation Phase

The Implementation Phase is the correction phase of the Control Room Review. During this phase the HED corrections developed and approved during the Assessment Phase will be installed.

Since the completion of all selected corrections will require close coordination with other enhancement programs (SPDS, upgraded emergency operating procedures, post accident monitoring instrumentation, etc.) operator training, and plant operating status, this phase will

be completed in accordance with implementation schedule guidelines developed by the Review Team. A follow-up procedure will also be instituted to ensure the successful completion of modifications.

During the investigative and assessment activities of the Control Room Review, a close technical coordination was maintained with other on-going programs for the enhancement of emergency response capability. These programs include the installation of an SPDS, the upgrading of emergency operating procedures, and the evaluation and upgrading of post accident monitoring instrumentation. While the scope and magnitude of these programs require separate development efforts and additional personnel, the Control Room Review has served as a forum for the discussion of concepts, human factors review, and schedule integration.

Figure 1-7 illustrates the integration plan for phased implementation of each of the emergency response elements of Supplement 1 to NUREG-0737. This figure shows the interfaces of the individual activities throughout the overall plan on a time scale basis and was used for planning and coordinating the efforts of the individual organizational units. The complex interrelation of the activities associated with the total provisions of Supplement 1 to NUREG-0737 are also illustrated.

It is beyond the scope of this document to address the results of each of these elements, however, it is noteworthy to define the existing interfaces:

- The NSSS Vendor Emergency Procedure Guidelines (EPGs) serve as the starting point for Emergency Operating Procedures (EOPs), SPDS, and Control Room Review Task Analysis; a program plan was developed to keep all organizations appraised of progress in each activity and to inform each organization of revisions to the EPGs.

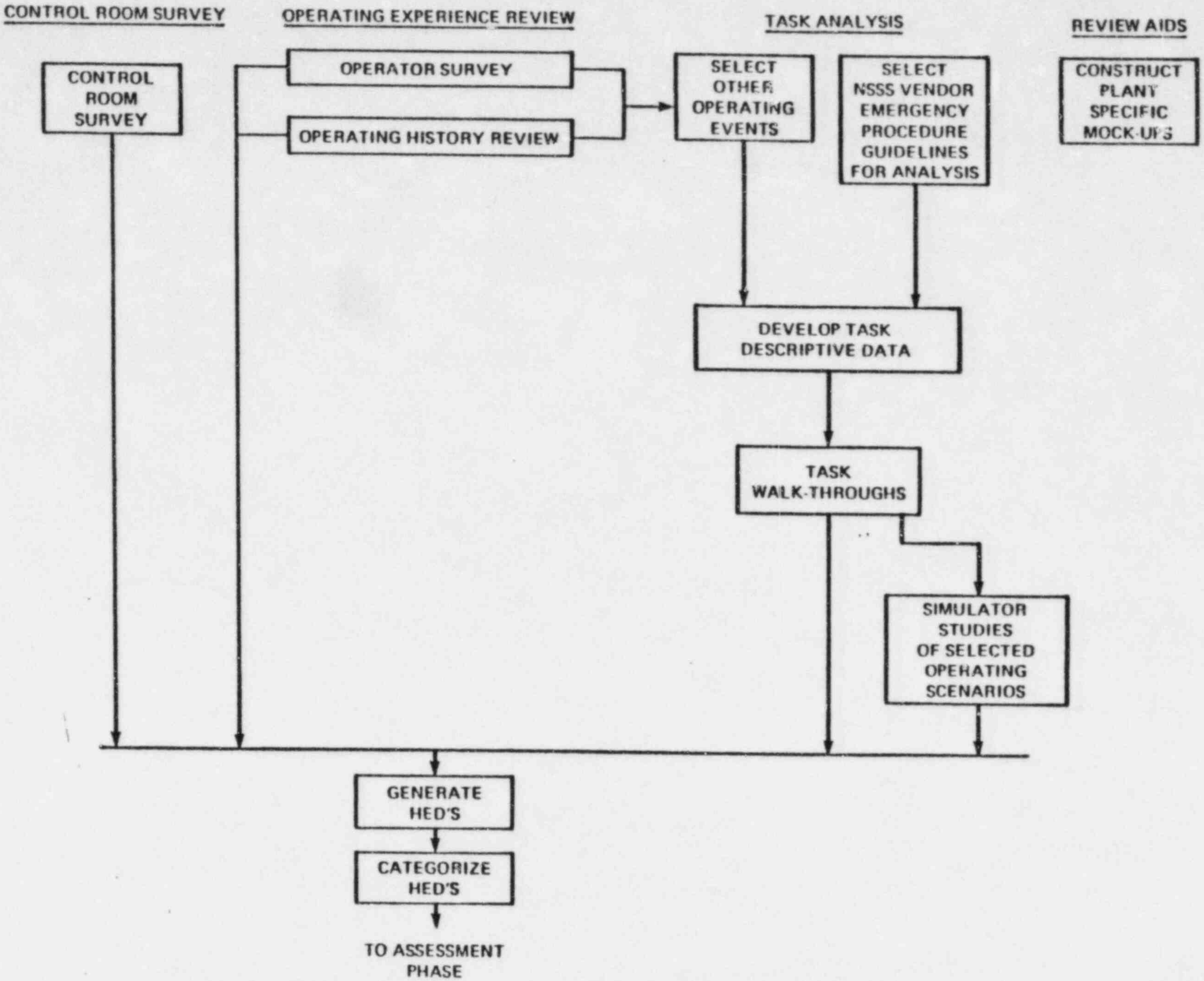
- Control Room discrepancies discovered in the Reg. Guide 1.97 Review process were coordinated with the assessment of all Control Room Review HEDs in the assessment and solution phases of the Control Room Review.

- The SPDS design, development and implementation was scheduled to take advantage of knowledge gained from the various elements of Control Room Design Review and the development of the sympton-oriented emergency procedures. The Control Room Review Team conducted a human factors review of the SPDS and its supporting displays during the development phases of the SPDS.

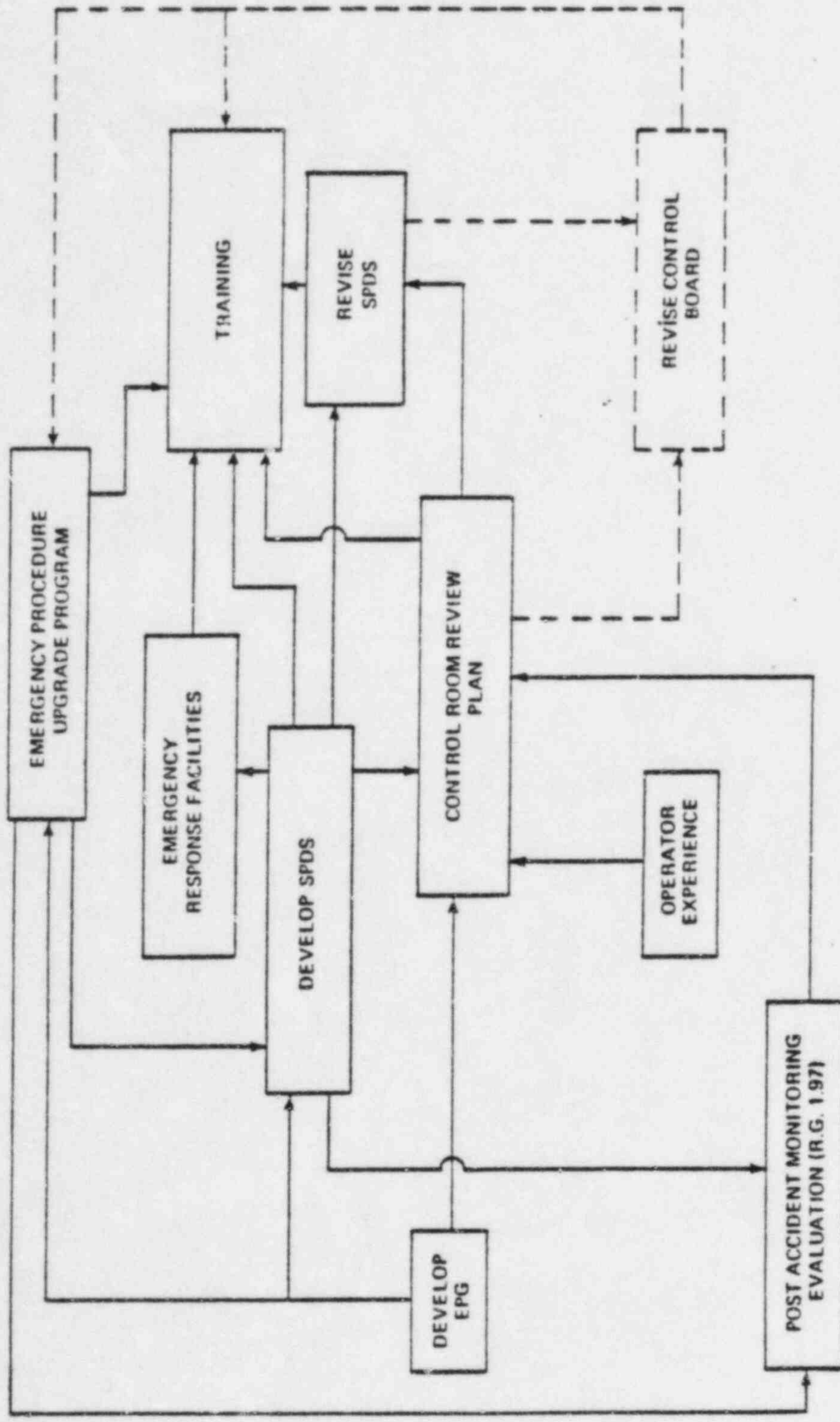
- Each of the emergency response elements will provide input to the training requirements thereby integrating the final phases of each element and its contribution to the overall emergency response preparedness.

CONTROL ROOM REVIEW

REVIEW PHASE ACTIVITIES



Page 11
Figure 1-6



DUKE POWER COMPANY
CONTROL ROOM REVIEW
PROGRAM INTERFACES

——— REVIEW & DEVELOPMENT ACTIVITIES
– – – IMPLEMENTATION ACTIVITIES
TIME ——→

2.0 Control Room Review Organization

2.1 Introduction

The Control Room Review was functionally organized as shown in Figure 2-1. Major elements included a Steering Committee, a Review Team, Duke line organizations, and consultants.

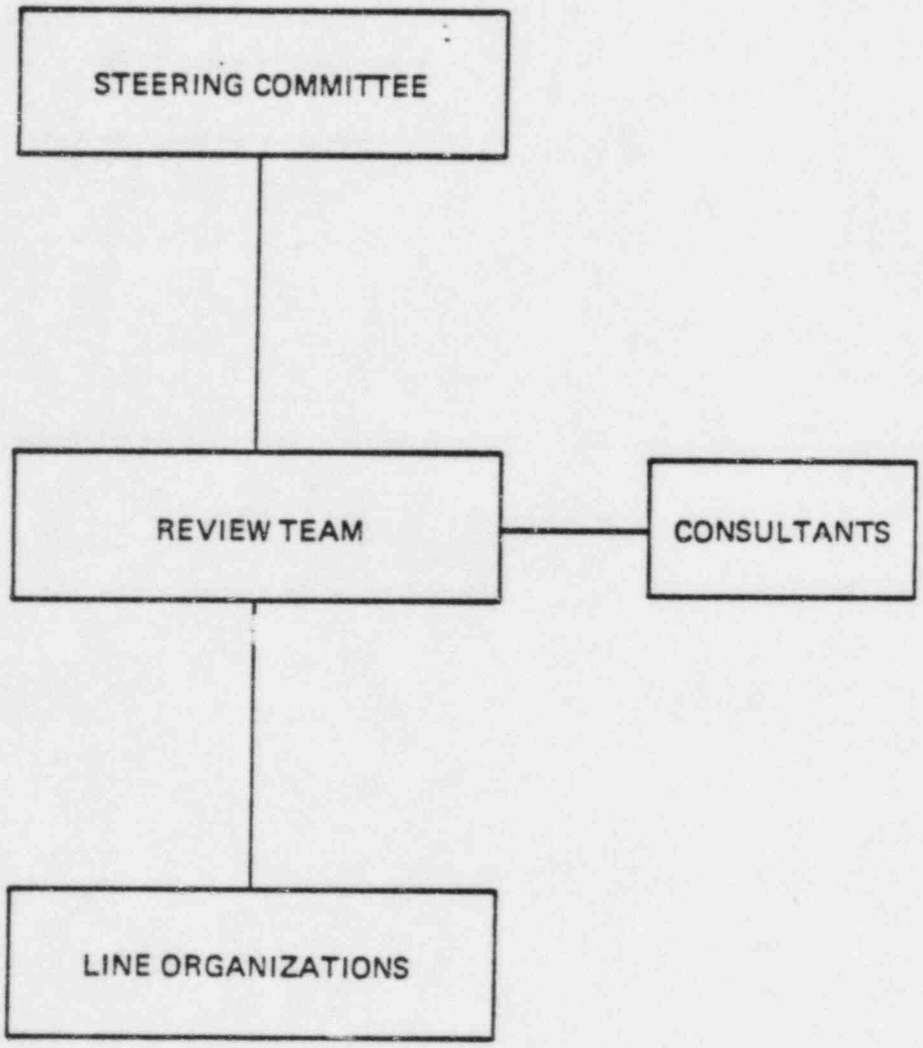
The primary responsibility of the Steering Committee was to provide management oversight to assure integration of the project objectives and to ensure meaningful Control Room improvement.

The Review Team, which reported to the Steering Committee through the Steering Committee Chairman, was responsible for planning, scheduling, coordination and implementation of the total integrated Control Room Review.

The Review Team was also responsible for assigning certain selected activities to Duke Power line organizations, and for the selection and direction of consultants who participated in the review and assessment activities.

DUKE POWER COMPANY
CONTROL ROOM REVIEW

MANAGEMENT APPROACH



2.2 Steering Committee

The Steering Committee was composed of eleven members representing the following areas within the company:

NUCLEAR PRODUCTION DEPARTMENT
- Nuclear Maintenance
- Nuclear Engineering (Licensing)
- Oconee Nuclear Station
- McGuire Nuclear Station
- Catawba Nuclear Station
- Nuclear Operation

PRODUCTION SUPPORT DEPARTMENT
- Production Technical Services

DESIGN ENGINEERING DEPARTMENT
- Electrical Division - Control Systems Engineering
- Safety Review, Analysis and Licensing Division
- Mechanical/Nuclear Division - Systems Engineering

A summary of the qualifications of the Steering Committee members is provided in the Control Room Review Plan.

The Steering Committee provided an experienced management team composed of individuals representing the departments of the company involved in the licensing, design, and operation of Duke Nuclear Units. The Committee met on a regular basis throughout the review and assessment activities of the Control Room Review to discuss current status of the review and the relation to other enhancement programs. The Committee also selected the Review Team personnel, approved the Control Room Review Plan developed by the Review Team, approved the review activity methodologies, and helped formulate and approved the method used by the Review Team for assessment of HEDs. The Committee was also responsible for the approval of the final Review Team recommendations and this report.

2.3 Review Team

The Review Team was composed of a core team of six full-time members. Additional members from the line organization were added during certain planned activities, such as Task Analysis and the Assessment Phase. The core team members included three Senior Reactor Operators (from Oconee, McGuire, and Catawba) and three Instrumentation and Control Engineers (from Design Engineering). The qualifications for personnel who served on the Core Review Team are shown in the Control Room Review Plan.

Under the direction of the Steering Committee, the Core Review Team developed the Control Room Review Plan. During the development stage, it was recognized that the Core Team possessed eminent qualifications through the diversity and amount of experience in both design and operation of nuclear power plants to plan and conduct the review. However, the Team also recognized the following items:

- Training was needed to familiarize personnel with human factors principles and their application to a Control Room Review.

- Specialized Human Factors expertise would be required in certain aspects of the review and assessment activities.

- Additional personnel would be required for certain labor intensive, review activities to maintain an efficient review schedule.

- Experienced personnel were available within the Duke line organizations who could aid in the review. This utilization of personnel could also prove beneficial in developing a more acute awareness of human factors concerns that could be applied to future designs.

- A full-scale mock-up of each control board to be reviewed would be needed for use during the Task Analysis activity, and to aid in the assessment of HEDs and the development of solutions.

In early April 1982, the Review Team discussed the general plans for the review and the approach to specific activities, such as task analysis and operator surveys, with a trio of human factors consultants, including Dr. Harry Snyder of VPI, Dr. Thomas B. Sheridan of MIT, and Dr. H. L. Parris of EPRI. These discussions led to a definition of the three major review activities, i.e., Control Room Survey, Task Analysis, and Operating Experience Review.

The Review Team finalized the Review Plan in May 1982, and presented it for Steering Committee approval. After approval, the Review Team engaged BioTechnology, Inc. as the human factors consultant for the review, assigned specific responsibilities to the Review Team, the consultant, and to appropriate line organizations, and began the detailed development of review activity methods and procedures, as well as the construction of photo-mosaic, full-scale mock-ups. Lead responsibility assignments are shown in Figure 2-2.

Figure 2-2
Control Room Review
Lead Responsibility Assignments

Item	Lead Responsibility
1. Management Oversite and General Project Coordination	Steering Committee
2. Control Room Review Planning, Scheduling, and Integration	Review Team
3. Review Phase	
A. Task Analysis	Review Team (assisted by BioTechnology, Inc. for methods development)
B. Operator Experience Review	BioTechnology, Inc. (assisted by Duke Line Organization for research in plant history review)
C. Control Room Survey	Duke Line Organization (assisted by BioTechnology, Inc. for methods development)
4. Assessment Phase	Review Team (assisted by BioTechnology, Inc. and by Duke Line Organization)
5. Implementation Phase	Duke Line Organization (under guidelines and procedures established by Review Team and approved by Steering Committee)
6. Final Report	Review Team (approved by Steering Committee)

2.4 Orientation and Training

The importance of training and orientation of Review Team members, participating line organization personnel, and consultants was recognized from the beginning of the Control Room Review. A thorough familiarization of review personnel with human factors principles and guidelines is important to a knowledgeable and proper review. Equally important, however, is the training of specialized teams in the procedures and methodology of particular activities, and the cross-training between disciplines, such as the familiarization of consultants with power plant design and operations.

The following training activities were arranged by the Review Team for review personnel:

- Dr. T. B. Sheridan of MIT presented a two-day Human Factors Seminar to the Review Team. The seminar outlined the use of human factors principles in the areas of panel design, training, ergonomics, and anthropometrics.

- Simulator/Procedure familiarization. In order to more fully understand the day-to-day activities associated with Control Room operation, the Review Team participated in a two-day simulator training session at the McGuire Training Center. Training in basic plant operation fundamentals, and the use of operating and emergency procedures was provided. The training included both classroom and hands-on experience using the procedures on the McGuire Simulator.

- An orientation was provided by the Review Team to familiarize BioTechnology personnel assigned to the Control Room Review effort with nuclear plant design and operation fundamentals. The topics discussed were: (1) plant systems, (2) instruments and controls, (3) plant layout and (4) Control Room layout.

- H. E. (Smoke) Price and Dr. Harold VanCott of BioTechnology, Inc., presented a two-day Human Factors Seminar to the individuals associated with the Control Room Review effort. The topics for discussion were centered around Human Factors Principles and their application to power plant Control Rooms.

- A two-day training course for personnel involved in the Control Room Review Task Analysis Activity was conducted by Harold VanCott,, Joseph Debor, and John Hill, from Bio-Technology. Following a formal lecture presentation, the attendees participated in a Task Analysis workshop where actual operator tasks were analyzed and task data was generated. The workshop concluded with walk-throughs of the task data on the plant control board mock-ups.

- A two-day training course for the Control Room Survey Team was presented by G. R. Hatterick and D. Taylor of Bio-Technology, Inc. The training session was conducted in two

phases: (1) a description/discussion phase and (2) a survey practice phase. The first phase included a description and discussion of the materials included in the Physical Survey Kit, and an explanation of the procedures for conducting the Physical Survey. The second phase consisted of a survey workshop, using a plant control board mock-up.

During the workshop, participants completed survey checklists, identified HEDs, documented findings, and practiced photographing HEDs where applicable.

3.0 Documentation

Early in the planning stages for the Control Room Review, it was recognized that efficient and thorough documentation methods would be necessary. The documentation systems developed for the review provided a method for performing the following functions:

- Procurement and retrieval of reference information for the Review, i.e., plant FSARs, NSSS Vendor, Emergency Procedure Guidelines, Human Factors Reference Works (MIL-STD-1472-C, VanCott - Kinkade, etc.), applicable NUREGs, etc.

- Filing and retrieval of correspondence, reports, and workplace procedures concerning the Review

- Documentation of the bases, methods, and criteria used for each review activity and for the assessment of discrepancies

- Compilation and retrieval of HEDs

Briefly, to accomplish the first two functions, reference material was obtained as necessary through existing company sources and procedures, and was maintained in the Review Team work area. Existing filing and document control procedures were utilized to establish a general file in the Design Engineering Department and the Nuclear Production Department for the review. In addition, a master file for Review materials was maintained in the Review Team work area.

To document the bases, methods, and criteria used for each review activity, a system of descriptive documents was developed:

- Control Review Plan - Provided the general plan, scope, and objectives for the Review.

- Work Plan - Provided a description on a more detailed level of the necessary activities to accomplish the review tasks defined in the Review Plan and to establish the interface between the Review Team and BioTechnology.

- Review Phase Methodologies - A separate document for each review activity provided the methods, bases, and procedures for each activity, including procedures for recording the results of each activity.

A computer data base was established to record, compile, and provide for easy retrieval of HEDs. An HED form (Figure 3-1) was used as the original HED record copy and as an input form for the data base. The data base allows sorting and retrieval of HEDs by various categories such as HED number, component type, control board location, or HED disposition (assigned during the Assessment Phase).

FILE I.D. = Q5

HUMAN ENGINEERING DISCREPANCY (HED)
(USE BLACK INK)

(001) HED SERIAL NUMBER ________ (002) ORIGINATOR ____ (003) DATE __/__/__

(004) PLANT SYSTEM ____

(005) CONTROL BOARD NO. ______ (006) CONTROL BOARD DEVICE NO. ______

(007) PHOTO I. D. NO. ______ (008) PHOTO INSTRUCTIONS ________________________

(009) ________________________

(010) COMPONENT TYPE: (CHECK ONLY ONE)

- ☐ CH-E30 SWITCH
- ☐ CONTROLLER
- ☐ METER
- ☐ CH-10250T SWITCH
- ☐ ANNUNCIATOR
- ☐ RECORDER
- ☐ OTHER SWITCHES
- ☐ LABELS
- ☐ INDICATOR LIGHTS
- ☐ MONITOR/STATUS LIGHTS
- ☐ NAMEPLATE
- ☐ ________________________

(011) HED SOURCE: (CHECK ONLY ONE)

- ☐ HFS ____________
- ☐ T/A ____________
- ☐ PAM ____________
- ☐ OER ____________
- ☐ ____________

(012) PROBLEM AREA: (CHECK ONLY ONE)

- ☐ CONTROL ROOM WORKSPACE
- ☐ COMMUNICATIONS
- ☐ ANNUNCIATOR WARNING SYSTEMS
- ☐ CONTROLS
- ☐ VISUAL DISPLAYS
- ☐ OAC
- ☐ LABELS AND LOCATION AIDS
- ☐ PANEL LAYOUT
- ☐ CONTROL DISPLAY INTEGRATION
- ☐ ________________________

HED DESCRIPTION:

(013) ________________________

(015) ________________________

(017) ________________________

(019) ________________________

(021) NUMBER OF ATTACHED SHEETS __

RECOMMENDATIONS:

(022) ________________________

(024) ________________________

(026) ________________________

4.0 Review Phase

4.1 Overview

The primary objective of the Review Phase was to identify HEDs in the man-machine interface in the Control Room. The activities of the Review Phase provided an examination of the design of the Control Room and the characteristics of the operator-interface to determine whether operator tasks can be effectively accomplished. The examination was conducted in three major areas:

- Control Room Survey
- Operating Experience Review
- Task Analysis

The division of the review into three major review activities ensured a comprehensive, but realistic examination of the Control Room. Each activity provided a unique, yet complimentary perspective. The Control Room Survey, for example, systematically compared all components against absolute human factors guidelines to determine HEDs. This "pass/fail" comparison, however, did not consider operating needs, operator experience, or component use relationships. The Task Analysis examined operator tasks to determine component use relationships, operating needs, and, because operators were participants in the Task Analysis, problems from operator experience. Similarly, the Operating Experience Review examined operating needs and problems from operator experience, but unlike Task Analysis which emphasized emergency operations, covered all operations and, in addition, examined plant operating history for recurring problems.

4.2 Categorization of Guidelines

The criteria used in each review activity for the identification of HEDs was specifically developed for each activity from a review of human factors guidelines, principally from NUREG-0700. The objective in categorizing and assigning specific guidelines to each review activity was to:

- Ensure that applicable human engineering guidel es provided in NUREG-0700 were considered and addressed in the Duke Control Room Review.
- Assign each guideline to the review activity that would provide the most appropriate perspective and expertise.
- Eliminate unnecessary repetition in the application of the guidelines.

Criteria for categorizing guidelines were developed and are listed in Figures 4-1 and 4-2. Figure 4-1 gives criteria for excluding NUREG-0700 guidelines from any of the review efforts. Figure 4-2 gives criteria for assignment of guidelines to specific review efforts.

The categorization was performed in two stages. The initial categorization was conducted at the management level by the Review Team Leader and the BioTechnology project manager. The initial categorization was made by considering the top levels for the guideline breakdown in NUREG-0700 (down to 4-digit headings). Guidelines were allocated to one of the three review activities or deleted from further consideration.

The initial guideline categorization and allocation was presented to the team leaders of each of the three major review efforts, i.e., Operating Experience Review, Control Room Survey, and Task Analysis. The team leaders for each effort examined the detailed items, as well as the top-level headings, before preparing detailed questionnaire/checklist items for their respective review efforts.

Figure 4-1

Criteria for Guideline Exclusion

1. Guideline addresses equipment or conditions that do not occur in Duke units (or a particular unit).

2. Guideline is tutorial, redundant, or specifics are covered elsewhere.

3. Guideline is not applicable to a Duke Control Room operation.

4. Guideline advocates a principle which is ambiguous or which is unquantifiable or unobservable in the context of a Control Room Review.

5. Guideline proposed criteria for a specific design rather than principles or criteria applicable to a general design review.

6. Guideline lists detailed measurements or criteria, but functional requirements or intent are covered in another guideline(s).

Figure 4-2

Criteria for Guideline Assigment
to Review Efforts

A guideline will be addressed in the operating experience review

IF

operating knowledge/experience is necessary to assess the guideline (e.g., user experience or knowledge of relationships between Control Room components is needed);

AND

it does not require measurement or systematic examination of Control Room components or ambient conditions against an absolute standard (or the topic should not be assessed solely on that basis).

A guideline will be addressed in the Control Room Survey

IF

it requires systematic examination of Control Room components or ambient conditions against an absolute standard either quantitative or categorical (i.e., qualitative human engineering principles must be applied objectively, systematically, and consistently to Control Room components or ambient conditions);

AND

task data and operating knowledge are not required.

A guideline will be addressed in the task analysis

IF

it requires assessment against specific task performance requirements or task interaction requirements.

4.3 Control Room Survey

4.3.1 Overview

The objective of the Control Room Survey (CRS) was to determine the extent to which Control Room equipment, components, and environment were in compliance with human engineering guidelines. The CRS included three different types of surveys:

- A Physical Survey was conducted, both on-site and using full scale mock-ups, to evaluate Control Room components and equipment.
- An Engineering Survey was performed to evaluate the Control Room against guidelines which could be assessed using engineering drawings, or which required special studies.
- An Environmental Survey was conducted to assess guidelines which required measurements of environmental factors, such as noise, illumination, etc.

The scope of these individual surveys and the specific methods used were oriented to the type of data to be collected and the most efficient and effective methods for obtaining the data.

Responsibility for arranging and conducting the Control Room Survey was assigned to the line organization in the Design Engineering Department. A Control Room Survey Team (CRST) was chosen and staffed by personnel familiar with Control Room/control board layout and design. The CRST worked closely with consultants from BioTechnology, Inc. (BTI) to develop the survey methods and materials. The CRST also performed the surveys, documented HEDs, and other survey results.

BTI was given responsibility for leading in the definition of survey methods, preparing final materials, and for providing human factors assurance of survey results. BTI also provided training to CRST members, which included participation in two pilot surveys.

4.3.2 General Methodology

In order to provide a framework for initiating CRS detailed activities, BioTechnology prepared a draft CRS Methodology Plan. The plan defined an approach to an integrated CRS program, with both common and survey-specific methods and materials identified. This Methodology Plan, through the joint efforts of the Duke CRRT and CRST and BioTechnology, was revised several times as methods and procedures became

more well-defined, forming the basis for the performance of the CRS.

The Methodology Plan was based on the following concepts for the CRS, worked out jointly between BioTechnology and Duke participants:

1. The methodology was to ensure that all assigned guidelines were included in the survey materials, and could be accounted for at the completion of the CRS.

2. Survey checklists were to be developed that would have a common format for all three survey types, and be equally manageable during the three types of applications.

3. Survey conduct was to be based on application of human factors principles at a higher level than the individual guidelines, without losing the intent and meaning of the individual guidelines.

4. Members of the CRST who would participate in the conduct of one or more of the survey types would be directly involved in development of survey methods and materials.

Guideline Categorization By Survey Type

The initial categorization of human factors guidelines resulted in assignment of a group of guidelines to the CRS. This effort also established, on a preliminary basis, a distribution of the guidelines to one or more of the type of surveys (Physical, Engineering, or Environmental). The BioTechnology survey team leader and the Duke CRST, with the participation of key personnel from the Engineering, Physical, and Environmental Survey groups, reviewed the meaning and intent of each guideline assigned to the CRST. The purpose of the review was to determine whether the guideline could be evaluated effectively by one or more of the three survey groups and, if so, which was the most appropriate survey group. The basis for each survey category assignment was the type(s) of observation or evaluation which must be made to determine compliance with the guideline, and the survey group which could most efficiently and effectively make the evaluation and/or collect the information.

Some guidelines were identified by the CRRT that are based on Duke Power Company (rather than NUREG-0700) criteria for evaluation during the surveys. These were categorized in the manner described above and added to the survey master list of guidelines.

