DETAILED CONTROL ROOM DESIGN REVIEW SUMMARY REPORT FOR THE WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

PREPARED BY

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT
SPRING CITY, TENNESSEE 37381

AND

ASSISTED BY

ESSEX CORPORATION
333 NORTH FAIRFAX STREET
ALEXANDRIA, VIRGINIA 22314

SEPTEMBER 1987

TVA

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TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

1.1 Historical Background 1

1.2 TVA's Controlling Documents For The Watts Bar DCRDR . . . 2

1.3 Scope Of The Watts Bar DCRDR 3

1.4 Coordination And Integration With Related Activities . . . 4

1.5 Organization Of The Report 5

1.6 Definition Of DCRDR Terms 6

2.0 PROJECT MANAGEMENT AND STAFFING 8

2.1 Management Structure 8

2.2 Team Qualifications And Participation
In Specific Review Tasks 9

3.0 DATA MANAGEMENT 13

3.1 Reference Documents 13

3.2 Data Collection Records 13

3.3 Documentation Of Data Collection
And Assessment Results 13

3.4 Process Tracking Tools 15

4.0 METHODOLOGY 16

4.1 Preparation 16

4.2 Data Collection 18

4.3 Assessment 26

4.4 Plant Management Review And Approval 30

5.0 DISCUSSION OF WATTS BAR DCRDR RESULTS 32

5.1 Quantitative Summary 32

5.2 Corrective Actions 33

5.3 Implementation Control Mechanisms And Schedule 35

TABLE OF CONTENTS (cont.)

6.0 REFERENCES 36

APPENDIX A: CORRELATION OF SER APPENDIX D PRIORITY 1 & 2 ITEMS WITH THE DCRDR PROCESS A-1

APPENDIX B: CORRELATION OF SER APPENDIX D PRIORITY 3 ITEMS WITH THE DCRDR PROCESS B-1

APPENDIX C: SUMMARY OF MODIFICATIONS TO THE PROGRAM PLAN C-1

APPENDIX D: WB6.3.14, STANDARD PRACTICE FOR CONDUCT OF THE DETAILED CONTROL ROOM DESIGN REVIEW AT WATTS BAR NUCLEAR PLANT D-1

APPENDIX E: RESUMES OF DCRDR PERSONNEL E-1

APPENDIX F: SUMMARY OF HEDS AND CORRECTIVE ACTION PLANS F-1

LIST OF ILLUSTRATIONS

		Page
Figure		
1.	Watts Bar Nuclear Plant Control Room Arrangement, Units 1 And 2	39
2.	Guidance, Direction, And Activities Of Detailed Control Room Design Review Preparation	40
3.	Example Of An HEC Worksheet	41
4.	Overview Of The Task Analysis And Verification Process	42
5.	Example Of An AIRD Form	43
6.	Example Of An AIRS Form	44
7.	Example Of Validation Observer Notes	45
8.	Example Of EI Performance Review Checklist	46
9.	Example Of Validation Comments	44
10.	Example Of HED Categorization Record	50
11.	HED Categorization Logic Diagram	51
12.	Example Of HED Corrective Action Plan (HEDCAP)	52
13.	Example Of HEDCAP Management Review/Concurrence Transmittal	53
Table		
1.	DCRDR Team Composition, Qualifications, And Task Participation	11
2.	Sources Of HECs	19
3.	Emergency Instructions Included In Validation	24
4.	HED Category Definitions	28
5.	Reasons For Omitting HECs From Futher Consideration	32
6.	Summary Of Corrective Action Decisions For HEDs In Each Assessment Category	33

1.0 INTRODUCTION

This Summary Report describes the performance and results of the Detailed Control Room Design Review (DCRDR) conducted at Watts Bar Nuclear Plant (WBN). Watts Bar is a two-unit Pressurized Water Reactor (PWR) nuclear power plant, owned and operated by the Tennessee Valley Authority (TVA). TVA is the architect-engineer. Westinghouse is the nuclear steam supply system (NSSS) supplier. Watts Bar is a Near Term Operating Licensee (NTOL) plant. Fuel load schedule is currently being reevaluated.

The Watts Bar DCRDR is one of several related activities which have been undertaken by TVA to improve the emergency response capabilities of Watts Bar, as required by NUREG-0737, Supplement 1 "Clarification of TMI Action Plan Requirements." The specific objective of the Watts Bar DCRDR is to identify and correct significant Human Engineering Discrepancies (HEDs) in the control room. In particular, the emphasis is on discrepancies that could affect operating safety. NUREG-0737, Supplement 1 specifies the minimum requirements for conducting a DCRDR. Additional guidance developed by the U.S. Nuclear Regulatory Commission (NRC) is provided in NUREG-0737 "Post TMI Requirments", NUREG-0700 "Guidelines for Conducting Control Room Design Reviews," and draft NUREG-0801 "Evaluation Criteria For Detailed Control Room Design Reviews". The Watts Bar DCRDR was conducted following these regulatory requirements and guiding documents.

1.1 Historical Background

TVA commitments related to the Watts Bar Nuclear Plant DCRDR include (1) the commitment to conduct a DCRDR in accordance with NUREG 0737, Supplement 1 requirements as stated in TVA's letter of April 15, 1983; and (2) other TVA commitments to address identified human factors problems with the Watts Bar control room as discussed below. A brief review of the major events to date in the Watts Bar DCRDR program provides the perspective to ensure that all commitments are properly closed out.

As part of the NRC task actions following the TMI-2 accident (Item I.D.1 of NUREG-0660 "NRC Action Plan of the Result of the TMI Accident," May 1980, and NUREG-0737, November 1980), the NRC required all licensees and applicants for an operating license to conduct a DCRDR to identify and correct human factors deficiencies in their control rooms. The DCRDR was to be conducted in accordance with NUREG-0700.

Applicants who were unable to complete the DCRDR before issuance of their operating license were required to conduct a preliminary design assessment (PDA) of the control room to identify human engineering discrepancies, and to establish a correction schedule, approved by the NRC staff. These applicants were also required to complete a full DCRDR later. Watts Bar has now completed this DCRDR review.

The NRC conducted an on-site review of the Watts Bar control room from October 6 through October 10, 1980. TVA performed a PDA of the Watts Bar control room and submitted its findings to the NRC in a report dated January 13, 1981.

Discrepancies identified in both the NRC staff's on-site review and TVA's PDA were documented in the NRC staff's control room design review report received by TVA on June 1, 1981. These discrepancies were ranked as priority 1, 2, or 3 based on the increased potential for operator error and the possible consequences of error. The NRC required TVA to implement corrective measures for priority 1 and 2 discrepancies prior to issuance of an operating license, and to report on priority 3 items as part of the Watts Bar DCRDR.

At an NRC-TVA meeting on June 16, 1981, the priority 1 and 2 items were discussed. Measures for correcting most of these items were resolved, and a schedule for correcting them was established. The remaining priority 1 and 2 items were finalized as a result of TVA letters dated August 20 and October 27, 1981, and January 18, March 26, and April 26, 1982. These letters contain license commitments resulting from the NRC's control room review and from the PDA. The commitments were made confirmatory items in Appendix D of NUREG-0847 "Watts Bar Safety Evaluation Report" (SER), June 1982. NRC was notified of final status of the priority 1 and 2 items on February 28, 1985.

During the DCRDR process, the team members recognized priority 1 and 2 corrective actions. Several Human Engineering Concerns (HECs) were resolved by taking credit for the original corrective actions.

In other cases the original corrective actions were reviewed and modified as part of the later integrated, more comprehensive DCRDR corrective action plans. Examples are improved labeling and board layouts. In a few situations, the specific original corrective action was found upon review to create additional discrepancies and alternative correction was approved as part of the DCRDR process.

A detailed review of earlier priority 1 and 2 commitments and corrective actions has been performed to document the correlations and changes caused by the integrated DCRDR process and planned corrective actions. A summary is contained in Appendix A of this report.

The remaining Priority 3 items were reviewed as part of the DCRDR process. Appendix B of this report contains a listing of each of these original priority 3 items, with the related team disposition.

1.2 TVA's Controlling Documents for the Watts Bar DCRDR

Two documents were prepared to control the performance of the DCRDR requirements of NUREG-0737, Supplement 1 at Watts Bar:

- Special Engineering Procedure OE-SEP 82-17, Control Room Design Reviews for All TVA Nuclear Plants. This document is TVA's Program Plan for DCRDRs, which was issued on April 13, 1983, and submitted for NRC review on June 9, 1983. The NRC provided comments on the Program Plan to TVA by letter dated December 23, 1983. The approach described in the Program Plan was modified to address the NRC comments, as described in Appendix C of this report.

- Standard Practice WB6.3.14, Conduct of the Detailed Control Room Design Review and Other Major Human Factors Reviews and Improvements at Watts Bar Nuclear Plant. This document is the plant-specific implementing procedure for the DCRDR at Watts Bar, using OE-SEP 82-17 as its core guidance. A copy is provided in Appendix D of this report.

1.3 Scope of the Watts Bar DCRDR

The Watts Bar DCRDR addressed the man-machine interfaces of the Main Control Room (MCR), the Auxiliary Control Room (ACR), and the adjacent switch transfer rooms. The DCRDR was conducted for unit 1, including equipment that will be used in common by both units. The physical areas reviewed are shown in Figure 1.

In terms of review tasks, the scope of the Watts Bar DCRDR was defined to include not only all DCRDR requirements stated in NUREG-0737, Supplement 1, but additional DCRDR tasks described in NUREG-0700 and draft NUREG-0801. The tasks are listed below. Asterisks identify the Supplement 1 requirements.

- Establish a qualified multidisciplinary team and a review program (plan) incorporating accepted human factors principles.*
- Establish a standardized method of collecting, recording, and storing DCRDR data.
- Conduct data collection and analysis to identify HEDs, including:
  - Review of documented operating experience (e.g., Trip Reports, Licensee Event Reports), to identify human engineering problems that have figured in abnormal occurrences in the past. (Because Watts Bar is an NTOL, data from other, similar plants were used.)
  - Questionnaire and interview survey of operations personnel to get information based on direct experience with control room equipment and operations.
  - Control room survey to identify deviations from accepted human factors principles.*
  - System function and task analysis (SFTA) to identify information and control requirements for emergency operations.*
  - Comparison of the display and control requirements identified in the SFTA to the existing components to identify mismatches (verification of the availability and suitability of all required controls and displays).*
  - Validation of the adequacy of the integrated control room configuration to facilitate operator tasks in the dynamics of operating emergency response.

- o Assess which human engineering discrepancies should be corrected, based on their operational and safety significance, and select design improvements to correct those discrepancies.*

- o Verify that each selected design improvement will provide the necessary correction and will not create any new HED.*

- o Coordinate DCRDR tasks and resulting design improvements with related efforts such as development of a Safety Parameter Display System (SPDS), implementation of Regulatory Guide 1.97 "Post Accident Monitoring" requirements, operator training, and development of symptom-based emergency operating procedures. This coordination is necessary to provide increased assurance of an integrated emergency response capability at Watts Bar.*

TVA will take advantage of the completed human engineering review to ensure approriate human engineering configuration for unit 2 control panels. This will be accomplished as follows:

- o Changes made to correct HEDs will be implemented in unit 2.

- o Implement any remaining SER Appendix D commitments in unit 2 not modified by the DCRDR HEDs.

- o A final human engineering configuration verification will be performed.

As a final comment regarding scope, the Watts Bar DCRDR focused on identification of problems and definition of solutions. The review function ends with management approval or disapproval of the solutions for implementation. Implementation of HED corrective actions requiring hardware changes will be accomplished by established TVA procedures for review and implementation of modifications.

1.4 Coordination and Integration with Related Activities

As stated earlier DCRDR is one of several related activities in progress which are designed to enhance human performance and safety in Watts Bar operations. Coordination and integration are required to ensure the maximum overall benefit from these activities.

There has been integration between the Watts Bar DCRDR and development of Watts Bar upgraded Emergency Instructions (EIs). Validation activities to support the DCRDR and the EI development program were conducted at the same time, with human factors observers for each program observing the same activities. Items resulting from the DCRDR validation observation were provided to the EI development team.

Members of the Watts Bar EI development team served as reviewers of the task analysis to ensure that the technical strategy of the Watts Bar EIs was correctly represented in the task statements.

Operations and human factors specialists doing the task analysis used both Westinghouse Emergency Response Guideline (ERG) and background documentation, and the Watts Bar EI Step Deviation Document as input to the task analysis.

The computer data base used for task analysis contains the EI step number and step objective information to enable cross referencing between task requirements and the step in which a task was performed. During verification, this cross reference capability was used to provide the shift crew with information so they could correctly identify the device used to perform the task. Following completion of all task analysis related activities, the DCRDR team provided to the EI development team a listing of all EI step objective statements and the corresponding EI steps. This information is available to the EI development team to use as an EI configuration management tool to ensure that the technical strategy for executing the same EI step objective is consistently applied.

A human factors review of the Technical Support Center computer at SQN led to generation of HECs. These were then considered applicable at WBN and assessed by the Watts Bar DCRDR Assessment Team.

HECs which specifically identified problems with inadequate training, or procedures or maintenance will be transmitted to the appropriate organization to be addressed and resolved.

Addition of new system capabilities, such as Bypassed and Inoperable Status System and Reactor Vessel Level Indicating System, are accomplished through the Engineering Change Notice (ECN) process.

The Sequoyah DCRDR data collection, assessment and corrective action activities were reviewed and considered where applicable in the Watts Bar DCRDR process.

1.5 Organization of the Report

The first three sections (1.0 - 3.0) of this report highlight the framework in which the DCRDR was performed. This introductory section (1.0) has summarized the objective of the project, the applicable regulatory requirements, project history, the role of the Program Plan and the site's implementing procedure, the scope of work, and coordination with related activities. Section 2.0 describes project team management and staffing. Section 3.0 describes the data management system.

Section 4.0 describes how the DCRDR was performed. It includes preparatory steps and team training, and describes the methods used to identify, assess, and develop corrective actions for HEDs.

Section 5.0 presents the DCRDR results. It includes a quantitative summary of HEDs identified and corrective actions to be implemented. This section also includes an overview of the nature of the corrective actions, and identifies the control mechanisms and schedule for implementation of corrective actions. A descriptive summary of each individual HED and its disposition is provided in an appendix.

There are six appendices to this Summary Report:

- o Appendix A summarizes the correlations between the proposed DCRDR changes and the SER Appendix D priority 1 and 2 items.

- o Appendix B provides correlation between the SER Appendix D priority 3 items and the DCRDR process.

- Appendix C summarizes the differences between the implemented Watts Bar DCRDR methodology and the methodology described in the generic TVA DCRDR Program Plan. These differences address NRC comments on the Program Plan.

- Appendix D contains the Watts Bar Standard Practice for DCRDR implementation.

- Appendix E provides resumes of the Watts Bar DCRDR personnel.

- Appendix F lists summary descriptions of all HEDs and corrective actions, with justifications for cases in which no corrective action is appropriate.

1.6 Definition of DCRDR Terms

The following definitions were used during the Watts Bar DCRDR:

- Function (Subfunction) - A kind of activity (or a static role) performed by one or more system constituents (people, mechanisms, structures) to contribute to a larger activity or goal state.

- Function/Functional Analysis - The examination of system goals to determine what functions they require. Also, examination of the required functions with respect to available manpower, technology, and other resources, to determine how the functions may be allocated and executed.

- Function Allocation - The distribution of functions among the human and automated constituents of a system.

- Human Engineering - The science of optimizing the performance of human beings, especially in industry. More narrowly, the science of design of equipment for efficient use by human beings (also called ergonomics and human factors engineering).

- Human Engineering Concern (HEC) - An item designated by a DCRDR team member as a potential HED.

- Human Engineering Discrepancy (HED) - A characteristic of the existing control room that does not comply with the human engineering criteria.

- System (Subsystem) - An organization of interdependent human-equipment constituents that work together in a patterned manner to accomplish some purpose.

- System Function Analysis - The determination of system functions required to meet system goals.

- Task (Subtask) - A specific action performed by a single system constituent, person, or equipment, that contributes to the accomplishment of a function.

- <u>Task Analysis</u> - A method used to delineate which specific actions must take place to accomplish system functions. In the DCRDR context, task analysis is used to determine the action and information requirements for individual tasks that must be completed in emergency situations.

- <u>Validation</u> - The process of determining whether the control room operating crew can effectively perform its functions given the control room instrumentation and controls, procedures, and training. In the DCRDR context, validation implies a dynamic performance evaluation.

- <u>Verification</u> - The process of determining whether instrumentation, controls, and other equipment are available to meet the specific requirements of the emergency tasks performed by operators.

2.0 PROJECT MANAGEMENT AND STAFFING

This section describes the Watts Bar DCRDR project management structure and responsibilities, personnel qualifications, and personnel participation in each Watts Bar DCRDR task.

2.1 Management Structure

As specified in the Program Plan, TVA established a management structure to provide central administration and coordination of all TVA DCRDRs. Management grade employees from design and operations organizations were assigned to serve as the focal point for the several projects. The responsibilities shared by these managers are listed in the Program Plan, Section 5.2.

The management included two technical Co-Team Leaders for each Review Team: one from the former Office of Engineering (OE) and one from the former Office of Nuclear Power (NUC PR). The Co-Team Leaders were given responsibility for immediate leadership of their team's activities at each site. Their specific responsibilities are listed in the Program Plan, Section 5.3.

As TVA's DCRDRs progressed, a transition to a single site management responsible for performance was found to be appropriate. This transition at Watts Bar occurred in January, 1986, as part of the owner-operator organization.

Watts Bar assigned a management-grade employee, Mr. J. J. Erpenbach from the Watts Bar site organization, as DCRDR Project Manager to administer and coordinate the DCRDR and related activities at Watts Bar. Mr. Erpenbach is a Registered Professional Nuclear Engineer who has been associated with TVA nuclear operations since 1973 and came to Watts Bar in 1977.