Development of Survey Materials

Although some materials needed for conduct of the surveys were unique to each survey type, some were common to all three surveys. In the interest of economy of preparation, as well as to reduce the need for different instructions for different survey modes, mode-specific materials were developed only when they were necessary for completion of that type of survey. Generic survey materials included:

- Survey topics and organization
- Conversion of guidelines to human factor principles
- Human factors principles checklists
- Procedures and materials for photographing HEDs
- Workplace Procedures for CRS Implementation

Each survey type (Physical, Engineering, and Environmental) was comprised of a number of principles statements, organized under the following 10 major topics:

(1) Control Room Workspace
(2) Communications
(3) Annunciators
(4) Controls
(5) Visual Displays
(6) Labels/Location Aids
(7) Computers
(8) Panel Layout
(9) Control-Display Integration
(10) Codes and Conventions

Except for topic (10), Codes and Conventions, the topics and their assigned topic numbers relate to the organization of guideline materials in NUREG-0700. This organization of topics aided the CRST in developing human factors principles from the NUREG-0700 guideline information and in cross-referencing cing between checklists and source documentation.

Principles Development

The human engineering guidelines assigned to the CRS activity were reviewed by the CRST and consultants from BTI. These guidelines were subdivided into three sets of guidelines, one for each survey type - Physical, Engineering, and Environmental.

The guidelines were further studied to develop statements of the human engineering principle which was the foundation for each guideline. The goal was to develop a principle statement broad enough to encompass all of the types of components

or characteristics to which the guideline was intended to apply, yet sufficiently specific so that the scope and context would be evident to the user.

Each principle and its supporting examples and reference information was documented on a Principles Reference Sheet (PRS) (See Figure 4-3). All PRSs were reviewed by BTI to ensure suitability of guideline combinations, comprehensibility, and appropriateness as baseline survey information. In addition, to ensure thoroughness of the survey, if the principle or its examples involved a "common and generic discrepancy," as defined by NRC, or an HED previously found as a result of the McGuire-1 preliminary assessment, these were coded on the PRS to provide a cross-reference to master lists of these discrepancies. When all reviews and revisions were completed, BTI prepared the PRSs in final form, to be used as the basis for survey checklist development.

Checklist Development

This activity involved developing a standard format for survey checklists, applicable to all three survey types, and finalizing checklist content. BTI had lead responsibility for this effort, with review and final approval by the CRST. Checklist content development involved converting the statements of human engineering principles, contained in the Principles Reference Sheets, into a form which was readily usable in each of the applicable survey types.

A checklist page contains a single principle statement and its example(s). Space is provided on each checklist page to indicate whether the principle has been surveyed for the particular survey segment and, if non-compliance is found, to reference the HED number where the discrepancy is described. Space is also provided to record brief comments (e.g., regarding unusual conditions) which the reviewer may wish to retain. The checklist format is illustrated in Figure 4-4. As in the PRSs, if a principle or example was based on a guideline that was considered to be a common Control Room discrepancy (Generic HED) or included guidelines found to be discrepant in the McGuire preliminary assessment (McGuire HED, this was noted appropriately and cross-referenced to the source documentation.

4.3.3 Survey Team Training

A two-day training session was conducted by BTI prior to the initiation of the actual CRS surveys. This training consisted of both a classroom orientation and familiarization phase, and a "hands-on" practice phase. Training materials included the prototype survey kits and other materials to be used during the surveys, examples of deficiencies found in Control Rooms, and samples of properly completed HED forms. BTI staff members answered questions about, and provided guidance for, interpretation of the human factors principles included in the checklists, and explained the contents and intended use of the survey kits.

The classroom portion of this training preceded the practice phase which was conducted during two pilot Physical Surveys described in the next section.

4.3.4 Physical Survey

The CRS Methodology Plan called for two pilot Physical Surveys, one for Catawba Unit 1 and one for Oconee Unit 1. The primary purpose of the pilot surveys was to continue the training and familiarization of Physical Survey team members beyond that achieved through classroom training. A secondary objective was to test the methods and materials developed for the surveys, and refine and revise them as needed before finalization. Pilot surveys were not "trial runs," that is, they were actual Physical Surveys, the results of which became part of the Control Room Review.

Both pilot surveys were initiated in the mock-up facility, and completed on-site in the unit Control Room. Two BTI staff, experienced in human factors evaluation of nuclear power plant Control Rooms, worked directly with the assigned survey team for the first week in the mock-up. Thereafter, for both pilot surveys, one BTI staff member stayed with the team.

As each pilot survey began, the BTI member worked closely with the team, providing guidance in implementation of procedures, identification of HEDs, and completion of records. The Duke team members actually performed the surveys. As team experience was gained, BTI participation became less active, reverting more to advising and monitoring of survey performance. During this phase, inadequacies of materials and procedures were noted for revision, and some changes were implemented in process. This role continued through the on-site portion of the survey, including review of HEDs for accuracy and adequacy.

Through this mechanism of pilot surveys, procedures and materials were refined, and all Duke CRST members designated for participation in Physical Surveys gained in-depth experience while at the same time conducting valid surveys. All remaining Physical Surveys were conducted by the Duke CRST with BTI providing human factors assurance of the results.

Each Physical Survey (PS) team consisted of two Duke Power Company engineers who were already familiar with the station equipment, and who had participated in the development of the methods and materials. The designated team leader for each station was responsible for all necessary prearrangements and for directing the survey of that particular unit. The members of the survey team accomplished the survey and recorded HEDs. In general, one used the survey kit containing the checklists and associated reference materials, and the other completed the HED forms. As each survey segment was completed, team members had the option of alternating in their roles. One or both of the team members could also act as photographer.

Each unit Control Room was surveyed by survey objects. A survey object consisted of the application of the human factors principles in a specific topic area (e.g., controls) to a specific physical aspect of a Control Room for that unit (e.g., a major panel). Principles for each topic were numbered in the checklists in the order in which they would normally be surveyed. Each topic was evaluated for all portions of the unit Control Room to which it was applicable before moving on to the next topic. This permitted maintenance of continuity of thought for each topic until the entire unit had been evaluated for that topic.

The Physical Survey of each station/unit took place in two stages. The first stage was performed at the full-scale mock-up of the unit; the second stage on-site in the Control Room. It was recognized that many topics and principles could not be fully and adequately evaluated using a mock-up, but this survey stage served two useful purposes:

1. Conducting the first part of the survey on a reasonably high-fidelity mock-up enabled the survey team to become thoroughly familiar with the control boards (and during the pilot surveys, with the survey procedures).

2. Since the mock-ups show photographs of the actual control boards, many topics and principles could be at least partially surveyed there, saving valuable time which would otherwise be required on-site in the Control Room. This reduced the extent to which the survey team interfered with ongoing Control Room activities.

The results of the Physical Survey were documented and indentified HEDs were recorded.

4.3.5 Engineering Survey

The general methods and materials used in the Physical Survey were also applicable to the Engineering Survey (ES), but there were some differences in the approach and utilization of materials.

Engineering Survey checklists, were prepared for desk-top application of survey principles. Separate topical packages were prepared for designated survey "objects," but these were defined at a higher level than in the Physical Survey. The primary difference occured at the panel level, with one checklist package provided for a unit's Main CR panels, one for the Back Panels, and one for the Local Panels, since it was determined that individual checklists need not be maintained for each panel during the Engineering Survey.

The Engineering Survey was conducted by a number of individuals representing technical specialities within Duke Power Company. The guidelines assigned to the ES comprise four major technical categories:

1. Control board design
2. Computer and CRT equipment design
3. Systems engineering
4. Other miscellaneous specialities.

A majority of the ES principles concern control board design issues which were handled by the Engineering Survey team members, each of whom also participated as members of the Physical Survey teams. Other organizations within the Control Systems Group were called upon to provide the necessary expertise for application of principles within a technical specialty.

The designated team leader for the Engineering Survey was responsible for the following activities:

- Developing the ES principles
- Categorizing the ES principles into suitable technical topics
- Assigning checklist responsibility to the appropriate disciplines in Duke Power Company
- Coordinating the checklisting efforts.

The ES was performed by applying the checklist principles to drawings, specifications, and other forms of documentation that describe the Control Room features of topical interest.

The results of the Engineering Survey were documented and identified. HEDs were recorded.

4.3.6 Environmental Survey

The Environmental Survey (EV) methodology, although generally consistent with that of the Physical and Engineering Surveys, has some unique features. These differences are based, in part, on the guidelines addressed in the EV survey, the means necessary to assess adequacy, and certain historical aspects. These differences are discussed in the remainder of this section.

The Environmental Survey methodology was based on making measurements and collecting data before application of the EV principles checklists. All of the unique materials requirements were based on the data collection segment of the EV surveys. The following specialized materials were defined and developed by the EV team and reviewed by BTI, and used during the surveys:

- Data Collection Station map for each Control Room
- Temperature, Humidity, and Air Velocity Record Sheets for HVAC Measurements
- Sound Survey Ambient Noise Record Sheets
- Sound Survey Annunciator Alarm Record Sheets
- Lighting Survey Luminance and Reflectance Record Sheets
- Lighting Survey Auxiliary Shutdown Area Illuminance Record Sheets.

Each Environmental Survey (EV) team consisted of two Duke employees who were familiar with the station and its equipment: an Industrial Hygienist from the Production Environmental Services of the Production Support Department and an Instrumentation and Control Engineeer from the Design Engineering Department. The survey responsibilities were divided as follows:

a. Instrumentation and Control Engineer

   - Team Leader
   - Prearrangement of station visits
   - Checklist and HED completion
   - Data collection assistance.

b. Industrial Hygienist

- Lead responsibility for collecting and recording data
- Training of all team members in the field calibration and operation of the data collection equipment.

Other Duke Power Company personnel were utilized to assist in data collection and recording as needed.

The Environmental Survey of each Control Room consisted of two segments: Measurements, or data collection, and Evaluation. In each segment, survey principles were addressed in three categories: HVAC, sound, and lighting. Each unit Control Room was surveyed by segment for each category using the following general approach:

1. The Control Room was divided into separate physical areas for the collection of environmental data. These areas correspond to the primary operator work stations and were referred to as Data Collection Stations (DCSs).
2. Environmental data required for each topic was collected at each DCS.
3. The collected data was recorded on the appropriate data record form.
4. Checklists, developed from human engineering principles, were completed using the recorded environmental data.
5. Deviations of the existing design from the human factors principles were identified on the checklist.
6. HEDs were written to document the identified deviations.

Environmental data for the measurement of Control Room lighting was collected by an independent consultant (Gibbs and Hill, Inc.) who was selected to perform this portion of the Environmental Survey.

A survey of the environment (HVAC, sound, and lighting) in the Auxiliary Shutdown Area of each unit was also conducted. Many of the environmental guidelines specified in NUREG-0700 are not applicable to the Auxiliary Shutdown Area. The CRST, with assistance from BioTechnology, developed guidelines to be used for a survey of this area. NUREG-0700 was used as a basis, and appropriate standards were identifed as examples in each applicable principles checklist for an operating area of this type.

The measurements methodology for these areas also differs because of the problems of creating the conditions that would exist under the circumstances necessitating occupancy. Survey data were collected at each Auxiliary Shutdown Panel and at each Auxiliary Feedwater Pump panel according to the follo·ing methods:

1. HVAC Survey. Ambient temperature, humidity, differential temperature, and air velocity data were collected under normal operating conditions and recorded for reference only.

Under certain postulated conditions (e.g., Auxiliary Feedwater Pumps Operating) this area can be expected to experience larger variations of temperature and humidity than under normal operating conditions. since it would be impractical to measure these variations, projections from Duke Power Company analyses were used. These computer analyses were performed using data for heat gain from piping, motors, etc., located in this area. These projections were entered onto the appropriate data record form in lieu of actual measurements.

2. Sound Survey. Measurements of ambient noise levels were collected and recorded at each panel under normal operating conditions only.

3. Light Survey. The following data were collected and recorded by the EV team under both normal and emergency lighting system conditions:

   - Illumination level
   - Uniformity
   - Supplemental light
   - Task Area luminance ratios
   - Shadowing
   - Glare
   - Reflectance
   - Color
   - Light intensity for internally illuminated devices.

The results of the Environmental Survey were documented and identified HEDs were recorded.

10. GENERAL CODING CONVENTIONS

SHAPE AND SIZE CODING

Principle 10.2: Where controls are coded by shape or size, they should be visually and tactually distinguishable.

Examples:

- The shape of continuous control knobs should be visually and tactually distinguishable from discrete control knobs.
- Controls which may be manipulated in a "blind" fashion should be visually and tactually identifiable and separated (e.g., alarm acknowledge and silence buttons).
- If size coding is used:
  - have a minimum of 3 different sizes
  - ★ the same function should have the same size of control (C423)
  - have a 1/2" miminum difference in knob diameter coding
  - have a 0.4" minimum difference in knob thickness coding.

Guidance: NUREG-0700, Sections 6.4.2.2.c,d,e, 6.4.4.1.b,c, Van Cott & Kinkade, Section 8.2.4
Survey Application: Physical

Revision: 10-25-82 B

DUKE POWER COMPANY— HUMAN FACTORS SURVEY CHECKLIST

STATION-UNIT:	SURVEY TYPE:	SURVEY MODE:
	PHYSICAL	GENERAL

SURVEY STATUS		
N/A	MU	CR

TOPIC:	SUBTOPIC:
10. GENERAL CODING CONVENTIONS	SHAPE AND SIZE CODING

HED NUMBERS

PRINCIPLE:

10.2: Where controls are coded by shape or size, they should be visually and tactually distinguishable.

Examples:

CR • The shape of continuous control knobs should be visually and tactually distinguishable from discrete control knobs.

CR • Controls which may be manipulated in a "blind" fashion should be visually and tactually identifiable and separated (e.g., alarm acknowledge and silence buttons).

- If size coding is used:
  - — have a minimum of 3 different sizes;
  - ★— the same function should have the same size of control (C423);
  - — have a 1/2" miminum difference in knob diameter coding;
  - — have a 0.4" minimum difference in knob thickness coding.

COMMENTS:

LEGEND:
✓: SURVEY COMPLETE
— : NOT SURVEYABLE
? : MORE REVIEW NEEDED
★ : GENERIC HED
@ : MCGUIRE AUDIT HED

4.4 Operating Experience Review

4.4.1 Overview

The objective of the Operating Experience Review (OER) was to identify features of Control Room operation or design which could potentially degrade effective control of the plant during normal or emergency operations. The review focused on two primary areas, (1) an operator survey, performed with questionnaires and interviews, and (2) a review of the operating history of each plant, including an examination of generic industry problems for applicability to the Duke review.

BioTechnology, Inc., (BTI) was assigned lead responsibility for the OER. Duke line organizations assisted BTI in the research necessary to review plant and industry operating history.

The Review Team arranged for the briefing of station personnel, the scheduling of operator interviews, and the distribution of questionnaires. The Review Team also assisted BTI in the questionnaire development and, jointly with BTI, reviewed the operator survey results and recorded HEDs. BTI conducted all operator interviews, administered the distribution and the collection of questionnaires, and performed the data reduction necessary to provide the final OER results.

4.4.2 Operating History Review

The two objectives of this activity were to (1) develop guidelines for analyzing relevant operating history reports for factors which may have a significant effect on human performance, and (2) review those reports which pertain to Oconee or McGuire Nuclear Stations where human factors may have been casually related. The Catawba Station was not included in this activity because at the time of this review the station was still under construction. BioTechnology was responsible for developing the guidelines and the Duke Nuclear Safety Assurance Group was responsible for conducting the review.

Planning discussions were held between BioTechnology, the Duke Control Room review leader, and the Duke manager for nuclear safety assurance. These planning meetings included a review of the Duke Procedure for Incident Investigation and Report Preparation and the various types of documentation available for the review. The purpose of these planning discussions was to formulate a basis for what could be "practically" expected from the available documentation of operating history. Based on these discussions, it was decided that the scope of the review would include Duke Incident Investigation Reports (IIRs), Station Incident Reports (SIRs), and INPO Significant Operating Event Reports

(SOERs). It was specifically agreed that Licensee Event Reports (LERs) submitted to the NRC need not be included in the review as these would always be covered in more detail by the IIRs or SIRs. Similarly, any LERs from other utilities would be accounted for in the INPO SERs and SOERs. Finally, it was agreed that the guidelines would make use of existing Duke procedure and policy whenever possible.

The final guidelines for the operating history review are contained in the Operating Experience Review Methodology and Procedures. Since the actual operating history reports were reviewed by safety review groups at each station who were not familiar with NUREG-0700 or the Control Room Review process, some background information was provided as part of the final guidelines. The final guidelines also represented what was considered to be a thorough approach from the human factors point of view and a practical approach from the safety assurance point of view. The operating history review took place over a period of approximately two months. The results of the review by the station safety review groups are indicated below.

Operating History Review Results

	McGuire	Oconee
IIRS Reviewed	339 (4)	133 (41)
SERS Reviewed	24 (0)	92 (0)
SOERS Reviewed	11 (0)	31 (2)
Note: Potential HEDs are Shown in Parenthesis	4	43

4.4.3 Operator Survey

a. Questionnaire Development and Administration

The Operator Survey included activities for questionnaire development, station briefing, questionnaire distribution to the stations, and return of completed questionnaires. These activities were the responsibility of BioTechnology. Duke station management personnel were responsible for questionnaire distribution to station operations personnel and for any followup needed to have the questionnaires completed in the allotted time.

Questionnaire Development

The first step in developing the questionnaire was assembling a pool of items which would be candidates for

the questionnaire or interview activities. Principal sources of these items were:

- Generic questions for nuclear power plant operations which were a part of a Control Room evaluation kit developed by BioTechnology.
- Topics generated by Duke for inclusion in the operating survey.
- NUREG-0700 items allocated to the operating experience review.
- Potential HEDs from the operating history review.

These items were assembled and organized into candidates for questionnaire and interview items.

The second step was developing the specific structure and format for the questionnaire. Since problems were the focus of the effort, it was decided to format the questions in the form of problem statements and have respondents either disagree with the statement (i.e., it is not a problem) or agree with the statement and specify the degree of concern. It was further decided that space would be blocked out on the questionnaire form to encourage the respondent to provide specific details about each problem statement. The final form of the response categories is indicated below.

[ ] Not Applicable	DETAILS: This space is for details such as:
[ ] False-No problem	- A specific component or system
[ ] True-Minor inconvenience	- A specific poor design or operational feature
[ ] True-Could affect performance	- Description of a relevant example or incident
[ ] True-Could affect availability	- A specific policy, procedure, or operator aid
[ ] True-Could affect safety	- Suggestions for improvement
[ ] No opinion or not enough data	

The third step was preparing the specific questionnaire items from the candidate list developed earlier. This step went through a series of iterations until both BioTechnology and Duke were satisfied that all of the assigned items from NUREG-0700 were covered and the questionnaire items were complete and unambiguous. In effect, this iteration served the purpose of a pre-test to ensure that respondents would understand the questionnaire items.

The fourth step was developing a personal data sheet for each respondent to document information about his or her job category, license status, educational level, and height and weight (to allow later development of a profile of body dimensions).

Questionnaire respondents were guaranteed anonymity, as far as Duke Power Company was concerned. Respondents returned the questionnaires directly to BioTechnology in a pre-stamped envelope. A tear-off slip was attached to the questionnaire for the respondent to provide his name for use only by BioTechnology in contacting the respondent for further clarification or information. All questionnaire data were then processed by a code number.

Station Briefing and Questionnaire Distribution.

A briefing at each station was held to acquaint the management and supervisors at each station with the plan for collecting questionnaire and interview data. Briefings were held during regular station supervisors meetings to reach the greatest number of personnel.

Each supervisors meeting typically contained the superintendent of operations, operating engineers, shift supervisors, and some assistant shift supervisors--usually 12 to 15 people.

On the day the station briefing was conducted, the required number of questionnaires for distribution to station personnel were given to the station. An operating engineer was the point of contact for each station and took charge of distributing the questionnaires within the plant to the various position levels on each operating shift.

Return of Completed Questionnaires.

Questionnaires were delivered in a pre-stamped and pre-addressed envelope for direct mailing back to BioTechnology. As the questionnaire was received at BioTechnology, the code number and respondent's name were recorded in a log and the tear-off I.D. slip was removed and kept in a secure personal file. Any further treatment of the questionnaire was controlled by a coded questionnaire number with no indication of the respondent's name.

4.4.4 Interview Development and Administration

Some operator experiences cannot be easily solicited by a questionnaire, and these items were designated for collection by interview. this activity included the following two subactivities.

Interview Protocol Development.

Interview protocol development was a two-step process. First, the general approach and scope were developed. it was determined that the interview would be a loosely structured, informal interview conducted in a confidential manner on a one-on-one basis with a BioTechnology human factors professional. The interviewer would not tape the session but would take written notes. To support the interview, a short introduction was prepared to present to the interviewee and a looseleaf notebook containing a complete photographic mosaic of the entire Control Room, panel layout drawings, and a list of station abbreviations were used to identify specific Control Room problems or concerns. Finally, it was decided that specific items in the interview would be drawn from the preliminary analysis of the questionnaire data and the operating history review.

The second step was the identification of specific items for inclusion during the interview. Sources of specific items included:

- Items that were difficult for inclusion in the questionnaire.
- Areas of concern as suggested by the preliminary questionnaire results.
- Incidents or problems determined from the operating history review.
- Problems with particular components, systems, or panels which would help in identifying potentially difficult operating sequences or procedures which should be included in the task analysis review.
- Areas of interest to Duke management such as workload, staffing, training, and local panel difficulties.
- Suggestions to improve operations in the Control Room.

All of these items were organized into specific categories with prompts or cues to stimulate discussion. The generic Control Room categories are illustrated in Figure 4-5.

Interviews.

A schedule was developed and coordinated between BioTechnology and Duke to conduct interviews with all three stations over approximately a one-month period. BioTechnology organized two-man interview teams to conduct the interviews at each station.

The interviews were conducted in the administration building at each station in a private room. The interviewee was given a brief overview of the Control Room design review effort and the purpose of the operating experience review activity in particular. The interviewee was assured that anything said to the BioTechnology interviewer would be kept in strict confidence. The interviewers generally guided the discussion but did not attempt to constrain the interviewees from discussing any concern they wanted to.

4.4.5 Operating Experience Review Data Reduction

Because of the large amount of data obtained from the number of questionnaires which were returned (161) and interviews conducted (106), it was necessary to have a data reduction activity prior to the identification of HEDs. Data reduction consisted primarily of collating data by issue, compiling data by individual and by question, and developing generic or related concerns. It is important to point out that the results of this activity did not summarize the questionnaire or interview data but rather organized and integrated the data. Anonymity of questionnaire respondents and interviewees was maintained and data was organized by station, category of problem, and individual code numbers.

Questionnaire Data Reduction.

A computer program was developed to codify and tabulate questionnaire responses. After the questionnaires received in the mail were logged in, the data was keyed into the computer. Questions related to Control Room problems were of two types.

The first type, generic Control Room questions, required respondents to identify the level of concern they had for any question (problem statement) and then provide written details. The response categories and numerical codes entered into the computer were as follows:

1. No problem

2. Minor inconvenience

3. Could affect performance

4. Could affect availability

5. Could affect safety

6. No opinion or not enough data

7. Indication of a desire for discussion or clarification

8. (No meaning attached to this number.)

9. No response

10. Not applicable.

The items of most serious concern were coded as 5 (safety) and the least concerns were coded as 1 (no problem). Whether or not the respondent provided details was simply coded a "yes" or "no." The second question type was the general evaluation question. For this series of questions, respondents provided their general evaluations of certain broad issues. Topics covered by these questions were training, plant maintenance, workload, procedures, Control Room staffing, local panels, and the auxiliary shutdown panel.

The program generated a compilation of the answers to each question by all respondents at a particular station, and for each individual a compilation of responses to all the questionnaire items. The final step in the data reduction was to collate the answers by question for each respondent at the station.

Interview Data Reduction

Information obtained from the interviews was recorded in the form of notes by the interviewer, often supplemented by marked-up panel layout drawings. The interviewer tried to obtain as much specific information about the problem as possible, including the component, Control Room panel, system, and interviewee's principal concern. As soon as practicable after the interview was completed, these notes were transcribed onto an interview results form designed to be similar to the HED recording form. The next step in reducing the interview data was to collate all of the concerns raised by two or more individuals as generic concerns. The information obtained from each individual about the same problem was then written as one single generic concern and the code number for each individual who raised that concern was included on the final form.

Organization of Data Packages for HED Review.

After the questionnaire and interview data reductions described above were completed, the results were organized into data packages for disposition and identification of HEDs. Three

data packages were prepared for each station that participated in the Control Room Review:

1. A distribution of questionnaire responses for all individuals who completed the questionnaire.

2. An individual data package which consisted of the results from the questionnaire and interview for each individual. In many cases, the individual had submitted a questionnaire and had also participated in the interview, and the package contained both subsets of data.

3. A generic data package consisting of a composite of question details and a compilation of every concern raised by more than one individual. The concerns were then given a generic title and organized by problem areas.

The results of the questionnaire and interview data reduction, and the results of the operating history review, represent potential HEDs. Six disposition alternatives were identified:

1. The problem or area of concern was beyond the scope of the Control Room Review effort or any other practical design or operational change.

2. The problem description needed verification or clarification before disposition could be made.

3. The problem was not a human engineering discrepancy but did represent a legitimate area of concern and should be brought to the attention of plant management.

4. The potential HED should be discovered or validated during task analysis.

5. The potential HED should be discovered or validated during the Control Room Survey.

6. The potential HED was a legitimate human engineering discrepancy based on operational experience and should be documented in the prescribed manner for HEDs.

The methodology for examining the results of the operating history review was essentially the same as for the results of the questionnaire and interview.

All potential HEDs were reviewed and finally documented as (1) legitimate human engineering discrepancies, (2) supporting documentation for HEDs identified in the Control Room Survey and Task Analysis activities, (3) problems brought to the attention of Plant Management, or (4) as areas of concern beyond the scope of Control Room Review or any other practical design or operational change.

Figure 4-5

GENERIC CONTROL ROOM ISSUES

- Controls
- Displays
- I&C General (Absence or Excess)
- Panel Layout
- Control-Display Integration
- Annunciator System
- Process Computers
- Labels
- Control Room Layout and Workspace
- Control Room Environment
- Emergency Equipment
- Communications
- Normal Operating Procedures
- Abnormal or Emergency Procedures
- Training
- Plant Maintenance
- Local Panels
- Auxiliary Shutdown Panel
- Workload
- Staffing and Personnel in Control Room
- Suggestions to Improve Control Room Operations

4.5 Task Analysis

4.5.1 Introduction

The primary objective of the Task Analysis activity was to evaluate the human engineering suitability of controls and displays to support the effective accomplishment of operator actions required during certain normal and emergency operations.

The Task Analysis activity performed a detailed investigation of selected operational sequences. The operator tasks for each sequence were identified together with the components required to perform each task. A walk-through of each task was then performed on a mock-up of the control board, and finally the components and their arrangement were analyzed for human engineering suitability for the task involved.

This approach complemented the Control Room Survey and Operating Experience Review by identifying HEDs which become apparent upon consideration of the way components are used. For example, an information item, needed for the performance of a task, might be unavailable in the Control Room. This particular inadequacy may not be picked up on the Control Room Survey because a non-existent display cannot be evaluated. It may not have been noted in the Operating Experience Review because the operator may have adapted to less convenient or more indirect information sources. Task analysis would identify this component from the analysis of the task in which it was used.

The Task Analysis activity emphasized emergency operating sequences and used the NSSS vendor Emergency Procedure Guidelines (EPGs) as a basis. The EPGs used in the task analysis activity are the Emergency Response Guidelines (ERG) of the Westinghouse Owners' Group for McGuire and Catawba, and the Abnormal-Transient Operating Guidelines (ATOG) of Babcock and Wilcox for Oconee. In addition, normal operating sequences selected from the results of the Operating Experience Review were evaluated.

BioTechnology, Inc. (BTI) was responsible for the development of the Task Analysis methodology, for the training of Duke personnel in its application, and for the continuing review of the procedures used and the product achieved in the Task Analysis. The continuing Task Analysis work and the selection of operational sequences for review was performed by Duke personnel assigned to task analysis teams. In training Duke participants, BTI delivered a short series of lectures on human factors to the Control Room Review Team, conducted a workshop for participants in the Task Analysis, and participated in a pilot Task Analysis. BTI provided two members of its human factors staff to meet regularly with the Duke Task Analysis Teams for consultation on any necessary refinement

of procedures, and for the systematic review of Task Analysis results.

4.5.2 Selection and Training of Task Analysis Teams

The use of subject matter experts, personnel familiar with the design or operation of a system, is important to all Task Analysis activities. It is particularly crucial to have expert knowledge in a Task Analysis of a complex system such as a nuclear power plant. To this end, the Review Team selected personnel to staff three Task Analysis Teams, one team each for McGuire, Catawba, and Oconee. Each team was composed of a Senior Reactor Operator (a certified operator in the case of Catawba, which was under construction during the Task Analysis activity) and an engineer familiar with plant system design. The three teams were under the direction of an engineer experienced in plant systems design and Control Room/control board design, who served as Task Analysis Group Leader. The Task Analysis Group Leader and the three operator members of the Task Analysis Teams were also members of the Core Review Team.

BioTechnology, Inc. (BTI) provided both human factors training and Task Analysis training for team members. In addition, a one-week pilot Task Analysis program was performed. During the pilot program, the teams performed Task Analysis under the direct supervision of the BTI Task Analysis consultants. The pilot program gave each team the opportunity to practice what had been learned in the training lectures and to be critiqued by the consultants. The program also provided input to the refinement of the final methodology and procedures used.

4.5.3 Scope of the Task Analysis

It was recognized during the Review Plan development that Task Analysis had not been formally applied to any significant extent in the power industry. Also, Task Analysis has, in general, been used only on smaller systems, consoles, etc., or on limited portions of larger, more complex systems or equipment. A practical application of Task Analysis to a nuclear power plant would require a determination of where Task Analysis would be most beneficial.

Primary emphasis for the Control Room Review was placed upon improving the plant emergency response capability. Therefore, it was consistent to emphasize emergency operations in the Task Analysis. It was also noted that thorough systems analyses of transients and accident conditions had been performed by the NSSS vendors in their development of emergency procedure guidelines (EPGs). These guidelines define the functions allocated to the Control Room operating crew to provide effective operation and control of the plant under a variety of abnormal and emergency conditions. As such, the

EPGs form a sound technical basis for the development of plant-specific emergency procedures as well as Task Analysis. The EPGs were chosen as the basis for the emergency operations portion of the Task Analysis activity. However, due to a difference in format between the Westinghouse EPGs (Emergency Response Guidelines or ERGs) and the B&W EPGs (Abnormal Transient Operating Guidelines or ATOG) a slightly different method of operating sequence selection between the Westinghouse plants (McGuire and Catawba) and the B&W plant (Oconee) was necessary. This selection process is described in the next section.

While the emphasis of the Task Analysis activity was placed on emergency operations, problem areas in normal operation were also of concern. However, normal operations constitute a diverse, open-ended set of operator tasks and combinations of those tasks. A method was needed to select a reasonable set of tasks to be analyzed.

It was recognized that most plant operation time is spent performing "normal" operations. Operators inherently experience problems in normal operation more than in any other mode. Operational experience would appear to provide the most effective means of determining where problems may exist during normal operations. Therefore, the results of the Operating Experience Review were used to identify problem areas in normal operation as a basis for the selection of normal operating sequences to be analyzed.

4.5.4 General Description of Task Analysis Method

The methodology for Task Analysis activity was based on methods developed and applied to the design and test of numerous military and industrial systems. In particular, it draws upon and adapts state-of-the-art methods and procedures developed and used for Task Analysis by the General Physics Corporation and BioTechnology, under contract to the Nuclear Regulatory Commission. As a result, it is compatible with the NRC Task Analysis Methodology and consistent with the guidelines for Task Analysis outlined in NUREG-0700.

The Duke Task Analysis method uses the NRC Task Analysis Methodology as a basis, but adapts it to identify HEDs by reference to plant control board mock-ups. Briefly, the Task Analysis Methodology provides a means of transforming operational sequences into operator task and task-element descriptions, and then using this information to identify human engineering discrepancies (HEDs) in Control Rooms. This process consists of a series of four steps (See Figure 4-6):

1. Selection of operating sequences

2. Development of task descriptive data

3. Human engineering discrepancy identification and documentation

4. Simulator studies

Step 1: Sequence Selection and Origination

In order to perform a Task Analysis, information on plant operations must be arranged in the form of operating sequences (an orderly progression of operator tasks). Guidelines (ERGs) have been published in an operating sequence type of format by the Westinghouse Owner's Group. ERGs provide a number of chains of consecutive operator actions, each chain related to particular events or occurrences. In the Task Analysis, each chain is defined as an operating sequence. All chains for each Westinghouse plant (McGuire and Catawba) were analyzed. Accordingly, there was no need to select particular ERG sequences for analysis.

For the B&W plant (Oconee), the ATOG as published by B&W was the source of emergency operating sequences. Five credible pathways through the successive actions and decisions within ATOG were selected. The Task Analysis used these five sets of successive occurrences as the operating sequences or scenarios for Oconee. The five pathways were selected in a way to comprise a comprehensive inventory of possible emergency actions. The five pathways were selected from a large number of possible pathways through ATOG actions. While it is possible that other equally valid sequences could have been selected, the five chosen are fully credible and provide a reasonable and comprehensive exercise of Control Room interfaces.

In addition to emergency sequences based on ATOG and ERGs, normal operating sequences were selected for analysis after a review of the results of the Operating Experience Review. this selection was plant specific since is was based on the problems identified through operational experience at each plant.

Step 2: The Development of Task Descriptive Data

Step 2 of Task Analysis is often referred to as task description. Since ERG sequences are written in a different format than ATOG sequences, there is a difference in the initial stage of task description. Despite different treatments in the initial stage of analysis, all analyses arrive at the task level of describing operator action and then proceed to the element level within each task. The "bottom line" for purposes of the Task Analysis is that for all sequences, whether normal, ERG-based, or ATOG-based, the analysis will develop a listing of the interfaces (displays and controls) used by operators and an indication of the relative order in which they are employed.

Development of Data from ERG-Derived Sequences.

A Task Sequence Chart (TSC) (Figure 4-7) was completed for each ERG sequence, listing task titles in the main sequence in the order of sequence progression, along with information on the sequence and sequence step to which a branch is possible.

Development of Data from ATOG-Derived Sequences.

The Task Analysis Team for Oconee prepared an Operating Sequence Overview (OSO) for each selected operating sequence. The OSO described the conditions preceding the event, the action that initiated the sequence, the progression of action during the sequence, and the final conditions upon its termination.

Following completion of the OSO, a Clustered-Task Sequence Chart (CTSC) (See Figure 4-8), which lists the tasks to be performed in clusters related to an occurence in the sequence was developed.

Development of Data for Normal Sequences.

The sequences for normal operations were treated the same as ATOG-based sequences. The sequence was documented in an Operating Sequence Overview (OSO) and the OSO was followed by completion of a Clustered-Task Sequence Chart (CTSC).

Completion of Task Data Forms (TDFs).

A TDF was completed for each task of the operating sequences analyzed. Principally the TDF (Figure 4-9) is a detailed description of the activities of the operator in performing the task. The task is broken down into individual actions of the operator, termed "elements" or "task elements." The description for each element indicated the operator's job category (when appropriate), his physical location, the action he takes, the component he uses, the parameter involved, and the plant system affected by or associated with his action. Communication equipment used in performing a task was also be noted.

Step 3: Human Engineering Discrepancy Identification

Step 3 is the use of task-element descriptions, a Control Room mock-up, and Task Analysis HED Principles (see Figure 4-10) in an integrated effort to identify HEDs.

In Step 3, the Task Analysis team performed a walk-through of each task. They used the full scale mock-up to visualize exactly how each task was performed, both by itself and in relation to preceding and succeeding tasks. They looked for ways in which physical factors could impede task performance.

The identification of HEDs was guided by the Task Analysis HED principles. As an example, the following type of problems were considered:

- Lack of particular controls or displays needed to do the task
- Inability to read pertinent displays from the location of the operator when doing the task
- Information display inadequate to provide information of the type and accuracy needed for the task.

When an HED was identified, it was noted and subsequently reported on an HED form.

Step 4: Simulator Studies

During the planning stages of the Control Room Review, the Review Team was concerned that highly time dependent or system-response dependent operator actions might be difficult to analyze using an unpaced walk-through on a static mock-up. A provision was made in the Task Analysis Methodology to select sequences which appeared to require a more dynamic representation for study at the McGuire simulator.

During the Task Analysis, the Task Analysis Teams did not identify any sequences which required simulation to analyze. All sequences analyzed, both normal and emergency, were found to be amenable to walk-through on a static mock-up. A study of several selected emergency oeprating sequences, as well as some of the more dynamic normal operations was performed, however, to (1) confirm the Task Analysis methodology, (2) confirm previously identified HEDs, (3) identify any new HEDs discovered during simulation.

The following sequences were studied:

- Steam generator tube rupture
- Rod ejection incident
- Recovery from inadvertent safety injection
- Loss of all AC power
- Startup (partial)
- Feedwater bypass to main regulating valve
- Control of diesel generators

- Control of nuclear service water (in various modes)

- Control of charging and letdown systems (in various modes)

- Exercise of computer displays

Each sequence was performed by a crew consisting of two operators and one engineer (all members of the Task Analysis Teams). Another engineer member of the team and two consultants from BioTechnology, Inc. served as observers. The performance of each sequence was video-taped for later playback and discussion. The previous Task Analysis data and HEDs for the sequence were compared with the results of the simulated run during these discussions and any differences were noted.

The results of this study showed that the Task Analysis methodology was an effective tool to identify HEDs. No new HEDs were identified using simulation, but the previously identified HEDs were confirmed. The study also showed that the simulator was an excellent tool to evaluate the operational impact of HEDs.

4.5.5 Human Factors Assurance

BioTechnology, Inc. (BTI) had the lead responsibility for Human Factors Assurance within the Duke Task Analysis effort. Human Factors Assurance equates simply to taking every action within reason to make certain that the analysis is performe in an understandable, thorough, and correct manner. To this end, three factors were emphasized:

1. Select the proper people for the analysis and give them the necessary training.

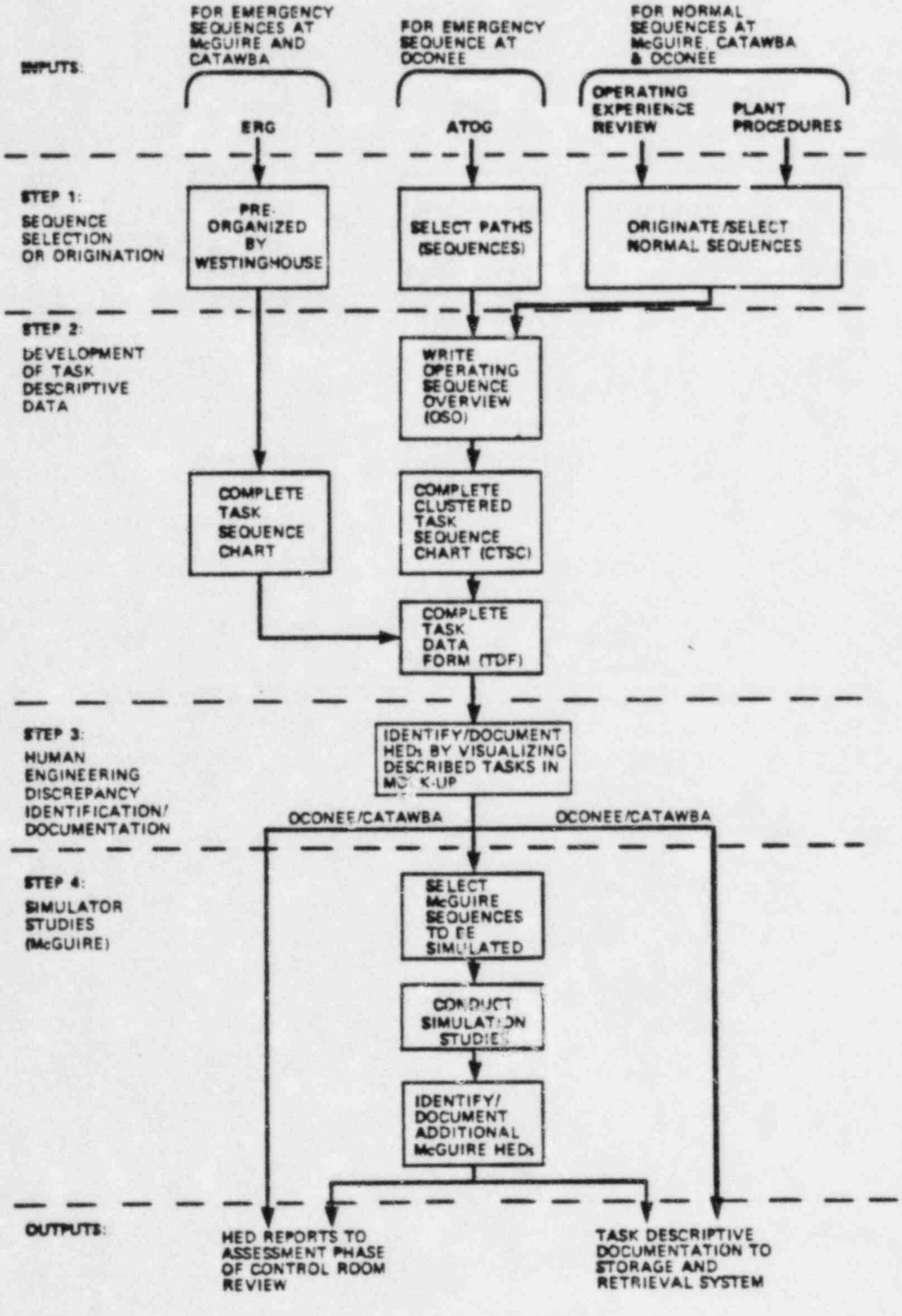
2. Human-engineer the analysis to make it readily understandable and convenient.

3. Review the product and re-instruct the team as needed.

Product review and re-instruction was carried out by BTI in a structured manner. This process involved BTI's reading of data packages for selected sequences completed by each plant team, verbal discussion of any lack of clarity or deviations from standard format, and direct participation with each plant team as they originated task descriptions. this was done during monthly visits by BTI representatives to the Duke Task Analysis Team and at BTI's home office between visits. BTI wrote a "Task Analysis Review Memo," generally after each visit, in which they documented any problems discovered and, if necessary, recommended procedures to prevent their recurrence. Review of written material focused upon consistency

across the three plant teams, consistency with the methodology and procedures, and clear communication of meaning. HED reports were considered for these same factors and for conformity with Task Analysis HED Principles.

Task Analysis Process



DUKE POWER COMPANY
TASK SEQUENCE CHART (TSC)

Sequence No. ECA-2 Sequence Title Loss of All AC Power

Plant, Unit # Catawba 1
Rev. # 1 Sept 1981

TASKS IN MAIN SEQUENCE		W Ref.	SEQUENCES/TASKS POTENTIALLY BRANCHED TO*			Comments
Number	Task Title		Sequence Number	Task No.	Title	
1	Verify reactor trip	C20.1				
				B-1a	Manually trip reactor	
		C10.1	ECA-1	1	Manually trip reactor and turbine	
				B-1b	Dispatch personnel to to restore power to AC vital buses	
2	Verify turbine trip	C20.2				
				B-2	Manually trip turbine	
3a	Try to restore power to any AC emergency bus	C20.3				
				B-3a	Emergency start and load diesel	
				B-3b	Trip diesel	
3b	X-conn with Unit 2 power	C20.3				
4	Verify NC isolation	C20.4				
				B-4a	Close PZR PORV's	
				B-4b	Close letdown and excess letdown isolation valves	

Form Revision: 9/18/82

*Enter only one task namely the task immediately branched to.

DUKE POWER COMPANY
CLUSTERED–TASK SEQUENCE CHART (CTSC)

Plant, Unit # Oconee #1

Sequence No. 1 Sequence Name ATOG Rev. # 0

Sequence Outline	TASKS Number	TASKS TITLE
A. Both Main Feedwater Pumps trip		
B. All three Emergency Feedwater Pumps fail to start		
C. Reactor trips on high RCS pressure	I.1.a	Manually trip the Reactor
	I.1.b	Manually trip the Turbine
	II.1.0	Verify Reactor Power decreasing
D. Group 1 Control Rods fail to drop	II.1.a	Start HPI from BWST
	II.2.0	Verify all rods on bottom
	II.2.a	Begin emergency boration
	II.3.0	Verify all Main Turbine Stop Valves shut
	II.4.0	Verify Letdown flow through Block Orifice only
	II.5.0	Verify Feedwater runback
	II.6.0	Verify ICS NNI power on
	II.7.0	Verify Station on Startup Transformer
	II.8.0	Verify E.S. actuation if required by RCS pressure
	II.9.0	Verify adequate Subcooling Margin
	II.10.0	Determine lack of heat transfer
E. P.O.R.V. opens and fails open	III.B.1.0	Determine adequate Subcooling Margin
F. Operator shuts RC-4 which fails Throttled	E.1	Determine P.O.R.V. status
	E.2	Shut valve RC-4
G. Operators trip all four Reactor Coolant Pumps due to Inadequate Subcooling Margin	III.B.2.0	Trip all Reactor Coolant Pumps
H. Operators initiate HPI	III.B.3.0	Initiate HPI
I. Pressurizer becomes filled	III.B.4.0	Determine if superheated conditions exist
J. Feedwater re-established	III.B.5.0	Determine if Feedwater is available
	III.B.6.0	Initiate Emergency Feedwater or Main Feedwater if available
	III.B.7.0	Determine if Feedwater is adequately re-established

DUKE POWER CO. – TASK DATA FORM (TDF)

Plant, Unit # Catawba #1

Operating Sequence Name Loss of All AC Power Number ECA-2 Rev. # 1 Sept. 1981 Page 1 of 1

Task Title Manually trip reactor Task # B-1a

Task Objective Trip Reactor

Task Cue No automatic trip

Comments

Subject			Immediate Object of Action (Control Room Component)				Remote Object of Action					Communication	
Who	Location	Behavior Verb	Name	Description	I.D.	LOC.	System	Plant Component	Component/System State	Parameter	Parameter State	(Other Party & Location)	HED I.D. No.
	1MC1	Turns	Rx Trip Trn A & B	Switch	IR-20 IR-21	1MC1	IPE	Rx Trip Bkr A&B	Open	—	—	—	—
	1MC1	Verifies	Rx Trip Bkr 1A	Ind Light	IR-22	1MC1	IPE	Trip Bkr 1A	Open	—	—	—	—
	1MC1	Verifies	Rx Trip Byp Bkr 1A	Ind Light	IR-23	1MC1	IPE	Trip Byp Bkr 1A	Open	—	—	—	—
	1MC1	Verifies	Rx Trip Bkr 1B	Ind Light	IR-25	1MC1	IPE	Trip Bkr 1B	Open	—	—	—	—
	1MC1	Verifies	Rx Trip Byp Bkr 1B	Ind Light	IR-26	1MC1	IPE	Trip Byp Bkr 1B	Open	—	—	—	—

REVISION: 9/18/82

TASK ANALYSIS HED PRINCIPLES

1. Are all of the controls, displays and indicators that are required to perform this task present in the control room?

2. Are the controls, displays and indicators grouped in accordance with the information and control requirements of this task?

3. Are the controls, displays and indicators labeled according to the requirements of this task?

4. Can the displays and annunciators used in this task be read accurately from viewing position of the operator? Can displays be read while operating associated controls?

5. Do the displays give the operator direct, readily usable information:

   - Parameter values with required precision?
   - Range, band, limit shown if the operator needs to know in/out of range/band, above/below limit, etc.
   - Trend information when needed?
   - Rate of change information when needed?
   - Percentage information used only when appropriate?
   - Digital or analog information used when needed?
   - Status or demand information as appropriate for the task?*

* To be noted only for cases known to the operator; task analysis is not expected to determine power source of all indications.

P-26

6. If instrumentation or control capabilities are unavailable under certain plant conditions, are there alternate means provided for the operator to meet task needs.

7. Are related controls and displays within functional groups, arranged in the same relative positions? For example:

A display	B display	C display
A control	B control	C control

8. Is the display obscured while operating its associated control?

9. Are there any controls, control positions or displays which the operator knows do not serve any function?

NOTE

If the Task Analysis Team discovers a HED which in their judgement would require operational knowledge to discover or would be a decrement to Task performance, they should feel free to report it even though it is nominally allocated to the Survey or Operating Experience Review.

5.0 Assessment Phase

5.1 Overview

The objective of the assessment program was to provide an organized and consistent method for determining the significance of each HED, for developing feasible solutions, and for estimating solution costs. These evaluations were used to decide which HED solutions represented cost-effective improvements to the Control Room. Because the combined areas of nuclear safety and operator error are difficult to assess on an absolute cost/benefit basis, no well accepted cost effectiveness criteria presently exist for use in judging human factors improvements to Control Rooms. Duke Power's HED assessment program was designed to identify cost-effective improvements, using relative cost/benefit evaluations, the experience of qualified Duke operators and engineers, and the advice of human factors specialists.

The correction of a human engineering deficiency should result in an improvement to the affected Control Room; however, the amount of benefit derived from that correction is directly tied to the significance of the HED as it relates to the performance of the intended operating task. The HED significance can be expressed as the ratio of the likelihood (potential) that the HED will induce an operator error divided by the potential for error detection and recovery, all multiplied by the consequence to plant operation if the error is made and goes undetected. Expressed functionally:

$$\text{HED significance} = \frac{\text{Potential for Error}}{\text{Potential For Recovery}} \times \text{Consequence of Error}$$

All three of these factors were considered in determining the significance of an HED to operator task performance. Because the benefit derived from correcting a given HED is directly proportional to the significance of that HED (as it relates to operator performance), the evaluations of potential and consequence were used to quantify the benefits in HED cost/benefit analyses. This benefit evaluation was conducted on a relative basis for all appropriate HEDs. HED significance was not judged by actual monetary benefit; rather, the significance of a specific HED was judged on a relative scale in relation to the significance of all other HEDs.

Upon completion of the relative significance evaluations, solutions were developed for HEDs determined to be deficiencies. HED solutions included physical Control Room modifications, surface enhancements to control boards, recommendations for procedure revisions or additional training as appropriate. Cost estimates were prepared for HED solutions.

The information resulting from the relative benefit and cost evaluations was used to decide which HED solutions represented cost-effective improvements to each plant.

5.2 General Description of Criteria/Methods

The assessment program was divided into six phases as follows (see Figure 5-1):

Phase I...HED information organization.

Phase II...Screening and HED relative significance evaluation.

Phase III...Determining optimal HED solutions.

Phase IV...Cost evaluation for HED solutions.

Phase V...Deciding which HED solutions represent cost-effective improvements to each Control Room.

Phase VI...Resolution of all remaining HEDs.

While the work schedules of the phases overlapped at times, the phases were distinct in function and purpose. This work was performed by the Control Room Review Team, assisted by consultants from BioTechnology.

Phase I: HED Information Organization

The purpose of this phase was to organize all HEDs in preparation for future evaluation. HED information contained in a computer data base, was sorted by various parameters to facilitate the review process. The majority of HED evaluations were organized and conducted on a control board by control board basis. With the use control board mock ups, this approach ensured that HED significance was evaluated and solutions were developed in an integrated manner.

Phase II: Screening and HED Relative Significance Evaluation

This phase first addressed the issue of whether a given Human Engineering Discrepancy (HED) actually represented a deficiency in the man-machine interface. It was anticipated that in some situations, an identified HED (one based on a population sterotype violation, for example) may not have actually represented a deficiency when reviewed in a broader context (the identified component may have followed a different, yet logical plant stereotype, for example). All HEDs in this category were removed from futher assessment with brief written justification for the removal.

Some HEDs required individual assessment due to their unique nature. The few HEDs of this type were collected in a separate, individual review category for resolution in Phase VI.

Additionally, remaining HEDs were screened to identify those where control board surface enhancement clearly represented the optimum solution. (Surface enhancement is defined as those techniques of improved labeling, demarcation, and color coding/shading which

require minimal or no engineering alteration.) These surface enhancement HEDs were removed from further relative cost/benefit assessment and addressed in Phase VI with other remaining proposed surface enhancement solutions.

For all remaining HEDs not segregated by screening reviews, relative significance evaluations were completed. This evaluation was comprised of objective and subjective estimates of (1) the potential for an error being induced by the HED, (2) the potential for the induced error to be detected and corrected in time, and (3) the consequence of that error on plant functions, if it remains undetected. In summary, the total relative significance of an HED was quantified as the ratio of potential for error over potential for recovery, all multiplied by the consequence of error. The error and recovery potentials were subjectively arrived at by team consensus through the use of predetermined criteria while the consequence was determined from the hierarchy of systems required to maintain an acceptable nuclear safety margin, availability, reliability, and efficency.

Phase III: Determining Optimal HED Solutions

Upon completion of the relative significance evaluations in Phase II, optimal solutions were developed. HED solutions predominantly addressed physical changes, procedural modifications, and/or training improvements; however, the undue reliance of training and procedure solutions was avoided. All proposed physical change solutions were evaluated for feasibility of implementation and to assure that solutions could be implemented in accordance with good human engineering practice.

If during this phase it became clear that the optimal solution for a given HED was surface enhancement, the HED was removed from further formal assessment and transferred to the surface enhancement category. This decision was adequately documented and the HED was resolved in conjunction with all other surface enhancement HEDs in Phase VI.

Phase IV: HED Solution Cost Estimating

The purpose of this phase was to evaluate implementation costs associated with each HED solution. This evaluation addressed costs associated with three distinct areas of resources most commonly utilized for HED resolution. Those areas are: (1) engineering and construction resources for physical changes, (2) plant operations costs for procedural changes, and (3) resources for additional training and/or simulator changes. The combined or separate evaluation of these three areas represents the total cost evaluation for each HED solution.

Phase V: Decision on Optimal HED Solutions to be Implemented

A final subjective determination was made concerning which HED solutions should be implemented. This determination was aided by the

previously outlined evaluations; however, the final decision was based primarily on the experience and qualifications of Review Team personnel. HEDs not selected for optimal solution, were addressed in Phase VI.

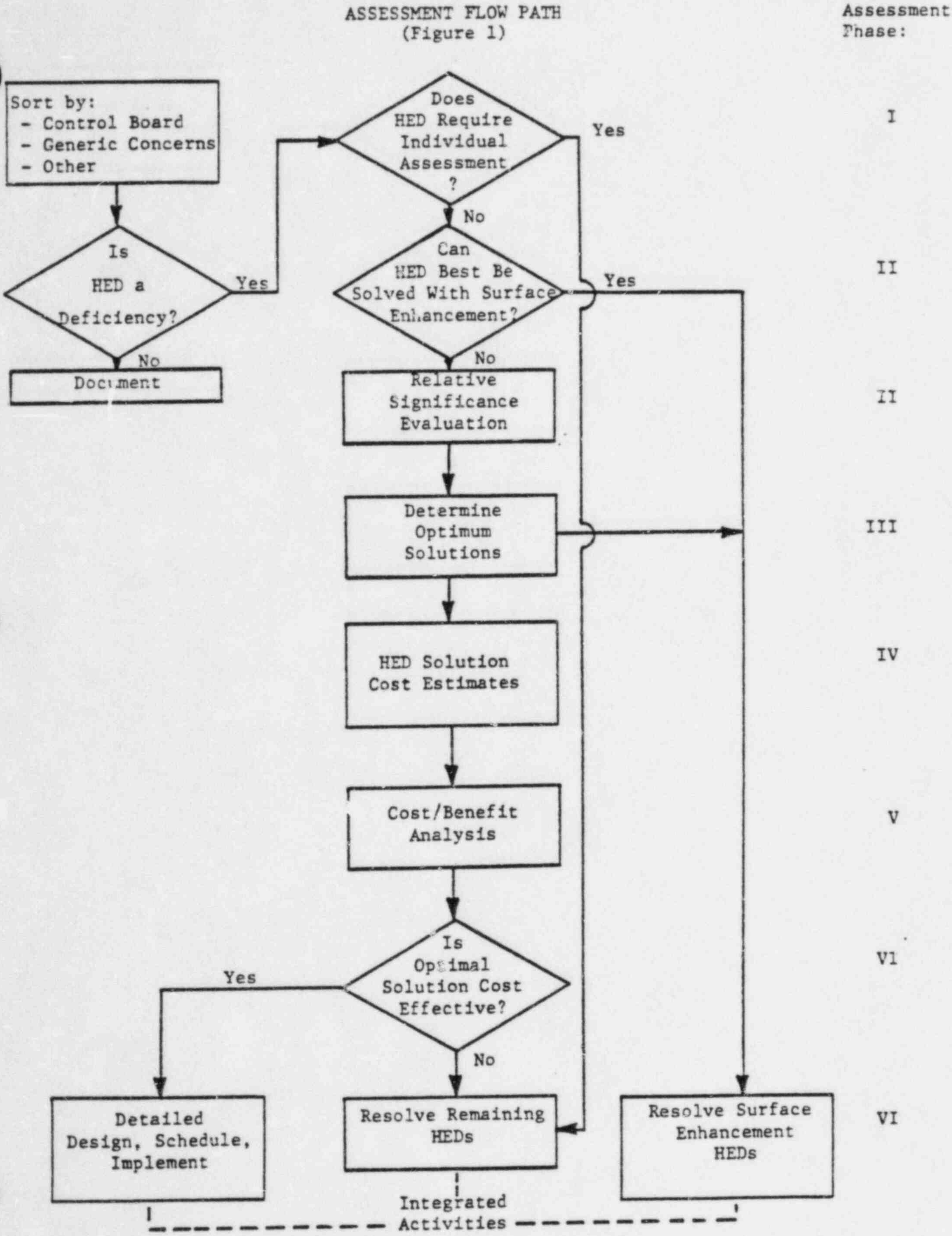
Phase VI: Resolution of Remaining HEDs

The first part of this phase represented an iteration of the solution determination/evaluation/decision phases. All HEDs not selected for optimal solution were reviewed to determine alternative approaches that represented partial solutions. These alternative approaches included revised physical change solutions, greater emphasis on surface enhancement techniques, greater use of procedural changes or training awareness, or combinations of all four.

A second part of Phase VI involved the solution of all surface enhancement related HEDs. This work was conducted under a Control Room Review policy for surface enhancement that ensures consistency. Additionally, any surface enhancements related to approved optimal solutions were factored into a longer ranged plan for surface enhancement upgrade.

The third part of this phase involved the final disposition of HEDs requiring plant management attention. These HEDs were documented and transmitted to appropriate station organizations for their use in improving awareness among operators, as well as completing certain recommendations.

ASSESSMENT FLOW PATH
(Figure 1)



6.0 Implementation Phase

The primary objective of the Implementation Phase is to implement modifications, procedures and training as necessary to resolve significant human engineering discrepancies (HEDs) identified in the Assessment Phase. Since the Review Team was an ad hoc group especially assembled for the purpose of the Control Room Review, the Duke line organizations (principally the Design Engineering, Construction, and Nuclear Production Departments) will be responsible for the implementation of all corrections. The Steering Committee as a part of its management oversight function was responsible for definition and assurance of the transition of work to the line organizations.

In general, implementation work will be handled under the existing Nuclear Station Modification Program. This program is a part of the corporate Quality Assurance Program and is designed to assure the quality of design, procurement, and construction work performed in a modification to operating Duke nuclear stations. A similar part of the Quality Assurance Program, designed for plants under construction, will be used for modifications to Catawba before licensing.

The Review Team assembled a package for each HED which contained the recommended correction for implementation by the line organization. Where possible, these packages were grouped by control board so that a "control board change package" could be implemented for a specific board to aid the coordination of physical changes, operator training, and procedure modification.

The Review Team also provided a relative implementation priority schedule for use by the line organizations. This "schedule" gives a priority for the physical installation or implementation of a modification. It was determined by considering the significance of the HED, the time required for design and procurement work, and the time and mode of plant operation required for installation. The actual implementation date for each modification, as well as the scheduling of design and procurement work, will be performed by the line organizations.

7.0 Future Control Room Modifications

The need for a human factors review of future proposed changes affecting the Control Room was recognized during the planning stage of the Control Room Review. Reviews of this nature have, in the past, been performed in conjunction with engineering reviews on plants under construction, and when system changes were made to operating plants. For plants under construction, the reviews have also included the use of full scale mock-ups to obtain operator feedback on proposed control and instrumentation arrangements. However, due to (1) increasing plant complexity, (2) the increasing frequency of plant systems changes and (3) changes related to regulatory activities, an enhanced review procedure, emphasizing human factors, is needed.

In addition, advances in equipment technology and in human factors and systems analyses, have identified the need to define standards for the design of and the changes made to the Control Room/operator interface to (1) preserve a consistent approach, (2) provide for feasible enhancements, and (3) incorporate necessary modifications with a minimum of negative impact on the operator.

The Control Room Review Plan was developed with the philosophy of using the Duke line organization as much as possible in order to upgrade human factors expertise throughout the Company. In addition, the methodologies developed for the Control Room Survey and the Task Analysis provide a foundation for the development of formal review methods and the incorporation of human factor criteria in design and equipment guidelines and standards.

The line organization will be responsible for implementing the necessary criteria, standards and guidelines, and for developing the necessary procedures and methods to ensure an adequate, integrated review of future modifications.