The transition to site management responsibility was made at a clear break point between Watts Bar DCRDR tasks. This was after completion of document review, the questionnaire/interview survey, and most control room survey work. It was before initiation of task analysis, Information and Control (I&C) verification, validation, HED assessment, and development of corrective actions. To ensure an effective transition, the Project Manager was responsible for preparation of a plant-specific instruction (Standard Practice). It governed completion of Watts Bar DCRDR tasks in accordance with the intent of the TVA Program Plan and particular needs and practices at Watts Bar. The DCRDR Project Manager assumed a combination of the responsibilities previously assigned to the overall program management function and to the previous technical Co-Team Leaders. These responsibilities are listed in the Standard Practice, Section 4.1. (Appendix D).

The Co-Team Leader concept was also changed at this time. An individual Watts Bar DCRDR Team Leader, Mr. J. F. Brooks, was assigned full time to manage the day-to-day assessment activities, while the Project Manager led the remaining data collection activities with the assistance of human factors specialists and other supporting personnel. The Team Leader's responsibilities are listed in the Standard Practice, Section 4.2 (Appendix D).

There was also a change in team membership. A dedicated team of operations, engineering, and human factors personnel was established for HED assessment. Essex Corporation, a consultant organization specializing in human factors, was used. Additional Essex human factors specialists were added to the team to take a lead role in the task analysis, verification, and validation activities needed to complete the data collection. Team member responsibilities are also listed in the Standard Practice, Section 4.3. (Appendix D).

2.2 Team Qualifications and Participation in Specific Review Tasks

Since various types of training and experience are needed to perform DCRDR tasks, a multidisciplinary team was required. It included experts in human factors, operations, instrumentation and control engineering, and nuclear engineering. The specific, minimum qualification requirements used to select team personnel were as follows:

- <u>Human Factors Specialist</u> - The human factors specialist was required to have a degree, preferably at the graduate level, in one of the disciplines recognized as related to human factors. In addition, the person was required to have a minimum of five years of experience in the application of human factors engineering.

- <u>Reactor Operator (RO)</u> - An RO license and a minimum of two years of operating experience were required. For the assessment, including development of corrective actions, a Watts Bar license was required.

- <u>Instrumentation and Control Engineer</u> - A bachelor's degree in engineering and a minimum of three years of applied experience in the nuclear field was required. The engineer must be familiar with the regulations, standards, and design constraints that have an impact on nuclear power plant control room design.

- <u>Nuclear Engineer</u> - A bachelor's degree in nuclear engineering and a minimum of three years of applied experience in the nuclear field were required.

The Core Team was made up of personnel representing these disciplines. Individuals selected for the Core Team met and in most cases substantially exceeded the minimum qualifications described above.

The members of the Core Team were primarily in-house personnel. Consultants were included on the Core Team as necessary to augment in-house skills, particularly in the area of human factors. Other operations and engineering personnel assisted the Core Team in various data collection activities (e.g., specification of detailed, plant-specific I&C requirements in the task analysis, and performance of validation exercises). They provided review and input in the development of the HED corrective actions.

In addition, a second nuclear engineer was assigned to the Core Team. He was a certified Shift Technical Advisor (STA). STAs were also used to review the task analysis/information and control requirements prior to verification to ensure technical accuracy with respect to plant system functions.

The qualifications of Core Team members and other support personnel are summarized in Table 1. Their contributions to specific tasks are also indicated in the table. Resumes are provided in Appendix E of this report.

TABLE 1
DCRDR TEAM COMPOSITION, QUALIFICATION AND PARTICIPATION

PERSONNEL	PRIMARY AREA OF EXPERTISE	FORMAL EDUCATION	YEARS OF RELEVANT EXPERIENCE	PARTICIPATION IN DCRDR TASKS							
				REVIEW OF DOCUMENTED OPS EXPER	QUESTIONAIRE SURVEY	OPS INTERVIEWS	CR SURVEY	TASK ANALYSIS	I & C VERIFICATION	CR VALIDATION	ASSESSMENT
PROJECT MANAGEMENT											
J. J. ERPENBACH	NUCL. SYSTEM/ OPS ENGINEERING	B.S.M.E. M.S.N.E.	14					X		X	X
J. R. MANER	I & C ENGINEERING	B.S.E.E.	15	X	X	X	X				
J. A. MARTIN	I & C ENGINEERING	M.S.E.E.	20	X	X	X	X				
J. F. BROOKS	I & C ENGINEERING	B.S. ENGINEERING SCIENCE	8								X
PROJECT TEAM											
G. T. DENTON	OPERATIONS	FORMERLY LICENSED RO	30	X		X	X				
G. A. ELLIFF	HUMAN FACTORS	PH.D. INDUSTRIAL ENGINEERING	8					X	X	X	X
D. W. FLETCHER	I & C ENGINEERING	B.S.E.E.	4			X	X				
F. GIBBS	NUCL. SYSTEM/OPS ENGINEERING; COMPUTER SYSTEMS ENGINEERING	B.N.E., M.N.E.	7				X				
B. A. GLICKSTEIN	HUMAN FACTORS	B.S., PSYCHOLOGY	3							X	
J. R. HENNESSY	HUMAN FACTORS	PH.D.,PSYCHOLOGY	25		X		X				
D. A. KULISEK	NUCL. SYSTEMS/OPS ENGINEERING	B.S.N.E., WBN SRO & STA CERTIF.	5			X	X				X
R. G. ORENDI	NUCL. SYSTEM/OPS ENGINEERING	FORMERLY SRO B.S.M.E., M.S.N.E.	15								X

TABLE 1
DCRDR TEAM COMPOSITION, QUALIFICATION AND PARTICIPATION

PERSONNEL	PRIMARY AREA OF EXPERTISE	FORMAL EDUCATION	YEARS OF RELEVANT EXPERIENCE	PARTICIPATION IN DCRDR TASKS							
				REVIEW OF DOCUMENTED OPS EXPER	QUESTIONAIRE SURVEY	OPS INTERVIEWS	CR SURVEY	TASK ANALYSIS	I & C VERIFICATION	CR VALIDATION	ASSESSMENT
PROJECT TEAM (CONT.)											
R. F. PAIN	HUMAN FACTORS	PH.D. APPLIED EXPERIMENTAL PSYCH.	22							X	X
B. PARAMORE	HUMAN FACTORS	M.A., EDUCATION	12						X	X	
D. PILSITZ	OPERATIONS	FORMER LICENSED SRO (SHIFT SUPERVISOR)	18					X	X		
H. E. PRICE	HUMAN FACTORS	B.S.E.E.; GRADUATE WORK EXPERIMENTAL PSYCH	34								X
C. G. SEAMAN	EMERGENCY PROCEDURES	LICENSED RO (WBN COLD LICENSE)	8					X		X	
E. SHEEHY	NUCL. SYSTEMS/OPS ENGINEERING	B.S.E.E.; M.S. PSYCHOLOGY	18			X	X				
H. P. VAN COTT	HUMAN FACTORS	PH.D. EXPERIMENTAL PSYCHOLOGY	34							X	X
I. G. WARREN	OPERATIONS	LICENSED RO (WBN COLD LICENSE)	7					X			X
M. L. YOUNG	I & C ENGINEERING	B.S.E.E.	17								X

3.0 DATA MANAGEMENT

Effective data management is one of the major factors affecting the success of a DCRDR program. Data management in the context of the Watts Bar DCRDR is defined to include:

- Maintenance of reference documents and guiding procedures for the DCRDR.
- Compiling and maintaining historical files of questionnaires, interview results, completed checklists, task analysis forms, and other data collection instruments.
- Maintaining an auditable record of data collection results, assessment results, and Corrective Action Plans.
- Establishment and maintenance of process tracking mechanisms to support control of the process and related data as the DCRDR proceeds.

3.1 Reference Documents

Reference documents used as background for the Watts Bar DCRDR are listed in Section 6.0. These reference documents primarily include NRC guidance documents, and industry and NUTAC human factors reference documents, TVA engineering standards and specifications. The Watts Bar draft Technical Specifications and Final Safety Analysis Report (FSAR), and related documents and materials were also provided to assist team members in performing their DCRDR duties and responsibilities.

In addition to these basic reference documents, the following were available: the plant EIs, Revision 1 of the Westinghouse Emergency Response Guidelines (ERGs), a supplemental generic ERG supplement prepared by Westinghouse for Upper Head Injection/Ice Condenser plants, and the Watts Bar EI Step Deviation Document. The team also had access to plant drawings, other operating procedures, and related documents needed to support effective research into the nature of problems presented to the team.

3.2 Data Collection Records

Operator questionnaires, interview comments, completed survey checklists, and other source documents were retained for historical records. In addition, these data collection records served as a valuable resource during assessment and development of corrective actions to clearly understand the nature and implications of the identified concerns.

3.3 Documentation of Data Collection and Assessment Results

Documentation packages were developed which include the data collection findings, assessment findings, corrective action plans, and information from supporting analyses. The forms included in these packages are described below. Also see Section 4 for further examples and discussion of integration of the forms into the DCRDR process.

3.3.1 Human Engineering Concern (HEC) Worksheets

The TVA Program Plan established a two-step process for identifying HEDs to ensure that no problem which might affect operator performance would be eliminated prematurely from consideration. The first step was identification of human engineering concerns. HECs were documented on Human Engineering Concern (HEC) Worksheets. See Figure 3 for an example.

The HEC Worksheet is the primary record for data collection results. It identifies the nature of the problem, affected components, data source, person identifying the problem, and related data to support assessment and disposition of the HEC.

HEC worksheets were assigned control numbers for tracking purposes. These numbers identified the primary data collection activity (e.g., operating experience review, controls checklist, verification, etc.) in which the HEC was identified.

3.3.2 HED Categorization Record

HEC's determined by the Assessment Team to be (1) a valid departure from a human engineering guideline, (2) related to operations in the main or auxiliary control room or transfer of control to the auxiliary control room, and (3) applicable to Watts Bar, were designated for inclusion in HEDs.

The HED Categorization Record was used to document the Assessment Team's determinations with respect to the significance of the problem(s). See Figure 10 for an example.

Each HED Categorization Record had as attachments one or more HEC forms documenting the specific problem(s) included in the HED. The HED Categorization Record includes summary information regarding the problem description, and a formal documentation section for assessment results. Assessment Team members present signed and dated the HED Categorization Record, indicating concurrence or non-concurrence with the assessment of the HED.

3.3.3 HED Corrective Action Plan (HEDCAP) Form

An HED Corrective Action Plan (HEDCAP) Form was used to document the decisions with respect to disposition of each HED. The HED Categorization Record (with supporting HECs) was attached to this form. The HEDCAP form specifies the recommended corrective action to be implemented or the justification for no corrective action. See Figure 12 for an example.

After review by the Assessment Team, each member signed and dated the HEDCAP Form, indicating concurrence or non-concurrence with the proposed corrective action. The completed and signed HEDCAP Form constituted the DCRDR Team's recommendation to management for closeout of the HED.

3.3.4 HEDCAP Management Review/Concurrence Form

Ultimate decisions regarding implementation of corrective actions are the responsibility of TVA management. To bring the DCRDR Assessment and Corrective Action process to closure, it was necessary to obtain management concurrence with the proposed corrective action.

A HEDCAP Management Review/Concurrence Form was prepared for each HEDCAP to obtain and document management's position with respect to each recommended corrective action. See Figure 13 for an example.

3.4 Process Tracking Tools

Because of the large amount of data to be considered and processed in the DCRDR project, and because of the need to ensure that an effective, integrated corrective action strategy results from the DCRDR, several process tracking and data management tools were developed and used.

3.4.1 Assessment Team Meeting Record Logbook

Assessment occurred in formal Assessment Team meetings. A logbook was kept to document these meetings.

3.4.2 HEC To HED Link Report Data Base

For each HEC, the HEC number, HEC short title, and selected other data was entered. After an HEC was assigned to an HED, the link between the HEC and the corresponding HED was entered into the data base. This enabled the team to readily track which HECs were in an HED, and conversely, to identify the HED to which a given HEC had been assigned.

3.4.3 HED Data Base

An HED data base was established. Data fields included HED number, category, and safety significance. Affected components, panel identifier, and other descriptive data was added as appropriate.

4.0 METHODOLOGY

This section describes how the Watts Bar DCRDR was performed. It includes a summary of preparation activities and a summary of the methods used in each major DCRDR task.

4.1 Preparation

Figure 2 identifies preparation activities, and the sources of guidance and direction, as established in the TVA Program Plan. The basic preparation activities included obtaining and becoming familiar with reference documents and instruments/equipment needed for certain DCRDR tasks; and training of DCRDR personnel.

4.1.1 Reference Documents

Documents used in the Watts Bar DCRDR included human factors engineering references (sources of principles, criteria, and methods); TVA engineering design guides, criteria, and standard practices; and plant-specific technical documents. A complete list of Watts Bar DCRDR resource documents is provided in Section 6.0, References.

4.1.2 Instrument Needs

During the conduct of the control room survey, team members and specialists had access to the following instruments, calibrated in accordance with manufacturers' specifications, with ancillary equipment:

- Photometers with illuminance sensors for footcandle measurement and luminance sensors for footlambert measurement.
- Sound-level meters and octave analyzers to measure noise/sound pressure levels in weighted networks and in octave bands.
- Cameras equipped for providing color photography of control room panels, work stations, work areas, and access paths.
- Environmental instruments, including: thermometers (temperature gradients); sling psychrometer with conversion charts for dry/wet bulb readings (percent humidity); Alnor velometer, liquid-filled manometer, or hot-wire anemometer (airflow rates).

4.1.3 Training of the Watts Bar DCRDR Team

Team members received training in several stages of the Watts Bar DCRDR. Initially, a 2-day course was presented to increase team awareness of human factors in the control room and familiarize them with methods, forms, and documentation requirements.

Instruction included a period of approximately 1/2 hour to 1 hour on each of the following topics:

- o Human Factor Engineering
- o HFE Documentation
- o Visual and Auditory Perception
- o Principles of Learning and Training
- o Stress and Fatigue
- o HFE in Workspace Layout
- o Anthropometrics
- o Controls and Displays
- o Panel Layout
- o HFE in Computers
- o HFE in Communications
- o Task Analysis
- o Control Room Light and Sound Surveys
- o Interview Techniques
- o Use of Checklists.

This course was prepared and conducted under the supervision of J. A. Martin, one of the TVA DCRDR Co-Team Leaders, and human factors specialist Dr. J. R. Hennessy. The course was conducted three times, in August of 1983 and in July and November of 1984.

Newly assigned personnel, and others unable to attend the course, received individual tutoring by the human factors specialist.

In early 1986 the transition to site management of the DCRDR project occurred. A new team was formed to complete the data collection activities and perform assessment. Additional training and team building sessions were conducted. The topics included Watts Bar DCRDR background (objectives, commitments, scope, history), integration and interface requirements, documentation requirements and packaging for assessment, assessment methodology and criteria, and scheduling and planning for completion of the Watts Bar DCRDR project.

As part of this training, a human factors engineering workshop was conducted, emphasizing issues important to the remaining tasks of the Watts Bar DCRDR. The following topics were included:

- o The system perspective on performance
- o Types and causes of human error; error significance and error management
- o Task analysis
- o Applying human factors principles to procedures
- o Assessment
- o Corrective actions - engineering changes and surface enhancements

These sessions were conducted over a 2-day period in April 1986 by Watts Bar DCRDR Project Manager J. J. Erpenbach and human factors specialists Dr. H. P. Van Cott and Dr. R. F. Pain.

Training on the task analysis methodology was provided for Watts Bar operations and engineering personnel involved in the review of task analysis data and the specification of detailed plant-specific I&C requirements. The task analysis training was based on guidance developed jointly by the Watts Bar DCRDR Project Manager, human factors specialist

Dr. G. A. Elliff, and operations specialist D. Pilsitz. This training was conducted by the Watts Bar DCRDR Project Manager beginning in June 1986 and continued informally as questions arose during the development of the task analysis data base.

Training for control room validation was provided to all validation participants, including the control room operating shift team and DCRDR team members serving as DCRDR validation observers. This 3-hour training session, included an overview of the Watts Bar DCRDR; the definition of validation and its role in both the DCRDR and procedures development; the specific objectives and uses of validation findings; the steps of the validation; validation team composition and responsibilities; and the forms to be used. Validation training was prepared and conducted in June 1986 by the Watts Bar DCRDR Project Manager, assisted by human factors specialists Dr. G. A. Elliff and B. Paramore.

4.2 Data Collection

The objective of data collection was to identify all human engineering concerns (HECs) that might potentially represent an HED. The output of all data collection activities was HECs, documented on the worksheet form shown in Figure 3.

There were four major data collection activities:

- o Review of operating experience, involving document review, questionnaires, and interviews with operations personnel.
- o Survey of the control room
- o Task analysis and verification of I&C availability and suitability
- o Control room validation.

The majority of the first two activities -- the review of operating experience and the control room survey -- were conducted from October 1984 through January 1985. Some additional followup on control room survey items was done later in 1985.

The remaining data collection activities -- task analysis/I&C verification, and control room validation -- were conducted in 1986.

HECs were also defined from other sources. They include:

- o The SER, Appendix D (several Appendix D items were deferred to be addressed in the Watts Bar DCRDR; See Appendix B of this report)

- o The Sequoyah DCRDR, including review of the Sequoyah HECs by TVA's former Office of Engineering to identify Sequoyah HECs relevant to Watts Bar

- o Other reviews by the former Office of Engineering

- o Items identified by the NRC Resident Inspector, and by other TVA personnel.

Table 2 summarizes the results of the Watts Bar DCRDR data collection tasks to the development of HECs.

TABLE 2
SOURCES OF HECs

Source	Number
General	110
Control Room Workspace	97
Communication	45
Alarm System	243
Controls	138
Visual Displays	358
Labels	194
Process Computers	163
Panel Layouts	321
Control Display Integration	90
Task Analysis/Verification	115
Validation	39
Total HECs	1913

A special group of HECs from Sequoyah were those identified during review of the Sequoyah Technical Support Center (TSC). This group was adopted in its entirety for input to the development of the Watts Bar TSC, one of the DCRDR-related activities specified in NUREG-0737, Supplement 1.

4.2.1 Review of Documented Operating Experience

The document review included Licensee Event Reports (LERs), Significant Event Reports, and DCRDR reports from other plants. A total of 284 LERs were reviewed. The Institute of Nuclear Power Operations (INPO) provided these reports. Included were reports from PWRs with a cause code related to operator error, procedure problem, or design or construction problem.