The Review Team will make recommendations to the Steering Committee at the conclusion of all Control Room Review activities concerning areas which the Team feels should be strengthened. The Steering Committee will evaluate the Review Team recommendations and, working with line organization, prepare an overall plan for implementation by the line organization.

Appendix A

A WORK PLAN FOR THE
BIOTECHNOLOGY CONTRACT TO SUPPORT
DUKE POWER COMPANY FOR:

- OPERATING EXPERIENCE REVIEW
- TASK ANALYSIS
- CONTROL ROOM SURVEY

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A WORK PLAN FOR THE BIOTECHNOLOGY CONTRACT TO SUPPORT DUKE POWER COMPANY FOR

- Operating Experience Review
- Task Analysis
- Control Room Survey

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Harold E. Price, Project Director

Revision 2, November 1, 1982

REVISION LOG

Revision #	Date	Description	Pages Affected
0	7/19/82	Original issue	All
1	7/30/82	Revised after Duke review	(Title page)(i) (ii)(iii)(iv) (2)(3)(3a)(4) (4a)(6)(8)(12) (16)(17)(18)(20) (21)(22)(23)(24) (29)(37)(39)(40) (41)(42)(43)(44) (45)(46)(47)(49) (50)(51)(52)(53) (54) (Page numbers
2	11/1/82	Revised to update	(Title page)(i) (ii)(iii)(iv) (3)(3a)(4)(4a) (9)(11)(13)(17) (19)(24)(25)(28) (29)(30)(31)(32) (33)(34)(35)(36) (37)(40)(41)(42) (43)(44)(46)(47) (Page numbers change from page 38 to end of report)

CONTENTS

Page

Introduction 1

Technical Presentation 5

Planning and Coordination 6

P-1 Conduct Planning Conference 6

P-2 Prepare Work Plan 7

P-3 Prepare Training Seminar 7

P-4 Present Human Factors Training Seminar 8

P-5 Maintain Continued Project Planning and Coordination 8

P-6 Establish 0700 Guideline/Review Categories 9

Operating Experience Review 10

O-1 Assemble Item Pool for Operator Survey 10

O-2 Develop Guidelines for Operating History Review 11

O-3 Review Incident Reports and Other Operational Data 12

O-4 Develop Questionnaires 12

O-5 Develop Interview Protocol 13

O-6 Prepare Training Presentation 14

O-7 Conduct Training Presentation 15

O-8 Collect Questionnaire Data 16

O-9 Develop Questionnaire Analysis Procedure 17

O-10 Analyze Operator Questionnaire Data 18

O-11 Prepare Operating Experience Review Methodology Report 18

O-12 Finalize Interview Format/Training 19

O-13 Conduct On-Site Interviews 20

O-14 Develop Interview Data Analysis Procedure . . . 21

O-15 Analyze Operator Interview Data 22

O-16 Document and Describe Human Factors Problems . . 23

O-17 Prepare Final Report and Continuing Support . . 23

CONTENTS (Continued)

Page

Task Analysis 24

T-1 Select Vendor EPGs for Analysis 25

T-2 Develop Task Analysis Methodology 25

T-3 Task Analysis Training Preparation 27

T-4 Conduct Task Analysis Training Workshop 27

T-5 Perform Pilot Task Analyses 27

T-6 Prepare Task Analysis Methodology Report 28

T-7 Selection of Other Operating Events 29

T-8 Conduct Written Task Analyses and Evaluate Human Engineering Suitability on Unit Mockups 29

T-9 Review Tasks for Simulator Studies 30

T-10 Develop Methodology for Task Sequence Real-Time Studies 30

T-11 Conduct Real-Time Simulator Studies 31

T-12 Conduct Simulator Studies for Selected Event Sequences 31

T-13 Prepare Final Report of Task Analysis Activities 32

T-14 Provide Human Factors Assurance Review and Continuing Support 32

Control Room Survey 34

S-1 Review 0700 Guildeines and Establish Survey Categories 34

S-2 Develop Physical Survey Methodology 35

S-3 Develop Modified Checklists and Materials for the Control Room Physical Survey 36

S-4 Develop and Conduct Physical Survey Team Training 37

S-5 Conduct Pilot Survey of Units 38

S-6 Conduct Physical Survey of Remaining Units . . . 38

S-7 Develop Engineering Survey Methodology 39

S-8 Develop Engineering Survey Materials 40

S-9 Develop and Conduct Engineering Survey Team Training 40

CONTENTS (Continued)

Page

S-10 Conduct Engineering Survey of All Units 41

S-14 Develop Environmental Survey Methodology 41

S-15 Develop Environmental Survey Materials 42

S-16 Conduct Environmental Survey of All Units . . . 43

S-17 Provide Human Factors Assurance Review and Continuing Support 43

S-18 Prepare Survey Methodology Report 44

S-19 Prepare Summary Final Report 45

Schedule of Activities 46

Project Management and Staffing 50

INTRODUCTION

This document is a work plan which describes the activities for accomplishment of the control room review tasks concerned with:

- Operating experience review
- Task analysis
- Control room survey.

In addition, a separate effort for planning and coordination is described.

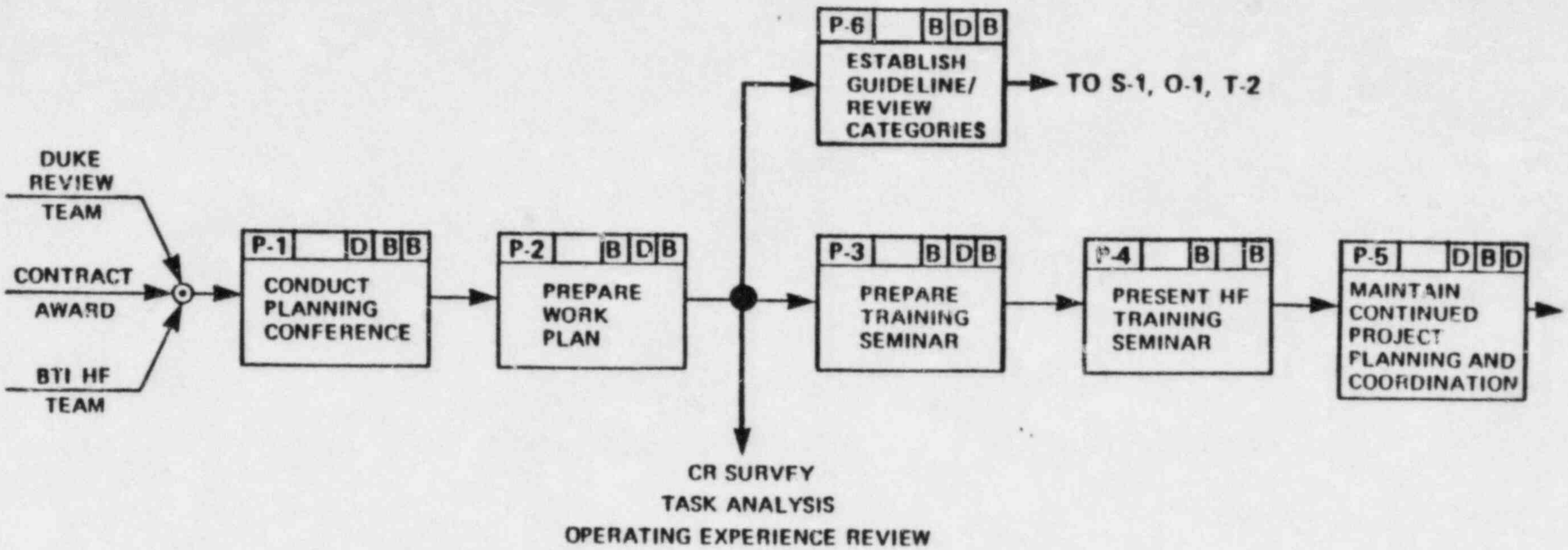
The work plan is strictly a document guiding the work effort between Duke Power Company and BioTechnology, Inc. (BTI), and is not a part of the Duke Control Room Review Plan. It is possible that some aspects of the work plan may later be included in the control room review plan, but that is not the primary purpose of the work plan.

This initial plan is a result of a planning conference conducted at Duke Power Company July 12-14, 1982. Revisions and updates will be made as necessary during the course of the project.

The common goal of the effort described in this work plan is to identify human engineering discrepancies (HEDs). While not specifically addressed in this plan, we also recognize that the control room review process is part of a larger effort that includes incorporating a safety parameter display system, upgrading emergency procedures, and using post-accident monitoring instrumentation. Coordination and cooperation with these activities will be undertaken as necessary.

The work plan has been prepared primarily as four flowcharts depicting the activities of each of the principal efforts, a narrative description for each of the activities, a schedule for all activities, and a project management and staffing plan. The flowcharts depicting the major efforts and their activities follows. Insofar as practical, dependencies and interactions between activities are shown, although not every possible interaction or feedback loop is indicated in order to keep the chart simple. The flow of activities from left to right is generally in correspondence with the time, although the relevant position of the activities on the chart does not correspond with a linear time schedule. The precise schedule information must be obtained from the schedule chart provided later. The next part of this work plan, Technical Presentation, will describe each of the activities depicted on the flowchart.

PLANNING AND COORDINATION



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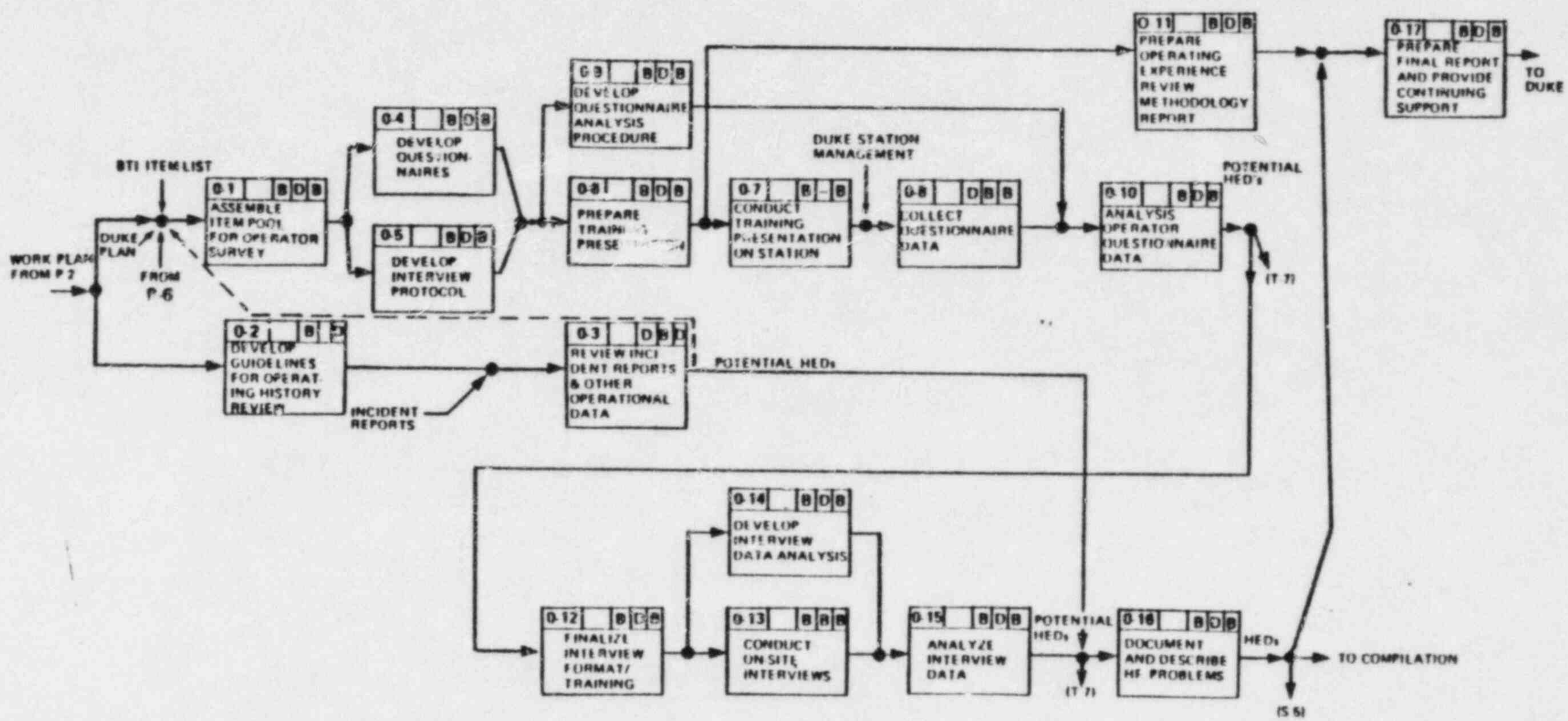

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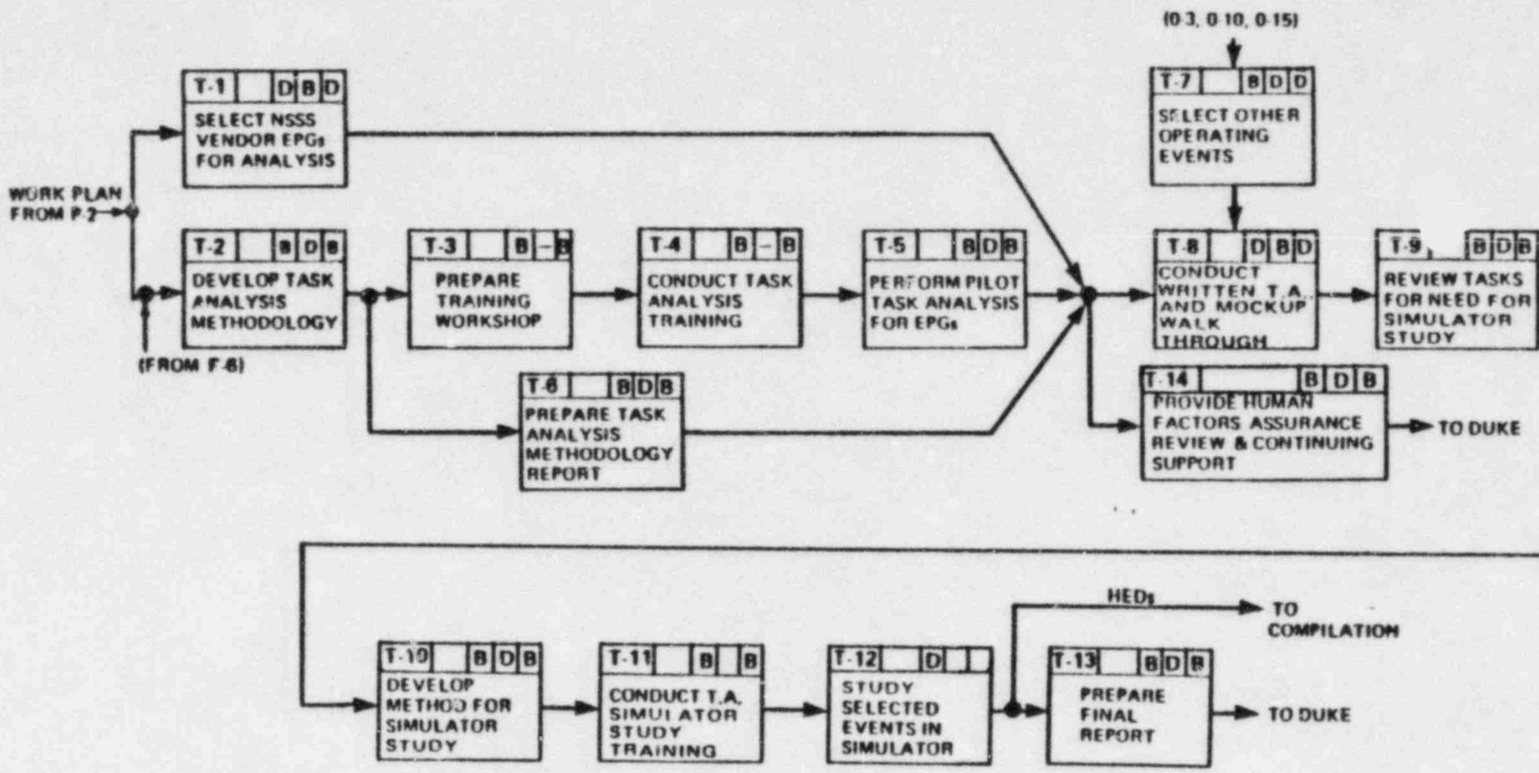
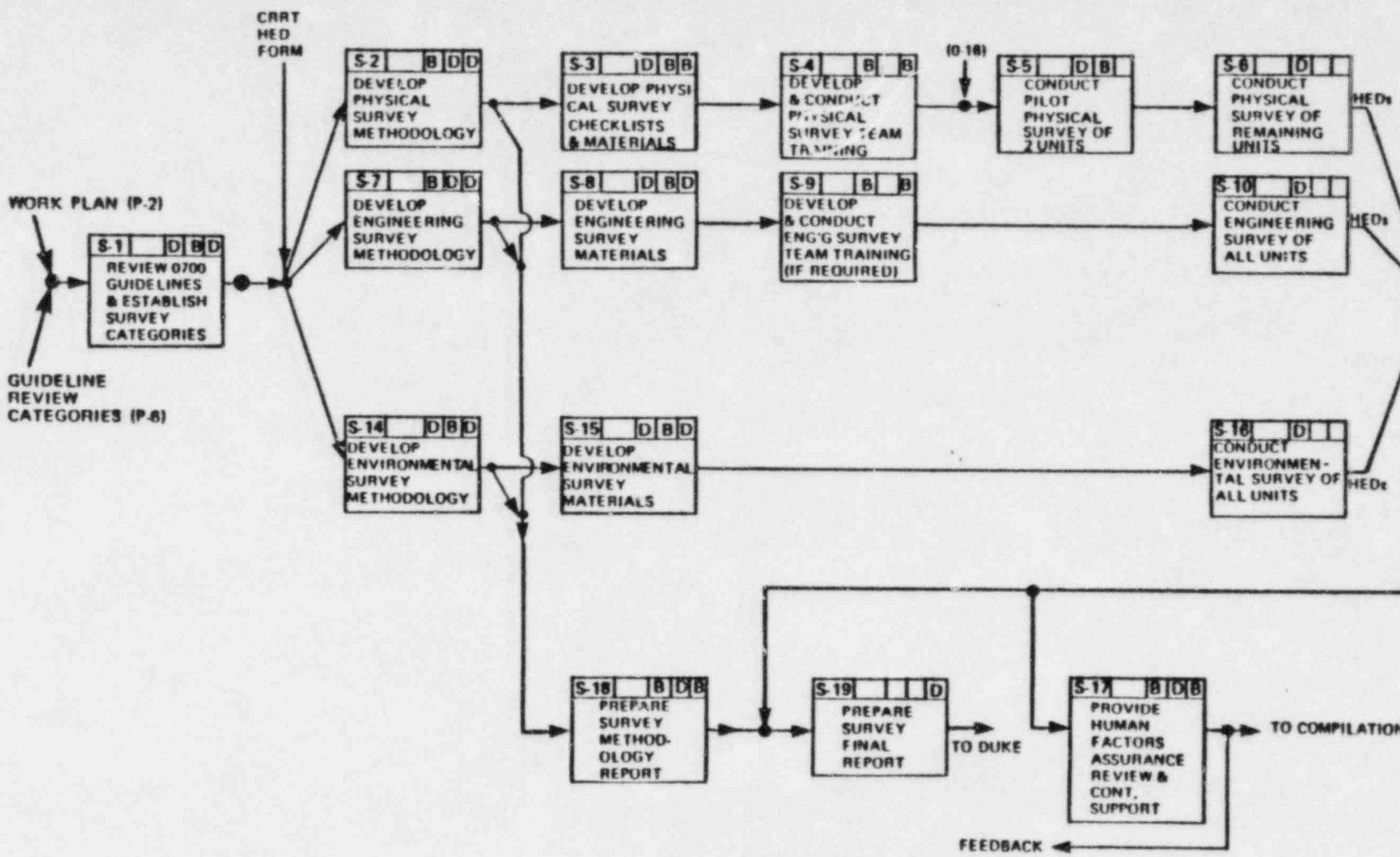
Revision 2

TASK ANALYSIS



CONTROL ROOM SURVEY



TECHNICAL PRESENTATION

This part of the work plan contains the technical presentation describing the initial work plan for accomplishing the activities of the three major efforts. The flowcharts contained in the Introduction of this work plan will be useful to the reader in following the technical presentation and description of each activity. This flowchart identifies the major efforts of the work plan and the series of activities to accomplish each major effort. Each activity is designated on the flowchart by an alphanumeric code for ease of reference to the activity descriptions. Each activity on the flowchart is further coded in terms of responsibility for implementing that activity. This appears as the three letters in the upper right-hand corner of the boxes. The letter "D" stands for Duke, and "B" stands for BioTechnology. From left to right, the letters represent who has the primary responsibility, review and comment responsibility, and responsibility for preparation of the final material. The responsibilities are elaborated on in the narrative discussions of each activity.

The technical presentation is organized into four sections corresponding to the four efforts in the work plan. A brief overview of each effort is presented first, followed by a description of each of the activities required to accomplish the effort. In general, the activity descriptions will contain the purpose, dependencies/interactions with other activities, approach and responsibility, and the principal product identified at the end of each activity.

Planning and Coordination

This section of the work plan presents activities concerned with overall project planning and coordination which are not specifically associated with any of the three major efforts. These activities will generally involve participation by the BTI Project Director, Harold E. (Smoke) Price, or the BTI major effort team leaders. Certain activities have already been identified and will be discussed. Other activities which will occur as the project progresses are simply accounted for in Activity P-5, Maintain Continued Project Planning and Coordination. Five planning and coordination activities have been identified and are briefly described below.

P-1 Conduct Planning Conference

Immediately upon notice of contract award to BioTechnology, a Planning Conference was scheduled for the week beginning July 12, 1982. The purpose of the conference was to discuss in more detail the objectives, constraints, and general interaction of the three major efforts: (1) Operating Experience Review (OER), (2) Task Analysis (TA), and (3) Control Room Survey (CRS). Each of these three efforts was divided into a series of activities in the initial proposal. The Planning Conference more specifically defined those activities and identified the inputs to and outputs/products from each activity. In addition, general responsibility for each activity was determined. Finally, an initial schedule of all activities was determined.

Products. Duke/BTI agreement on general work plan.

P-2 Prepare Work Plan

Following the Planning Conference at Duke, BioTechnology returned to their home office to prepare an initial work plan for the entire project effort. This work plan includes identification of all activities in each of the three major efforts, laid out in the form of a flowchart indicating dependencies and interactions between activities. A narrative description of each activity is presented which generally describes the purpose, significant dependencies/interactions, the approach and responsibility (lead, review/comment, final preparation), and finally a statement of the principal products resulting from the activity.

This initial work plan has been prepared as a working document by BTI. The documented work plan will be discussed with the Duke Control Room Review Team and briefed to the Duke Steering Committee.

Products. Initial Duke/BTI work plan.

P-3 Prepare Training Seminar

The purpose of this activity is to prepare a two-day training seminar on human factors and the control room survey approach being taken by Duke and BTI, based on a seminar which BTI has already developed on "Practical Human Factors for Power Plant Evaluation and Improvement" and the initial work plan. The seminar topics will be prepared to cover fundamentals of human behavior, the requirements of NUREG-0700 and other NRC guidance as interpreted by Duke/BTI in the work plan, and other specific topics to be jointly determined. Vugraphs and 35mm slides will be used extensively, with BTI key personnel leading the seminar topics. Interaction between the seminar leaders and participants will be encouraged.

Products. Seminar agenda, handouts, and audio-visual aids.

P-4 Present Human Factors Training Seminar

The human factors training seminar developed in Activity P-3 will be presented at Duke Headquarters in Charlotte over a two-day period. BTI key personnel will act as seminar leaders and present various topics using vugraphs and 35mm slides to supplement the presentation. Handouts will be available to all participants. Duke key personnel may lead some portions of the seminar describing specific activities of the work plan. The final content and organization of the seminar will be decided approximately two weeks before the seminar. Approximately 15 Duke personnel are expected to attend the seminar.

Products. A two-day seminar on human factors and the Duke/BTI work plan for control room reviews.

P-5 Maintain Continued Project Planning and Coordination

Throughout the project, BTI will maintain close and continued coordination with Duke and participate as appropriate in planning the specifics of various activities or tasks within an activity. As in all complex projects, it can be expected that this initial work plan will have to be modified and additional activities or tasks will arise. For example, the following tasks have already been identified as requiring further planning and coordination:

- Orientation of BTI personnel to the Duke nuclear generating stations
- A coordination meeting to resolve the human engineering discrepancy (HED) format final form

- Discussion and resolution of the extent of a data management system
- Review and revision of the Duke control room review plan
- Revision and update of the Duke/BTI work plan.

All coordination and planning activities will be carried out by the Duke control room review leader and the BTI project director, although other personnel may participate as required.

Products. Planning, coordination, scheduling, and revision and preparation of project activities and tasks as required.

P-6 Establish 0700 Guideline/ Review Categories

The purposes of this activity are to:

(1) Ensure that all of the Human Engineering Guidelines provided in NUREG-0700 are considered for applicability and addressed in the Duke Control Room Design Review if applicable;

(2) Assign each guideline to the review activity that will provide the most appropriate perspective and expertise for addressing each guideline;

(3) Eliminate unnecessary repetition in the application of the guidelines.

BioTechnology and Duke will jointly discuss the approach for categorizing guidelines and BTI will prepare the final procedure. Duke and BTI will then jointly make the categorization to the Operating Experience Review, Task Analysis, or Control Room Survey. Each team leader will then incorporate the guidelines into the methodology of each of the three major efforts for identifying HEDs.

Products. Categorization procedure, categorized guidelines, allocations to review activities, and a method to maintain guideline listing.

Operating Experience Review

The objective of the operating experience review (OER) is to identify features of control room operation or design which could potentially degrade effective control of the plant during normal or emergency operations. In addition, the review may identify positive features at each station that contribute to good operator performance and could be shared with other stations. The survey will include licensed personnel and non-licensed personnel in operator training, as well as a review of relevant operating history documentation.

This section of the work plan presents the activities for developing potential HEDs from a review of operating experience. BioTechnology will have the lead responsibility for developing questionnaires and interviews, preparing and conducting training on the use of the questionnaire interview technique at each station, administering the questionnaires and conducting the interviews, and analyzing the data to document potential human factors problems. Duke will be responsible for the review of industry and plant incident reports, but BioTechnology will provide criteria for conducting this review. Sixteen activities are proposed and are designated O-1 through O-16. Each activity is described below. The entire effort is scheduled for approximately a five-month period.

O-1 Assemble Item Pool for Operator Survey

The purpose of this activity will be to assemble a pool of items which will be candidates for the questionnaire or interview survey of Duke operating personnel. The principal source of items will be from:

- A BTI general item list
- The BTI generic operator questions from the control room evaluation kit
- A list of topics generated by Duke as indicated in their plan dated July 9, 1982
- NUREG-0700 items (identified in (Activity P-6)
- Potential HEDs from the operating history review (O-3) if available.

BTI will assemble and organize the items, separate them into candidates for questionnaires and interviews, and prepare potential questionnaire items. Each item will be a question related to control room design, procedures, communications, training, and other factors which affect operator performance. Duke will review the candidate questionnaire and interview items and provide feedback. BioTechnology will then prepare the final items.

This activity will begin immediately following the initial planning conference.

Products. Candidate questionnaire or interview items.

O-2 Develop Guidelines for Operating History Review

The purpose of this activity is to provide guidelines for analyzing operating history incident reports for factors which may have a significant effect on human performance. BTI will develop the guidelines and coordinate with Duke.

The guidelines will be developed based on what can be "practically" expected from LERs, station incident reports,

and other industry-wide reports. BioTechnology will develop the guidelines based on the requirements for preparing LERs and station incident reports and other related studies such as NUREG/CR-1928 which is a new method of coding and sorting LER data. BioTechnology will also prepare guidelines for summarizing and formatting any information obtained from the review. The guidelines will be coordinated with Duke for any comments and BioTechnology will prepare the final set of guidelines for use during the actual operating history review.

Products. Guidelines for reviewing and documenting the results of the operating history review.

O-3 Review Incident Reports and Other Operational Data

This activity will be conducted by Duke using the guidelines developed in Activity O-2. Potential HEDs will be listed and may be useful in Activity O-1, assembling the item pool for the operator survey; and Activity T-7, selecting the final tasks for the written task analysis. All potential problems will be documented whether they are part of the CRDR or not.

Products. Lists of potential HEDs for (1) compilation and assessment, or (2) further investigation.

O-4 Develop Questionnaires

The purpose of this activity is to develop a questionnaire suitable for eliciting critical incidents or significant problems from operating personnel. The items will come from the pool developed in Activity O-1. The questionnaire items will be restricted to those items which are meaningful to the operators without any explanation and which generally have clear-cut choices for answers.

BioTechnology will take responsibility for developing the questionnaire and instructions for completion. Questionnaire items will be written in such a way that they will not be threatening to the individual or suggest that we are trying to collect information on his personal performance. Rather, the concept will be that this is an opportunity for him to convey operating difficulties that impact the entire operational staff. Further, potential solutions will also be encouraged.

A cover sheet will be designed by BioTechnology to include basic demographic, education, experience, and other kinds of data useful for the data analysis activity. Operators will be asked to provide their names to BioTechnology in order that further inquiries may be pursued, but the operators will be assured that their responses will remain anomymous (if they prefer) to Duke management.

Duke will review the draft questionnaire form and conduct an informal pilot test to determine (1) if questions are clear and meaningful; (2) that the survey can be completed in a reasonable amount of time. BioTechnology will then prepare the final reproducible copy of the questionnaire.

Products. Questionnaire and cover letter for survey of operator personnel.

O-5 Develop Interview Protocol

Some operator experiences cannot be easily collected by questionnaire and these will be designated for collection by interview. These items, identified in Activity O-1, will be prepared by BTI for a loosely structured informal interview protocol. Also, the questionnaire design and analysis will be developed in such a way that the results from the questionnaire

analysis will identify key considerations or issues which should be discussed during the interview. Therefore, the interview items will not be completely developed during this activity but the interview protocol can be established in order to prepare a training presentation for station personnel.

The interview is anticipated to require approximately one hour. A representative sampling of 50% of the operations staff at each station is planned in order to include a wide range of experience and perspectives.

In developing the interview protocol, BTI will specify the number of people and the time frame we expect to be on site to do the interviewing. Duke will be responsible for setting up specific personnel to interview on specific days. Also, as was the case with the questionnaire, individuals will not be specifically identified with specific comments if they choose to remain anonymous. BTI will, however, keep a record of the particular interviews so that critical or follow-up information may be requested if necessary. Finally, while the essential interview will be scheduled for one hour, interviewers will be prepared to interact with operational personnel as long as constructive interchange is occurring.

Products. General concept of the interview protocol and suggested scheduling for each station.

O-6 Prepare Training Presentation

After the questionnaires, interview protocol, and review of incident reports have been completed, a training presentation will be prepared by BTI to describe the objective and procedure for collecting data from plant operators. The training presentation will be prepared to orient the operating staffs at each

station as to the overall purpose of the data collection, the preferred schedule, the technique to be used, facilities required, and any other special requirements. The final form of the questionnaire and interview protocol, supplemented by vugraphs, will be the basis for the training presentation. The presentation will be prepared to take approximately 30-45 minutes. BTI will coordinate the presentation with Duke, but BTI will be responsible for the final preparation.

Products. A 30-45 minute briefing with vugraphs and handouts.

O-7 Conduct Training Presentation

A training presentation will be conducted at each station to present and discuss the objectives and needs of the data collection activity. At the same time it is anticipated that constraints affecting data collection at each station will be identified and discussed by the station management.

The training presentation will be presented during a station supervisor's meeting in order to reach the greatest number of personnel without special arrangements. It is anticipated that the superintendent of operations, operating engineers, shift supervisors, and some assistant shift supervisors would normally be present at these meetings, and some 12 to 15 people could be briefed at the same time. It is also anticipated that, given appropriate notice, these meetings could probably be scheduled on successive days at McGuire, Catawba, and Oconee (Tuesday, Wednesday, and Thursday, respectively) and thus minimize travel and logistics.

On the same day the training presentation is conducted at each station the questionnaires will be delivered for internal

station distribution. Current plans are to provide a questionnaire for every licensed member of the operating staff or those in license training. Thus, this would include the superintendent of operations, and all other licensed personnel including shift technical advisors and assistant nuclear control operators. In addition, nuclear equipment operators in training will also be provided questionnaires. Each questionnaire will have a pre-addressed and stamped envelope for returning the questionnaire to BioTechnology offices in Virginia. This will ensure respondents of anonymity. However, BTI will keep a confidential record of all those who have submitted questionnaires so pertinent issues can be clarified, and we can "jog the memory" of those individuals who have not submitted their questionnaire.

BTI will be responsible for conducting the training presentation at each station. Duke will be responsible for making arrangements at each station. Any pertinent issues or points that come up during the training presentation will be summarized by BTI and included in the methodology report (Activity O-11). It is anticipated that the training presentation will take from 30 to 45 minutes, although the team will be prepared to spend one-half day at each site.

Products. Operating experience review, training presentation at McGuire, Catawba, and Oconee stations.

O-8 Collect Questionnaire Data

Questionnaires should be distributed to the operators as early as possible following the training presentation (Activity O-7). Since many of the supervisory personnel will be present during the training seminar, it is expected that distribution can be facilitated. As discussed in Activity O-4, the design goal will be a questionnaire that takes approximately

4 to 5 hours to complete, thus hopefully not presenting too great a burden on operating personnel. However, in order to provide adequate time for all personnel to respond to the questionnaires, a period of three weeks has been allocated for return of the questionnaires. After approximately two weeks, some gentle reminders will be put out to those personnel who have not responded. All questionnaires will be mailed and received at the BioTechnology office in Falls Church, Virginia. Duke will take responsibility for distribution of the questionnaire and encouragement of personnel to complete and return them. BTI will be responsible for collecting, logging, and assembling all returned questionnaires.

Products. Completed questionnaires to BTI.

O-9 Develop Questionnaire Analysis Procedure

Development of the questionnaire data analysis procedure can begin as soon as the questionnaires have been developed (Activity O-4). Insofar as practical, BTI will develop a numerical analysis technique in order to statistically analyze questionnaire responses. At a minimum, questionnaire responses can be tabulated and reported in terms of such variables as frequency and importance of each item according to different operator and experience variables such as type of license, years of experience, and education. In any event, all questionnaire data will be compiled by BTI to facilitate both a statistical and practical analysis. During the compilation each questionnaire will be reviewed for clarity and completeness, and where necessary, follow-up inquiries will be made by BTI to the individual completing the questionnaire.

Products. Procedure for analysis for questionnaire data in a reliable and consistent manner.

O-10 Analyze Operator Questionnaire Data

Utilizing the procedure developed in Activity O-9, all data from the operating experience questionnaires will be analyzed by BTI to identify potential HEDs. Both the initial identification and the analysis of human factors problems will have been carefully coded to identify specific design features, procedures, or other factors specific to each unit in a manner consistent with the HED form. Where the problems represent a consistent concern and appear to have operational significance, they will be carried forward for more detailed review. The compiled questionnaire data will be reviewed by Duke for practical significance.

Products. Completed data from questionnaires to Duke; potential HEDs.

O-11 Prepare Operating Experience Review Methodology Report

BioTechnology will prepare a report describing fully the approach, rationale, and all facets of the methodology for conducting operating experience reviews. This report can be started after the materials have been prepared for the training presentations (Activity O-6). It is anticipated that the methodology report will be continually updated and refined until all data have been collected and analyzed. The report will be in a form suitable for answering any questions the NRC or Duke management may pose concerning the operating experience review methodology for each unit. Duke will be expected to review and comment on the report, and the final methodology report will be prepared by BTI.

Products. Methodology report suitable for inclusion in the final report.

O-12 Finalize Interview Format/Training

The interview protocol developed in Activity O-5 and the results from the questionnaire data analysis of Activity O-10 will be the basis for finalizing the interview format. BTI will prepare an interview format which will be used to prompt the interview to insure that all critical items are discussed with the operator being interviewed. Critical items will be those that evolve from the questionnaire data, or were earlier judged to be inappropriate for questionnaires but significant and worthy of discussion.

Those BTI personnel anticipated to actually conduct the interviews on station will be trained to insure interviewer reliability and to eliminate, as far as possible, any inconsistencies in the interviewing technique. Once the interview format is established, BTI will review the content with the Duke CRDR team to insure that a standard interview should take approximately one hour.

BTI will also recommend an interview schedule for all three stations. Working with Duke personnel, the schedule will be developed on a realistic basis to obtain approximately 50% of the licensed operating personnel or those in training for a license. In general, three teams will be formed to conduct interviews at each of the three stations.

BTI will be responsible for the final interview materials and arrange to have interview teams at the stations as required.

Products. Final interview format and trained interviewers; schedule for conducting approximately 125 interviews at the three stations.

O-13 Conduct On-Site Interviews

The work plan calls for interviewing approximately 50% of the candidate personnel to obtain a representative sample of all classifications of personnel. The classification and number of persons in each classification at each site has been estimated as indicated below.

	Number of Operators						
Classification	OS		MC		CN		
Operating Engineers	2		2		2		
Assistant Operating Engineers	2		2		2		
Shift Supervisors	3		3		3		
Assistant Shift Supervisors	8		8		8		
Nuclear Control Operators	10		12		12		
Assistant Nuclear Control Operators	10		8		8		
Nuclear Equipment Operators*	4		4		4		
Shift Technical Advisors	3		0		0		
Simulator Instructors	3		2		0		
Totals	45	+	41	+	39	=	125

*Nuclear Equipment Operators in R.O. License Class.

Duke will be responsible for selecting and notifying these personnel to be interviewed and arranging for their availability.

The general interview procedure will be for a team of two experienced BTI personnel to arrange to spend several consecutive days at each station. Some interviews would be conducted at

the administration building and others would be conducted at the training center. Interviewers will use the pre-prepared interview format and layout drawings and photographs of the control room in order to discuss items of concern with the operators. Considering logistics factors, time to review the interview notes, and the fact that some interviews may last longer than an hour, it is currently anticipated that each interviewer can conduct four interviews per day. Allowing for the inevitable unforeseen contingencies, it seems reasonable that all interviews can be completed at all stations during a four-week period.

BioTechnology personnel will also transcribe and summarize the interview data prior to analysis. As was the case with the questionnaires, all potential problems will be coded as appropriate to record on the HED forms for later analysis and retrieval. Duke will be provided with the interview summary data for review from a practical operational viewpoint. Once again, operator anonymity will be maintained, but BioTechnology will keep a master reference list in order to return to certain individuals for clarification or elaboration of critical comments.

Products. Completed interviews of up to 125 operating personnel.

O-14 Develop Interview Data Analysis Procedure

Development of the interview data analysis procedure can begin as soon as the interview format has been established (Activity O-12). Numerical analyses will be more difficult to perform with interview data, and it is anticipated that the

primary technique will be a content analysis performed by BTI. The content analysis can then be treated numerically in order to summarize key issues and again relate them to factors such as classification, experience level, and education. Interview data will also be related to previous or antecedent questionnaire items to establish consistency, reliability, and validity, where practical. In any event, all interview data will be summarized by BTI to facilitate both a numerical and practical analysis. During the summarization each interview will be reviewed for clarity and completeness and, where necessary, follow-up inquiries will be made by BTI to the individual who was interviewed.

Products. Procedure for analysis of the interview data.

O-15 Analyze Operator Interview Data

Utilizing the procedure developed in Activity O-14, all data from the operating experience interviews will be analyzed by BTI to identify potential HEDs. Both the initial identification and the analysis of human factors problems will have been carefully coded to identify specific design features, procedures, or other factors specific to each unit in a manner consistent with the HED form. Where the problems represent a consistent concern and appear to have operational significance, they will be carried forward for more detailed review. The summarized interview data and the raw interview data will be reviewed by Duke for practical significance.

Products. Potential HEDs.

O-16 Document and Describe Human Factors Problems

The purpose of this activity will be to describe in detail potential HEDs which have been identified and analyzed to be practically significant. All HEDs will be systematically recorded on the standardized HED report form and coded for retrieval. It is expected that a final HED format will be mutually agreed upon by Duke and BTI early in the project. In any event, a prefilled HED form will result from this activity, and it will be compiled for further action in the assessment phase or become an input for further review during the control room survey (Activity S-5).

Products. HEDs for (1) compilation and assessment, (2) further investigation, or (3) forwarding to the station management.

O-17 Prepare Final Report and Continuing Support

BioTechnology will prepare a final report of the operating experience review effort. The report will incorporate (or reference) the methodology report prepared in Activity O-11 and will present the results from the operating experience review effort. The report will be in a form suitable for answering questions that the NRC or Duke management may pose concerning the operating experience review results for each unit.

BioTechnology is also prepared to provide continuing support as necessary to Duke in ongoing activities related to operating experience review. Our personnel would also be available to informally interact with the NRC Division of Human Factors Safety personnel to obtain their reaction to any activity in this area.

Products. Final report of operating experience review effort.

Task Analysis

This section of the Work Plan describes the activities needed to develop a task analysis methodology and to apply this methodology to the analysis of operator performance in response to selected emergency and normal events.

The objective of a task analysis is to identify human engineering discrepancies (HEDs) that occur due to the task demands on a control room operator. The overall approach to be employed will be to perform written task analyses using generic vendor emergency procedure guidelines as a basic input, modified and expanded as necessary to be specific to the units at McGuire, Catawba, and Oconee. For Oconee, ATOGs will be used as the basic input to the task analysis of its units. For McGuire and Catawba, the Westinghouse ERGs will be used as the basic input. In addition, selected normal operating procedures will be analyzed. These unit-specific analyses will then be used as scenarios for walk-throughs on control board mockups to determine whether or not HEDs exist in each unit control room. HEDs that are identified during this process will be documented for subsequent assessment and possible correction. Selected tasks that cannot be fully evaluated using a static mockup will be studied using the Oconee or McGuire simulators.

BTI will develop the task analysis methodology, train Duke personnel in its application, participate in the development of three pilot tasks analyses used for Duke personnel training, participate in task analyses of the first two to three of the total number of emergency and normal events to be analyzed, and provide human factors assurance review and continuing support on the task analyses for the remainder of the operating sequences to be analyzed. BTI will develop principles for use by Duke in

identifying HEDs during the walk-through of task analyses and will develop criteria for determining which operating sequence tasks may require simulator study.

Duke will select vendor EPGs and normal operating sequences for task analysis, develop control room mockups, and perform the major effort in task analysis using the mockups, and when necessary, real-time simulation.

Fourteen activities are planned and are designated as T-1 through T-14. They will start with the development of task analysis methodology by BTI in July 1982 and continue through the delivery by BTI of a final report on 15 April 1983. Task analysis data collection will begin on 15 September 1982 and will be complete by 11 March 1983, a total period of six months.

T-1 Select Vendor EPGs for Analysis

The purpose of this activity will be to select the vendor-developed EPGs around which task analysis will be developed. Duke Power will select all or some of the EPGs based on criteria that it develops. BTI will review the candidate list of EPGs and provide feedback. Duke will then prepare the final list which will be the basis for subsequent task analysis. This activity will begin the following initial planning conference.

Products. List of EPGs for task analysis.

T-2 Develop Task Analysis Methodology

The purpose of this activity is to develop the methodology, procedures, formats, controlled vocabulary, and other items to be used in conducting task analyses and in applying it in the context of mockups and simulators. The following specific items will be developed:

1. A task analysis methodology

2. Task analysis procedures

3. Task analysis data collection formats

4. A controlled vocabulary for use in making entries in the task analysis format

5. Generic guideline principles for the identification of HEDs in task analysis

6. Criteria for the selection of tasks for crew walk-throughs and for real-time simulation of task performance

7. Approach for follow-up to the McGuire PDA audit.

Input to 1, 2, 3, and 4 above will come from NUREG-0700 and from work on task analysis methodology done by BTI under contract to NRC. Input for 5 and 6 will come from the human factors literature and BTI experience in task analysis using real-time simulator validation. Input for 7 will come from Duke's documentation of the McGuire PDA audit.

BTI will have major responsibility for Items 1, 2, 3, 5, and 6. Duke will review these items. Duke will have responsibility for expanding on a controlled vocabulary already provided by BTI and for follow-up on the McGuire PDA audit, including any methodology or procedure that may be called for. BTI will have responsibility for preparing a document that includes the items listed above.

Products. A single document containing task analysis methodology and the items associated with its application.

T-3 Task Analysis Training Preparation

The purpose of this activity is to prepare a training workshop for training Duke staff in task analysis. This activity will be the responsibility of BTI and will be derived from material developed in T-2.

Products. Products of this activity will consist of an outline of a one-week training workshop, vugraphs, handouts, and examples for use in the training workshop.

T-4 Conduct Task Analysis Training Workshop

The purpose of this activity is to provide training for up to ten Duke personnel in task analysis methods. The workshop will be based on material developed in T-3. BTI will assume responsibility for developing the training and providing instructors and training materials for the workshop which is expected to be a maximum of five working days. Duke will provide classroom space, vugraph projector, 35mm carousel projector, blackboard, and electric power.

Products. The product of this activity will be Duke personnel familiar with the purpose and application of task analysis methods, procedures, and forms.

T-5 Perform Pilot Task Analyses

The purpose of this activity is to provide Duke personnel who have attended the Task Analysis Workshop with hands-on experience in performing task analyses. This experience will consist of three Duke teams developing task analysis data using the methodology developed in T-2 and generic task data already developed and supplied by Westinghouse. Each team will develop

a different task analysis. Teams will work independently in developing the pilots but will assemble for comparing results and for resolving differences in the application of the methodology. It is anticipated that the completed pilots may be useful as inputs to the subsequent task analysis to be done under T-8.

BTI will take the lead in supervising the development of the pilot task analyses and will participate in that process in order to provide assurance of adherence to procedures, completeness, and accuracy. The pilot will include preparation of written task analysis documentation and its use in walk-throughs on unit mockups. Duke will provide personnel for the three pilot task analyses.

Products. Three pilot task analysis documents and HEDs identified on mockups.

T-6 Prepare Task Analysis Methodology Report

The purpose of this activity is to prepare a task analysis methodology report for guidance to Duke task analysis teams in performing task analysis in T-8. This report will be based in large part on the methodology developed in T-2 modified as a result of its use in the Training Workshop (T-4) and the performance of the pilot task analyses (T-5). BTI will be responsible for the preparation of the methodology report. Duke will review it. BTI will prepare the report in final copy for subsequent use by Duke Task Analysis teams.

Products. Task Analysis Methodology Report.

T-7 <u>Selection of Other Operating Events</u>

The purpose of this activity is to select other operating events (non-EPG events) for task analysis in order to identify HEDs that affect operator performance under normal conditions such as plant start-up. Input to this activity will come from O-3, O-11, or O-15 of the Operating Experience Review.

BTI will assume responsibility for recommending and preparing the list of events to be analyzed. Duke will review the BTI list, and a final selection will be made jointly.

<u>Products</u>. A list of operating events to be analyzed.

T-8 <u>Conduct Written Task Analyses and Evaluate Human Engineering Suitability on Unit Mockups</u>

This is the most important task analysis activity. Its purpose is to prepare written task analyses for all emergency and other operating events previously selected by Duke, to evaluate the human engineering suitability of components required for the performance of tasks in each event on unit specific mockups, and to identify and document HEDs resulting from this activity.

Duke will assume responsibility for planning and supervising the preparation of the written task analyses and the evaluation on mockups. In doing so it will use Duke task analysts trained in T-4 for all events to be analyzed. BTI will provide one trained task analyst to each of the three Duke analysis teams for the first two task analyses to be done by each Duke team. Duke will prepare final copies of all documentation.

Products. The products of this activity will consist of fully documented task analyses, mockup evaluations, and HEDs for all events selected for analysis for three Duke stations.

T-9 Review Tasks for Simulator Studies

Certain tasks may be identified for simulator study. These tasks include those which must be performed within a limited time period. Tasks such as these may require evaluation in a dynamic, real-time simulator. The purpose of this activity is to review all tasks analyzed in T-8 to identify those that may require real-time simulator studies. This review and selection activity will use criteria for selection of tasks for real-time simulation developed in T-2.

BTI will have responsibility for the development of criteria to determine tasks to be studied. Duke will use this criteria to review the task analysis developed in T-8 to select those tasks requiring real-time simulation.

Products. A list of tasks to be studied by real-time simulation.

T-10 Develop Methodology for Task Sequence Real-Time Studies

The purpose of this activity is to develop a method for studying the performance of task sequences in a real-time simulation of the sequence using a plant simulator. This activity will entail real-time event simulation using operator crews. Video recording may be employed as an aid in identifying task performance problems.

BTI will be responsible for the development of this methodology. Duke will review it. BTI will prepare a report describing the method and its application for use by Duke.

Products. Real-Time Task Study Methodology Report.

T-11 Conduct Real-Time Simulator Studies Training

The purpose of this activity is for BTI to train Duke task analysis teams in the method developed in T-10 for real-time task simulator studies. It is anticipated that this training can be provided in a classroom and simulator. Training materials will include the methodology report developed in T-10.

BTI will provide training instructors and training materials. Duke task analysis teams will be trained.

Products. Duke task analysis teams trained in real-time simulation of task performance.

T-12 Conduct Simulator Studies for Selected Event Sequences

The purpose of this activity is to study task performance on event sequences selected in T-9 for real-time simulation. Duke will be responsible for performing and documenting the results of the studies, with BTI participating in the initial studies.

Products. Documentation of real-time studies of task performance and of the identified HEDs.

T-13 Prepare Final Report of Task Analysis Activities

The purpose of this activity is to document the task analysis methodology employed, the rationale for its selection, the forms and other materials used for analysis by Duke, and a summary of the results of the task analysis. BTI will assume responsibility for preparing this report in draft form for Duke review. Following Duke review, BTI will prepare the report in final form. The report will not include the written task analyses nor the HEDs resulting from the mockup task performance evaluation and real-time simulator studies of task performance. The latter will be documented and reported by Duke and will be reviewed by BTI.

Products. Final report of task analysis methodology and summary of task analysis results.

T-14 Provide Human Factors Assurance Review and Continuing Support

The purpose of this activity is to provide human factors assurance that the written task analyses, mockup verifications and real-time studies performed by Duke conform to the methodology developed in T-2 and documented in T-6 and T-10, or that deviations from it conform to accepted human factors practices in performing task analysis for the purpose of identifying human engineering design discrepancies.

BTI will perform this human factors assurance function by visiting Duke analysis teams and/or reviewing Duke task analysis documentation periodically throughout Activities T-8 and T-12 or more often at Duke's request. Should BTI identify

problems in documentation or methodology, it will bring these to the attention of the Duke Control Review Team Leader. BTI will provide such other continuing support as may be requested by Duke Power.

<u>Products</u>. Human factors assurance review and continuing support.

Control Room Survey

This section of the work plan presents the approach for performing the control room survey. The objective of the control room survey task is to determine the extent to which the characteristics and features of Duke Power control rooms are in accord with applicable human factors guidelines. The survey will include the control rooms at Oconee (3 units), McGuire (2 units), and Catawba (2 units) nuclear stations, and will be based on the guidelines contained in NUREG-0700, Section 6. The task will be conducted as specially designed survey subtasks oriented to the type of data to be collected and the most efficient and effective methods of obtaining the data. BTI will be responsible for assisting Duke in establishing survey categories for guidelines; developing methodologies for all survey categories; reviewing the guidelines for development of Duke-specific survey checklists; working with Duke to develop checklists of HF principles and other survey materials; and participating with Duke in pilot surveys of units at Oconee and Catawba. In addition, BTI will provide a continuing human factors assurance review and human factors assistance as needed, and provide a report of the methodology used and the success achieved in satisfying survey objectives. Sixteen activities are designated for conducting the control room survey and are designated S-1 through S-10 and S-14 through S-19. The survey task will encompass a period of approximately 9 months. Each activity is elaborated on below.

S-2 Review 0700 Guidelines and Establish Survey Categories

The purpose of this activity is to ensure that all applicable guidelines are assigned to appropriate responsibility categories, and that survey team members understand the intent

and purpose of each guideline. This activity will focus on three points. First will be that the items contained in the survey checklists do not unnecessarily duplicate those more appropriately addressed by the operating experience review effort or the task analysis effort. Second, the items contained in the survey checklists are consistent with the design and operating policies of the Duke nuclear power stations. Third, the items are assigned to specific survey categories based on the type of information and the means of collecting it. Duke will have lead responsibility for this task, with BTI assistance throughout. BTI will provide Duke survey team members with training and indoctrination on specific 0700 guidelines, will work with Duke on identifying appropriate items for the survey checklists, and will assist in establishing category assignments for each survey item.

Products. The products of this activity are the guidelines interpretation sessions with survey team members, and guidelines category recommendations to the CRRT for the following categories: operator experience review (Task O), task analysis (Task T), control room survey (Task S). In addition, guidelines which are interpreted as being not applicable to Duke nuclear stations will be collected in a separate category. After the CRRT finalizes the category assignments, the guidelines for which the survey task has responsibility will be further categorized for physical survey of the control room, engineering survey, and environmental survey.

S-2 Develop Physical Survey Methodology

The purpose of this activity is to develop the methods and general procedures to be used for the conduct of the physical survey of mockups and control rooms. This activity will be initiated when CRRT survey/guideline categorization is complete.

Specific approaches and methods will be defined which are compatible with other survey activities and review tasks, reflect the policies and overall approach established by Duke Power, and which will optimize the conduct of the physical survey portion of the control room review. BTI will develop a recommended methodology which will be reviewed and finalized by Duke. The methodology will be further refined or modified, as appropriate, following completion of each pilot physical survey (S-5).

Products. The products of this task will be a definition of the physical survey objectives, methods, and procedures to be used during the physical survey, requirements for physical survey materials development, and general requirements for physical survey team training.

S-3 Develop Modified Checklists and Materials for the Control Room Physical Survey

The purpose of this activity is to develop the specific materials to be used by the survey team for the conduct of the physical survey. Duke will initially define the format and content of the physical survey checklist and HED recording forms, based on the agreed-upon methodology (S-2) and the preferred Duke approach. BTI will review these preliminary definitions and provide recommendations for alternative and/or additional physical survey materials. As appropriate, materials will be briefly tested with the mockups. Final approval of physical survey materials is the responsibility of Duke. BTI will produce and assemble the materials in a form which will support the conduct of the physical surveys.

Products. The products of this activity will include a checklist which is specific to Duke physical control room survey needs and is based on accepted human factors engineering

principles and data. Other products will include the CRRT-specified forms and instructions for HED recording instructions, materials for photographing HEDs, and related typical reference materials. Also included are checklists and guidelines for scheduling and conduct of physical survey site visits. All materials will be refined and modified, as appropriate, at the completion of each pilot physical survey. Additional quantities needed to support completion of the physical survey (S-6) will be produced following these modifications.

S-4 Develop and Conduct Physical Survey Team Training

The purpose of this activity is to provide all members of the physical survey team with a good understanding of the methods, materials, and procedures for performing physical control room surveys. All BTI and Duke personnel who are designated for physical survey participation will participate in the training sessions, to be held prior to the pilot physical surveys. BTI will prepare any special instructional and familiarization materials, and will provide familiarization training using actual survey materials and control room mockups. One training session will be held for all survey teams.

Products. Trained survey team members.

S-5 Conduct Pilot Survey of Units

The purpose of this activity is to perform a pilot physical survey of the two types of Duke Power control units. Goals are to establish experienced Duke survey teams, test the physical survey checklists and other materials, and identify control room HEDs. The objective of the BTI effort is to provide human factors professionals to assist Duke in conducting a survey of two units using the checklist and procedures developed earlier (Activities S-2 and S-3).

BTI human factors engineering personnel will participate in both pilot surveys (Oconee-1 and Catawba-1). Pilot surveys will be initiated on the appropriate control room mockup using the survey materials developed for this type of evaluation, and then be completed in the equivalent control room.

Products. Products of the pilot surveys will be identified HEDs and requirements for modification/refinement of physical survey methods and materials.

S-6 Conduct Physical Survey of Remaining Units

The purpose of this activity is to identify HEDs in the control rooms of units not evaluated during the pilot surveys. Following the conduct of the pilot tests and modifications of the control room survey procedure and checklists, the remainder of the units at the three stations will be surveyed. As in the pilot surveys, the initial portion of the physical survey for each control room will be performed on the appropriate control room mockup, and completed in the actual control room. It is anticipated that this activity will be primarily conducted by the Duke review team, but BTI personnel are expecting to provide assistance on an as-needed basis in this activity.

Products. The products of this activity will be the identified HEDs.

S-7 Develop Engineering Survey Methodology

The purpose of this activity is to establish the methods and general procedures to be used for the conduct of the engineering survey of the control rooms. This activity will be initiated when survey/guideline categorization (S-1) is complete, jointly with the development of the physical survey methodology (S-2). Specific approaches and methods will be defined which are compatible with other survey activities and review tasks, reflect the policies and overall approach established by Duke Power, and which will optimize the conduct of the engineering survey portion of the control room review. BTI will develop a recommended methodology which will be reviewed and finalized by Duke. The methodology will be further refined and modified, if necessary, as experience in the conduct of the engineering survey (S-10) dictates.

Products. The products of this task will be a definition of the engineering survey objectives, methods, and procedures to be used during the engineering survey, requirements for engineering survey materials development, and requirements--if any--for engineering survey team training.

S-8 Develop Engineering Survey Materials

The purpose of this activity is to develop the specific materials to be used by the survey team for the conduct of the engineering survey. Duke will initially define the format and content of the engineering survey checklist, HED recording forms, and other materials, based on the agreed-upon methodology (S-7) and the preferred Duke approach. BTI will review these preliminary definitions and provide recommendations for alternative and/or additional engineering survey materials. Final approval and production of engineering survey materials is the responsibility of Duke.

Products. The products of this activity will include a Duke-specific checklist, similar to that used in the physical survey (S-3), for items to be evaluated as part of the engineering survey. Other products will include the CRRT-specified forms and instructions for HED recording, instruments (e.g., forms or standard memos) for obtaining engineering data from other sources, and related typical reference materials. All materials will be refined and modified, as appropriate, as survey experience dictates.

S-9 Develop and Conduct Engineering Survey Team Training

The purpose of this activity is to provide all members of the engineering survey team with a good understanding of the methods, materials, and procedures for performing engineering control room surveys, if needed. All Duke personnel who are designated for engineering survey participation will participate in the training session, to be held prior to initiation of the physical surveys. BTI will prepare any special instructional and familiarization materials, and will provide familiarization training using actual survey materials. It is possible that,

since the engineering survey team members will be participating in establishing methodology (S-7) and developing materials (S-8), and may also be part of the physical survey team, special training may not be required. If it is deemed necessary, however, it will be conducted in coordination with the physical survey team training activity (S-4).

Products. Trained survey team members.

S-10 Conduct Engineering Survey of All Units

The purpose of this activity is to identify HEDs based on engineering factors in each of the seven Duke control rooms. This activity will be performed by Duke personnel. BTI personnel will provide assistance on an as-needed basis.

Products. The products of this effort will be identified HEDs and supporting engineering data and specifications.

S-14 Develop Environmental Survey Methodology

The purpose of this activity is to develop the methods and general procedures to be used for the conduct of the environmental survey of the control rooms. This activity will be initiated when survey/guideline categorization is complete, jointly with the development of physical survey methodology (S-2). Specific approaches and methods will be defined which are compatible with other survey activities and review tasks, reflect the policies and overall approach established by Duke Power, and which will optimize the conduct of the environmental survey portion of the control room review. Duke will develop a recommended methodology which is compatible with environmental measures already completed. This will be reviewed by BTI, and

comments and recommendations will be provided, to be finalized by Duke. The methodology will be further refined or modified, if necessary, as experience in the conduct of the environmental survey dictates.

Products. The products of this task will be a definition of the environmental survey objectives, methods, and procedures to be used during the environmental survey and requirements for environmental survey materials development.

S-15 Develop Environmental Survey Materials

The purpose of this activity is to develop the specific materials to be used by the survey team for the conduct of the environmental survey. Duke will initially define the format and content of the environmental survey checklist and HED recording forms, based on the agreed-upon methodology (S-14) and the preferred Duke approach. BTI will review these preliminary definitions and provide recommendations for alternative and/or additional environmental survey materials. Final approval and production of environmental survey materials is the responsibility of Duke.

Products. The products of this activity will include a Duke-specific checklist, similar to that used in the physical survey, for items to be evaluated as part of the environmental survey. Other products will include the CRRT-specified forms and instructions for HED recording, instructions and materials for obtaining environmental measures and data, and related typical reference materials. Also included are checklists and guidelines for scheduling and conduct of environmental survey site visits. All materials will be refined and modified, as appropriate, as survey experience dictates.

S-16 Conduct Environmental Survey of All Units

The purpose of this activity is to document environmental data and identify HEDs based on environmental factors in each of the seven Duke control rooms. This activity will be performed by Duke or other contract personnel. BTI personnel will provide assistance on an as-needed basis.

Products. The products of this effort will be identified HEDs and supporting environmental data and specifications.