The following criteria were used to screen LER reports for potentially relevant human engineering concerns:

- o Does the LER indicate a deficient condition in the control room layout, panel layout, procedures, training or communications?
- o Does the LER indicate that a change to the control room layout, procedures, training, or communications has helped, or might have helped, to prevent or reduce the effects of the event?
- o Does the LER indicate that the event could have been averted or responded to better, had additional instruments and/or controls been available?

The review of the LERs, the Significant Event Reports, and the industry's DCRDR experience was done primarily by the Watts Bar DCRDR team's operations representative.

4.2.2 Operations Questionnaire

The questionnaire provided in the Program Plan, was used. It included both open-ended items and specific multiple choice questions taken from NUREG-0700.

The questionnaire was given to all licensed operators at the plant. The questionnaire was confidential unless a respondent requested contact with the Watts Bar DCRDR team.

The questionnaire returns were treated as follows. Open-ended question responses and comments were consolidated and summarized by topic. Response counts were prepared for all items. The reduced data was provided to the Watts Bar DCRDR team for use in preparing HECs.

The questionnaire data were also reviewed to prepare additional questions for the operator interviews, and to familiarize the Watts Bar DCRDR team members with operator-identified areas of concern for follow-up in the control room survey.

4.2.3 Operator Interviews

The interview form provided in the Program Plan was used. The structure and content of this form were derived from EPRI NP-309. Before they conducted interviews, Watts Bar DCRDR team members were trained according to the guidelines of T.J. Bouchard in the Handbook of Industrial and Organizational Psychology.

Twenty-one unit operators and assistant shift engineers were interviewed individually. Three to six hours were required to complete each interview. Interview responses were kept confidential. Interview data were reduced in the same manner as the questionnaire responses, and then given to DCRDR team members for use in preparing HECs.

4.2.4 Control Room Survey

Nine checklists were used to guide and document the control room survey effort. The checklists were provided in the Program Plan. They address the following topics, corresponding to the major groupings of human engineering criteria in NUREG-0700:

- o Control room workspace (including the lighting, noise, and HVAC surveys)
- o Communications
- o Alarm systems
- o Controls
- o Visual displays
- o Labels and location aids
- o Computers
- o Control-display integration
- o Panel layout

The checklist criteria used in the surveys are based on the criteria in NUREG-0700, Section 6.0. A small number of item revisions were made based on the TVA Office of Engineering design guides, MIL-STD-1472C, INPO 83-042, and American Society of Heating, Refrigeration and Air Conditioning Engineer guidelines for environmental surveys. Measurement worksheets and data forms were included with checklists as appropriate.

Checklist use required selection of one of three human engineering compliance choices: Not Applicable, Yes, or No. "Yes" signifies compliance with human engineering principles. "No" signifies an HEC. Reasons for all "No" entries were written in the comment column.

On completion of a checklist, or during performance of the checklist, the Watts Bar DCRDR team member completed HEC Worksheets as necessary. The team members submitted their completed checklists and HECs to the team leader.

4.2.5 Task Analysis and Verification of I&C Availability and Suitability

Task analysis was conducted to define operator action and information requirements for emergency operations. This was done through an independent analytic effort, starting from systems function data. The resulting requirements were then used to verify that the control room provides all necessary instrumentation and controls. It was further used to verify that the I&C design characteristics were suitable to meet the specific operational requirements identified in the task analysis. Any inconsistencies were documented as HECs.

The task analysis process was a descriptive process which extracted generic operator action and information requirements from systems function data. This data was provided in the Westinghouse Owners Group (WOG) Emergency Response Guidelines (ERGs), supplemental ERG analysis developed by Westinghouse for Upper Head Injection Ice Condenser plants, and the Westinghouse System Review and Task Analysis (SRTA) background documents.

These generic requirements were converted to a plant-specific level based on plant system differences. The results were documented in an auditable, tabular format for use in verification and entered into a data base management system to facilitate cross referencing of tasks to EI and ERG Step Objectives.

Figure 4 gives an overview of the steps involved. The steps are described below:

1. Prepare a list of generic tasks. Revision 1 of the WOG ERGs was used. The task(s) for each ERG step were recorded, including the primary action and the contingency action to be taken when the expected response was not obtained. This was done by a human factors/operations specialist.

2. Develop generic action and information requirements for each task. The ERG background documents, which describe the bases for ERG steps were used in this effort. The generic tasks were broken out into subtasks (behavioral elements).

   Implied elements, such as verification of expected response after a control action, were included. Information from caution and note statements was included as applicable. The behavioral elements were defined by a sequence number, action descriptor (verb), the system and system component to which the action is directed, the parameter or condition to be altered or monitored, and the expected response (direction, state, value). I&C requirements associated with the expected response were also entered insofar as possible based on the generic information. These data were recorded on the Action-Information Requirements Details (AIRD) form as illustrated in Figure 5. This was also done by the human factors/operations specialist.

3. Convert generic requirements to plant-specific requirements. Plant documentation was used for this purpose, such as the system documentation, draft Technical Specifications and Limiting Conditions of Operation, system documentation, Emergency Instructions (EIs), and system/equipment in-service test data. The relevance of the generic tasks was reviewed. A generic task was omitted from further analysis when the justification for omission was clearly based on plant system design differences; otherwise it was retained.

   The AIRD forms were then modified to accurately reflect the plant-specific parameters, values, ranges, units, rates, and other differences from the generic I&C requirements in the Westinghouse ERG SRTA background documents. Situation-dependent terms, such as "decreasing," "stable," and "normal," were quantified where appropriate and meaningful. As part of this process, valve response times were also examined. This was done to identify valves that have a stroke time significantly different from operator expectations.

   The initial analysis of ERG step relevance and requirements conversion was done by the human factors/operations specialist. Watts Bar operations and engineering personnel then researched and specified the final, plant-specific information requirements.

4. Reorganize and summarize the data. The data for all behavioral elements of the same type were grouped. "Type" refers to commonality of plant system, component, parameter and class of action (i.e., control action or information-gathering action). The result of this step was an Action-Information Requirements Summary (AIRS) form for each behavioral element type, as illustrated in Figure 6.

5. Cross check action and information requirements to the WOG-ERG instrument and control inventory. This was done by the human factors/operations specialist to verify the completeness of requirements identification. The requirements on the AIRS forms were compared to the I&C requirements listed by the Westinghouse Owners' Group in its System Review and Task Analysis (SRTA) of the basic version of the ERGs. Missing items were added to the AIRD and AIRS data files and listed, so that they would be included in the I&C verification.

Verification of I&C availability and suitability was done in the control room. Walk-throughs were conducted by DCRDR team personnel, with assistance from on-shift operators, to evaluate whether each requirement has been met satisfactorily. The AIRS forms generated in the task analysis were used to guide and document verification. The verification summary block on the form was completed. If the action-information requirement was not satisfied, an HEC Worksheet was prepared.

4.2.6 Control Room Validation

The objective of DCRDR control room validation, as defined in NUREG-0700, is to ensure that "the physical and organizational design for operations is adequate to support the effective integrated performance of the functions of the control room operating crew." The validation process in the DCRDR was specifically directed to ensuring adequate design to support emergency operations.

Emergency Instruction (EI) walk-throughs were conducted in the control room to evaluate design adequacy in the context of integrated operating sequences. Real-time performance was simulated as closely as possible in this setting. The Watts Bar control room simulator is being procured. It was decided that use of another plant's simulator would be inappropriate because of the importance of the specific plant I&C design to Watts Bar DCRDR validation.

These walk-throughs were also used to collect data to meet part of the EI validation requirements. The objectives of control room validation and EI validation are very similar. Both evaluate the compatibility of design, staffing, and procedural guidance.

Table 3 lists the EIs performed during validation. They were performed in their entirety, including the primary path and each contingency path for plant "response not obtained."

TABLE 3
EMERGENCY INSTRUCTIONS USED
FOR VALIDATION

NUMBER	TITLE
E-0	Reactor Trip or Safety Injection
ES-0.1	Reactor Trip Response
ES-0.2	SI Termination
ES-0.3	Natural Circulation Cooldown
E-1	Loss of Reactor or Secondary Coolant
ES-1.1	Post LOCA Cooldown
ES-1.2	Transfer to Containment Sump
ES-1.3	Transfer to Hot Leg Recirculation
E-2	Evaulted Steam Generator Isolation
E-3	Steam Generator Tube Rupture (SGTR)
ES-3.1	SI Termination Following SGTR
ES-3.2	Post-SGTR Cooldown Using Backfill
ES-3.3	Post-SGTR Cooldown by Ruptured S/G Depressurization
E-FOP	Foldout Page
FR-S.1	Response to Nuclear Power Generation/ATWS
FR-S.2	Response to Loss of Core Shutdown
FR-C.1	Response to Inadequate Core Cooling
FR-C.2	Response to Saturated Core Cooling
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 Loss of Normal Steam Release Capabilities
FR-H.5	Response to Steam Generator Low Level
FR-P.1	Response to Pressurized Thermal Shock
FR-P.2	Response to Cold Overpressure Condition
FR-Z.1	Response to Phase B Containment Pressure
FR-Z.2	Response to Containment Flooding
FR-Z.3	Response to High Containment Radiation
FR-I.1	Response to High Pressurizer Level
FR-I.2	Response to Low Pressurizer Level
FR-I.3	Response to Voids in Reactor Vessel
ECA-0.0	Loss of All AC Power
ECA-0.1	Loss of All AC Power Recovery Without SI Required
ECA-0.2	Loss of All AC Power Recovery With SI Required

The minimum shift complement was used -- one SRO and two ROs. Human factors specialists and engineering personnel were involved as observers. The lead observer was a human factors specialist who coordinated technical performance of the validation. There were two additional human factors observers -- one to focus on DCRDR issues and one to focus on EI issues.

A systems engineer participated as the fourth observer, focusing on the compatibility of the instructions with system response characteristics. The primary objective of the engineering observer was to identify any needs for EI revision based on system design characteristics.

Before each walk-through began, the engineering observer described the conditions leading to EI entry. During each walk-through, he stated the system response cues that affect the course of action. Walk-through steps are described below.

1. Perform a practice walk-through. This was done to identify how the activity might be phased in the final walk-through so that the focus of observer attention could be on one crew member at a time.

   In addition, this initial walk-through provided an opportunity to observe the interactions in operator communications and movements. The operators were asked to represent actual performance as much as possible, with the control room supervisor (SRO) directing the activity in his usual role. Use of communications equipment was simulated, as well as normal communications between control room personnel, use of performance aids, and use of auxiliary unit operators (AUOs).

2. Discuss details and phasing of the walk-through. This was done to resolve any questions about cues and feedback, operator interactions, time-sensitivity of steps, and steps that may involve special potential for incorrect operations. The phasing of activity was also established for the final walk-through.

3. Perform final walk-through. During the final walk-through, the operators took turns simulating and explaining their actions. As each action was enacted, the operator pointed to the control(s) and display(s) used, and stated the parameter and/or component being controlled or monitored, the expected result, significant communications with personnel in or out of the control room, other procedures or references if used, and significant thoughts, diagnoses, and decisions.

4. Review the results. After each walk-through, observers discussed all questions/potential problems identified with the operators.

Several forms were used to document the validation: an Observer Notes Form (Figure 7), an EI Performance Review Checklist (Figure 8), and a Validation Comments Form (Figure 9). For the DCRDR, HECs were written from the applicable items on the Validation Comments Form. Comments concerning the EIs were provided to the Team Leader for the EI development effort.

4.3 Assessment

To facilitate assessment, a full-scale, three-dimensional color photo mockup of the Unit 1 control room, common equipment and portions of the backup control room was constructed. The mockup room provided storage space for Watts Bar DCRDR documentation, reference documents, and other materials, and work space for the Assessment Team. All Assessment Team meetings were held in the mockup room.

The assessment approach was generally as described in the Program Plan. The specific assessment methodology used is described in detail in the following paragraphs. The Assessment Team consisted of six members, including the Team Leader, a human factors specialist, a reactor operator licensed at Watts Bar, an instrument engineer, a nuclear engineer, and a Watts Bar Shift Technical Advisor (STA). In order for the Assessment Team to assess HEDs, a quorum had to be present. A quorum consisted of at least five members of the Assessment Team. The human factors specialist and the reactor operator were required to be present at all assessment meetings.

There were five phases in the assessment, beginning with the initial determination of which HECs were valid HEDs, and ending with the verification of recommended corrective actions for HEDs. Each phase is described in the following subsections.

4.3.1 Determination of HEDs

The first phase of assessment was to determine whether each HEC should be assessed as a valid HED, either individually or in combination with other HECs. Some concerns were written up as HECs more than once during the several data collection activities. Very similiar HECs, where the problem described in the HEC had previously been grouped into an HED, were cross-referenced to the HED addressing the problem and not considered further.

Other HECs had been corrected in the period between their identification and the assessment. For these, the team confirmed the adequacy of the current design by inspecting the components involved in the control room and then the corrected HECs were not considered further as HEDs. Other HECs specifically identified maintenance needs (loose knobs, etc.). These HECs were not made into HEDs since the problem was clearly a maintenance problem instead of an equipment design problem. Instead, a Maintenance Request will be prepared for the required maintenance.

For the remaining HECs, the team evaluated their validity as concerns, and their relevance to the scope of the DCRDR, using the following criteria:

- The HEC must represent an actual deviation from a human factors criterion.

- The HEC must be related to the operation of the control panels in the main or auxiliary control room or transfer to the auxiliary control room.

- The HEC must apply to the actual plant.

If an HEC was determined to be a valid concern within the scope of the DCRDR effort, it was designated as an HED, either individually, or in conjunction with other related HECs.

A number of HECs addressed organizational management concerns (e.g., operator workload, organizational communications). Others specifically identified problems with procedures, training and maintenance. Another group addressed TSC design. Although these HECs identify problems that are outside the scope of the control room equipment design, which is the primary focus of the DCRDR, they are important factors in plant operating safety and effectiveness. They also represent issues important in related activities which must be coordinated and integrated with the DCRDR. The Watts Bar DCRDR team therefore decided to establish umbrella HEDs for these types of concerns. Some of these HEDs will be referred to other, more appropriate working groups and organizations, as identified in Appendix F. These groups are responsible for further evaluation and feedback.

4.3.2 Grouping of Related Problems (HECs) into HEDs

The objective in this phase was to identify HECs that should be considered together. Examples included HECs that were highly similar, a particular class of concern, or involved related concerns. Other HECs were grouped when it was clearly apparent that one integrated corrective action, such as a panel relayout, would be required to solve several layout HECs on the panels. This grouping helped the Assessment Team consider the potential for cumulative and interactive effects among HECs in the assessment and corrective action process.

Grouping was partially provided automatically by the control room survey checklist design, which organized the data by human engineering topics and subtopics (e.g., lighting, communications, labeling). Panel identification provided another ready means of grouping.

4.3.3 HED Categorization

The objective of HED categorization was to prioritize importance to assist in development of needs for corrective action. The Assessment Team applied a formal evaluation process and set of criteria to determine the HED categories. The decisions were documented on the HED Categorization Record shown in Figure 10. See Figure 11 for a logic diagram of the process. The category definitions are summarized in Table 4.

Critical Safety Function (CSF) is the function which the symptom oriented EIs (or as applicable function restoration guidelines) are developed to maintain. The HEDs are related to controls and displays used to perform the EI or in a system needed to support or maintain a CSF.

TABLE 4

HED CATEGORY DEFINITIONS

1. Category I
   Errors resulting from HEDs in this category directly challenge or cause a loss of a CSF.

2. Category II
   Errors resulting from HEDs in this category reduce or cause the loss of resource(s) needed to maintain a CSF.

3. Category III
   Errors resulting from HEDs in this category adversely affect normal operation or have the potential to affect CSF resource(s).

4. Category IV
   Errors resulting from HEDs in this category have no significant effect on plant operations.

NOTE: The team may also decide to not rate (NR) selected HEDs. This is particularly true if there is difficulty in determining the specific error that might be associated with them. This rating may also be used for selected HEDs that could be considered outside the scope of the DCRDR process.

As Figure 11 indicates, there were three progressive levels of evaluation and screening to determine category, plus a separate evaluation of safety significance.

At the first level of assessment for category, the criterion is likelihood of error to occur. If the likelihood of error associated with an HED was determined to be very low, an HED was categorized as Category 4.

At the next level of evaluation, the criterion is the potential results of the error, in terms of operating performance degradation. These HEDs were rated as Category 3.

At the third and final level, the criterion is the severity of any potential effect of an error on a critical safety function. This criterion determined the category rating for HEDs evaluated at this level, and could yield Category 1, 2, or 3 HEDs.

After the categorization of an HED was completed, another evaluation was conducted to refine the determination of safety significance. All HEDs, including those in Category 4 (very unlikely to cause an error that could impair plant operations), were subjected to this additional evaluation. A safety significant HED was defined as any HED that could result in a plant condition that exceeds a Technical Specification Safety Limit or a Limiting Condition of Operation (LCO). This resulted in a code (S or NS) assigned to each HED.

If agreement about the HED category or the safety significance code was not unanimous, the majority decision prevailed, but any differing view was documented. In cases of tie votes, the most conservative position (higher category or safety significant designation) was adopted.

The team also decided not to rate a few HEDs. This was done by the team if the specific or cumulative error associated with the HECs involved could not be assessed by established methods. These were given high priority for corrective action. This was also done for a few HEDs that were outside the scope of control room equipment design. All other steps of the DCRDR process were applied to this small group of nonrated HEDs.

4.3.4 Development of HED Corrective Actions

After the HEDs had been categorized and coded for safety significance, the fourth phase of assessment began with the Team Leader's assignment of HEDs to the team members for development of corrective action according to their areas of expertise. Additional supporting personnel were involved as appropriate.

Corrections were developed between team meetings and then submitted formally to the team for comment, questions, and approval. The period between meetings allowed for further research into the issues by means such as contacts with vendors and input from engineering and operations personnel. In some cases, as with a few annunciator HEDs, development of a specific correction was deferred pending a more detailed study of the issues.

Corrective action alternatives included surface enhancement (e.g., changing labels, adding demarcation), training, procedure revision, software modifications, and hardware modifications. When it was judged that the correction would involve movement, modification, or addition/deletion of controls and displays, the correction was evaluated with other alternatives. Consideration was also given to how it would impact the existing control room (consistency and compatibility), correction of other HEDs, plant availability, operator training and performance, and procedures. Integration with other NUREG-0737 Supplement 1 activities and programs was also evaluated.

HEDs concerned with component arrangement on the panels were first grouped by panel. Therefore, any recommendations for a particular HED would necessarily consider other HED recommendations for the same panel.

The mockup was used extensively in development of corrective actions, particularly those involving panel layout problems. Operations personnel were invited into the mockup area to review and comment on proposed relayout options as part of the HED Corrective Action Plan (HEDCAP) development process. Their comments were incorporated into the final HEDCAP for submission to the team.

All supporting HECs and HED assessment documentation was included as part of the HEDCAP package. See Figure 12 for an example of the HEDCAP form.

4.3.5 Verification of HED Corrective Actions

The last phase of the assessment process involved formal team review of each HEDCAP. During a typical meeting, the HED issue was reviewed, and then followed by the proposed detailed correction. For some HEDs, several alternatives were described. The corrections were verified against two primary criteria:

- The correction resolved the original human factors concern.
- The correction did not result in new human factors concerns.

Other questions regarding I&C, nuclear systems, and other operational aspects of the correction were encouraged. Some HEDCAPs were presented to the team several times as each submittal resulted in further definition of HED issues and improvements to the HEDCAP.

HEDCAP approval was documented with team signatures. If a team member did not concur with the majority decision, this was documented.

4.4 Plant Management Review and Approval

After completion of the Assessment Team review, each HEDCAP package was submitted for management review. The initial review was performed by the Watts Bar DCRDR Project Manager. Each HEDCAP was reviewed for clarity, completeness, overall adequacy to address the HED, and feasibility.

HEDCAP packages were then forwarded to operations for review. See Figure 13 for this transmittal form. Licensed shift personnel reviewed each package in detail for technical adequacy, feasibility, and operational impact. In several cases, teams of operations and management personnel reviewed the HEDCAP package in the main control room. The mockup was also used to explain and demonstrate the proposed changes.

Two levels of upper site management reviewed and approved each HEDCAP package. These managers were licensed or had SRO equivalency certification.

Any differences, suggested changes, or justifications for no action resulting from this review process were reviewed by the DCRDR Project Manager. When appropriate, the DCRDR Project Manager requested Assessment Team assistance in evaluating the acceptability and consistency of the final management position.

As the development of corrective actions continued, opportunities for increased integration and improvement of corrective actions were recognized by team members. When HEDCAP revisions were prepared, they received the same team and management review process as the original HEDCAP.

5.0 DISCUSSION OF WATTS BAR DCRDR RESULTS

This section provides a quantitative summary of the DCRDR results, and description of the types of corrective action to be implemented. Implementation mechanisms and schedule are discussed.

5.1 Quantitative Summary

There were 1913 HECs identified from all sources. Of these, 1351 were assigned to HEDs, either individually or in conjunction with other HECs. Table 5 shows the reasons for omitting the remaining HECs from further consideration as HEDs.

TABLE 5
REASONS FOR OMITTING HECs FROM FURTHER CONSIDERATION

Omission	Number	Percent Of All HECs
Already Corrected	188	10%
Not A Valid Concern	154	8%
Referral For Maintenance Action	22	1%
Duplicate Of Another HEC	198	10%
Total	562	29%

Note: See Section 4.3.1 for the criteria applied to determine HEC validity.

The usual case was for a group, rather than a single HEC, to be assigned to an HED. The groups were established on the basis of relationships among the concerns. The grouping of concerns facilitated attention to cumulative and interactive effects in both the assessment of HED significance and the development of corrective actions.

A total of 219 HEDs were prepared*. Corrective actions are planned for 152 HEDs. Table 6 provides an overview of corrective action decisions for the HEDs in each assessment category.

* The HED sequence numbers are from 001 to 222. Three sequence numbers were reserved but never used (207, 209, and 210); thus the actual HED total is 219.)

TABLE 6
SUMMARY OF CORRECTIVE ACTION DECISIONS
FOR HEDs IN EACH ASSESSMENT CATEGORY

	Correction(s) Planned	No Corrections(s) Planned	Total
Category 1			
Safety Significant (S)	6(3%)	0(0%)	6(3%)
Not Safety Significant (NS)	0(0%)	0(0%)	0(0%)
Category 2			
S	6(3%)	0(0%)	6(3%)
NS	7(3%)	0(0%)	7(3%)
Non-rated	3(1%)	0(0%)	3(1%)
Category 3			
S	15(7%)	0(0%)	15(7%)
NS	69(31%)	13(6%)	82(37%)
Category 4			
S	2(<1%)	4(2%)	6(3%)
NS	38(17%)	43(20%)	81(37%)
Category Non-rated	13(6%)	0(0%)	13(6%)
Total			
S	29(13%)	4(2%)	33(15%)
NS	114(51%)	56(25%)	170(76%)
Non-rated	16(7%)	0(0%)	16(7%)
Reserved Numbers (not used)		3(1%)	3(1%)

The Corrective Action Plan for an HED does not necessarily include a change for every individual HEC assigned to the HED. The Corrective Action Plan is intended to satisfactorily reduce overall error potential. As a result, analysis of corrective action requirements in the context of the group of items, and in relation to actions recommended to correct other HEDs, may lead to a determination that no change is necessary or appropriate for a given HEC item.

5.2 Corrective Actions

The planned corrective actions include numerous hardware changes and surface enhancements. Also included are further studies and surveys where appropriate.

Panel Layouts

Using the mockup extensively, panel layouts were improved in a systematic manner where necessary. Hierarchical labeling, demarcation and mimicking were employed to enhance the proposed layouts. Operation input was obtained and further changes incorporated. Changes are planned on several panels. See HED 156, 157, 161, 163, 167, 174 and 179 for examples.

Controls and Displays

Shape coding, inadvertent operation, and conversion requirements between controllers and indicators were addressed and changes are planned. See HED 83 and 91. Indicators and recorders will be improved with several corrective actions. See HED 106, 107, and 119 for examples. Standards are proposed for color banding, pointer visibility, non-linear scales, graduation intervals, range, precision, lettering, etc.

System Upgrades

Corrective actions include plans for pre-trip alarm sensors for the main generator, level detectors for the waste gas decay tanks, a NPSH trip for the standby main feedwater pump. Upgrade of containment isolation indication system and relocation of feedwater isolation resets. Several other major upgrades such as RVLIS will be incorporated into the control room interface.

Labeling

Numerous labeling items were addressed and specific corrective actions proposed for both the main and auxiliary control rooms. A new labeling standard will be developed with operational input. It will provide a uniform scheme for labeling with standardized names, abbreviation, acronyms and symbols. A survey of the panels will be performed and necessary changes made to ensure acceptability per the standard.

Computers

The DCRDR team has recommended system upgrades including display enhancement interfacing with other computers, additional needed displays and man-machine interface (MMI) upgrades. The DCRDR team also recommended MMI upgrades to the process computer and reliability upgrades. A study will evaluate the concerns and recommendations of HED 138-142, 146-152 and 194 to ensure implementation of integrated solutions for computer hardware and software.

Annunciators

Many problems were identified and corrective actions proposed in the areas of multiple input, the need for reflash and the necessity of sending an operator locally to get further information. Also investigated were the areas of priority coding, ambiguous annunciators, unnecessary alarms, nuisance alarms and needed additional alarms. An annunciator study will further evaluate the concerns and recommendations of HED 37-54, 56-63, 65-68, 94, 144 and 145 to ensure implementation of integrated solutions based on operator needs.

Communication

A survey of communication needs will be done to confirm effectiveness and integration of needed changes in this area. See HED 20, 21, 30 - 36.

Lighting, Ventilation, and Noise

Surveys and confirmation of effective corrective actions are planned for these areas. See HED 13, 14, and 15.

Administration, Procedures and Training

In addition other administrative, procedural and training corrective actions are planned. These are summarized in Appendix F.

5.3 Implementation Control Mechanisms and Schedule

Hardware modifications indicated in Appendix F will be implemented in accordance with established TVA controls. Any change in the original corrective actions specified in Appendix F will receive a human factors review in accordance with established TVA controls. All SER Appendix D commitments are factored into the MCR design. All future changes to MCR design including SER Appendix D commitments will be made only after proper human factor review.

Current plans are to implement the corrective actions specified in Appendix F prior to fuel load. Schedules of implementation will be developed based on more detailed review of the corrective actions by the responsible organizations. Corrective action will be tracked by the TVA Corporate Commitment Tracking System which is used to track all commitments made to the NRC.

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6.2 TVA

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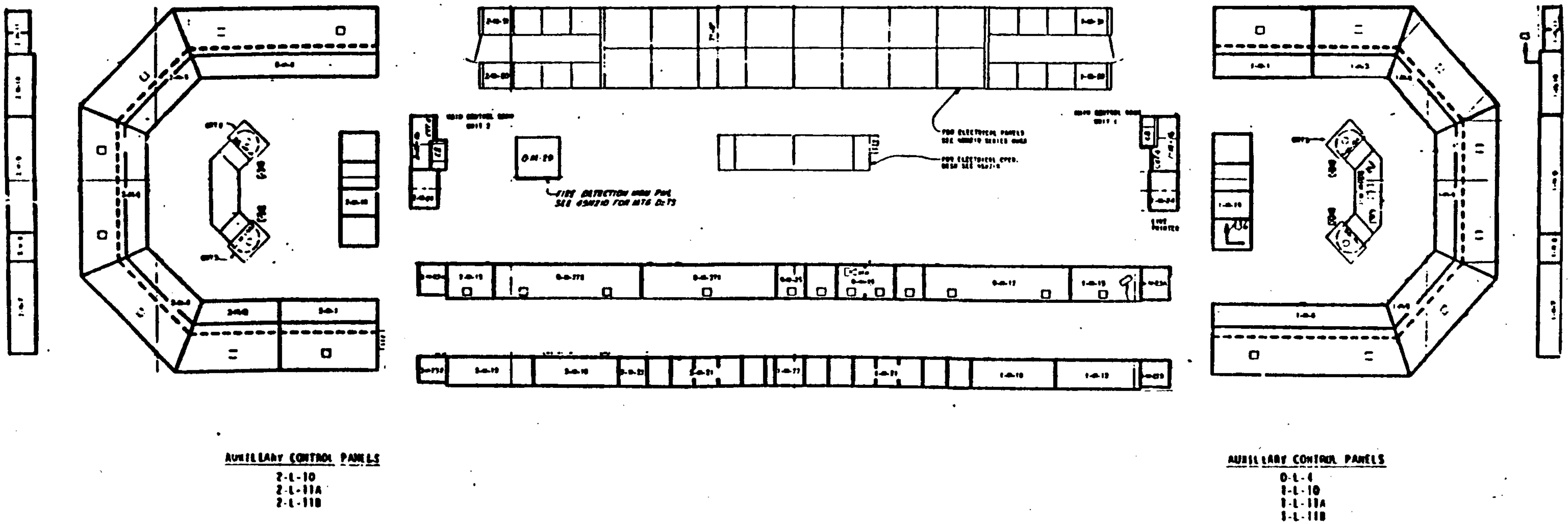

Figure 1
WATTS BAR NUCLEAR PLANT CONTROL ROOM ARRANGEMENT - UNITS 1 & 2

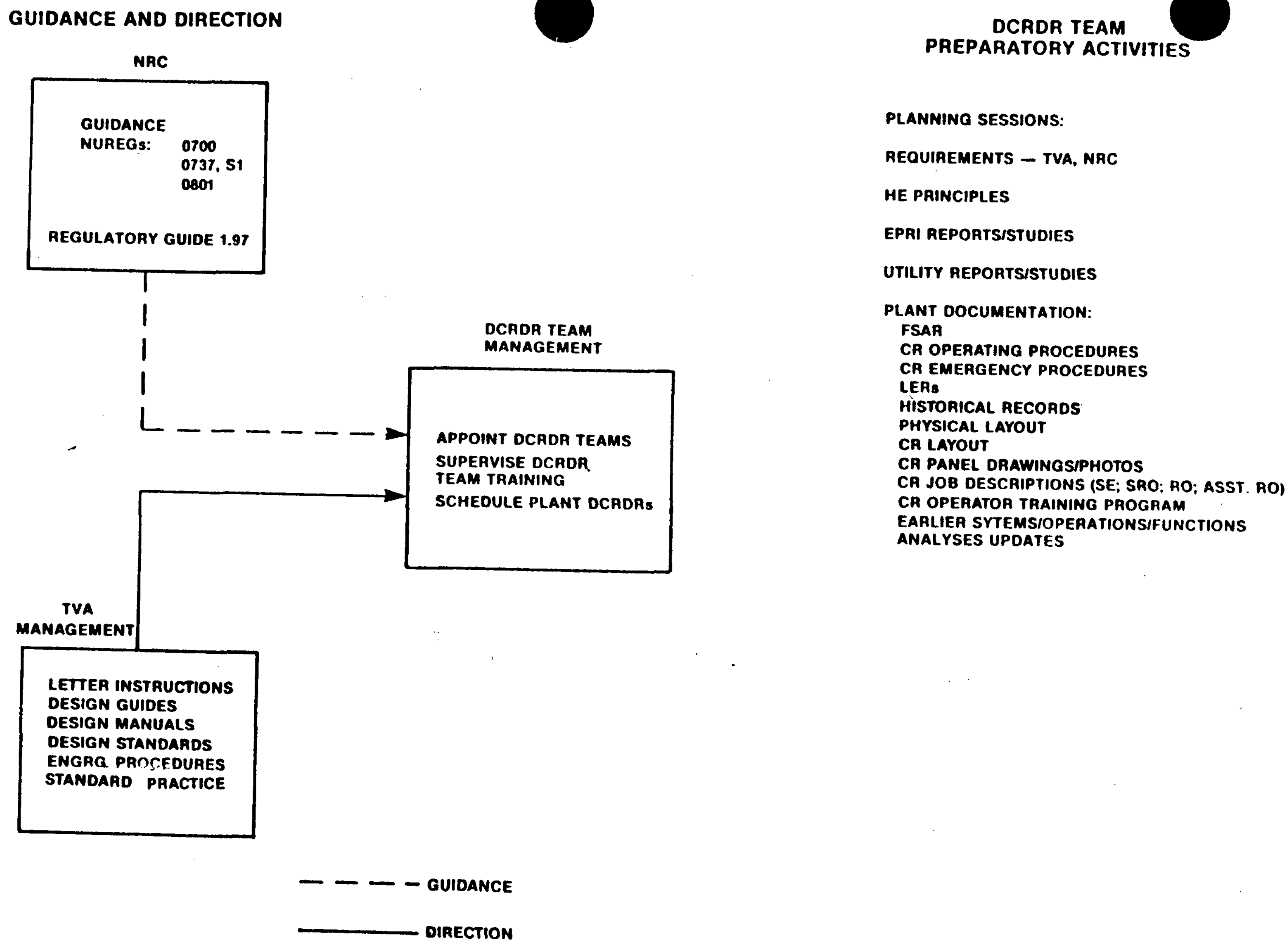

FIGURE 2. GUIDANCE, DIRECTION, AND ACTIVITIES OF DETAILED CONTROL ROOM DESIGN REVIEW PREPARATION

FIGURE 3

EXAMPLE OF HEC WORKSHEET

Revision _____ Date __________

HUMAN ENGINEERING CONCERN (HEC) WORKSHEET

Plant: Watts Bar Nuclear Plant
Unit: 1 - 2 - 0 - Simulator
Date: 1/2/85

HEC ID No.: MX 8088
(Panel) (Checklist) (Sequence No.)

HEC Short Title: Pressurize tail pipe temperature indicator and acoustic monitor not grouped together

Location: M-4/27

Checklist Item: 8.1.1.a, 8.1.1.b, 8.2.1.c, 8.2.2.b

How HEC Identified: Checklist

Plant System/Subsystem: 68

Components Involved (UNID/Name): TI-68-330, 329, 328, 331; XX-68-363

Human Performance Modality Affected (vision, hearing, decision making, etc.):

Decision making

Detailed Description: See short title - temperature indicators are on M-4, acoustic monitor on M-27

Impact/Significance of Concern (identify how concern relates to events, modes, functions, tasks, any safety consequences, and describe relationship to any other concerns as appropriate):

Delay possible in recognizing flow in tail pipe. Lack of sensitivity to increases in flow where the initial condition was a small leak (i.e., PORV was not seating well and the tailpipe was hot).