S-17 Provide Human Factors Assurance Review and Continuing Support

The purpose of this activity is to provide assurance that all aspects of the control room survey effort are being performed in accordance with accepted human factors criteria and standards. Throughout the control room survey efforts, BTI will provide human factors assurance for all of the activities. In particular, we anticipate sufficient interaction with the Duke control room survey teams even though the primary responsibility for conducting the survey will be held by Duke. While assisting Duke in conducting the two pilot surveys, BTI staff members will independently note any HEDs they detect and determine whether such HEDs are also identified by the Duke survey team using the approved methods and materials. This BTI activity will be secondary to their primary function of assisting and advising the Duke survey team. It is also planned that BTI human factors professionals will review HEDs from the control room survey efforts to determine if they are clearly and adequately described with respect to the potential for human performance degradation or error.

BioTechnology is also prepared to provide continuing support as necessary to Duke in ongoing activities related to the control room survey. Our personnel would also be available to informally interact with the NRC Division of Human Factors Safety personnel to obtain their reaction to any activity in this area.

Products. The products of this activity are the HEDs and other survey results which are generated during the physical, engineering, and environmental control room surveys, reviewed by human factors specialists for acceptability.

S-18 Prepare Survey Methodology Report

The purpose of this activity is to provide the management of Duke Power with a report on the adequacy of the control room survey methodology. BTI will prepare a report describing fully the approach and rationale for the control room survey. The report will document the development of the Duke-specific checklists, the procedures for conducting the surveys, and the results and justification for the conclusions reached. The report will be in a form suitable for answering questions that the NRC or Duke management may pose concerning the control room survey for each unit. The report will be prepared initially based on the methodologies established in Activities S-2, S-7, and S-14, and supplemented or modified as each of the subsequent survey activities is completed. When all planned survey activities have been completed, the working methodology report will be prepared as a draft report for the control room review team and steering committee review. Following this review, and any needed discussions to clarify disagreements or unclear items, the report will be prepared in final form and submitted to Duke.

Products. Survey Methodology Report.

S-19 Prepare Summary Final Report

The purpose of this activity is to document the findings of the control room survey effort. Preparation of the report will be a Duke survey team responsibility, but BTI personnel will be available to assist on an as-needed basis.

Products. Survey Final Report.

SCHEDULE OF ACTIVITIES

This part of the work plan presents a schedule of the activities proposed for accomplishing the four efforts of the project:

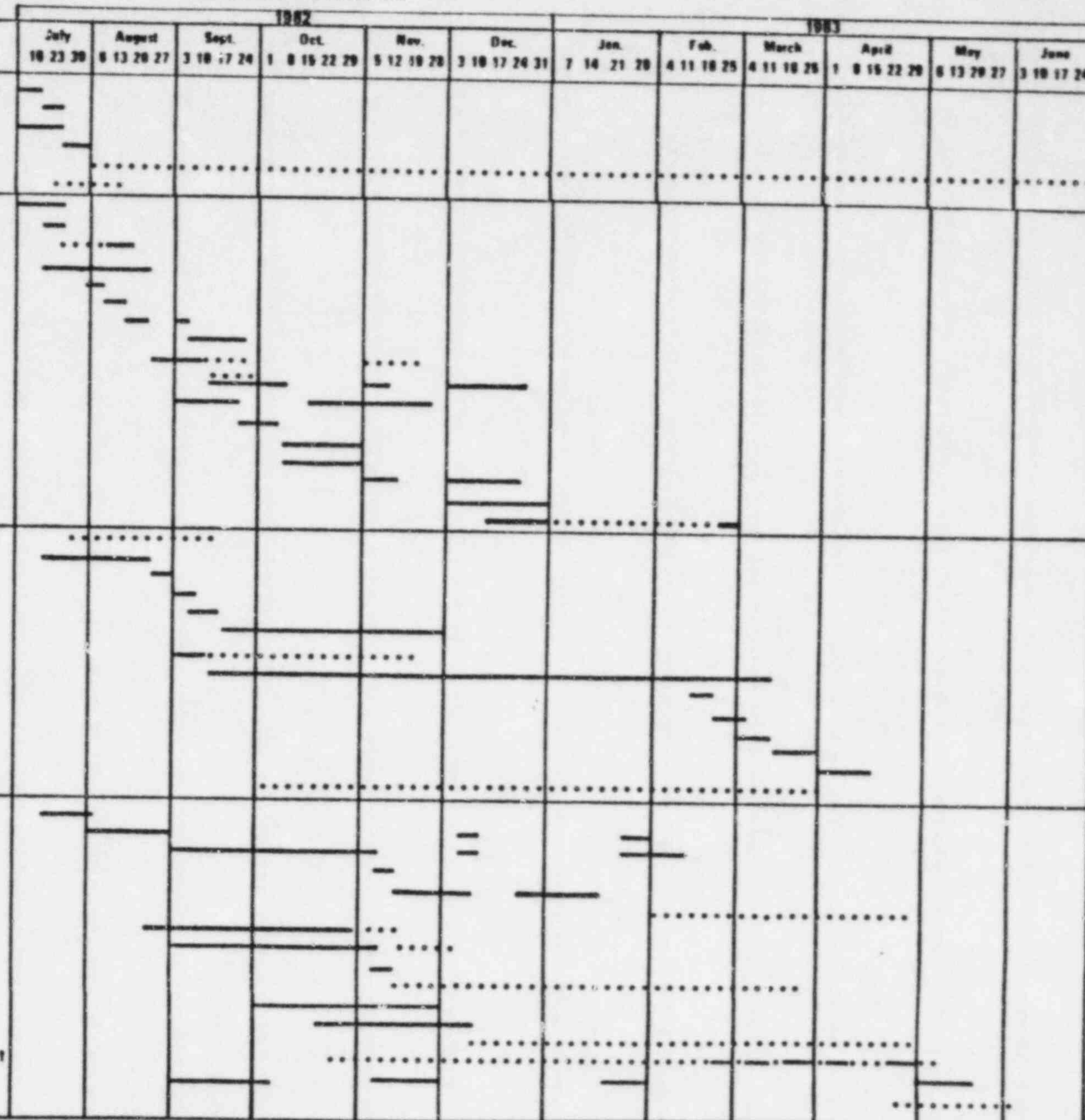
- Planning and coordination
- Operating experience review
- Task analysis
- Control room survey.

The chart which follows indicates calendar months and the dates of every Friday of that month; thus, any activity scheduled for completion during any week would be expected to be completed and delivered by hand, mail, or express on that Friday. Specific delivery dates or other commitments for specific days of the week will be documented separately in project memoranda.

A separate chart is included to indicate the travel related to project activities and schedule dates. A third chart is included in this section to summarize the schedule of activities.

SCHEDULE OF ACTIVITIES

Group	Activ. No.	Activity Title
Planning & Coordination	P- 1	Conduct Planning Conference
	P- 2	Prepare Work Plan
	P- 3	Prepare Training Seminar
	P- 4	Present HF Training Seminar
	P- 5	Maintain Continued Project Planning and Coordination
	P- 6	Establish 0700 Guidelines/Review Categories
Operating Experience Review	0- 1	Assemble Item Pool for Operator Survey
	0- 2	Develop Guidelines for Operating History Review
	0- 3	Review Incident Reports and Other Operational Data
	0- 4	Develop Questionnaires
	0- 5	Develop Interview Protocol
	0- 6	Prepare Training Presentation
	0- 7	Conduct Training Presentation on Station
	0- 8	Collect Questionnaire Data
	0- 9	Develop Questionnaire Analysis Procedure
	0-10	Analyze Operator Questionnaire Data
	0-11	Prepare Operating Experience Review Methodology Report
	0-12	Finalize Interview Format/Training
	0-13	Conduct On-site Interviews
	0-14	Develop Interview Data Analysis Procedure
	0-15	Analyze Interview Data
	0-16	Document and Describe HF Problems
	0-17	Prepare Final Report and Continuing Support
Task Analysis	T- 1	Select NSSS Vendor EPGs for Analysis
	T- 2	Develop Task Analysis Methodology
	T- 3	Prepare Training Workshop
	T- 4	Conduct Task Analysis Training
	T- 5	Perform Pilot Task Analysis for EPGs
	T- 6	Prepare Task Analysis Methodology Report
	T- 7	Select Other Operating Events
	T- 8	Conduct Written Task Analysis Mockup Verification
	T- 9	Review Tasks for Need to Validate
	T-10	Develop Method for Simulator Validation
	T-11	Conduct Additional Task Analysis Training
	T-12	Validate Selected Events in Simulator
	T-13	Prepare Final Report
	T-14	Provide Human Factors Assurance Review & Continuing Support
Control Room Survey	S- 1	Review 0700 Guidelines and Establish Survey Categories
	S- 2	Develop Physical Survey Methodology
	S- 3	Develop Physical Survey Checklists and Materials
	S- 4	Develop and Conduct Physical Survey Team Training
	S- 5	Conduct Pilot Physical Survey of 2 Units
	S- 6	Conduct Physical Survey of Remaining Units
	S- 7	Develop Engineering Survey Methodology
	S- 8	Develop Engineering Survey Materials
	S- 9	Develop and Conduct Engineering Survey Team Training
	S-10	Conduct Engineering Survey of All Units
	S-14	Develop Environmental Survey Methodology
	S-15	Develop Environmental Survey Materials
	S-16	Conduct Environmental Survey of All Units
	S-17	Provide Human Factors Assurance Review and Continuing Support
	S-18	Prepare Survey Methodology Report
	S-19	Prepare Survey Final Report



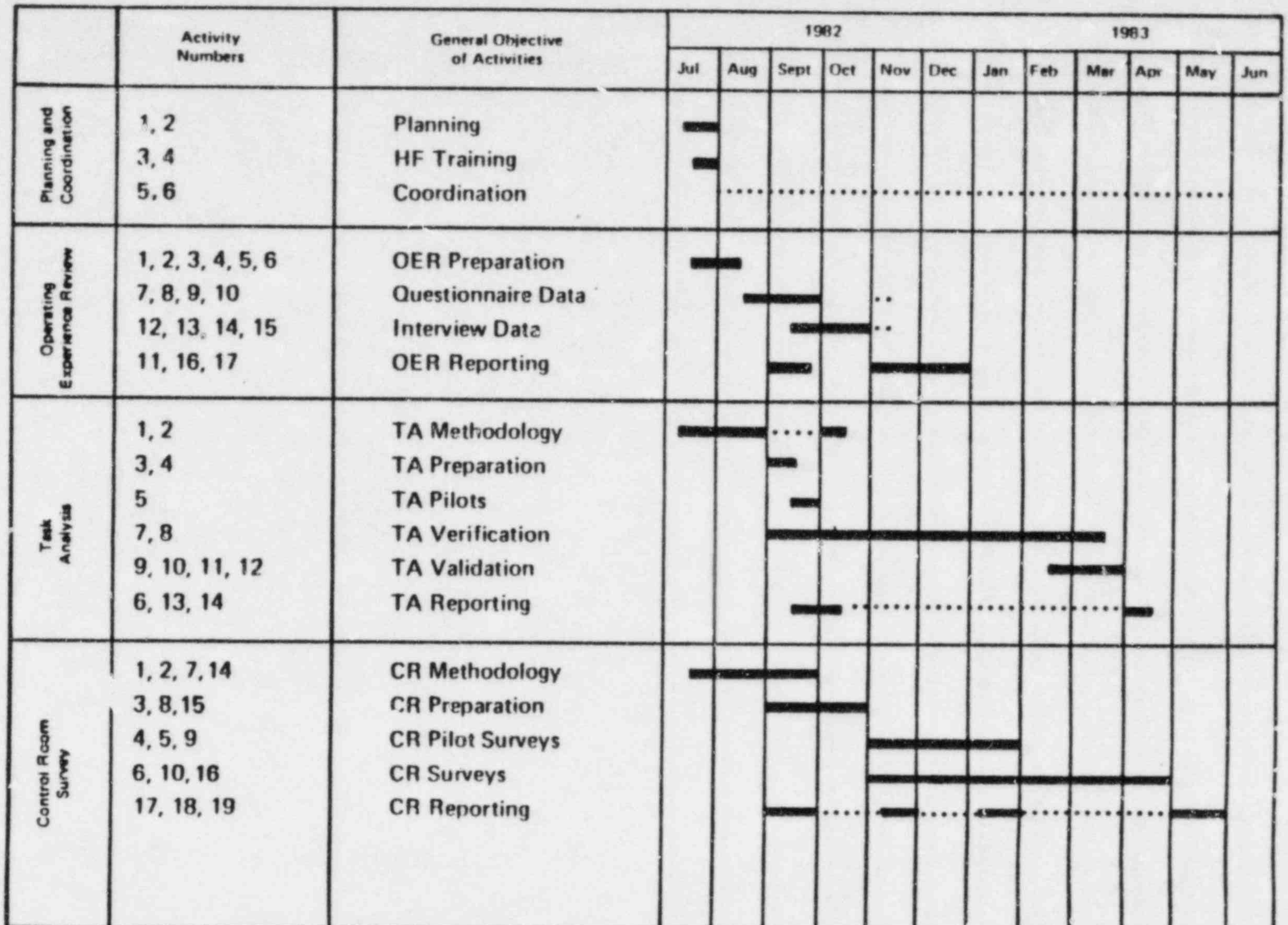
Revision 2

PROJECTED PROJECT TRAVEL

Activity #	Date	# Trips	# Persons	# Days/Nights
P-1	7/12-14/82	1	3	3/2
P-5	7/19-20/82	1	1	2/1
P-5	Throughout	5	1	2/1
P-4	7/26-28/82	1	3	3/3
O-4,5	8/4-5/82	1	2	2/2
O-7	8/16-20/82	1	2	4/4
O-10	9/27-29/82	1	2	3/2
O-13A	10/4-8/82	1	2	5/5
O-13B	10/11-15/82	1	2	5/5
O-13C	10/18-22/82	1	2	5/5
O-13D	10/18-22/82	1	2	5/5
O-13E	10/24-28/82	1	2	5/5
O-15,16	11/16-18/82	1	2	3/2
O-17	12/15-16/82	1	1	2/2
T-4	8/29-31/82	1	2	3/3
T-5	9/7-10/82	1	4	4/3
T-6	9/29-30/82	1	2	2/2
T-8	9/13-15/82	1	1	3/3
T-8	9/13-17/82	1	4	5/5
T-8	9/19-20/82	1	1	2/2
T-8	9/19-23/82	1	4	5/5
T-9	2/15-16/82	1	2	2/2
T-11	3/7-8/83	1	3	2/2
T-12	3/14-17/83	1	2	4/4
T-12	3/14-17/83	1	1	4/4
T-14	11&12/82,1/83	3	1	2/2
T-14	11&12/82,1/83	3	1	3/3
S-1,2	8/2-4/82	1	1	3/2
S-2,7,11,14	8/16-17/82	1	2	2/1
S-3,8	9/7-8/82	1	1	2/1
S-3,8,12,15	9/20-22/82	1	2	3/2
S-3,8,12,15	10/11-14/82	1	2	3/2
S-3,13,16	11/1-2/82	1	2	2/1
S-4	11/8-10/82	1	2	3/2
S-5	11/15-19/82	1	2	5/5
S-5	11/22-12/3/82	1	1	10/10
S-5	1/3-7/83	1	2	5/5
S-5	1/10-22/83	1	1	10/10
S-6,10,13,16,17	2/22-24/83	1	1	3/2
S-6,10,13,16,17	3/7-9/83	1	1	3/2
S-6,10,13,16,17	3/21-23/83	1	1	3/2
S-6,10,13,16,17	4/4-6/83	1	1	3/2
S-17	4/25-28/83	1	2	4/3

NOTE: This table has not been kept up-to-date.

SUMMARY OF CRDR WORK PLAN



PROJECT MANAGEMENT AND STAFFING

The BTI project will be under the active management of Harold E. (Smoke) Price, Executive Vice President of BTI and Director of the Division of Human Factors and Training. Mr. Price will actively participate in all the project efforts as well as be the point-of-contact for coordinating BTI participation. In addition to Mr. Price, team leaders for the three principal efforts have been identified as follows:

- Operating Experience Review--H.E. (Smoke) Price
- Task Analysis--H.P. Van Cott
- Control Room Survey--G.R. Hatterick.

Other members of the BTI staff will be used under the direction of the above personnel. A staffing chart follows indicating the estimated level of effort by category for each activity discussed in the proposal. Following the chart are brief biographical summaries of BTI personnel and consultant personnel with experience in human factors and nuclear power plant operations and safety who may participate in the project.

BIOTECHNOLOGY STAFFING CHART

	Activ. No.	Activity Title	Exec. Prof.	Senior Staff	Staff	Senior Prog.	Prog.	Senior Proj.	Proj.	Senior RA	RA	Secretary	Graphics	Totals
			Personnel Categories and Days											
Planning & Coordination	P- 1	Conduct Planning Conference	7		3	—	—				—			10
	P- 2	Prepare Work Plan	4		2	—	—				—	2	3	11
	P- 3	Prepare Training Seminar	5		2	1	—				—	1	4	13
	P- 4	Present HF Training Seminar	4		2	1	1				—	—	—	8
	P- 5	Maintain Continued Project Planning and Coordination	8		4	—	—				—	—	—	12
Operating Experience Review	O- 1	Assemble Item Pool for Operator Survey	½		3	—	[illegible]				2	1	—	6½
	O- 2	Develop Guidelines for Operating History Review	½		1	—	1				—	1	—	3½
	O- 3	Review Incident Reports and Other Operational Data	1		1	—	—				—	—	—	2
	O- 4	Develop Questionnaires	1		3	1	4				2	3	1	15
	O- 5	Develop Interview Protocol	½		1	1	—				1	1	½	5
	O- 6	Prepare Training Presentation	1		1	—	1				—	1	2	6
	O- 7	Conduct Training Presentation on Station	3		3	—	—				—	—	—	6
	O- 8	Collect Questionnaire Data	—		1	—	1				1	1	—	4
	O- 9	Develop Questionnaire Analysis Procedure	1		2	1	1				—	1	1	7
	O-10	Analyze Operator Data Questionnaire	1		3	1	—				3	2	—	10
	O-11	Prepare Operating Experience Review Methodology Report	3		4	3	2				3	4	3	22
	O-12	Finalize Interview Format/Training	1		2	1	1				1	½	½	7
	O-13	Conduct On-site Interviews	6		7	7	14				2	4	1	41
	O-14	Develop Interview Data Analysis Procedure	1		2	1	1				1	—	—	6
	O-15	Analyze Interview Data	1		3	1	3				3	4	1	16
	O-16	Document and Describe HF Problems	1		2	2	2				1	3	1	12
	O-17	Prepare Final Report and Continuing Support	3		5	2	2				3	4	2	21
Task Analysis	T- 1	Select NSSS Vendor EPGs for Analysis	1			—	—	—	—		—	—	—	1
	T- 2	Develop Task Analysis Methodology	3			5	5	1	5		2	4	2	27
	T- 3	Prepare Training Workshop	2			3	—	1	—		1	3	—	12
	T- 4	Conduct Task Analysis Training	4			4	—	4	—		—	—	2	12
	T- 5	Perform Pilot Task Analysis for EPGs	4			5	—	5	5		—	—	—	19
	T- 6	Prepare Task Analysis Methodology Report	3			5	—	—	5		2	3	2	20
	T- 7	Select Other Operating Events	1			—	—	—	—		—	—	—	1
	T- 8	Conduct Written Task Analysis Mockup Verification	5			5	5	5	5		—	—	—	25
	T- 9	Review Tasks for Need to Validate	1			1	—	—	—		—	—	—	2
	T-10	Develop Method for Simulator Validation	1			5	4	—	—		—	—	—	10
	T-11	Conduct Additional Task Analysis Training	2			2	0	—	—		1	1	1	7
	T-12	Validate Selected Events in Simulation	4			4	—	4	4		—	—	—	16
	T-13	Prepare Final Report	2			6	—	—	5		2	3	2	19
	T-14	Provide Human Factors Assurance Review & Continuing Support	8			6	—	—	—		—	2	—	16
Control Room Survey	S- 1	Review 0700 Guidelines and Establish Survey Categories	—		6	—	—	3			—	1	—	10
	S- 2	Develop Physical Survey Methodology	—		5	4	—	3			1	4	—	19
	S- 3	Develop Physical Survey Checklists and Materials	—		7	3	3	3			3	10	5	34
	S- 4	Develop and Conduct Physical Survey Team Training	1		4	1	—	2			—	—	—	8
	S- 5	Conduct Pilot Physical Survey of 2 Units	5		5	13	—	12			—	—	—	35
	S- 6	Conduct Physical Survey of Remaining Units	2		5	2	—	3			—	—	—	12
	S- 7	Develop Engineering Survey Methodology	—		2	1	—	—			—	1	—	4
	S- 8	Develop Engineering Survey Materials	—		2	2	—	—			1	2	1	8
	S- 9	Develop and Conduct Engineering Survey Team Training	—		1	1	—	—			—	—	—	2
	S-10	Conduct Engineering Survey of All Units	—		—	—	—	—			—	—	—	—
	S-11	Develop Operations Administration Survey Methodology	—		1	—	—	—			—	1	—	2
	S-12	Develop Operations Administration Survey Materials	—		2	—	—	—			1	1	1	5
	S-13	Conduct Operations Administration Survey of All Units	—		—	—	—	—			—	—	—	—
	S-14	Develop Environmental Survey Methodology	—		1	—	—	2			—	1	—	4
	S-15	Develop Environmental Survey Materials	—		1	—	—	1			1	1	1	5
	S-16	Conduct Environmental Survey of All Units	—		—	—	—	—			—	—	—	—
	S-17	Provide Human Factors Assurance Review and Continuing Support	2		4	2	2	2			—	—	—	12
	S-18	Prepare Survey Methodology Report	2		7	5	—	4			4	6	2	30
	S-19	Prepare Survey Final Report	1		5	—	—	—			—	—	—	6
		TOTALS												

NOTE: This chart has not been updated since the original plan.

PERSONNEL EXPERIENCED IN NUCLEAR POWER PLANT HUMAN FACTORS

T&M CATEGORY	INDIVIDUAL/ POSITION	DISCIPLINE/ SPECIALTY	HFE EXPERIENCE (YEARS)	NUCLEAR EXPERIENCE			
				CONTROL ROOM REVIEWS	STAFFING & TASK ANALYSIS	HFE CRITERIA	OPERATING PROCEDURES
Executive Professional	H.E. (Smoke) Price	Human Factors Engineer	25 +	✓	✓	✓	
Executive Professional	H.P. Van Cott, Ph.D.	Experimental Psychologist	25 +	✓	✓	✓	
Executive Professional	T.J. Post	Industrial Engineering	25 +	✓		✓	✓
Staff Professional	G.R. Hetterick	Human Factors Engineer	25 +	✓		✓	
Staff Professional	R.F. Pain, Ph.D.	Experimental Psychologist	20		✓	✓	
Staff Professional	R. Pulliam, Ph.D.	Educational Technologist	25 +			✓	
Sr. Program Professional	B. Paramore	Operations Analysis	12	✓	✓	✓	
Sr. Program Professional	J.S. Sanders	Electronics Engineering	16			✓	
Sr. Program Professional	M.G. Smith, Ph.D.	Engineering Psychologist	16	✓	✓	✓	✓
Sr. Program Professional	M.B. Bauman	Industrial Psychologist	8	✓	✓	✓	
Sr. Program Professional	D.F. Taylor	Industrial Engineer	10	✓		✓	✓
Program Professional	C.R. Sawyer, Ph.D.	Experimental Psychologist	5			✓	
Program Professional	J. P. Bongarra	Industrial Psychologist	10		✓	✓	✓
Sr. Project Professional	J. DeBor	System Analyst	14	✓	✓	✓	✓
Project Professional	R.E. Malsano	Experimental Psychologist	6		✓	✓	
Consultant (Executive Professional)	T.B. Malone, Ph.D.	Engineering Psychologist	20	✓	✓	✓	
Consultant (Staff Professional)	M. Kirkpatrick, Ph.D.	Engineering Psychologist	15	✓	✓	✓	
Consultant (Program Professional)	J.S. Kidd, Ph.D.	Experimental Psychologist	25+			✓	
Consultant (Program Professional)	J.H. Hill	Engineering Psychologist	25+		✓	✓	✓
Consultant (Program Professional)	C.O. Muehlhause, Ph.D.	Nuclear Engineer	25+		✓	✓	

Duke Power Company

McGuire Nuclear Station
Units 1 & 2
Control Room Review
Supplement to Final Report

Table of Contents

Section		Page
1.0	Introduction	1
2.0	Summary of Plant-specific Review Phase Activities	1
3.0	Summary of Assessment Activities	3
4.0	Implementation Schedule	6

Appendix:

A. Surface Enhancement Solution HEDs

B. Physical Change Solution HEDs

C. HEDs Not Corrected

D. Implementation Priority Schedule

Foreword

The Final Report of the Duke Power Control Room Review together with this companion Supplement for McGuire Units 1 & 2 constitutes the complete "Summary Report" as required by Supplement 1 to NUREG-0737.

1.0 Introduction

This Supplement to the Duke Power Control Room Review - Final Report describes the Assessment Phase results for the review of McGuire Nuclear Station, Units 1 and 2. It also describes certain plant-specific items from the Review Phase of the McGuire review and presents an implementation priority schedule for HED solutions.

2.0 Summary of Plant-specific Review Phase Activities

2.1 Control Room Survey

The Control Room Survey was conducted in accordance with the Control Room Survey Methodology described in the Final Report. The Survey included the main control boards and other ancillary operating panels in the Control Room, and the operating panels in the Auxiliary Shutdown Area In addition, an environmental survey of both areas was performed.

2.2 Task Analysis

The Task Analysis for McGuire was conducted in accordance with the Task Analysis Methodology as described in the Final Report. The emergency procedures portion of the Task Analysis covered all Westinghouse Emergency Response Guidelines (ERGs) listed in Table 2-1. The normal procedures portion of the Task Analysis was plant-specific.

As described in the Final Report, the normal procedures covered were selected from the results of the Operating Experience Review (OER) for McGuire, and from the experience of operators on the Task Analysis Team.

Due to the specific component-related nature of many OER comments, two classes of normal operating sequences were established for Task Analysis (1) sequences which required the generation of task descriptive data to perform a walk through evaluation and (2) component-related items and other sequences for which a walk-through evaluation could be performed without the generation of task descriptive data. Table 2-2 lists the normal sequences selected for Task Analysis.

In addition to these sequences, a review of the annunciator alarm and status light panels was also conducted. This review was performed by reviewing the tasks generally performed at each major operator work station and comparing the alarm and status indication requirements

to the existing indication. Working definitions of what should constitute an annunciator alarm or status panel indication were developed to aid in this review. These definitions are shown in Tables 2-3 and 2-4. The Task Analysis HED Principles (contained in the Final Report) were used with these definitions to identify possible HEDs in the following areas:

- o Location of indication
- o Arrangement within panels
- o Classification of indication as alarm or status
- o Redundant indication
- o Use of abbreviations and message content
- o Readibility

2.3 Operating Experience Review (OER)

The OER was conducted by BioTechnology in accordance with the methodology described in the Final Report. In addition to specific areas concerning control board and Control Room design and arrangement, the interviews and questionnaires also covered the use of procedures, training, station staffing, and general station operation, among other areas. OER comments in areas beyond the scope of the Control Room Review were documented and transmitted to the attention of station management. The Review Team requested station management to review these comments and initiate appropriate action if required.

2.4 Unit 1/Unit 2 Difference Evaluation

The McGuire Control Room is a two unit Control Room containing the main control boards for both Units 1 and 2 in a "horseshoe" arrangement. The same type of components are used on each control board, and the arrangement of the system controls is essentially identical.

Because of the similarity between the Unit 1 and Unit 2 control boards, the task analysis and control room survey activities were conducted for Unit 1. HEDs identified during these review activities also applied to Unit 2 unless

a specific difference in the units existed. A component by component comparison of the units was performed to identify any existing differences. Where differences were identified, a Survey or Task Analysis evaluation, as appropriate, was conducted to identify any specific HEDs for Unit 2.

3.0 Summary of Assessment Activities

3.1 Overview

The objectives of the Assessment Phase of the Control Room Review for McGuire were to:

- o Determine the importance of each HED to plant operation
- o Develop feasible solutions and estimate solution costs
- o Select cost-effective improvements to the Control Room

<u>Significance Evaluation</u>

Of prime importance in the Assessment Phase was the task of establishing the significance of an HED as it relates to the performance of the intended operating task. The significance evaluation considered a combination of factors including the potential for operator error, the potential for error detection and recovery, and the consequence of the error to plant operation and safety. This process established a relative significance for an HED. It was recognized early that not all HEDs would require this formal significance evaluation and a selective screening process was developed.

HEDs were reviewed to determine the following:

1) Is the HED a deficiency?

2) Due to its unique nature, does the HED require individual study and assessment?

3) Can the HED be resolved with surface enhancements?

4) Should the HED be resolved to maintain consistency with control room conventions or standards?

5) Is the HED part of a larger generic HED or a duplicate from another review effort?

6) Is the HED deficiency so minor that no physical change is needed and the only action required is to establish operator awareness through training?

7) Is the HED in the process of resolution with an existing design change?

All HEDs not initially categorized in the screening activity were processed through the significance evaluation activity. The final disposition of significance evaluation of an HED was based primarily on the judgement of the Assessment Team composed of three Senior Reactor Operators, three Mechanical/Nuclear Engineers, two Electrical Engineers, and one Human Factors Specialist. The process was systematically applied through the use of work place procedures, and standard evaluation forms.

Solution Development

HEDs determined to be deficiencies were selected for resolution through physical control room modifications, surface enhancements to control boards, recommendations for procedure revisions, or additional training as appropriate. Three solution teams, each consisting of one operator and one engineer, were assisted by engineers from Design Engineering and Human Factors Specialists from BioTechnology in developing integrated solutions on a control board basis. For each control board, all HED solutions (both physical changes and surface enhancements) were reviewed to assure that no additional human factors deficiencies were created while solving HEDs, and to assess the impact of these corrections on operating crew effectiveness and system safety.

HED solutions were evaluated for the feasibility of implementation by examining the as-built status of the McGuire Control Boards for any physical restraints of installation, and by discussing proposed solutions with systems engineering personnel in the Electrical and Mechanical Divisions of Design Engineering. Proposed solutions were cost estimated by a standard menu of cost estimate information developed by the Review Team with assistance from McGuire Construction Department personnel. HEDs with more complex solutions, such as the installation of new equipment or modification of existing equipment to provide signal sources, the processing of new signals, and cabling necessary to provide those signals to the control room, were separately cost estimated on an individual basis with assistance

from Electrical and Mechanical Division personnel from Design Engineering.