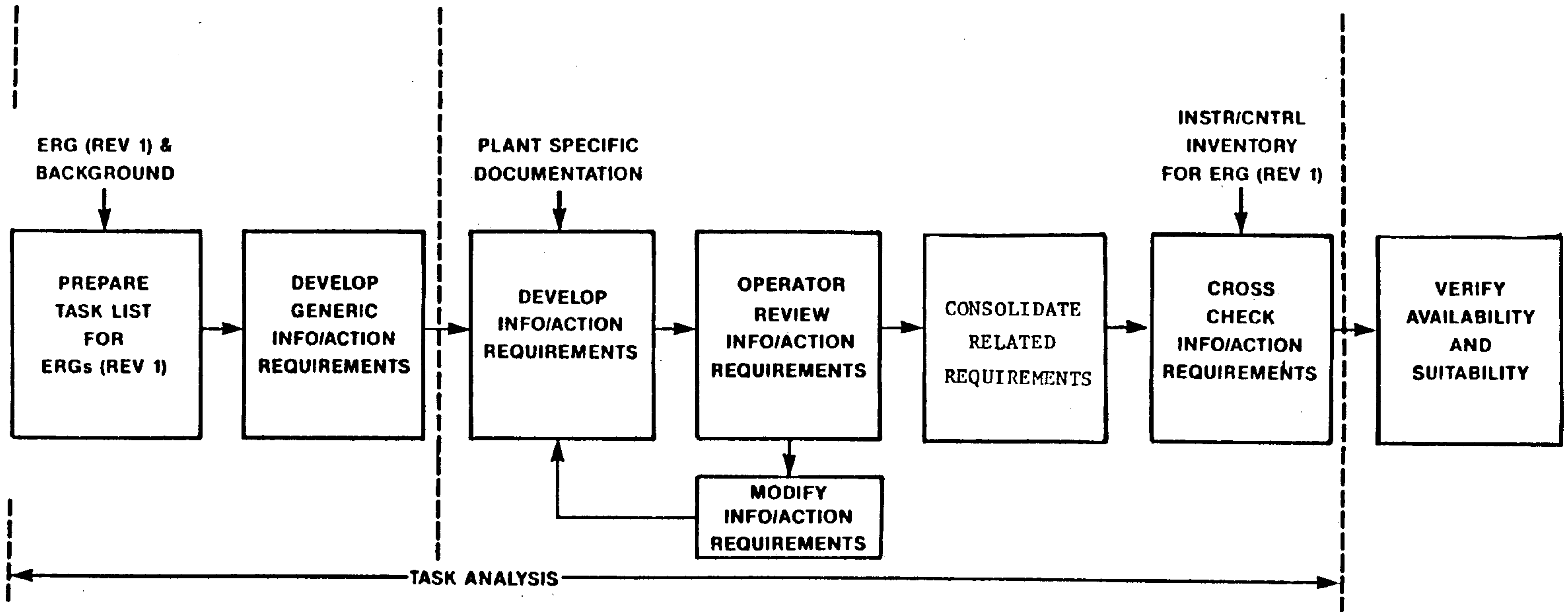

FIGURE 4. TASK ANALYSIS AND VERIFICATION PROCESS

FIGURE 5

EXAMPLE OF AIRD FORM

ACTION-INFORMATION REQUIREMENTS DETAIL (AIRD)
(SORT BY EI)

PAGE 32

WBN UNITS: 1 & 2 ORIGINATOR: C. GAL DATE: 04/11/86
ESSEX REVIEWER: DALE PILSITZ DATE: ________
EI NO: ES-0.1 ERG NO: ES-0.1 TVA REVIEWER: ____________________ DATE: ________
EI STEP: 21 ERG STEP: 12
EI OBJECTIVE: MAINTAIN STABLE PLANT CONDITIONS

ERG OBJECTIVE: MAINTAIN STABLE PLANT CONDITIONS

BEHAVIORAL ELEMENTS

ACT	VERB	SYSTEM		COMPONENT	PARAM	DIRECTION	STATE/ VALUE	UNITS/ RATE	PREC	RNG/ R.T.	TREND REQ	PSV	COMMENTS
	OBS	62	CVCS	CHG LTDN	FLOW	N/A	45-75	GPM	5	45-75	N		NONE
	MON	68	RCS	PZR	LEVEL	=	25	%	5	20-100	N		NONE
C	ADJ	03	MFW	FW FCVs	POS	O/C	PROP AL	N/A	N/A	15 SEC	N		AFW/MFW VLVS.
	OBS	03	MFW	FW FCVs	POS	N/A	O/C	N/A	N/A	N/A	N		AFW/MFW VLVS, VLV POS STATUS IND
	OBS	03	MFW	FW	STATUS	N/A	RUNNING	lb/Hr	1E6	15E6	N		FLOW > 0
	MON	03	MFW	SGs	LEVEL	BETWEEN	>10 & 50	%NR	10	10-60	Y		NONE
D	ADJ	01	MS	SG PORVs	POS	O/C	O/C	N/A	N/A	15 SEC	N		PIC-1-6A, 13A, 24A, 31A
	OBS	01	MS	SG PORVs	POS	N/A	O/C	N/A	N/A	N/A	N		VLV POS STATUS IND, DEMAND IND
	ADJ	01	MS	CNDSR STM DUMP VLVS	POS	O/C	THROTTLE	N/A	N/A	15 SEC	N		HS-1-103A, B, HS-1-103D, PIC-1-33
	OBS	01	MS	CNDSR STM DUMP VLVS	POS	N/A	O/C	N/A	N/A	N/A	N		VLV POS STATUS IND
	MON	68	RCS	RCS	Tavg	=	557	DEG F	1	557-640	Y		NONE

FIGURE 6

EXAMPLE OF AIRS FORM

PAGE NO.: 328

ACTION-INFORMATION REQUIREMENTS SUMMARY (AIRS)
(SORT BY EI)

PLANT: TVA - WATTS BAR

SORT BLOCK	
REQS TYPE:	INFO
SYSTEM:	MFW 03
COMPONENT:	SB MFP
PARAMETER:	POS

SUMMARY OF REQUIREMENTS BLOCK			
VALUE/RANGE:	0-300	0-1200	0-6000
UNITS:	Amps	PSIG	gpm
PRECISION:	10	20	100
RESPONSE TIME:	N/A	N/A	N/A
TYPE:	C	C	C

VERIFICATION SUMMARY BLOCK

I.D. NO	PANEL	PASS	FAIL	ACTUAL RANGE	ACTUAL PRECISION	HED NO.
1-EI-3-200	1-M-4	✓		0-400 Amps	10	
1-PI-3-203A	1-M-3	✓		0-1200 PSIG	20	
1-FI-3-208	1-M-3	✓		0-6000 gpm	100	

INDIVIDUAL DETAILS

I	STEP	ACT	VERB	DIRECTION	STATE/ VALUE	UNITS/ RATE	RNG/ R.T.	PREC	TREND REQ	CMT
ES-0.1	04P	A*	OBS	N/A	RUNNING	AMPS PSIG GPM	0-300 0-1200 0-6200	10 50 100	N	N
ES-0.1	17P	C.	OBS	N/A	OFF	AMPS PSIG GPM	0-300 0-1200 0-6200	10 50 100	N	Y
ES-0.1	20P	E	OBS	N/A	RUNNING	AMPS PSIG GPM	0-300 0-1200 0-6200	10 50 100	N	Y
ES-0.1	21	C	OBS	N/A	RUNNING	AMPS PSIG GPM	0-300 0-1200 0-6200	10 50 100	N	Y
ES-0.2	33	C	OBS	N/A	RUNNING	AMPS PSIG GPM	0-300 0-1200 0-6200	10 50 100	N	Y

FIGURE 7

EXAMPLE OF VALIDATION OBSERVER NOTES

WBN - DCRDR VALIDATION
JUNE 16-20, 1986
OBSERVER NOTES
FORM 1

✓(OK), NA, X (Problem/Question)

✓ Sufficent Information
✓ Clear Instructions
✓ Sequence Correct
✓ Timing Correct
✓ Communications
X I&C Met
✓ Traffic Pattern
✓ Workload

BG Initials

WBN
E-2 Unit 1 or 2
Page 3 of 4
Rev. 2

FAULTED STEAM GENERATOR ISOLATION

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
CAUTION:	The pressure difference between the RCS and the Faulted S/G should be maintained <1600 psid.	
2	Isolate Faulted S/G	
	a. CLOSE Faulted S/G MSIV and MSIV bypass	
	b. Ensure AFW - ISOLATED	
	c. Ensure MFW - ISOLATED	
	d. Ensure S/G PORV - CLOSED	d. Locally close isolation valve
	e. Ensure blowdown - CLOSED	
	f. Ensure TD AFW pump being supplied from intact S/G	f. IF both S/G 1 and 4 Faulted, THEN ensure at least one MD pump aligned to an intact S/G, THEN stop TD AFW pump

① MOTOR & TURB AFWP LVL CONTROLS
"HARD TO OPERATE" - not labelled
"in manual" (should be added) inconsistent with other controls that are labelled as such
1-HS-3-174, 173, 172, 175 TD
164, 156, 148, 171 MOTOR
prev covered?

② layout inconsistent TD / MD

③ #'d in corner on TD, but not on MD

Move so that MD control switches can be layed out like TD.

FIGURE 8

EXAMPLE OF EI PERFORMANCE REVIEW CHECKLIST

WBN – DCRDR VALIDATION
JUNE 16–20, 1986
EI PERFORMANCE REVIEW CHECKLIST

FORM 4

EI No. E-2 Title: Faulted Steam Generator Isolation

✓(OK), NA, X (Problem/Concern)

✓ 1. Is sufficient information provided in the EI for qualified, trained operators to perform each required action?

✓ 2. Is sufficient information available for the operator to make a correct choice at each decision point?

✓ 3. Does the EI adequately handle needs for concurrent verifications of plant status or actions?

✓ 4. Did personnel use or expect system responses or other information that is not indicated in the EI? If so, should this information be in the EI?

✓ 5. Did personnel perform any action that was not specified in the EI? If so, should be action be specified in the EI?

✓ 6. Was an alternate path used, not in the EI, that should be identified?

✓ 7. Is any terminology, nomenclature, abbreviation, acronym, or symbol used in the EI that is not familiar to operators?

✓ 8. Are locations of equipment, controls, or displays that are infrequently used, are in out-of-the-way places, or are at local panels adequately described?

✓ 9. Did expected equipment responses correspond to what is in the EI?

✓ 10. Is the EI consistent with the manning philosophy?

✓ 11. For EI's performed by more than one person, are the individual responsibilities clear?

✓ 12. Where setpoints or other limiting values apply, was enough guidance presented to ensure timely operator action?

✓ 13. Was sufficient information given to allow the operators to find the appropriate controls and displays?

FIGURE 8

EXAMPLE OF EI PERFORMANCE REVIEW CHECKLIST

WBN - DCRDR VALIDATION

EI Performance Review Checklist (cont'd)

✓ 14. Were prerequisites for starting equipment clearly identified when necessary?

✓ 15. Did the EI instruct the operators to start equipment at the appropriate time?

✓ 16. Did communications occur at the appropriate points?

✓ 17. Was any interference in communications observed?

✓ 18. Is the information provided in the EI in a form that is easily used?

NA 19. Was the coordination of multiple flow paths or multiple EI's handled in a manner that resulted in each operator being aware of his responsibilities and of current plant conditions?

X 20. Were instructions concerning actions to be taken presented clearly?

✓ 21. When the EI references non-EI procedures, are significant man/machine or procedural concerns noted.

✓ 22. Are all necessary controls and displays provided in the control room?

✓ 23. Are there any cases where a control or display is not suitably designed to meet the operator's needs? (e.g., insufficient scale range; insufficient capability to regulate flow)

✓ 24. Are there any displays which cannot be seen when needed because they are not close enough to the control being operated?

✓ 25. Is staffing sufficient in relation to control room design to meet all operational requirements in a timely and reliable manner?

✓ 26. Are there any problems with physical interference or communications interference between operators?

✓ 27. Does the senior reactor operator have any difficulty with panel visibility or operator communications from his work station?

FIGURE 8

EXAMPLE OF EI PERFORMANCE REVIEW CHECKLIST

WBN – DCRDR VALIDATION

EI Performance Review Checklist (cont'd)

X 28. Are there any controls/displays that are difficult to locate, read, or operate, or take more time than should be necessary, (unusual location, poor panel layout, poor labeling)?

Comments:

Prepared by: Barbara Paramore

Date: 6/19/86

FIGURE 9

EXAMPLE OF VALIDATION COMMENTS FORM

WBN - DCRDR VALIDATION
JUNE 16-20, 1986
VALIDATION COMMENTS
FORM 5

EI No. E-2 Faulted Steam Generator Isolation

EI STEP NO.	COMMENT	SUGGESTED RESOLUTION/REFERENCES
2b,•	The motor driven and turbine driven AFW pump level controls are "hold to operate" and are not labelled as similar controls that are also "hold to operate". The reason given for this discrepency was that the AFW pumps level controls are only hold to operate in manual. To be consistent, labels should be added. (1-HS-3-174A, 173A, 172A, 175A, 1-HS-3-164A, 156A, 148A, 171A)	Add labels: "HOLD TO OPERATE IN MANUAL"
2b.	The turbine driven AFW pump level controls are numbered in the upper left hand corner for easy identification. The motor driven AFW pump level controls have no such labels. Labels should be added for ~~[illegible]~~ easier recognition and to insure consistency. (1-HS-3-164A, 1-HS-3-156A, 1-HS-3-148A, 1-HS-3-173A)	Add numbers to MD AFWP LVL controls similar to TD AFWP LVL controls.

FIGURE 10

EXAMPLE OF HED CATEGORIZATION RECORD

WBN
WB6.3.14
Page 20 of 26
Revision 1

FIGURE 6
WATTS BAR NUCLEAR
DETAILED CONTROL ROOM DESIGN REVIEW

HED NO. 159

CAT: ~~2~~ 1

HED CATEGORIZATION RECORD

SAFETY (Y/N) Y

LIKELIHOOD THAT HED WILL CAUSE ERROR						
CAT 4		CAT 1, 2, or 3				
DEFINITELY NOT	VERY UNLIKELY	PROBABLY NOT	MAYBE	PROBABLY	VERY LIKELY (SWRP BO MY JB)	DEFINITELY

RESULT OF ERROR (IF UNCORRECTED)						
CAT 3			CAT 1, 2, or 3			
NO EFFECT	REQUIRES ADDITIONAL STEPS	REDUCTION IN OPER PERFORMANCE	LOSS OF COMPONENT FUNCTION	LOSS OF SYSTEM FUNCTION (JB SW BO RP MY)	EXTENDED LOSS OF SYSTEM FUNCTION	EXTENDED LOSS OF ~~SYSTEM~~ Plant FUNCTION JTB 6/2/86

EFFECT ON MAINTENANCE AND/OR RESTORATION OF A CSF						
CAT 3		CAT 2		CAT 1		
NO EFFECT	POTENTIAL REDUCTION TO CSF MAINT RESOURCE	REDUCED CSF MAINT RESOURCE CAPABILITY (MY JB SW RP BO)	LOSS OF CSF MAINTENANCE RESOURCE	CHALLENGE TO A CSF	LOSS OF CSF	PREVENT RESTORATION

REMARKS/JUSTIFICATION: Lack of Feedwater Isolation Reset & Status in the MCR. This is a time critical task required to be performed during EI's.
Team agrees to upgrade this to a Cat 1 based on information in VE-016 JTB 7/21/86

TEAM MEMBER	TEAM MEMBER SIGNATURE	CONCURRENCE		DATE
CRDR Leader	J Brooks	(YES)	NO	6-5-86
Human Factor Spec	J Keston	(YES)	NO	6/5/86
Reactor Operator	Gregg Wagner	(YES)	NO	6/5/86
Instrument Engineer	Maurice L. Young	(YES)	NO	6/5/86
Nuclear Engineer	Robert D. Orendi	(YES)	NO	6/5/86
Other		YES	NO	
Other		YES	NO	
Other		YES	NO	

FIGURE 11

LOGIC PROCESS FOR ASSESSMENT

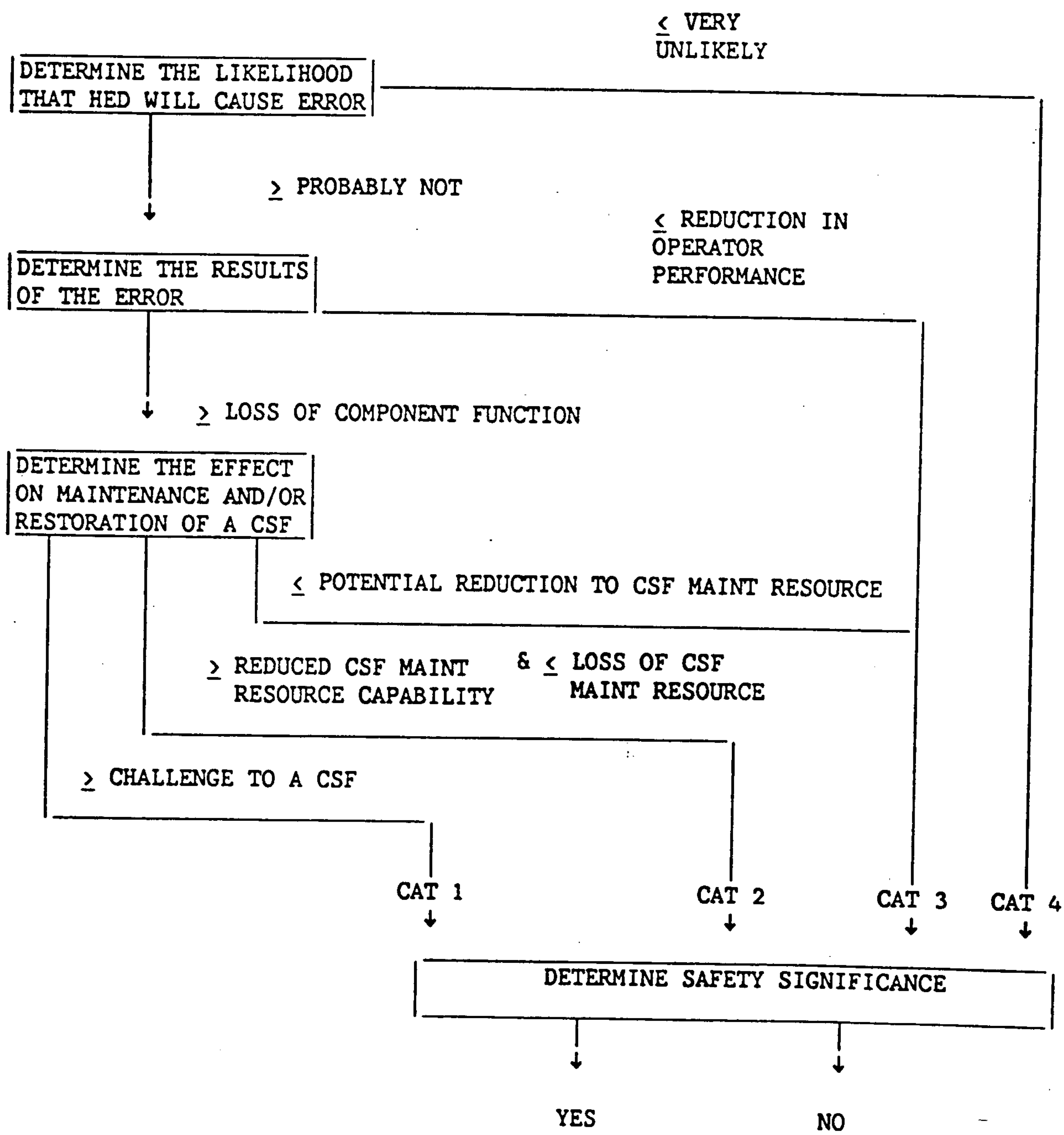

FIGURE 12

EXAMPLE OF HED CORRECTIVE ACTION PLAN

WATTS BAR NUCLEAR
DETAILED CONTROL ROOM DESIGN REVIEW
HED CORRECTIVE ACTION
Final PLAN

HED No. 159

CAT: 1

SAFETY (Y/N) Y

HED Short Title: Lack of Feedwater Isolation Reset and Status.