Selection of Cost-effective Improvements

.. ratio of HED significance to solution cost was calculated for HEDs with an assigned significance. This ratio, similar to a benefit/cost evaluation, provided a relative ranking of HEDs from most cost-effective to least cost-effective. The Review Team reviewed the range of this ratio as an aid in determining which solutions represented cost-effective improvements to the Control Room.

HEDs without assigned significance, such as HEDs with surface enhancement solutions or HEDs with solutions required to maintain Control Room conventions, were subjectively reviewed as to cost-effectiveness by the Review Team to aid in the selection of cost-effective improvements.

All HEDs where solutions were not judged to be cost-effective were reviewed in an effort to determine if alternative solutions existed. Possible alternatives included revised physical solutions, more emphasis on surface enhancement techniques, the use of procedures or training awareness, or some combination of these areas. Where an applicable alternative solution was selected, the HED was assigned to the appropriate category. Where no applicable alternative solution was identified, the HED was documented as such.

3.2 Summary of Results

Table 3-1 summarizes the results of the Assessment Phase. The number of HEDs in each of the final disposition categories is shown.

Appendix A contains a listing of HEDs to be solved by surface enhancement techniques.

Appendix B contains a listing of HEDs in the physical change category.

Appendix C contains a listing of HEDs which were not solved by surface enhancement, physical changes, procedure modification, enhanced training, awareness, or some combination of these methods.

4.0 Implementation Schedule

An implementation schedule for HED solutions will be developed. The development of this schedule will consider two basic criteria: (1) the significance of the HED and (2) the complexity of the design/installation and/or material procurement for the HED solution. The method of implementation prioritization used will ensure the effective use of company resources for design and installation, consistent with HED significance.

The detailed design and installation of HED solutions will, in general, be handled by the line organization under the existing Nuclear Station Modification Program.

The proposed HED solution implementation schedule (Appendix D) will be transmitted as a revision to this Supplement by March, 1984.

Table 2-1

McGuire Nuclear Station
Control Room Review
Emergency Response Guideline Sequences
for Task Analysis

E-0:	Reactor Trip or Safety Injection
ES-0.1:	Reactor Trip Recovery
ES-0.2:	Natural Circulation Cooldown
ES-0.3:	SI Termination Following Spurious Safety Injection
E-1:	Loss of Reactor Coolant
ES-1.1:	SI Termination Following Loss of Reactor Coolant
ES-1.2:	Post-LOCA Cooldown and Depressurization
ES-1.3:	Transfer to Cold Leg Recirculation Following Loss of Reactor Coolant
ES-1.4:	Transfer to Hot Leg Recirculation
E-2:	Loss of Secondary Coolant
ES-2.1:	SI Termination Following Loss of Secondary Coolant
ES-2.2:	Transfer to Cold Leg Recirculation Following Loss of Secondary Coolant
E-3:	Steam Generator Tube Rupture
ES-3.1:	SI Termination Following Steam Generator Tube Rupture
ES-3.2:	Alternate SGTR Cooldown
ES-3.3:	SGTR with Secondary Depressurization
ECA-1:	Anticipated Transient Without SCRAM
ECA-2:	Loss of All ac Power
ECA-2.1:	Loss of All ac Power Recovery Without SI Required
ECA-2.2:	Loss of All ac Power Recovery With SI Required

Table 2-1
(Continued)

ECA-3: SGTR Contingencies

FR-C.1: Response to Inadequate Core Cooling

FR-C.2: Response to Degraded Core Cooling

FR-C.3: Response to Potential Loss of Core Cooling

FR-C.4: Response to Saturated Core Cooling Conditions

FR-I.1: Response to Pressurizer Flooding

FR-I.2: Response to Low System Inventory

FR-I.3: Response to Voids in Reactor Vessel

FR-H.1: Response to Loss of Secondary Heat Sink

FR-H.2: Response to Steam Generator Overpressure

FR-H.3: Response to Steam Generator High Level

FR-H.4: Response to Steam Generator Low Level

FR-H.5: Response to Loss of Steam Generator PORVs or Condenser Dump Valves

FR-P.1: Response to Imminent Pressurized Thermal Shock Condition

FR-P.2: Response to Anticipated Pressurized Thermal Shock Condition

FR-S.1: Response to Nuclear Power Generation

FR-S.2: Response to Loss of Core Shutdown

FR-Z.1: Response to High Containment Pressure

FR-Z.2: Response to High Containment Sump Level

FR-Z.3: Response to High Containment Radiation Level

Table 2-2

McGuire Nuclear Station
Control Room Review
Normal Sequences Selected
for Task Analysis

1. Items which require generation of task descriptive data to perform walk-through evaluation.

    a. CA System Operation
    b. RN System Operation
    c. NI (UHI portion) System Operation
    d. NI (Accumulator portion) System Operation
    e. NR System Operation
    f. Operations at HVAC Control Board
    g. Operation of Pressurizer Relief Tank Controls
    h. Operation at Aux. Shutdown Panel

2. Component-related items from OER and other items which do not require the generation of task descriptive data to analyze with a walk-through evaluation.

    a. CM/CF System Startup
    b. Turbine Startup
    c. Operation of Moisture Separator/Reheater Controls
    d. Review of Annunciators, Status Lights, and ESF Monitor Light Panels

Table 2-3

McGuire Nuclear Station
Control Room Review
Annunciator Alarm Criteria

Alarms alert the operator (through attention-gaining methods) to system or component parameters which are out of design or operational limits. An alarm (displayed on annunciator panels) alerts the operator to:

1 - Impending Technical Specification Violations
Out-of-tolerance conditions which may lead to system degradation, trips, or ESF actuation

2 - Automatic Actuation of Engineered Safety Features

3 - Automatic Actuation of Reactor Trip and/or Turbine Trip

4 - Alarms on Unmanned Local Panels

5 - Blocking or Failure of Automatic or Manual Control Room Functions

6 - Loss of Control Room Instrumentation or Equipment

7 - Conditions Requiring Operator Action to Prevent or Recover from Component/System Degradation

Table 2-4

McGuire Nuclear Station
Control Room Review
Status Light Criteria

Status Light Panels are used to display information to the operator to aid in system status determination and/or alarm/problem diagnosis.

Status Light Panels should:

1 - Display System/Sub-system Level Status Information

2 - Not Display Component Status Unless:

a. Required for problem/alarm diagnosis
b. Not readily available at control board-mounted controls or instrumentation

3 - Not Display Redundant Information

Table 3-1

MCGUIRE NUCLEAR STATION
Control Room Review
HED Assessment Disposition

Number of HEDs	Disposition Category
59	HEDs with assigned significance points
44	HEDs violating Control Room Conventions
65	HEDs requiring Surface Enhancement
8	HEDs requiring Special Evaluation
222	Non-deficiencies
240	Duplicate/Supporting HEDs
25	Management Attention HEDs
14	HEDs already resolved through NSM process
677	Total McGuire HEDs

Appendix A

McGuire Nuclear Station

Control Room Review

Surface Enhancement Solution HEDs

HED RIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0003	DWG	9/17/82				RECORDER	T/A E-0-1	LABELS AND LOCATION AIDS

SCRIPTION:
LABELS FOR HAGAN RECORDERS ARE NOT PERMANENT SEE ATTACHMENT 1 FOR LIST OF RECORDERS IDENTIFI ED IN MOCKUPS

COMMENDATION:
NEED PERMANENT TAGS CUT-INCLUDE INSTRUMENT NUMBER,RECORDER NUMBER,AND PAPER TYPE NUMBER

DISPOSITION SUENH DESCRIPTION: INSTALL PERMANENT RECORDER LABELS

HED RIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0016	DWG	9/17/82	CA	1MC10 CA49	OE CLOSEUP OF DEVICE CA49	OTHER SWITCHES	T/A E-0-B-7	LABELS AND LOCATION AIDS

SCRIPTION:
START AND STOP IS NOT PERMANENTLY LABELED

COMMENDATION:
ADD START AND STOP POSITION LABEL

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL START/STOP ESCUTCHEON PLATE

HED RIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-0066	DWG	9/29/82	CA	1MC4 IF4A	OX INCLUDE IF4A, IF4B, IF4C AND IF4D	NAMEPLATE	T/A OP/6250/02-13	LABELS AND LOCATION AIDS

SCRIPTION:
NAMEPLATE LACKS PROPER DESCRIPTION OF ITS FUNCTION

OMMENDATION:
INCLUDE "SUCT" ON NAMEPLATE

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0068	DWG	9/29/82	CA	1MC4 1F4C		NAMEPLATE	T/A OP/6250/02-13	LABELS AND LOCATION AIDS

DESCRIPTION:
NAMEPLATE LACKS PROPER DESCRIPTION OF ITS FUNCTION
SEE PHOTO WITH HED M-1-0066

RECOMMENDATION:
INCLUDE "SUCT" ON NAMEPLATE

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0070	DWG	9/29/82	CA	1MC4 1F40			T/A OP16250102-13	LABELS AND LOCATION AIDS

DESCRIPTION:
ODD SCALE,GRADUATIONS ARE NOT CLEAR SEE PHOTO WITH M-1-0066

RECOMMENDATION:
CHANGE SCALE SO GRADUATIONS ARE CLEAR AND OF LOGICAL INCREMENTS

DISPOSITION SUENH DESCRIPTION: INSTALL NEW SCALE 0-450 GPM

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0077	DWG	9/29/82	SA	1MC10 CA47		NAMEPLATE	T/A OP/6250/02-13	LABELS AND LOCATION AIDS

DESCRIPTION:
LACKS "AB" ON VALVE NUMBER

RECOMMENDATION:
MAKE NAMEPLATE 1SA-48ABC ALSO INCLUDE COLLAR

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0078	DWG	9/29/82	SA	1MC10 CA48		NAMEPLATE	T/A OP/6250/02-13	LABELS AND LOCATION AIDS

DESCRIPTION:
LACKS AB ON VALVE NUMBER

RECOMMENDATION:
MAKE NAMEPLATE 1SA-49ABC ALSO INCLUDE COLLAR

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0095	DWG	10/07/82	NV	1MC10 NV85	2K CLOSEUP OF NV85	CONTROLLER	T/A ES-0.2-1	LABELS AND LOCATION AIDS

ESCRIPTION:
KNOB TOO BIG FOR LABEL UNDERNEATH IT

ECOMMENDATION:
MAKE LARGER LABEL AND EXTEND POINTER OR CHANGE SWITCH HANDLE TO ONE SIMILAR TO CATAWBA 1MC10 DEVICE NV-111

DISPOSITION SUENH DESCRIPTION: DO NOT IMPLEMENT

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0096	DWG	10/07/82		1MC2 SM53	2L INCLUDE SM53 AND SM36	NAMPLATE	T/A ES-0.2-5A	LABELS AND LOCATION AIDS

DESCRIPTION:
POSSIBLE CONFUSION WITH DEVICE SM 36

RECOMMENDATION:
CHANGE LABEL TO READ STEAM DUMP INTLK BYP TRN A

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0097	DWG	10/07/82		1MC2 SM96		NAMEPLATE	T/A ES-0.2-5A	

DESCRIPTION:
POSSIBLE CONFUSION WITH DEVICE SM 36 SEE PHOTO WITH HED M-1-0096

RECOMMENDATION:
CHANGE LABEL TO READ STEAM DUMP INTLK BYP TRN

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0102	PAT	10/08/82	NC	1MC10 NC 102	2N CLOSEUP OF NC 102	NAMEPLATE	T/A ES-0.2-14F	LABELS AND LOCATION AIDS

DESCRIPTION:
SWITCH NAMEPLATE NOT CLEAR ABOUT FUNCTION OF SWITCH

ECOMMENDATION:
CHANGE NAMEPLATE TO PORV MODE NORM/LOW 1NC-34 A SELECT

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED RIAL NO.	ORIG	DATE	PLAN, SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-0103	PAT	10/08/82	NC	1MC10 NC 103	2M CLOSEUP OF	NAMEPLATE NC 103	T/A ES-0.2-14F	LABELS AND LOCATION AIDS

SCRIPTION:
SWITCH NAMEPLATE NOT CLEAR ABOUT FUNCTION OF SWITCH

COMMENDATION:
CHANGE NAMEPLATE TO PORV MODE NORM/LOW 1NC-32 B SELECT

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

-1-0106	DWG	10/19/82	NV	1MC10 NV111	2P CLOSEUP OF	NAMEPLATE NV111	T/A ES-0.2-16	LABELS AND LOCATION AIDS

ESCRIPTION:
NAMEPLATE DOES NOT PROPERLY DESCRIBE VALVE FUNCTION

ECOMMENDATION:
SEE ATTACHMENT

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

-1-01.1	DWG	11/01/82	NV	1MC10 NV93	2R CLOSEUP OF	NAMEPLATE NV93	T/A ES-0.2-B-2	LABELS AND LOCATION AIDS

ESCRIPTION:
THERE IS NO NAMEPLATE

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL PERMANENT NAMEPLATES ON NV92,93,78,79

-1-0127	DWG	11/18/82	NC	1MC10 NC77	2V CLOSEUP OF	NAMEPLATE NC77	T/A ES-1.2-8	LABELS AND LOCATION AIDS

SCRIPTION:
NAMEPLATE DOES NOT REFLECT SWITCH FUNCTION, ALSO APPLIES TO NC94 AND NC88

COMMENDATION:
CHANGE NAMEPLATES PER ATTACHMENTS

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATES

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0138	DWG	11/30/82	KF	1MC9 RN8A	3B CLOSEUP OF RN8A	METER	T/A ECA-2-B-18C	LABELS AND LOCATION AIDS

SCRIPTION:
SCALE IS UNCLEAR,UNABLE TO DETERMINE KF WATER LEVEL

ECOMMENDATION:
CHANGE SCALE SUCH THAT ONE CAN TELL LEVEL AND ADD ANNUNCIATOR FOR LOW POOL LEVEL

DISPOSITION SUENH DESCRIPTION: PROVIDE NEW SCALE FOR KF POOL LEVEL METE

-1-0172	DWG	1/04/83	NC	1MC10 NC45	3G CLOSEUP OF NC45	LABELS	OER IQ-022-07-03	VISUAL DISPLAYS

ESCRIPTION:
LABEL DOES NOT REFLECT ITS FUNCTION THE RECORDER IT CONTROLS IS LOCATED ON 1MC5

RECOMMENDATION:
CHANGE LABEL

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

1-1-0177	DWG	1/04/83	NC	1MC5 NC3C		METER	OER I-02.08-20	VISUAL DISPLAYS

ESCRIPTION:
OVERPOWER AND OVERTEMPERATURE D/T METERS(NC3C, NC3D,NC4C,NC4D,NC5C,NC5D,NC6C,AND NC6D,) READ I
PERCENT BUT THE SPECIFICATIONS READ IN DEGREES THIS REQUIRES A MATHEMATICAL CONVERSION.

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METE ALES 0-80 F

1-1-0189	PAT	1/06/83	NV	1MC10 NC110		LABELS	Q-04.039-1	LABELS AND LOCATION AIDS

ESCRIPTION:
1NV-121 CONTROLS LETDOWN FLOW WHICH IS NOT REDILY APPARENT

COMMENDATION:
RELABLE

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0198	DWG	1/21/83	RN	1MC9 RN7	3F	METER	T/A OP/6400/06-8	LABELS AND LOCATION AIDS

ESCRIPTION:
SCALE IS DIFFICULT TO READ

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METER SCALE 739'-741'

1-1-0258	ALK	12/06/82	GEN		HFS PS10.1	CODES AND CONVENTIONS

ESCRIPTION:
COMPONENTS THAT DO NOT CONFORM TO COLOR CODE CONVENTIONS. (NRC C422,C517)
(SEE ATTACHED PAGE)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: CHANGE SWITCHES TO CONFORM TO COLOR CODE PARTNO

1-1-0274	ALK	12/07/82	GEN		HFS PS5.1	VISUAL DISPLAYS

ESCRIPTION:
NO UNITS ON SCALE PLATES OR UNITS NOT IN A CONSISTENT LOCATION
(SEE ATTACHED SHEET)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PLACE UNITS ON METER SCALES IN CONSISTENT LOCAT

1-1-0281	ALK	12/07/82	GEN		HFS PS5.3	VISUAL DISPLAYS

ESCRIPTION:
SCALE AND POINTER HAS PARALLAX PROBLEMS (SEE ATTACHED SHEET) (OR ELECTRONIC DISPLAYS)

COMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF - ADD ROD IDENTIFICATION STRIP

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0282	ALK	12/07/82	GEN				HFS PS5.5	VISUAL DISPLAYS

ESCRIPTION:
SCALE HAS TOO MANY GRADUATIONS BETWEEN NUMBERS (SEE ATTACHED SHEET)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-REPLACE METER SCALES

1-1-0283	ALK	12/07/82					HFS PS5.5	VISUAL DISPLAYS

DESCRIPTION:
SCALE IS NOT NUMBERED BY 1'S,2'S,5'S (SEE ATTACHED SHEET)
(NRC C515)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-REPLACE METER SCALES

M-1-0285	ALK	12/07/82	GEN				HFS PS5.6	VISUAL DISPLAYS

DESCRIPTION:
NEGATIVE SIGNS ARE NOT SHOWN ON SCALE FOR NEGATIVE VALUES.
(SEE ATTACHED SHEET)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-ADD+AND/OR-ON METER SCALES

-1-0287	ALK	12/07/82	GEN				HFS PS5.9	VISUAL DISPLAYS

DESCRIPTION:
SCALES WITHOUT RANGE MARKINGS (SEE ATTACHED SHEET)
(NRC C523) (MPA A10)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF - ADD NORM OP BANDS TO METERS

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0288	ALK	12/07/82	GEN				OER Q-01-001-01	VISUAL DISPLAYS

DESCRIPTION:
RELATED DISPLAYS DO NOT HAVE CONSISTENT SCALES (SEE ATTACHED SHEET)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-INSTALL NEW METER SCALES

1-1-0292	ALK	12/07/82	GEN			RECORDER	HFS PS5.14	VISUAL DISPLAYS

DESCRIPTION:
DIFFICULT TO ASSOCIATE RECORDER PEN TO PROPER SCALE. (SEE ATTACHED SHEET) (OR TO NAMEPLATE) (ALSO PS 5.3)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-INSTALL NEW RECORDER PENS

1-1-0307	ALK	12/10/82	GEN			NAMEPLATE	HFS PS6.1	LABELS AND LOCATION AIDS

DESCRIPTION:
AUX SHUTDOWN PANEL NAMEPLATES ARE NOT EASILY READABLE (HAS OLD-STYLE NAMEPLATES WITH 1/8" LETTERING, WHITE LETTERS ON BLACK BACKGROUND, CONDENSED LETTERING) (RCP MON. AND CF PNLS ALSO

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATES & ANN WINDOW

M-1-0308	ALK	12/10/82	GEN			NAMEPLATE	HFS PS6.1	LABELS AND LOCATION AIDS

DESCRIPTION:
NAMEPLATE CHARACTERS ARE TOO SMALL (SEE ATTACHED SHEET) (MPA A11(1))

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-ENGRAVE WITH LARGER CHARACTERS

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0309	ALK	12/10/82	GEN			NAMEPLATES, OTHER LABELS	HFS PS6.1	LABELS AND LOCATION AIDS

DESCRIPTION:
LETTERS AND/OR NUMERALS ARE NOT ORIENTED VERT- ICALLY.
(SEE ATTACHED SHEET)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-REPLACE VERTICALLY ORIENTED LABEL

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0311	ALK	12/10/82	GEN				HFS PS6.2	LABELS AND LOCATION AIDS

DESCRIPTION:
LACKS NAMEPLATE, ENGRAVINGS, LABELS, BUTTONS, LENSES, ESCUTCHEONS, ETC.
(SEE ATTACHED SHEET) (ALSO REF. CONTROLS PS4.4 HED M-1-361 FOR

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-LABEL COMPONENTS APPROPRIATELY

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0313	ALK	12/10/82	GEN				HFS PS6.3	LABELS AND LOCATION AIDS

DESCRIPTION:
LEGEND, LABEL, ESCUTCHEON, ENGRAVING, ETC. REPEATS NAMEPLATE INFORMATION.
(SEE ATTACHED SHEET) ALSO USE OF "CONTROL," "CONTROLLER","SELECT", OR "SELECTOR" IS UNNECES

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: REMOVE REDUNDANT INFO ON NAMEPLATES, METER LEGE

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0322	ALK	12/10/82	GEN			NAMEPLATE	HFS PS6.9	LABELS AND LOCATION AIDS

DESCRIPTION:
NAMEPLATE DOES NOT ADEQUATELY DESCRIBE FUNCTIONOF DEVICE.
(SEE ATTACHED LIST) (NRC C631)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-ENGRAVE AND INSTALL NEW NAMEPLATE

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0324	ALK	12/10/82	GEN			LABELS	HFS PS6.10	LABELS AND LOCATION AIDS

ESCRIPTION:
LABELING OR ENGRAVINGS DO NOT CONTRAST WELL WITH BACKGROUND. (WORN ENGRAVINGS,ETC.)
(SEE ATTACHED SHEET) (ALSO REF. PS 4.4 - HED M-1-361)

ECOMMENDATION:
REPLACE WORN E30 LENSES AND BUTTONS. INSTITUTE PROCEDURES TO PERIODICALLY REVIEW AND
REPLACE WORN LENSES AND BUTTONS.

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-REPLACE WORN E30 LENSES AND BUTTO

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0327	ALK	12/10/82	GEN			LABELS	HFS PS6.13	LABELS AND LOCATION AIDS

ESCRIPTION:
ROMAN NUMERALS ARE USED TO INDICATE CHANNELS OFINSTRUMENTATION.
(SEE ATTACHED SHEET)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL LEGEND PLATES WITH ARABIC #

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0333	ALK	12/10/82	GEN			CONTROLLER	HFS PS4.1	CONTROLS

ESCRIPTION:
OPERATION OF KNOB NOT OBVIOUS - NEEDS INDICATION OF DIRECTION OF OPERATION. ALSO NOT
CLEAR AS TO WHAT HAPPENS WHEN KNOB IS TURNED. (SEE ATTACHED SHEET) (MPA A14, NRC C421)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-ADD DIRECTION LABELS TO CONTROLLE

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0337	ALK	12/10/82	GEN			ALL DEVICES	HFS PS4.2	CONTROLS

ESCRIPTION:
USE OF "MAN" SHOULD REFER CONTROL TO ANOTHER CONTROL DEVICE. "MAN" SHOULD NOT BE USED FOR
"ON", "OFF", "OPEN", "CLOSE", ETC. (SEE ATTACHED LIST) (NRC C422)

ECOMMENDATION:
NEED SPECIAL STUDY TO DETERMINE WHICH "MAN" USES SHOULD BE "ON" (OR OPEN, CLOSE) AND
CHANGE AS NECESSARY.

DISPOSITION SUENH DESCRIPTION: INSTALL NEW ESCUTCHEON PLATES

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0359	ALK	12/13/82	GEN			CH-10250T SWITCH	HFS PS4.2	CONTROLS

DESCRIPTION:
POORLY ARRANGED ESCUTCHEON PLATE. "RESET/TAVE/STM PRESS"-1ML2,SM36 (ID# G60)
ALSO HVAC - VU11,12,21,22 (ID#H31), VX9,18,(ID#H32) ALSO VP 19 (ID#M35) RCP MON PNL (ID #M52)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL NEW ESCUTCHEON PLATES

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0361	ALK	12/13/82	GEN				HFS PS4.4	CONTROLS

DESCRIPTION:
CONTROL POSITIONS NOT IDENTIFIED (MISSING ESCUTCHEONS,BUTTONS,LENSES, NOT ENGRAVED,ETC)
(SEE ATTACHED SHEET) INCORE INSTR. CAB.(CENTER POS. FOR TOGGLE SW. NOT IDENTIFIED) (ID # M73)

RECOMMENDATION:
REPLACE WORN E30 LENSES AND BUTTONS INSTITUTE PROCEDURES TO PERIODICALLY REVIEW AND
REPLACE WORN LENSES AND BUTTONS.

DISPOSITION SUENH DESCRIPTION: ASSESSED IN PARTS-REPLACE WORN ESCUTCHEONS LENS

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0370	ALK	12/15/82	GEN				HFS PS5.1	VISUAL DISPLAYS

DESCRIPTION:
SCALE UNITS ARE INCORRECT OR CONFUSING. (SEE ATTACHED SHEET)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METER LEGEND PLATES

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0374	ALK	12/16/82	GEN				HFS PS6.10	LABELS AND LOCATION AIDS

DESCRIPTION:
NAMEPLATE, LABEL, ENGRAVING HAS MORE THAN 3 LINES, HARD TO READ.
(SEE ATTACHED SHEET)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PART NODEF - REMOVE LABELS FROM BOTTOM OF V5'S

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0375	ALK	12/16/82	EG	1MC11	L79	LABELS	HFS PS6.16	LABELS AND LOCATION AIDS

SCRIPTION:
MIMIC LINES OVER-LAP. SOME MIMIC STRIPS ARE MISSING (ID #L80,L81)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL NEW MIMIC STRIPS

-1-0407	ALK	1/06/83	CM	1MC13 CM4	N20	RECORDER	HFS PS5.3	VISUAL DISPLAYS

ESCRIPTION:
RECORDER POINTER IS UPSIDE-DOWN (BLUE PEN) ALSO 1MC4,1F8

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INVERT RECORDER POINTER

1-1-0415	ALK	1/07/83	GEN			LABELS	HFS PS6.15	LABELS AND LOCATION AIDS

ESCRIPTION:
MISSING SYSTEM DEMARCATION LINES. UNIT LINE ON 1MC1 (ID #L98) IR-IT SYS.,
1MC1-1MC2. 1MC10:IF-CA (ID # S19) 1MC11: NB-NI SYS (ID # S23)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: ADD NEW SYSTEM DEMARCATION LINES

1-1-0430	ALK	1/24/83	GEN				HFS 6.2	

ESCRIPTION:
PAM INDICATION IS NOT LABELED TO DISTINGUISH IT FROM OTHER INDICATIONS ON THE CONTROL BOARDS

ECOMMENDATION:
ADD NOTE TO CONTROL BOARD LAYOUT DRAWINGS TO DENOTE PAM INDICATORS AND RECORDERS.
CONTROL ROOM REVIEW TEAM SHOULD DECIDE METHOD FOR LABELING DEVICES.
DISPOSITION SUENH DESCRIPTION: INSTALL PAM LABEL ON BOTTOM OF RECORDERS AND ME

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0487	ALK	5/17/83	GEN			METER	U1/U2 DIFF	VISUAL DISPLAYS

SCRIPTION:
METER SCALE UNITS READ DIFFENTLY FOR UNITS 1 AND 2 (SEE ATTACHED SHEET)

ECOMMENDATION:
SEE ATTACHED SHEET

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METER SCALES

1-1-0488	ALK	5/17/83	GEN			NAMEPLATE	U1/U2 DIFF	LABELS AND LOCATION AIDS

ESCRIPTION:
NAMEPLATES READ DIFFERENTLY FOR UNITS 1 AND 2 (SEE ATTACHED SHEET)

RECOMMENDATION:
SEE ATTACHED SHEETS

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATES

1-1-0489	ALK	5/17/83	GEN			METER	U1/U2 DIFF	VISUAL DISPLAYS

ESCRIPTION:
METER SCALES ARE DIFFERENT FOR UNITS 1 AND 2 (SEE ATTACHED SHEET)

RECOMMENDATION:
SEE ATTACHED SHEET

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METER SCALES

1-1-0492	ALK	5/17/83	KC	MC11		NAMEPLATE	U1/U2 DIFF	LABELS AND LOCATION AIDS

ESCRIPTION:
UNIT 1 NAMEPLATES FOR KC 64 & 65 ARE ENGRAVED "KF HX OUTLET ISOL" BUT SHOULD BE "KF HX OUTLET FLOW" (UNIT 2 IS CORRECT)

COMMENDATION:

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATES

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-0493	ALK	5/17/83	EG	1MC11 EG 99		NAMEPLATE	U1/U2 DIFF	LABELS AND LOCATION AIDS

ESCRIPTION:
NAMEPLATE IS NOT CORRECT. PRESENTLY ENGRAVED "GEN BREAKER MOD-1AT", BUT SHOULD BE ENGRAVED "1A MAIN GEN BREAKER" (UNIT 2 IS CORRECT)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATE

1-1-0494	ALK	5/17/83	RN	1MC11 RN 118		NAMEPLATE	U1/U2 DIFF	LABELS AND LOCATION AIDS

)ESCRIPTION:
NAMEPLATE IS ENGRAVED "FWST PUMP 1" BUT SHOULD BE ENGRAVED "UNIT 1 FWST PUMP" (UNIT 2 IS CORRECT)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATES

1-1-0512	HEP	12/14/82					OER Q-01-02-03	PANEL LAYOUT

)ESCRIPTION:
UNIT 1 AND UNIT 2 MAIN GENERATOR CONTROLS ARE SIDE BY SIDE AND CAN BE CONFUSED 4*4*4* SEE ALSO QUESTION 31

RECOMMENDATION:
PROVIDE AN OBVIOUS PHYSICAL SEPARATOR BETWEEN UNITS

DISPOSITION SUENH DESCRIPTION: INCREASE WIDTH OF SYSTEM DEMARCATION LINE

1-1-0609	LTH	3/30/83				METER	OER Q-02-016-27	VISUAL DISPLAYS

ESCRIPTION:
THE ATTACHED DISPLAY OR METER SCALES REQUIRE CONVERSION OF THE DISPLAYED VALUE BEFORE IT CAN BE READ

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: PARTIAL NODEF-REPLACE RECORDER SCALE AND NP

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0653	DWG	1/27/83	CF	1MC10 1F24B		METER	T/A MMNS-1-3	LABELS AND LOCATION AIDS

DESCRIPTION:
METER SCALE GRADUATED IN UNCLEAR INCRAMENTS

RECOMMENDATION:
CHANGE SCALE TO 0-20,000 GPM WITH 1,000 GPM GRADUATIONS

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METER SCALE

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0671	DWG	2/15/83	ERF	GRB		OTHER SWITCHES	T/A MMNS-2-6	PANEL LAYOUT

DESCRIPTION:
OPERATING RECORDER UNDER VOLTAGE BLOCKING SWITCH IS LOCATED ON GEN RELAYING BOARD AND SHOULD BE ON 1MC1 ALSO LABELING COULD BE IMPROVED

RECOMMENDATION:
LOCATE ON 1MC1

DISPOSITION SUENH DESCRIPTION: PARTIAL [illegible]DEF-INSTALL NEW NAMEPLATES

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
M-1-0678	PAT	5/10/83	GEN				CR MOD SUG	VISUAL DISPLAYS

DESCRIPTION:
RECORDER SCALES HARD TO READ

RECOMMENDATION:
SUGGEST TO PLANT TO GRADUALLY REPLACE RECORDER SCALES WITH PLASTIC SCALES SIMILAR TO SCALE ON DEVICE 1R-7 ON 1MC-1 AS SCALES NEED REPLACING

DISPOSITION SUENH DESCRIPTION: REPLACE RECORDER SCALES WITH TRANSLUCENT SCALES

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-1-0683	PAT	5/20/83	ASP			METER	T/A AP/5500/17-5	VISUAL DISPLAYS

DESCRIPTION:
NO NARROW RANGE STEAM GENERATOR LEVEL METERS

RECOMMENDATION:
INSTALL NARROW RANGE METERS OR MARK WIDE RANGE METER WITH NORMAL N/R OPERATING BAND

DISPOSITION SUENH DESCRIPTION: ADD N/R INFORMATION LABEL

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO I. INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0690	PAT	5/20/83		ASP		LABELS	T/A AP/5500/17-7	LABELS AND LOCATION AIDS

ESCRIPTION:
PZR PRESS METER HAS LEVEL ON METER SCALE

ECOMMENDATION:
REMOVE ERONIOUS LABEL

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METER LEGEND PLATE

1-2-0308	ALK	5/12/83	GEN			NAMEPLATE	U1/U2 DIFF	LABELS AND LOCATION AIDS

ESCRIPTION:
DIFFERENCES OF NAMEPLATES FOR EQUIVALENT UNIT 1AND 2 COMPONENTS.(SEE ATTACHED PAGES)

ECOMMENDATION:
(SEE ATTACHMENTS)

DISPOSITION SUENH DESCRIPTION: ENGRAVE AND INSTALL NEW NAMEPLATES

1-2-0309	ALK	5/12/83	GEN			METER	U1/U2 DIFF	VISUAL DISPLAYS

DESCRIPTION:
DIFFERENCES OF METER SCALES FOR EQUIVALENT UNIT1 AND 2 COMPONENTS. (SEE ATTACHED PAGES)

RECOMMENDATION:
(SEE ATTACHMENTS)

DISPOSITION SUENH DESCRIPTION: INSTALL NEW METER SCALES

1-2-0313	ALK	5/17/83	GEN			CONTROLLER	U1/U2 DIFF	VISUAL DISPLAYS

DESCRIPTION:
DIFFERENCES IN CONTROLLER SCALES BETWEEN UNIT1 AND 2. (SEE ATTACHED PAGES)

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL NEW SCALES

DUKE POWER COMPANY
MCGUIRE NUCLEAR STATION
HUMAN ENGINEERING DISCREPANCY MANAGEMENT

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
1-2-0314	ALK	5/17/83	GEN			RECORDER	U1/U2 DIFF	VISUAL DISPLAYS

DESCRIPTION:
DIFFERENCES IN RECORDER SCALES BETWEEN UNIT 1 AND UNIT 2 (SEE ATTACHED PAGES)

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL NEW RECORDER SCALES

Appendix B

McGuire Nuclear Station

Control Room Review

Physical Change Solution HEDs

HED No. M-1-0001

Problem Description: The knobs for NIS recorder switches IR40 & IR41 are too big. This makes it difficult to read switch positions.