References: DCR-558, DCR-617

Plan: Recommendation is to relocate the reset pushbuttons from the Aux Instrument Room to M-3. A Feedwater Isolation status indicator will be addressed in HED-54 "Lack of Master Isolation Status Panel". This HED should also go to Training Section to ensure that the operators know that after the master Isolations are reset and the individual loops are reset, then the (over)

Principally prepared by: Warren Date: 8/15/86

Team Member	Team Member Signature	Concurrence	Date
CRDR Team Leader	J F Brooks	(Yes) No	9-3-86
Human Factor Spec	[illegible signature]	(Yes) No	9-3-86
Reactor Operator	Gregg Warren	(Yes) No	9/3/86
Instrument Engineer	M. L. Young	(Yes) No	9/3/86
Nuclear Engineer	[illegible signature]	(Yes) No	9/3/86
Shift Technical Advisor	[illegible signature]	(Yes) No	9-3-86

FIGURE 13

EXAMPLE OF MANAGEMENT
REVIEW & CONCURRENCE TRANSMITTAL

Superintendent, O&TS
Watts Bar Nuclear Plant ONP

WATTS BAR NUCLEAR PLANT (WBN) - CONTROL ROOM DESIGN REVIEW (CRDR) CORRECTIVE ACTION PLAN

Attached is a team proposed corrective action plan for Human Engineering Design (HED) (Number/Short Title) ______

#159 LACK OF FEEDWATER ISOLATION RE[illegible] STATUS

Please review this plan and provide your concurrence and/or comments by 9/2/86

Office of
Plant Manager
Watts Bar Nuclear Plant

AUG 28 '86

Route to	Info	Act'n	Reply
Plant Manager			
Asst to Plt Mgr			
[illegible] Safety & Fire Prot			
FORS			
Training (E&TT)			
Rad Controls			
Supt (O&TS) (1)			
Asst to Supt (O&TS)			
Chemistry			
Operations			
Sg Prot (O)			
Tech Support			
Preop			
Training (Ops)			
Supt (M) (2)			
Asst to Supt (M)			
SP (S[illegible] Mtn)			
SP ([illegible])			
SP ([illegible], Tr[illegible], EO)			
Bldg Svs			
Elect Mtn			
Inst Mtn			
Mech Mtn			
Secretary			
Document Control			
FILE			

J. J. Erpenbach [signature] / [illegible]
J. J. Erpenbach
CRDR Project Manager

JJE:LLE

______

J. J. Erpenbach, CRDR Project Manager
WATTS BAR NUCLEAR PLANT (WBN) -

(✓) Concur. Proceed to implement.

( ) Do not concur. See comments.

Comments: ______

[signature] 8/27/86
Operations

M. K. Jones 8/28/86
for Plt Mgr or Supt, O&TS

[signature] for [illegible]
Site Director

APPENDIX A

WATTS BAR NUCLEAR PLANT

Summary of Correlations Between

Control Room Design Review Items

And

SER Appendix D Priority 1 & 2 Items

This appendix provides summary statements of the correlations between the SER (based on the TVA February 28, 1985 submittal) and DCRDR items where differences or enhancements have been recognized. Narrative summary description of the SER item, the original and then the DCRDR corrective action is provided. Further detail is available on site.

1.3 Description of Problem

No headsets are located on any of the back cabinets.

Corrective Actions

Sound-powered jacks SP1-SP6 in the unit 1 side of the main control room (MCR) have a permanent hanger with a headset located near them.

DCRDR recommended that instead, a lockable storage container will be provided to keep the headsets because the sound-powered phone cords were found to be a tripping hazard.

3.3 Description of Problem

Alarms are not prioritized.

Corrective Actions

High-priority alarm windows have been color coded red to distinguish them from all nonemergency alarms.

DCRDR recommended that specific windows change in priority and that this aspect be included in an annunciator study.

4.2 Description of Problem

Labeling on many valve controllers does not consistently or clearly associate direction of movement with resulting action. A clockwise movement does not always result in valve opening.

Corrective Actions

Directional arrows for forward and reverse acting controllers were added to specific controllers.

DCRDR recommended 1) rewiring the controllers if possible to obtain direction movement consistency, 2) adding labels to improve understanding of controller inconsistencies, and 3) providing additional training due to inconsistencies.

4.7 Description of Problem

Valve control handles which must be held for many seconds are difficult to hold.

Corrective Actions

"Hold to operate" tags were added to valve switches where needed.

Switches that had required excessive effort to operate were reviewed by the DCRDR team. Operational input was that new switches have replaced the old ones and this was no longer a problem.

5.1 Description of Problem

Scale divisions and ranges are not always immediately obvious.

Corrective Actions

The scales of selected indicators have been color coded to identify the abnormal operating ranges.

DCRDR recommended that scale enhancements be made for those cases in which it was determined that performance might be affected. A standard is under development for the design of indicator and recorder scales to prevent new problems from arising.

5.4 Description of Problem

Displays indicating sequential information are not always located sequentially or grouped together for ease in visual scanning (see Item 5.7).

5.5 Description of Problem

Meters indicating parameters that must be compared are not grouped for ease in distinguishing similar or different values (see Item 5.7).

5.6 Description of Problem

Meters that indicate different parameters look alike, have similar scales and are similarly labeled. Reading errors could result (see Item 5.7).

5.7 Description of Problem

Identification of a specific meter is not always obvious among a string of meters.

Corrective Actions

Items 5.4 through 5.7 have been corrected by the addition of functional nameplates and demarcation lines.

DCRDR recommended grouping of indicators and controls. Demarcation was enhanced in the panel layout HEDs.

5.8 Description of Problem

Meters labeled "B" left and "A" right violate sterotypical convention.

Corrective Actions

Specific indicators were rearranged to comply to convention.

DCRDR panel layout optimization attempted to place components in a loop 1, 2, 3, 4, or pump A, B, C order.

5.9 Description of Problem

The subcooling margin monitor is not installed or onsite. Readouts and displays could not be observed.

Corrective Actions

A dual scale was added to PI-68-69 to read temperature scaled from 212°F to 695.5°F.

DCRDR recommended installing RVLIS. It would provide a display for the subcooling margin.

6.1 Description of Problem

Controls are not arranged in logical order (that is, by function or sequentially). (See Item 6.5)

6.2 Description of Problem

Demarcation between units 1 and 2 and common controls and displays is not clearly indicated. (See Item 6.5)

6.3 Description of Problem

Large string/matrices of switches are located at several places on panels, specifically for component cooling water, water service systems, essential raw cooling water, and ventilation. (See Item 6.5)

6.4 Description of Problem

The feedwater and condensate system had a sequence of valves (left to right "C-B-A-B-A"). (See Item 6.5)

6.5 Description of Problem

There are several long strings (greater than 4) of vertical meters.

Corrective Actions

Meters were given demarcation and/or summary tags to distinguish them from adjacent displays.

DCRDR addressed items 6.1 through 6.5 in the panel layout HEDs.

7.1 Description of Problem

Some displays are not located directly above the controls that relate to them. (See Item 7.2)

7.2 Description of Problem

There are many instances where controls and displays are arranged "B" on left and "A" on right (not typical stereotype).

Corrective Actions

Many devices have been moved to correct violations of conventional arrangements. Functional nameplates and demarcation lines have been added.

DCRDR further addressed item 7.1. and 7.2 while reworking the individual panel layout HEDs. See Appendix F for layout HEDs.

7.3 Description of Problem

Maintenance and test controls and displays are located on some panels that contain important operating functions.

Corrective Actions

SIS test valve handswitches were demarcated and given a summary tag. In addition, 20 Safety Injection System test switches were incorporated into a matrix switch/light box on M-6.

The DCRDR will add a symbol to the switch nametag. Panel layout HEDs addressed switch location.

7.4 Description of Problem

Some functional groups of valves are not arranged according to operating sequence.

Corrective Actions

Components have been arranged so as to improve functional grouping.

DCRDR layout HEDs further improved functional grouping. See Appendix F.

7.5 Description of Problem

Pattern recognition requirements of statalarm panels are too complex for rapid verification.

Corrective Actions

Annunciator trip status and monitor light boxes were given functional nameplates and were demarcated for clarification.

DCRDR recommended that all Phase B tiles be grouped in one panel. Trip status panel patterns are logical. Status panel logic will be modified.

APPENDIX B

WATTS BAR NUCLEAR PLANT

Summary Of Correlation Between

Control Room Design Review Items

And

SER Appendix D Priority 3 Items

CORRELATION OF SER APPENDIX D PRIORITY 3 ITEMS

WITH THE DCRDR PROCESS

Priority 3 items were not all listed in the SER Appendix D. The following list was compiled using the Priority 3 items originally identified in the Watts Bar Control Room Design Review/audit by NRC in 1980 (using the identifying number from that review/audit). Also included are items which were subsequently changed to Priority 3 items when the SER, Appendix D was issued (identified by asterick).

Also provided in the listing is the HEC number assigned to those items, with identification of the HED in which they were addressed and the HED dispositions. If an HED is not listed (i.e., N/A) the HEC was determined to be previously corrected prior to the assessment process.

Audit Report Number	HEC	HED	Corrective Action
6.2-A.3	1073	028	A number of burned out or extinguished overhead lights were observed indicating poor maintenance practices. Corrections: Any burned out or defective lighting should be corrected. Periodic inspections of lighting will be conducted. Frequency of inspections will be increased or decreased as necessary based on inspection data.
6.2-A.4	1074	028	Dirt on overhead plastic diffusers reduced lighting levels indicating poor maintenance. Corrections: Diffusers were cleaned. During the Control Room lighting inspection (see HEC 1073 above) any dirty diffusers are to be noted and cleaned.
6.5-A.2	5329	089	Information from some meters has to be converted to units the operator needs. An example is the "HP Turbine Impulse Chamber," reads in PSIA and must be converted to percent power. Corrections: For the example cited, a new scale is to be made per standard using the 0-100% scale. The generic problem will be addressed in HEC 5001 by establishing a standard and conducting a survey of indicators and recorders to ensure the units agree with technical specification. Indicator scale units, technical specifications units, procedure units, and operator expectations are to agree to the extent possible. The units displayed on the scale should be what the operator would expect based on training and experience.

Audit Report Number	HEC	HED	Corrective Action
6.5-A.11	5287	090	The meaning of green marking on the scales of the O-M-26 frequency indicators are not clear. Corrections: The location and purpose of the marking will be pointed out in Operator Group Training.
6.5-B.4	3186	037	Blank windows are intermixed with active windows on the Statalarm panels. Corrections: No action recommended. Some windows were intentionally left blank to provide vertical grouping to aid the operator in determining the logic for certain actuation signals (such as 1/2 and 2/3 logic along with coincidence signals). This is valuable information for the operator.
6.7-H*	3111	037	Some annunciator windows are not located in panels above (or near) associated controls.
6.7-K	3118	037	Grouping of tiles within an annunciator panel is poor. (Panels listed) Corrections: The HEC's along with several others related to annunciator windows were evaluated by the Operations group to determine validity, applicability, and severity of the HEC's. Four of the 31 suggested changes in HEC 3111 were approved. The others were judged not to be warranted. The regrouping of tiles within individual panels was not approved. No action was considered necessary at this time, HED 47 will study future needs for integrated changes to the annunciator systems. (See Appendix F.)
6.5-B.5	5192	N/A	The scale on FI-62-139 is not graduated to indicate decimal point to tenths for last digit. Correction: This item was corrected by changing the scale.
6.9-F	7088	N/A	The CRT color coding display requires some refinement for clearer status monitoring.
5.9.G*	7089	N/A	The status monitoring system was not functional. Correction: The equipment identified in these HEC's has been removed.

Audit Report Number	HEC	HED	Corrective Action
6.5-A.10*	5328	10004,	Various meters mounted high on panels are difficult to read by fifth percentile persons and introduce parallax problems. Note: This HEC was very broad in scope. As a result specific HEC's (numbered 1042 to 1051 and 1081 to 1095) were written. They are discussed below.
6.5-A.10*	1042	167	Controls and displays are too low and too high on Panel 1-M-9. Correction: An improved layout design using functional grouping and mimics has been prepared and is being considered. If implemented with the small handswitches it will be possible to mitigate a large percentage of the anthropometric problems.
6.5-A.10*	1043	201	Controls and displays too low, displays too high on Panel 1-M-10. Correction: No immediate corrective actions recommended. Controls, displays and annunciators are not located such that an error would likely occur as a result.
6.5-A.10*	1044	201	Controls too high on Panel 1-M-13.
6.5-A.10*	1045	201	Controls and displays are too low and too high on Panel 1-M-18.
6.5-A.10*	1046	201	Controls and displays too low, controls and annunciator panel too high on Panel 1-M-30. Correction: These items were handled as follows: Eberline keyboard accessibility was corrected by ECN 5833 and 5834. No further action was recommended. It was concluded that controls, displays and annunciators are not located such that an error would likely occur as a result. The Incore Temperature Monitoring System which is located low on Panel 1-M-18 will be deleted when RVLIS is implemented. See HED 005.
6.5-A.10*	1047	181	Controls and displays too low, annunciator panel too high on Panel 1-L-10.
6.5-A.10*	1048	181	Controls and displays too low, displays and annunciator panel too high on Panel 2-L-10. Correction: Anthropometric guidelines were considered during layout rework and annunciation handswitches were relocated. Handled by HEC 1047 (above).

Audit Report Number	HEC	HED	Corrective Action
6.5-A.10*	1049	201	Controls and displays too low, annunciator panel too high on Panel 0-L-4 (D, C, B, A) Correction: No action recommended. Controls, displays and annunciators are not located such that an error was likely to occur.
6.5-A.10*	1050	201	Controls and displays too low, displays too high on electrical control board. Correction: No action recommended (same as above).
6.5-A.10*	1051	179	Displays too high on Panel 1-M-1. Correction: No action recommended. Two instruments exceed the height guidelines, (the higher of the two by 4 inches) but it was decided not to move them for reasons of height alone. Parallax was not considered a problem because the instruments have horizontal displays.
6.5-A.10*	1081	156	Controls and indicators do not meet anthropometric guidelines (Panel M-2).
6.5-A.10*	1082	156 157 160	Controls and displays on Panel M-3 do not meet anthropometric guidelines. (Panel M-4) Correction: Controls and indicators that did not meet the guidelines were assessed. The variations were not considered serious enough to warrant corrective action on face value alone but were considered during panel layout. Some items that were corrected are FW reset push buttons, bypass controllers, AFW valve position lights, NIS bias selector, NIS level demand indicator and steam generator blowdown controllers.
6.5-A.10*	1084	160 161	Controls and indicators do not meet anthropometric guidelines.
6.5-A.10*	1085	161	Controls and displays on panels M-6 do not meet anthropometric guidelines. Correction: Controls and indicators that did not meet the guidelines were assessed. The variations were not considered serious enough to warrant corrective action on face value alone but were considered during panel layout. In most cases they could not be incorporated.

Audit Report Number	HEC	HED	Corrective Action
6.5-A.10*	1086	169	Controls and displays on M-12 do not meet anthropometric guidelines. Correction: No action was recommended. Height or depth reasons alone were not considered sufficient justification.
6.5-A.10*	1087	201	Indicator lights on Panel M-7 are too high. Correction: No action recommended. These lights are binary indication (normal and alternate feeder indicating lights) which would not cause an error being located slightly higher than 70 inches.
6.5-A.10*	1088	63	Controls and displays on O-M-26A, - 26B, -26C, 26D do not meet anthropometric guidelines. Correction: The annunciator response controller for these panels will be moved from a very low position to a higher, safer, more visible location. No other changes were approved.
6.5-A.10*	1089	170	Controls and displays on Panel M-15 do not meet anthropometric guidelines. Correction: No changes were recommended for this panel based on height alone.
6.5-A.10*	1090	201	Displays and controls on Panel M-23 are located too high. Correction: Upper Head Injection system will not be used. As a result controls on this panel are being removed.
6.5-A.10*	1091	201	Displays on M-11 below 41 inches. Correction: No changes recommended. Only one instrument falls under this guideline (XR-43-1006). The height criteria alone was not considered justification for a move nor is there space above it on the panel.
C.5-A.10*	1092	174	Displays and controls on Panel M-27A do not meet anthropometric guidelines.

Audit Report Number	HEC	HED	Corrective Action
6.5-A.10*	1094	174	Displays and control on Panel M-27B do not meet anthropometric guidelines. Correction: An improved layout design for panel M-27A and -B using functional grouping and mimics has been prepared and is being considered. If implemented with the small handswitches it will be possible to mitigate a large percentage of the anthropometric problems.
6.5-A.10*	1093	201	Displays on Panel M-25 do not meet anthropometric guidelines. Correction: Some instruments that were below guidelines were removed. (0-TR-90-177, 0-XR-90-178)
6.5-A.10*	1095	201	Controls and displays on Panel L-11 above 70 inches. Correction: No changes recommended. It was determined that the controls and displays were located such that no serious problems would result from height on depth guideline violations.
6.5-C.2*	5327	10002,	Some recorders do not indicate in real time. Correction: Chart paper will be provided that is graduated consistent with the normal speed of the recorder. The Mechanical Engineering Unit is charged with maintaining adequate supplies of the properly graduated chart paper for each type of plant recorder used. Date and time are logged on the leading edge of the chart paper when it is loaded and when shifts change. Changes in chart speed are also noted.
6.7-E* 6.7-J*	3180	042	Annunciators labeled ambiguously. Controls and displays referred to by annunciators have different label information. Correction: Recommendations were made to change specific ambiguous annunciator windows per various HEC's in HED 042. After the standard for abbreviations, acronyms and special terminology for Watts Bar is generated (per HED 135) annunciators are to be studied to remove ambiguous tile engravings. Tile engravings will be installed which accurately reflect the subject of the alarm.

Audit Report Number	HEC	HED	Corrective Action
6.8-A.6*	4093	083	Control position markings for controls mounted on panels are difficult to view. Correction: The large star handles will be replaced with a smaller version of the star type handle.
6.8-A.8*	4091	007	Some handswitches have positions marked on face plates that are not used and not labeled. Correction: Hand switches which had extra switch position markings with no labels have been corrected by covering the extra marks. Hand switches which have a spring return to center but have no automatic function do not need a "normal" or "reset" position indication. Only hand switches with an A-Auto or P-Auto function or center position will be labeled.
6.8-A.11* 6.8-A.14*	6189	007	Some controls have more than two status lights with no labeling. Correction: Controls with many status lights have been properly labeled or they are addressed in other HEDs.

APPENDIX C

WATTS BAR NUCLEAR PLANT

Summary Of Modifications To

The Program Plan

SUMMARY OF MODIFICATIONS TO THE PROGRAM PLAN

In June of 1983, TVA submitted a generic review plan to the NRC, titled "Program Plan for Control Room Design Reviews for All TVA Nuclear Plants." In general, the Watts Bar DCRDR was performed in accordance with the generic Program Plan. Modifications were made in the following areas: DCRDR team management, task analysis, I&C verification, and the HED Action Plan. The nature of these modifications is summarized below.

1. DCRDR Team Management

   The Watts Bar DCRDR was under co-management by the Division of Nuclear Engineering and Nuclear Power Site Management until January 1986. From then until present, Nuclear Power Site Management has directed the DCRDR. Continued support and coordination with DNE has been maintained. As part of this change, a project manager from the site Operations organization was appointed to direct the effort with the assistance of a single, dedicated team leader, replacing the two co-team leaders under the original management concept. Major activities performed during the latter management were completion of the task analysis, I&C verification, control room validation, HED assessment including development of corrective actions, and preparation of this summary report. This topic is addressed in more detail in Section 2.0 of the report.

2. Survey

   The control room survey (appendix A to TVA's Program Plan) was revised to clarify and incorporate input from operator questionaires and interviews. The safety related assessment was not done during the survey, but was done during the following assessment phase.

   The luminance level measurements were completed only for a few panels. No problems where found. A revised measurement technique will be used to verify lighting after corrective actions are complete.

3. Task Analysis

   The task analysis methodology described in the Program Plan was modified to address NRC concerns about the independence of the analysis from the existing instrumentation and controls available in the control room. Under the revised method, the Westinghouse Owner's Group Emergency Response Guidelines (ERG's), and the associated Background Documentation, were used as the generic baseline for identification of emergency operating tasks, required instrumentation and controls, and detailed I&C characteristics. The generic requirements were modified as necessary based on plant-specific design features. This methodology is described in more detail in Section 4.2.5 of the report.

4. <u>I&C Verification</u>

Verification of I&C availability and suitability to meet the requirements defined in the task analysis was conducted against the actual control room components rather than against an inventory document. Verification was not done in a walk-through. It was a checklist type activity conducted in the control room. Printouts of the I&C requirements generated in the task analysis made up the reference documentation against which the control room components were evaluated. This process is explained in more detail in Section 4.2.5 of the report.

5. <u>Action Plan</u>

Instead of a single Action Plan document, a Corrective Action Plan was prepared for each individual HED. This was done because many of the HEDs encompass a substantial number of related concerns, requiring considerable detail in the definition of recommended corrective actions.

APPENDIX D

WATTS BAR NUCLEAR PLANT

Standard Practice WB6.3.14

Conduct Of The Detailed Control Room
Design Review And Other Major Human
Factor Reviews And Improvements At
Watts Bar Nuclear Plant

WATTS BAR NUCLEAR PLANT TENNESSEE VALLEY AUTHORITY	(WBN) SITE INSTRUCTION TITLE: CONDUCT OF THE DETAILED CONTROL ROOM DESIGN REVIEW AND OTHER MAJOR HUMAN FACTOR REVIEWS AND IMPROVEMENTS AT WATTS BAR NUCLEAR PLANT	(DOCUMENT NO.): WB6.3.14 (REVISION NO.): 4 (UNIT - IF APPLICABLE) ____ ☐ Quality-Related ☒ Non-Quality-Related ☐ Safety-Related ☒ Non-Safety-Related ☐ PORC-Reviewed ☒ Non-PORC-Reviewed

RESPONSIBLE ORGANIZATION: Project Management

WRITTEN BY: D. A. Kulisek/J. Erpenbach (NAME)　　REVISED BY: J. Erpenbach (NAME)

SUBMITTED BY: (SUPERVISOR) J. J. Erpenbach (SIGNATURE)　　J. Erpenbach (NAME)

CONCURRENCE SIGNATURE	DATE	CONCURRENCE SIGNATURE	DATE
☒ Manager, Site Quality [signature]	9/23/87	☐	
☐ ANII/ANI		☐	
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PORC Meeting: ____ PORC Chairman　____ Number　____ Date

Approved By: [signature] Signature, Plant Manager　9-23-87 Date

(LAST PAGE OF THIS INSTRUCTION: 35)

0160A

REVISION LOG

REVISION LEVEL	DATE	AFFECTED PAGES	DESCRIPTION OF REVISION
0	03/31/86	All	New standard practice.
1	05/15/86	20	Update Figure 6 - HED Form.
2	06/26/87	All; Delete Punchlist	Include references to additional details of verification and validation in project file (Section 5.1.2). Incorporated requested clarification. Move original Section 5.1.2 to an Attachment. Delete Punchlist.
3	07/15/87	All	Comments from Engineering Assurance.
4	09/23/87	2, 4, 9, 11	Clarify terminology and description of methodology. Update references.

1.0 PURPOSE

This Standard Practice (WB) provides general guidance on the conduct of the Watts Bar Detailed Control Room Design Review (DCRDR) at Watts Bar Nuclear Plant (WBN). It also describes other project administrative details and requirements specified by the CRDR Project Manager

2.0 SCOPE

Watts Bar is committed to perform a detailed control room design review for human factor considerations. This is required by supplement 1 to NUREG 0737. A summary report of this activity is to be submitted to NRC by August 1, 1987. Before January 13, 1986, this review effort had been controlled by an Division of Engineering Design (DNE) procedure. On that date the site director named a CRDR project manager and directed site responsibility for the remainder of the effort. This standard practice specifies guidance for this review which covers the main and auxiliary control room boards (and related transfer devices between them).

The original DNE procedure was used as the basis for the generic TVA program plan which specified the general review methodology and was placed on the NRC docket. The program plan (Rev. 2) is now controlled and issued onsite in accordance with AI-4.8. The standard practice provides additional administrative details and responsibilities specific to the Watts Bar DCRDR effort. These are predominantly in section 5.1.

There are several previous, concurrent, or evolving projects and programs that have impact on the man/machine interface in the control room. Integration of these efforts with DCRDR is discussed in section 5.2.

Historically, numerous commitments and hardware configuration changes related to human factor guidance have been made at Watts Bar. Section 5.3 describes the relationship between this history and current and future reviews and changes.

Finally, a very clear distinction should be noted between the review of the existing man/machine interface for human factor enhancements and the implementation of enhancements. The scope of this standard practice and the related program plan is concerned primarily with the review function. Any recommendations for enhancements are reviewed and approved by plant management. Implementation of enhancements is controlled and is in accordance with other established site and TVA instructions. This standard practice may, however, coordinate, integrate, and track implementation; it does not control it.

3.0 REFERENCES

3.1 Source Document

None

3.2 Other Documents

3.2.1 CRDR Program Plan (OE-SEP 82-17, R2), Control Room Design Reviews for all TVA Nuclear Plants (controlled onsite in accordance with AI-4.8, Controlled Documents)

3.2.2 NUREG 0700, Guidelines for Control Room Design Reviews, September 1981

3.2.3 AI-2.8.5, Conditions Adverse to Quality - Corrective Actions

3.2.4 WB11.8, Reporting Adverse Conditions to Plant Superintendents

3.2.5 Memorandum W. T. Cottle to Those listed dated January 13, 1986, "WBNP - Appointment of a Project Manager for CRDR" (T16 860113 988)

3.2.6 For others see section 11 of reference 3.2.1

3.3 Commitments

3.3.1 NUREG 0737 Supplement 1 (Generic letter 82-33), "NRC Staff Recommendations on Requirements for Emergency Response Capability." December 17, 1982 - Requires detailed control room design review to be performed by each utility.

3.3.2 Letter from T. M. Novak to H.G. Parris dated May 20, 1985, forwarding the latest Watts Bar draft license - attachment 2, license condition 1.a requires Watts Bar to conduct a detailed control room design review for unit 1 and submit a summary report to NRC prior to April 1, 1987.

4.0 RESPONSIBILITIES

4.1 CRDR Project Manager

The CRDR Project Manager is responsible for:

4.1.1 Management or coordination of the remainder of the DCRDR, related interfaces, and hardware changes for unit 1 owner/operator.

4.1.2 Interfacing with required organizations that support the unit 2 project manager for the remaining unit 2 control room design and construction. Support site personnel during the unit 2 transfer process with change tracking programs.

4.1.3 Providing general guidance or management for other human factor reviews at Watts Bar.

4.1.4 Maintenance and implementation of the program plan and the additional administrative details and requirements of this standard practice.

4.1.5 Management of project resources to achieve desired quality within cost, schedule, and project constraints.

4.1.6 Specification of the systematic actions necessary for assurance of project quality.

Additional responsibilities and related authority and accountability are defined in the project work scope and the Responsibility and Accountability Profile for the project manager.

4.2 DCRDR Team Leader

The DCRDR team leader is responsible for:

4.2.1 Coordination of the review team efforts on a day-to-day basis.

4.2.2 Implementation and ensuring team implementation of the program plan and this standard practice to achieve the desired quality within the cost and schedule constraints.

4.2.3 Identifying to the project manager needed resources or other problems impacting team effectiveness or efficiency. Recommending and implementing improvements to enhance team review effectiveness or efficiency.

4.2.4 Notifying the project manager in a timely manner of significant human factor discrepancies, significant differences of professional opinions, or other conditions adverse to quality identified by the team.

4.3 Team Members

The DCRDR core team members are responsible for:

4.3.1 Providing competent professional expertise to the team effort in their field of experience.

4.3.2 Actively pursuing and implementing individual assignments from the team leader.

4.3.3 Identifying to the team leader needed resources or other problems impacting their effectiveness or efficiency.

4.3.4 Clearly and accurately documenting in a timely manner differing professional opinions in accordance with this standard practice.

4.3.5 During all phases of the effort, identifying to the team leader any HEC/HED that is believed to:

- o prevent the operator from performing timely action when operator action is required for the safe shutdown of the unit
- o result in inappropriate operator action or lack of appropriate operator action necessary for safe shutdown of the unit
- o cause the operator to take inadvertent action which would lead to unplanned release of radioactive material from the plant.

The team leader is responsible for promptly obtaining a team review. If the majority of the available team members agree with the identifier's concern, it will be reported to the plant management. It is the responsibility of plant management to appropriately disposition the item.

4.3.6 Consultants will follow the same procedures and requirements as TVA personnel.

.4 Conditions Adverse to Quality

Each employee is responsible to identify to plant management any condition deemed adverse to quality whether or not related to human factor considerations. These items are handled under AI-2.8.5, "Conditions Adverse to Quality - Corrective Actions," or WB11.8, "Reporting Adverse Conditions to Plant Superintendents." It is the responsibility of plant management to appropriately disposition these items.

5.0 INSTRUCTION

5.1 Detailed Control Room Design Review (DCRDR)

The detailed control room design review will be conducted in accordance with the guidance of reference 3.2.1. It provides the general methodology for performing DCRDRs at all TVA plants. It is, therefore, somewhat generic in nature. The following provides details specific to Watts Bar. In cases of conflict between the program plan and this standard practice, the standard practice should be followed. Important differences will be addressed in the Summary Report when submitted to the NRC.

5.1.1 Team Management/Scope of Effort

Team management is discussed in the program plan and section 4.2.

The scope of DCRDR review effort is limited to the main control room panels shown in the program plan and the auxiliary control room (and related transfer devices).

5.1.2 Task Analysis, Verification, Validation

Section 6.6 of the program plan generally discusses the task analysis phase of DCRDR. Specifically task analysis ensures that the main control room instrumentation and controls allow and support those tasks required to perform the actions in the emergency instructions and function restoration guidelines.

Attachment A contains original guidance provided to implement the program plan guidance. This task analysis activity was stopped prior to the walk-through activity described in Attachment A. This information is retained for documentation of worksheet methodology.

To meet the DCRDR requirements for task analysis and verification, a method previously used by Essex and other utilities will be used. This ensures independence of operator action and information requirements from existing control room instrumentation. The task analysis for WBN will be based on the Westinghouse Owners' Group Emergency Response Guidelines (WOG-ERGs), Revision 1, and background documents for each ERG for the identification of operator tasks. The review team assembled to carry out the task analysis will consist of Engineering and Operations personnel, members of the plant staff, and the human factors consultant. Action and information requirements will be developed independent of existing control room instrumentation. These requirements will then be compared with control room components and hardware to verify that required controls and instrumentation are available and compatible with operator needs. Any detected inconsistencies will be treated as human engineering concerns and assessed in the fashion described in subsection 5.1.3.

5.1.2.1 General Instructions

The task analysis procedure is a descriptive process which extracts generic operator action and information requirements from systems function data (as represented by the WOG-ERGs). These generic requirements are converted to a plant-specific level, and the results are documented in an auditable, tabular format for use as an input into a verification process.

These procedures are organized into six major activities as follows:

- Develop a list of tasks from the WOG-ERGs.
- Generate a list of generic actions and information requirements for each task, organized by task for the ERGs and all the Function Restoration Guidelines (FRGs).
- Convert the generic list to a plant-specific list.
- Reorganize and summarize the listing so that all action requirements of a given type and all information requirements of a given type are collected together. "Type" refers to a group of action or information requirements which all have the same system, plant component, and parameter.
- Cross-check information and action requirements to the WOG-ERG instrument and control inventory.
- Compare the summary requirements to the existing control room inventory to verify availability and suitability.

5.1.2.2 Process

The following documents were collected:

- Westinghouse Owners' Group Emergency Response Guidelines and Background Documentation, Revision 1.
- Plant-specific abbreviation list.
- System Piping and Instrument Diagrams.
- Plant Technical Specifications, Setpoints, and Operating Limits.
- Westinghouse Owners' Group System Review and Task Analysis Documentation.
- Other plant-specific documentation as appropriate.

This information is then used to complete an Action-Information Requirements Details (AIRD) form. A copy of this form is in Attachment B.

5.1.2.3 AIRD Review

A review of all AIRD forms is conducted. Forms are modified to accurately reflect the plant-specific parameters, values, ranges, units, rates, or other differences from the generic. A brief, concise explanation is entered for all identified plant-specific differences. This review includes a comparison of original worksheets developed for task analysis as described in Attachment A. Additional details of this review process are documented in the CRDR project file.

5.1.2.4 Specification Summary

To produce the Action-Information Requirements Summary (AIRS) forms (Attachment B), a computer program sort is developed. All behavioral elements from the AIRD forms are transformed by computer sort onto the AIRS forms. This forms the basis for an instrument and control specification. For each AIRS form, the behavioral element column entries for State/Value, Units/Rate, Range/Response Time, Precision, and Trending Required are summarized. These summaries are entered in the appropriate places in the AIRS summary-of-requirements block.

5.1.2.5 Cross-Check for Completeness

Upon completion of the action and information requirements summary on the AIRS forms, the inventory of parameters to be observed and/or controlled is compared to the instrumentation and control requirements listed by the Westinghouse Owners' Group in its System Review and Task Analysis (SRTA) of the basic version of the ERGs.

The cross-check includes instrumentation and control requirements for the foldout pages from the Westinghouse Owners' Group Emergency Response guidelines. The cross-check is done to identify instrument and/or control requirements not yet included in the Watts Bar task analysis. Any identified differences are listed individually on additional Action Information Requirements Details (AIRD) forms and Action Information Requirements Summary (AIRS) forms so they are included in the verification process. In this way, it is assured that all instrumentation and control requirements are addressed.

5.1.2.6 Verification

Verification of availability and suitability is performed in the control room. At this time the verification summary block on each AIRS form is completed with appropriate entries into each of the data fields. If existing instrumentation and/or controls fulfill the action-information requirements listed, a check is inserted in the "Pass" column. If the existing information-controls do not fulfill the action-information requirements listed, the "Fail" column is checked. An HEC form is then generated for each failed action-information requirement. All such HECs are then assessed.

5.1.2.7 Validation

The objective of validation is to ensure that the actions specified in the currently approved Emergency Instructions (EIs) can be followed by trained operators to effectively manage emergency conditions in the plant. Validation addresses:

- The operational usability and effectiveness of the current instructions.
- Instruction compatibility with expected plant responses.
- Instruction compatibility with hardware and the physical control room configuration.
- Instruction compatibility with the minimum shift crew.

Validation is a dynamic process and not a reference documentation based process.

The validation process has four basic steps:

- Practice the walk-through
- Discuss details and phasing of the walk-through.
- Perform the walk-through.
- Review the results.

Validation team members perform these four basic steps in sequence. Additional observers from the Operations Procedure Section, Westinghouse, Essex, and the DCRDR team may also be present and participate.

Throughout the first three steps, individual observers record their observations. During the review step, validation team members (observers and performing operators) compile and discuss their observations and identify man/machine and emergency instruction questions, concerns, and problems. These are documented for use and review.

All documentation is then collected, checked for general quality, copied for distribution, and then filed. Additional details for this process are documented in the CRDR project file.

5.1.3 Assessment

The assessment phase of DCRDR is generally described in section 8.0 of the program plan. Below is a detailed discussion of how each HEC will be assessed.

5.1.3.1 Phases of the Assessment Process

There are five major phases of the DCRDR assessment effort. These are briefly discussed below and in detail in section 5.1.3.3.

Phase I - Grouping of Concerns

In the first phase, the HECs found in the earlier survey and task analysis efforts are grouped into identifiable areas (panel, system, etc.). This allows easier review by the DCRDR team.