Solution Description:
Install new switches for IR40 & IR41 with short shafts and smaller knobs.

HED No. M-1-0004

Problem Description: All annunciator and status light HEDs were grouped together and reviewed as a package in an annunciator study. After undergoing a thorough screening process, seven categories of HEDs merited solutions. These seven categories are listed below:

1. Annunciators and status lights are not functionally grouped.
2. There are deviations from McGuire standard abbreviations list.
3. Some annunciators are used as status lights and some status lights are used as annunciators.
4. The color coding of annunciators creates poor contrast. Also, the color coding prioritization is not meaningful to the operators.
5. Some panels are mirror imaged.
6. Some new annunciators and status lights need to be added; others need to be deleted.
7. Tile engravings are inconsistent.

Solution Description:

All annunciators and status lights were reviewed addressing the seven categories previously identified. As a result, the following recommendations are made:

1. Functionally group and arrange annunciators and status lights with their respective systems.
2. Re-engrave tiles to meet standard abbreviation list. Revise abbreviation list as appropriate.
3. Annunciators which are status lights should be made status lights. Similarly, status lights which are annunciators should be made status lights.
4. Annunciator color coding should be eliminated with the exceptions of the first out panel (1FO1) and 1AD1 reactor and turbine trips.
5. Panels should be rearranged to eliminate the problem of mirror-imaging.
6. Several new annunciators and status lights will be added. Also, some annunciators and status lights will be deleted.
7. Inconsistent tile engravings should be corrected.

HED No. M-1-0018

Problem Description: The ESF Panel purpose is to provide an easy verification of SI valve alignment during injection, post UHI, cold leg recirculation and hot leg recirculation phases. Due to the panel arrangement there are inconsistencies in the light and not lighted status associated with Phase B isolation and UHI completion status which degrades the ability to quickley verify SI valve alignment.

Solution Description:

Improve the ESF Panel arrangement to provide easily recognized patterns of SI valve status. Review individual tile descriptions and abbreviations.

HED No. M-1-0020

Problem Description:

Existing containment pressure meters have too wide a range for reading normally expected values.

Solution Description:

Add a narrow range containment pressure meter on MC11 near existing meters.

HED No. M-1-0034

Problem Description:

There is no indication of subcooling margin in control room other than the computer.

Solution Description:

Provide digital monitors for subcooling margin, in all four loops and incore, on MC5.

HED No. M-1-0045

Problem Description:

When the CA storage tank is full, it is hard to read needle position.

Solution Description:

Extend the CA storage tank level meter range from 0 - 100% to 0 - 110%.

HED No. M-1-0054

Problem Description:

Valves CA-4 and CS-18 are required to be normally tagged out - no control or indication.

Solution Description:

Provide power enable/disconnect switches on MC10 for CA-4 and CS-18.

HED No. M-1-0075

Problem Description:

1A & 1B CA pump discharge pressure meter has an inverted scale.

Solution Description:

Replace 15 - 3 psi transmitter with a 3 - 15 psi transmitter so that the meter will read 0 - 2000 psi from bottom to top.

HED No. M-1-0104

Problem Description:

Indication for letdown flow is provided on a non-linear scale - normal value at bottom.

Solution Description:

Provide components necessary to linearize the scale on meter NV5e on MC5.

HED No. M-1-0105

Problem Description:

Manual loader and control switch for NV-459A are located too far apart for efficient operation.

Solution Description:

Move manual loader NC-11 from MC5 to MC10.

HED No. M-1-0107

Problem Description:

Indication for NC pump seal injection flow is provided on non-linear scale-normal value at bottom.

Solution Description:

Provide components necessary to linearize scales for meters NC7b, 10b, 24b, 27b.

HED No. M-1-0108

Problem Description:

ND system portion of MC11 is not arranged for efficient task performance.

Solution Description:

Rearrange components on the ND portion of MC11 as shown on solution forms.

HED No. M-1-0114

Problem Description:

When power is returned to the valve by the power disconnect switch, the valve may move from its present position.

Solution Description:

Rewire disconnect switch such that when the disconnect switch is in the disconnect position the valve switch will not energize the breaker contactors for the valve, but will still leave power on the indicator lights.

HED No. M-1-0117

Problem Description:

1A NS pump switch is not located in the same relative position as the 1B NS pump switch.

Solution Description:

Relocate 1A pump switch in the same relative position as 1B NS pump switch.

HED No. M-1-0121

Problem Description:

Scale range is too wide to read upper values of FWST level; there is no overlap between upper & lower range meters.

Solution Description:

Change scale of RN5f from 160" - 500" to 0" - 500" and add a narrow range meter for 400" - 500" range.

HED No. M-1-0124

Problem Description:

NCdT switch is mis-labeled and does not conform to Duke conventions.

Solution Description:

Replace switch and revise lens color and labeling to conform to Duke conventions.

HED No. M-1-0128

Problem Description:

Switches on NI portion of MC11 for certain valves which are normally tagged out with power removed.

Solution Description:

Provide power enable/disconnect switches for these valves on MC11.

HED No. M-1-0129

Problem Description:

Cold leg accumulator pressure and level meters are arranged by channel and not by function.

Solution Description:

Rearrange the meters such that pressures and levels are side by side for easier comparison.

HED No. M-1-0132

Problem Description:

Control switch for ZJ-82 is located on MC1 rather than with related controls on MC13.

Solution Description:

Move device IT63 from MC1 to MC13.

HED No. M-1-0139

Problem Description:

The RN system portion of MC11 is not arranged for efficient task performance.

Solution Description:

Rearrange components on the RN and RV portions of MC11 as shown on solution forms.

HED No. M-1-0141

Problem Description:

KC system portion of MC11 is not arranged for efficient task performance.

Solution Description:

Rearrange components on the KC portion of MC11 as shown on solution forms.

HED No. M-1-0142

Problem Description:

Control switch for NI-288A is on MC11 rather than with related controls on MC10.

Solution Description:

Move devices NI34 & 53 (power enable/disconnect) from MC11 to MC10.

HED No. M-1-0149

Problem Description:

Control switch for CF-124 is located on MC10 rather than with related components on MC13.

Solution Description:

Move device IF31 from MC10 to MC13.

HED No. M-1-0152

Problem Description:

Key activated controls in general are unnecessary.

Solution Description:

Remove all key switches under the direct control of the control room operator.

HED No. M-1-0176

Problem Description:

D/G power factor meters in control room and at the diesel panel are not consistent in movement.

Solution Description:

Change local D/G panel power factor meters so that they are consistent with the ones on the main control board.

HED No. M-1-0179

Problem Description:

Operator has no indication of glycol expansion tank level - depends on annunciator instead.

Solution Description:

Provide a glycol expansion tank level meter on MC9 (0" - 75").

HED No. M-1-0183

Problem Description:

FWST meters are not grouped together on MC9.

Solution Description:

Rearrange meters on the RN portion of MC9 such that FWST parameters are together, SNSWP parameters are together, and HX flow meters are together.

HED No. M-1-0184

Problem Description:

The knob on the rod bank selector switch is too large, it makes it difficult to determine which bank has been selected.

Solution Description:

Replace switch with handle and pointer that will clearly indicate which bank is selected.

HED No. M-1-0186

Problem Description:

Scale range for RN flow to D/G A & B is too narrow for normally expected values.

Solution Description:

Expand scale of RN4e & 4f on MC9 from 0 - 1000 gpm to 0 - 1500 gpm.

HED No. M-1-0188

Problem Description:

Circular meters on the HVAC control board are difficult to read.

Solution Description:

Change circular meters to VX252's.

HED No. M-1-0190

Problem Description:

Operator has no indication of NV flow to the PZR spray header.

Solution Description:

Install a flow element in the PZR spray line and a meter on MC5.

HED No. M-1-0192

Problem Description:
Maintaining proper seal injection flow requires continual operation of NV-241.

Solution Description:
Replace manual loader NV-111 with a manual/auto controller.

HED No. M-1-0194

Problem Description:

Operator has no indication of excess letdown flow

Solution Description:
Provide instrumentation as necessary for indication of excess letdown flow on MC5

HED No. M-1-0219

Problem Description:

Auxiliary Shutdown Area lighting is poor, non-uniform, shadowed in areas, and provides glare in other areas in both normal and emergency mode lighting.

Solution Description:

Improve area normal and emergency lighting.

HED No. M-1-0268C

Problem Description:

Functionally related controls or displays are not grouped together.

Solution Description:

Re-arrange and functionally group controls.

HED No. M-1-0269A

Problem Description:

NC Recorders are not arranged in a logical alphabetic sequence.

Solution Description:

Re-arrange recorders.

HED No. M-1-0272

Problem Description:

Many spare devices are still on the control boards.

Solution Description:

Remove all spare devices from the control boards.

HED No. M-1-0286

Problem Description:

Meter scales are nonlinear.

Solution Description:

Install components necessary to provide linear meter scales.

HED No. M-1-0331

Problem Description:

Cutler-Hammer E30 switch arrangements do not conform to Duke conventions.

Solution Description:

Change E30 switches, lens and pushbuttons as necessarv to conform with Duke conventions.

HED No. M-1-0343C

Problem Description:

Rotary selector switch positions do not conform to Duke conventions.

Solution Description:

Rewire or change selector switches as necessary to conform to Duke conventions.

HED No. M-1-0344

Problem Description:

Various control switches violate Human Factors guidelines for arrangement of control functions ("Open", "On" to the left etc.).

Solution Description:

Roll leads, change positions of associated indicating lights and re-engrave escutcheons as necessary.

HED No. M-1-0354

Problem Description:

There are no means of positive feedback associated with the reset and initiate pushbuttons.

Solution Description:

Install indicating lights which provide positive feedback for the reset and initiate functions.

HED No. M-1-0356

Problem Description:

Various rotary selector switches violate Duke conventions.

Solution Description:

Rewire switches and install escutcheons per solution form.

HED No. M-1-0363

Problem Description:

Various controllers have knobs that turn counter-clockwise to "open" a valve.

Solution Description:

Modify the controllers such that turning the knob clockwise will open the valve.

HED No. M-1-0376

Problem Description: Arrangement of miscellaneous drain panel does not correspond to switch arrangement for related valves. Very difficult to associate indicator lights to proper switches.

Solution Description:

Re-arrange miscellaneous drain panel indicating lights and associate switches by systems.

HED No. M-1-0403B

Problem Description:

Operator is unable to determine which group of 24 pts is currently printing on Ice Condenser recorder.

Solution Description:

Add two indicating lights on the Ice Consenser recorder to indicate 1st/2nd group of points.

HED No. M-1-0403C

Problem Description:

Rad monitor recorders do not print clearly and do not have channel cutout capability.

Solution Description:

Replace three rad monitor recorders.

HED No. M-1-0482B

Problem Description:

Demand position is displayed for SM PORV's and MSIV bypass resets.

Solution Description:

Provide positive feedback instead of demand position.

HED No. M-1-0482C

Problem Description:

Demand signal instead of actual valve position is displayed on the S/G PORV controllers.

Solution Description:

Provide open/close indicating lights for the controllers.

HED No. M-1-0482D

Problem Description:

emand signal instead of actual valve position is displayed on the CF bypass valve controllers.

Solution Description:

Provide open/close indicating lights for the controllers.

HED No. M-1-0486

Problem Description:

Recorder IR-7 on Unit 1 has its pen assignment reversed from the equivalent Unit 2 recorder.

Solution Description:

Re-assign signals to recorder IR-7 on 1MC1 so that pen color/parameter relationship is the same as recorder IR-7 on 2MC1.

HED No. M-1-0491

Problem Description:

Configuration of control switch NV83 does not truly represent the switch function.

Solution Description:

Replace with a switch configuration that better represents function.

HED No. M-1-0513

Problem Description:

The NV system portion of MC10 is not arranged for efficient task performance.

Solution Description:

Rearrange components on NV portion of MC10 as shown on solution forms.

HED No. M-1-0514

Problem Description:

NC system portion of MC10 is not arranged for efficient task performance.

Solution Description:

Rearrange components on the NC portion of MC11 as shown on solution forms.

HED No. M-1-0516

Problem Description:

The NI system portion of MC11 is not arranged for efficient task performance.

Solution Description:

Rearrange components on the NI portion of MC11 as shown on solution forms and provide the system mimic as shown.

HED No. M-1-0517

Problem Description:

The moisture separator/reheater portion of MC13 is not arranged for efficient task performance.

Solution Description:

Rearrange components on MC13 as shown on the solution forms.

HED No. M-1-0520

Problem Description:

The HVAC control board is not arranged for efficient task performance.

Solution Description:

Rearrange each section of the HVAC control board as shown on solution forms.

HED No. M-1-0522

Problem Description:

Plant assembly and evacuation alarms are in a poor location - on the end of 1MC9

Solution Description:

Move devices RF39, 61 & 62 to 1MC1 and move device RF60 to 2MC1.

HED No. M-1-0564

Problem Description:

Operator has no positive position indication for VQ-4.

Solution Description:

Provide a status light to indicate VQ-4 NOT CLOSED.

HED No. M-1-0565

Problem Description:

D/G Remote/local control switch difficult to operate.

Solution Description:

Replace E30 switch with a 10250T 3 position switch.

HED No. M-1-0580

Problem Description:

No page override in control room.

Solution Description:

Add page override feature and place override button on operator's console.

HED No. M-1-0587

Problem Description:

The steam generator board (MC2) is not arranged for efficient task performance.

Solution Description:

Rearrange components on MC1 and MC2, MC4 and MC10 as shown on the solution forms.

HED No. M-1-0610A

Problem Description:

The level for steam generator in wet layup can exceed the available range of display capability.

Solution Description:

Make lower tap for wet layup level the same as upper tap for narrow range level - add computer point.

HED No. M-1-0610C

Problem Description:

T-Average on computer stops reading at 530°F decreasing but T-Average point continues to indicate.

Solution Description:

Change programming such that when T-Average stops reading, asterisks appear in the value column.

HED No. M-1-0615

Problem Description:

No hot and cold leg NC temperature indication for determining the NC system delta temperature at ASP.

Solution Description:

Add cold leg temperature indication (hot leg already provided).

HED No. M-1-0616

Problem Description:

1MC13 contains several chemistry related components that are not used by operators.

Solution Description:

Move YM-188 and YM-192 to water treatment room and remove unnecessary polishing demineralizer switches.

HED No. M-1-0652

Problem Description:

Cold leg accumulator level meters indicate only the upper 10% of full range.

Solution Description:

Provide full-range level indication for all accumulators at a remote location outside containment.

HED No. M-1-0656

Problem Description:

Operator does not have control of the cold leg accumulator drain valves.

Solution Description:

Provide control switches for NI-57, 68, 79, 91, and 809 on NI portion of MC11.

HED No. M-1-0657

Problem Description:

Operator does not have controls or indications for NCDT, NCDT Pumps, and associated valves.

Solution Description:

Rearrange WL portion of MC11 and add switches, controllers, and meters for the NCDT.

HED No. M-1-0664

Problem Description:

There is no narrow range main steam header pressure indication.

Solution Description:

Provide narrow range main steam header pressure indication.

HED No. M-1-0665

Problem Description:

Operator has no indication of NI pump recirculation flow.

Solution Description:

Provide an NI pump recirculation flow meter on MC11.

HED No. M-1-0666

Problem Description:

Scale range on UHI surge tank pressure is too wide to accurately read normal values.

Solution Description:

Provide a narrow range UHI surge tank pressure meter on MC11 (1150 - 1300 psig).

HED No. M-1-0672

Problem Description:

UHI surge tank pressure and level meters are arranged by channel and not by function.

Solution Description:

Rearrange the meters such that pressures and levels are side by side for easier comparison.

HED No. M-1-0675

Problem Description:

Heater drain tank pump controls are located on 1MC-13 instead of their associated local control panel.

Solution Description:

Add switches for G1, G2, G3 and C1, C2, C3 heater drain pumps to the local heater drain control panels. Leave the existing switches in the control room.

HED No. M-1-0676

Problem Description:

Controls which are necessary to efficiently operate the BB system are not provided in the control room.

Solution Description:

Provide BB pump switches and 6 valve control switches on MC1.

HED No. M-1-0679

Problem Description:

The control room has no direct indication of which D/G panel alarm has caused the "D/G panel trouble" annunciator.

Solution Description:

Provide D/G Panel alarm (those which would cause a tech spec violation or would cause a diesel trip) information on the computer.

HED No. M-1-0681

Problem Description: Transfer switches require the operator to locate local/remote switch in status position to identify corresponding valve status and then to properly align switch before transfering control to auxiliary shutdown panel.

Solution Description:

Replace 12 switches and change engravings.

HED No. M-1-0682

Problem Description:

No nuclear flux indication at ASP.

Solution Description:

Add flux indication when new indication added by NUREG-1.97.

HED No. M-1-0686

Problem Description:

No control of charging flow at ASP.

Solution Description:

Install manual loader for NV-238.

HED No. M-1-0687

Problem Description:

Requires 2 operators to maintain VCT level.

Solution Description:

Add VCT level indication near valves for controlling VCT level.

HED No. M-1-0688

Problem Description:

No manual loader for NV-459A at ASP.

Solution Description:

Install manual loader for NV-459A.

HED No. M-1-0689

Problem Description:

No indication of letdown pressure, flow or temperature at ASP.

Solution Description:

Install letdown pressure, flow and temperature indication.

HED No. M-1-0691

Problem Description:

Inconsistent grouping of related components at ASP.

Solution Description:

Rearrange layout of ASP switches.

HED No. M-1-0693

Problem Description:

No means of dumping steam to establish a cooldown from ASP.

Solution Description:

Modify steam PORV's to allow local control other than beside the valves.

HED No. M-1-0694

Problem Description:

No control of pressurizer spray at ASP other than open/close for NV-21.

Solution Description:

Modify NV-21 for throttle capability and install manual loader.

HED No. M-1-0695

Problem Description:

No way to monitor NC pressure below 1700 psig. at ASP.

Solution Description:

Install wide range NC pressure indication at ASP.

HED No. M-1-0698

Problem Description:

No means of monitoring ND parameters at ASP.

Solution Description:

Add inlet and outlet temperature indication for ND heat exchanger.

HED No. M-1-0699

Problem Description:

Operator has no positive indication of the position of NV-840 for containment isolation.

Solution Description:

Provide OPEN/CLOSED indication on MC5 for NV-840; also provide key switch for power disconnect.

HED No. M-1-0700

Problem Description:
First-out alarms can clear with the normal acknowledge button before the first-out reset button is pressed.

Solution Description:
Change annunciator sequence from DSF-95 to SCFL.

HED No. M-1-0703

Problem Description:

Access to local panels in Auxiliary Shutdown Area is restricted due to pipe hangers, supports and other equipment.

Solution Description:

Review access in conjunction with lighting study and determine if any improvements can be made in panel access.

HED No. M-1-0714

Problem Description:

The range for the pressure relief tank does not meet the recommended Reg. Guide 1.97 range.

Solution Description:

Expand the scale of the PRT temperature meter from 50 - 300°F to 50 - 350°F.

HED No. M-2-0222

Problem Description:
Auxiliary Shutdown Area lighting is poor, non-uniform, shadowed in areas, and provides glare in other areas in both normal and emergency mode lighting.

Solution Description:

Improve area normal and emergency lighting.

HED No. M-2-0315

Problem Description:

CA storage tank level meter is shared between Unit 1 & 2. The meter is located on 1MC4.

Solution Description:

Provide a CA storage tank level meter on 2MC4.

HED No. M-2-0318

Problem Description:

Arrangement of meters for containment sump level, pressure and H_2 concentration is different between Unit 1 and Unit 2.

Solution Description:

Re-arrange Unit 2 meters to match Unit 1 meters.

HED No. M-2-0319

Problem Description:

VS containment isolation valves are arranged differently on Unit 1 and Unit 2.

Solution Description:

Re-arrange VS containment isolation valves per solution form.

HED No. M-2-0322

Problem Description:

Various Unit 2 controls are located on the Unit 1 side of the control room.

Solution Description:

Move the Unit 2 controls to the Unit 2 side of the control room.

HED No. M-2-0323

Problem Description:

Meter arrangement differs between Unit 1 and Unit 2.

Solution Description:

Re-arrange Unit 2 meters to match Unit 1 meters.

HED No. M-2-0325

Problem Description:

Various escutcheon plates on Unit 2 are different from Unit 1.

Solution Description:

Replace Unit 2 escutcheon plates per solution form.

HED No. M-2-0330

Problem Description: Unit #1 AB vent system Return Isolation valves are numbered 1RN299A and 1RN279B. Unit #2 AB vent system Return Isolation valves are numbered 2RV151A and 2RV152B.

Solution Description:

Change the Unit #2 system identifier from RV to RN and place the switches for these valves on the RN board.

HED No. M-2-0331

Problem Description:

Unit 2 HM system valves have different valve numbers from their associated Unit 1 valve.

Solution Description:

Change Unit 2 HM valve numbers to correspond with Unit 1 HM valves.

HED No. M-2-0336

Problem Description:

There is no computer alarm acknowledge pushbutton on 2MC2.

Solution Description:

Add computer alarm acknowledge pushbutton to 2MC2.

HED No. M-2-0457

Problem Description:

Access to local panels in Auxiliary Shutdown Area is restricted due to pipe hangers, supports and other equipment.

Solution Description:

Review access in conjunction with lighting study and determine if any improvements can be made in panel access.

Appendix C

McGuire Nuclear Station

Control Room Review

<u>HEDs Not Corrected</u>

HED No. M-1-0028

Problem Description:

Train A and Train B components are in reverse order.

Solution Description:

Rearrange 6 meters, 4 switches, and 2 annunciator panels so that A & B are in that order.

Justification:

The operator is looking for consistency between the two redundant channels and is not concerned with whether he is looking at Train A indication or Train B indication. Therefore, the order in which they are arranged is of no significance.

HED No. M-1-0038

Problem Description:

Four level indications for each steam generator are not grouped together.

Solution Description:

Rearrange meters on the turret section of 1MC2 so that the four level channels are together.

Justification:

Three of the four level meters in question are grouped together, with the fourth just above. Any rearrangement of the meters which groups all four together would create an even more significant HED by separating SM flow and CF flow indications, a grouping that is considered by operators to be a more important association.

HED No. M-1-0095

Problem Description:

Control knob is too big to read label underneath it.

Solution Description:

Replace knob with a T-handle.

Justification:

The problem of the control knob obscuring the label only happens when you are looking directly down on the handle. Replacing the knob with a different type of knob or T-handle could make the situation worse. The Review Team decided that the size of the knob did not impede the operator's performance.

HED No. M-1-0118

Problem Description:

ND & NS sump level meter is not located with associated controls.

Solution Description:

Relocate ND & NS sump level meter from right side of 1MC9 to the left side of 1MC9 (~2 ft.).

Justification:

There is no feasible location on the same board with the associated controls (1MC11) and the proposed relocation is not a significant improvement. In its present location, the meter is within a reasonable viewing distance and parallax is not a problem since the viewing angle is relatively small.

HED No. M-1-0150

Problem Description:

Steam generator wide range levels and level setpoints are not arranged in order on recorders SM8 and SM13 on 1MC2.

Solution Description:

Revise recorders SM8 and SM13 such that S/G 1A & 1B are on SM8 and S/G 1C & 1D are on SM13.

Justification:

Steam generators 1B & 1C are on a separate safety train from steam generators 1A & 1D; therefore, the suggested rearrangement would violate the train separation principle and could not be implemented without extensive modifications to the Westinghouse process system.

HED No. M-1-0152 (Partial)

Problem Description:

Key-operated controls present a potential impedence to operator performance.

Solution Description:

Remove all key-operated switches under the direct control of control room operators and replace with CH 10250T rotary switches.

Justification:

1) The OPC and MAINT TEST switches will not be replaced since they are integral with the vendor-supplied turbine panel.

2) The low pressure mode selector switch for PZR PORV s will not be replaced; the key is an efficient means of distinguishing this switch from other rotary switches in the NC system panel.

3) Tech Specs require that the lower containment purge isolation valves be locked in position so the key-operated switches are necessary.

HED No. M-1-0159

Problem Description:

Reading and calculating wide range ΔT is difficult due to distance between required displays.

Solution Description:

Provide hot leg temperature and cold leg temperature on same recorder.

Justification:

The hot leg temperature and cold leg temperature signals are channel-related such that providing the signals to the same recorder is not possible.

HED No. M-1-0268 (Partial)

Problem Description:

Functionally related controls and/or displays are not grouped together.

Solution Description:

Rearrange components so that functional relationships are obvious.

Justification:

1) The DC B/U Vapor Extractor switch is large and distinctive and is not operated within any time constraints; therefore, moving the switch would not be a significant improvement.

2) The shutdown banks are pulled one at a time and not as a group and once they are out the counters show an unchanging value, no matter how the banks move; the counters must be reset to zero. Therefore, having the shutdown bank counters grouped together would not be a significant improvement.

3) The arrangement of EMF modules by monitor number is of no importance. The modules are clearly labeled and are as efficiently arranged as they could be.

HED No. M-1-0269B

Problem Description:

The NC pump monitor panel is not arranged in a logical alphabetic or numeric sequence from left tr right or top to bottom.

Solution Description:

Rearrange the NC pump monitor panel in a logical alphabetic sequence.

Justification:

The NC pump monitor panel is located outside of the horseshoe area and is used only to verify existing NC pump alarms located inside the horseshoe; the Review Team decided therefore that rearrangement was unnecessary.

HED No. M-1-0270C

Problem Description:

Component arrangement differs for repeated groups.

Solution Description:

Rearrange section of 1MC8 which contains Nuclear Sampling controls.

Justification:

The only time that these valve controls are used by the operator is when directed by chemistry. These valves are grouped by valve numbers and when chemistry requests that one of the valves be operated, their request is by valve number. Therefore, the Review Team does not feel that it is necessary to rearrange this section of 1MC8.

HED No. M-1-0377

Problem Description:

The "C" fire pump does not have an ammeter dedicated to it like the rest of the 600V pumps and motors.

Solution Description:

Add an ammeter to the "C" fire pump.

Justification:

Since a meter indicating fire header pressure and an annunciator indicating pump failure to start are already provided, the Review Team decided that an ammeter would add little benefit to the operator.

HED No. M-1-0563

Problem Description:

Operators have no positive position indication for PZR spray valves 1NC27 and 1NC29.

Solution Description:

Change demand lights on controllers NC81 and NC82 to actual position lights (OPEN/CLOSED).

Justification:

The implementation of HED M-1-0190 will provide flow indication for the PZR spray header, which is an alternate means of indicating the position of the spray valves. Therefore, M-1-0563 need not be implemented.

HED No. M-1-0651

Problem Description:

Cannot monitor low range NI pump flow as when filling accumulator.

Solution Description:

Provide low range NI pump flow indication with signal from existing flow element in UHI fill line.

Justification:

While filling accumulator, flow is adjusted locally in the plant where low range flow indication does exist. Providing flow indication in the control room would not improve the operation and would be providing the control room operator with unnecessary information.

HED No. M-1-0654

Problem Description:

No indication of power mismatch signal for rod control.

Solution Description:

Add power mismatch meter that displays power mismatch signal which goes to automatic rod position control.

Justification:

No spare card slots exist for the additional circuit card that must be added for scaling and isolation of the mismatch signal. Installation of a new process cabinet for this signal is economically unfeasible for the non-safety rod control system.

HED No. M-1-0669

Problem Description:

Controls for 1SM78, 1SM84, 1SM90, and 1SM96 are not located with other SM components.

Solution Description:

Provide SM isolation and containment isolation signals to the subject valves.

Justification:

The subject valves are in lines which are small enough that flow is limited and automatic isolation is not required. The switches themselves are infrequently used, so they do not need to be moved.

Appendix

McGuire Nuclear Station

Control Room Review

Implementation Priority Schedule