Phase II - HEC to HED

The second phase is the review by the DCRDR team of each HEC to determine its validity. Since HECs can be generated from multiple sources (e.g., operators, DCRDR team member, and support personnel), this step is simply to verify that the HEC is a valid departure from human factors guidelines or criteria.

This verifies that: (1) the concern which may have come from the SQN simulator is in fact valid for the plant, (2) the item is within the DCRDR scope of activity. This verification of the HEC enables the concern to become a HED. The team may decide to handle HECs such as maintenance-related issues without further evaluation if the item is corrected.

Phase III - HED Categorization

The third phase is the establishment of a priority for correction of the HED.

Phase IV - HED Corrective Action

The fourth phase is the determination of the preferred corrective action for each HED recommended for correction.

Phase V - Proposed Corrective Action Review

The fifth part is verification and validation of each modification proposed as a result of a HED. Proposed modifications are made on mockups as appropriate and evaluated with procedures (e.g., emergency operating instructions, system operating instructions) to determine their overall effectiveness. Experienced operators are used to evaluate proposed modifications or alternative approaches. Established human factor guidelines are also used to review proposed modifications.

5.1.3.2 DCRDR Work Sessions

Five of the core DCRDR members (or alternates who are familiar with the subjects being discussed) must be present to have a quorum. The five must include the reactor operator and the human factor specialist. The core team members are discussed in section 5.1 of the program plan. If a vote is taken or if an absent team member does not agree with actions taken, this disagreement must be documented within 10 working days to the team leader. This applies to all team working sessions where a voting process is used.

The DCRDR meetings will be called by the team leader.

5.1.3.3 DCRDR Assessment Work Session Procedure

Phase I - Grouping of Concerns

The first phase is partially done as the HECs are written. The HECs from the same checklist are already grouped together, and the HEC number generally implies the panel unless the HEC applies to more than one panel. The HECs from task analysis can be grouped together.

The CRDR team members are requested to review all HECs. HECs can be grouped in specific areas (e.g., labeling, grouping/ demarcation) for presentation and team review. This effort may result in many identical or closely related HECs being combined into one HED. This allows the HEC to be addressed by the team in an orderly manner. These assignments are made by the DCRDR team leader or designated team members. Majority team approval is required for combining HECs.

Phase II - HEC to HED

The HECs being assessed are first evaluated as to validity. If a HEC is a valid departure from human factors guidelines or criteria and within the scope of the DCRDR effort, it is either upgraded into a HED or incorporated into a HED with other related HEC(s).

The following are criteria for determination of HEC to HED status (except as noted above:

1. The HEC must be related to the operation of the control panels in the main or auxiliary control rooms or transfer to the auxiliary control room.

2. The HEC must apply to the plant (i.e., not the simulator or mockup).

HEC(s) that are not incorporated into an HED are retained with justification for the team decision.

Phase III - HED Categorization

This phase involves the completion of the assessment worksheet by the team. The worksheet is designed to provide a documented method of determining each HED(s) potential for causing or contributing to operating crew error and the consequence of such error on plant safety and operation. See Figure 7 for a logic diagram of the process.

The HED assessment rates the HED with a priority. The higher the priority, the greater the potential impact of the HED on plant operations.

If other HEDs related to the HED being assessed may impact it in such a manner to make the HED more likely to occur, then it should be so noted on the HED.

Detail Discussion of Worksheet (Figures 6 and 7)

1. The worksheet first rates the HED for its likelihood for causing an error. The various points on the scale are defined in Table 1. HED(s) that the majority of the team assigns to CAT-4 are not evaluated further for category.

2. The next item for the team to rate is the result of an error if the error is uncorrected. Table 1 gives the definition of the various scale divisions. HED(s) that the majority of the team assigns to CAT-3 are not evaluated further for category.

3. The third step is the effect the error may have on the plant critical safety functions. These functions are defined to be those necessary to perform the EOPs. The scale mark definition is provided in Table 1.

For steps 1 through 3 above, the initials of the individual team member are placed on the scale corresponding to the member's assessment.

4. The worksheet will contain the rating on each scale from each team member. The decision as to what overall category the HED falls into is by a majority of the team members's rating. Each team member will verify the correctness when signoff is made on each HED. See Table 2 for overall category definitions.

5. The team then reviews each HED to determine the potential impact on safety. In general terms, these are those discrepancies affecting operator performance where the consequences of operator error could reduce the margin of plant safety below an acceptable level. More specifically, these would be discrepancies that could lead to violations of Technical Specification Safety Limits, Operating Limits, or Limiting Conditions for Operations.

6. The team leader adds to the remarks section aspects of the team discussion he deems appropriate for future reference and information.

The team may also decide to not rate selected HEDs. This may be done by the team if the specific or cumulative error associated with the HECs involved could not be assessed by the established methods. The not rated HEDs within the scope of the DCRDR will be considered high priority issues for correction. They will be addressed in the other DCRDR phases below.

Not rating may also be used for selected HEDs that could be considered outside the scope of the CRDR process.

When a CRDR team member signs the assessment worksheet, it indicates concurrence of the assessment done in steps 1 through 5.

If any team member does not agree, he so notes with a brief (1- or 2-sentence) reason on the HED assessment form. This may be followed by the team member preparing a further detailed written explanation within 10 days to the team leader. This explanation documents the details of the team member's differing professional opinion and its basis. This is attached to the HED assessment worksheet.

Phase IV - HED Corrective Action

This phase is accomplished through assignments made to team members and support personnel by the team leader. Some HEDs may be corrected by procedure revision or by cosmetic surface enhancement, such as changing labels or adding demarcation lines or mimic lines, etc. Correction of other HEDs may require more extensive measures. If it is determined that the correction must involve movement, modification, or addition/deletion of controls and displays, then these corrections are evaluated with other alternatives and with consideration of how the correction(s) will impact the existing control room (consistency and compatibility), correction of other HEDs, plant availability, operator training and performance, and procedures. In some cases, training may be the recommended technique to resolve HEDs.

The resulting recommended corrective action is reviewed by the entire team for agreement. Documentation of differing opinion is used if appropriate.

Phase V - Proposed Corrective Action Review

After completing the corrective action recommendation the team uses a mockup to review the changes recommended. The focus of this review determines if corrective action solved the original concern and considers the possibility of other HECs being created.

The team requests that plant operators review the corrective actions recommended. These operators should not have been involved in previous DCRDR work except for questionnaires and interviews. Operator comments are utilized to finalize the recommended corrective action. Any changes are reviewed and approved by the team.

5.1.4 Action Plan Preparation

The DCRDR team will prepare HED corrective action plans (HEDCAP) for submittal to the site management. The contents of these plans are described in section 9.4 of the program plan.

5.1.5 Plant Management Review and Approval

Performance of this activity is the responsibility of the site management.

5.1.6 Summary Report

The project manager with team assistance will prepare a summary report as described in section 10.0 of the program plan.

5.2 Interfaces and Integration with DCRDR

It is recognized that the DCRDR effort both in terms of review and the resultant implementation (controlled under other programs) needs to be integrated with several ongoing and future projects and programs. This is further specified in NRC guidance documents.

Clarification of these interfaces and integration of information across them is to be maximized during team activities.

5.3 History, Commitments, and Tracking

There has been a lengthy, complex, and detailed effort to incorporate human factor considerations into the Watts Bar control room. This history (and docketed and undocketed commitments) will be compiled and integrated. The impact of these historical issues on the DCRDR (and vice versa) will be documented and retained.

5.4 DOCUMENTATION

The documents prepared during assessment will be maintained at WBN. These documents shall be maintained, as a minimum, through the NRC audit of the DCRDR process. Following the NRC audit, a decision will be made regarding the retention requirements associated with these documents.

The documents associated with the DCRDR should be filled out in sufficient detail to assure adequate information is provided.

The following documents will be maintained in the DCRDR files:

- Program plan and revisions
- DCRDR team meeting log
- Operator questionnaire and summary
- Operator interviews and summary
- All HEC's
- Main control room checklists
- Task analysis, verification, validation documentation and methodology
- Assessment
    - All HED's
    - Assessment worksheets

- Corrective Action Plans
- Summary report
- Team member resumes
- Additional analysis
- Photographs of all panels
- DCRDR team member training
- Calibration records on instruments
    - Sound meters
    - Photometers
- Surveys
    - Sound/noise survey
    - Lighting survey

NOTE: Figures 1 through 5 have been moved to Attachment A.

FIGURE 6
WATTS BAR NUCLEAR
DETAILED CONTROL ROOM DESIGN REVIEW

HED NO. ____________

CAT: ____________

HED CATEGORIZATION RECORD

SAFETY (Y/N) ________

LIKELIHOOD THAT HED WILL CAUSE ERROR						
CAT 4		CAT 1, 2, or 3				
DEFINITELY NOT	VERY UNLIKELY	PROBABLY NOT	MAYBE	PROBABLY	VERY LIKELY	DEFINITELY

RESULT OF ERROR (IF UNCORRECTED)						
CAT 3			CAT 1, 2, or 3			
NO EFFECT	REQUIRES ADDITIONAL STEPS	REDUCTION IN OPER PERFORMANCE	LOSS OF COMPONENT FUNCTION	LOSS OF SYSTEM FUNCTION	EXTENDED LOSS OF SYSTEM FUNCTION	EXTENDED LOSS OF PLANT FUNCTION

EFFECT ON MAINTENANCE AND/OR RESTORATION OF A CSF						
CAT 3		CAT 2		CAT 1		
NO EFFECT	POTENTIAL REDUCTION TO CSF MAINT RESOURCE	REDUCED CSF MAINT RESOURCE CAPABILITY	LOSS OF CSF MAINTENANCE RESOURCE	CHALLENGE TO A CSF	LOSS OF CSF	PREVENT RESTORATION

REMARKS/JUSTIFICATION: ______________________________________

____

____

____

____

____

TEAM MEMBER	TEAM MEMBER SIGNATURE	CONCURRENCE		DATE
CRDR Leader		YES	NO	
Human Factor Spec		YES	NO	
Reactor Operator		YES	NO	
Instrument Engineer		YES	NO	
Nuclear Engineer		YES	NO	
Other		YES	NO	
Other		YES	NO	
Other		YES	NO	

TABLE 1
(Page 1 of 4)

1. Likelihood that HED will Cause Error

Definitely Not - HED cannot cause operator error under any operational condition.

Example: Loss of a redundant indicating light bulb.

Very Unlikely - The operational conditions under which this HED could result in an error requires simultaneous occurrences of multiple low probability events.

Example: The letter size for a red indicator light for a back panel is below minimum. All other board or equipment indications of a trip have failed and the operator goes to the back board and is unable to associate the illuminated red light with the resultant equipment trip.

Probably Not - The HED will cause an error only if operations requirements are changed.

Example: The functional tag letter size is marginal and violates checklist guideline, but the label is satisfactory due to present viewing distance.

Maybe - Insufficient information available to evaluate the likelihood that the HED will cause an error.

Example: All curved face vertical scale indicators reflect control room light.

Probably - The HED directly affects at least one aspect of system operation.

Example: The flow indicator associated with a controller is located some distance from the controller and with a group of similar indicators.

TABLE 1
(Page 2 of 4)

Very Likely - The HED directly affects the main purpose of the system's operation.

Example: A reactor coolant pump has an incorrect misleading label.

Definitely - The HED will result in an operator error under any operating situation.

Example: Valve switch position markings disagreeing with valve position, i.e., open - closed.

2. Results of Error (if Uncorrected)

No Effect - The error has no effect on any plant system.

Example: Operator depresses stop pushbutton for equipment already idle.

Requires Additional Steps - The error requires the operator to perform additional steps to bring about the desired result. No harmful effects are caused.

Examples: Failure to clear interlocks results in additional hand switch actuation to energize system.

Reduction in Operational Performance - The error reduces the range of operating capability of a plant system.

Example: Failure to close recirculation line after opening pump discharge.

Loss of Component Function - The error results in a component of a plant system being incapable of performing its function.

Example: Loss of one of the three condensate pumps.

TABLE 1
(Page 3 of 4)

Brief Loss of System Function - The error renders a plant system incapable of performing its function for a brief period of time.

Examples: Inadvertent isolation of the makeup water system.

Extended Loss of System Function - The error renders a plant system incapable of performing its function for an extended period of time.

Example: Opening disconnect switch prior to opening main power breaker which may result in damage to the disconnect.

Extended Loss of Plant Function - The error precludes timely plant startup.

Examples: Turbine bearing is destroyed.

3. Effect on the Critical Safety Functions (CSF)†

No Effect - Maintenance and/or Restoration of a CSF is unaffected by error.

Example: Loss of a turbine oil pump.

Potential Reduction to CSF Maintenance Resource - The error would result in the reduction of a CSF maintenance resource only in conjunction with other failures.

Example: The loss of a RHR room cooler.

Reduced CSF Maintenance Resource Capability - The error will result in a reduction in CSF maintenance resource capability.

Example: The loss of one ERCW pump in a train.

TABLE 1
(Page 4 of 4)

Loss of CSF Maintenance Resource - The error results in a reduction to the minimum resources for maintaining a CSF.

Example: Loss of one train of RHR.

Challenge to a CSF - The error results in a challenge to a CSF.

Example - Loss of both trains of RHR.

Loss of CSF - The error results in a loss of a CSF with a chance for immediate recovery.

Example: The auxiliary feedwater system is not presently available.

Prevents Restoration - The error results in the loss of a CSF and will preclude restoring the function within the time allowed.

Example: The long term loss of the auxiliary feedwater system.

† CSF is the function on which the symptom oriented EOIs (or as applicble function restoration guidelines) are developed to maintain. The HEDs that are related to controls and displays used to perform the EOIs or in a system needed to support or maintain a CSF.

TABLE 2

HED CATEGORY DEFINITIONS

1. Category I

Errors resulting from HEDs in this category directly challenge or cause a loss of a CSF.

2. Category II

Errors resulting from HEDs in this category reduce or cause the loss of resource(s) needed to maintain a CSF.

3. Category III

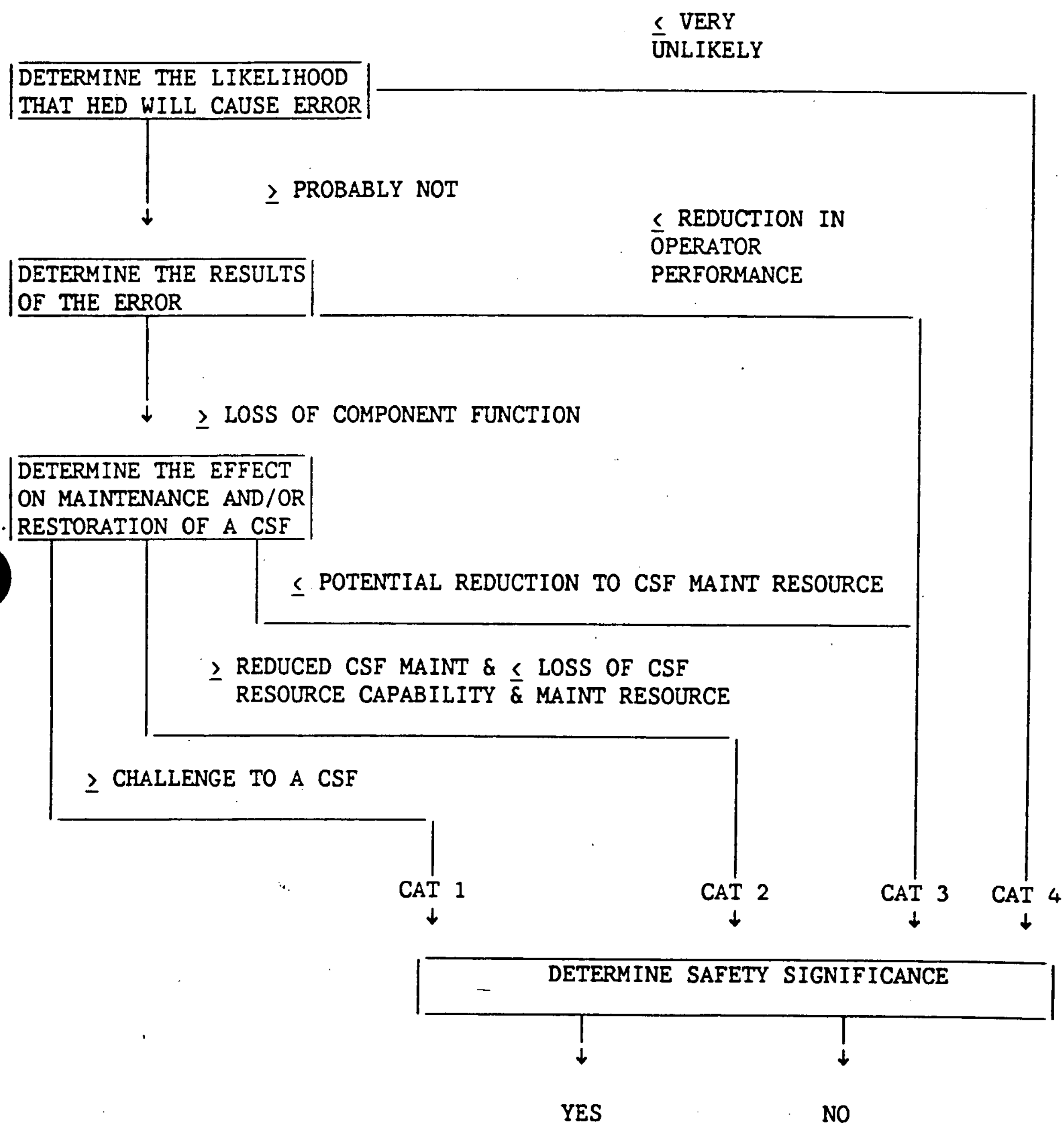
Errors resulting from HEDs in this category adversely affect normal operation or have the potential to affect CSF resource(s).

4. Category IV

Errors resulting from HEDs in this category have no significant effect on plant operations.

NOTE: The team may also decide to not rate (NR) selected HEDs. This is done by the team if the specific or cumulative error associated with the HECs involved could not be assessed by established methods. (See Section 5.1.3.3.) This rating may also be used for selected HEDs that could be considered outside the scope of the CRDR process.

FIGURE 7
LOGIC PROCESS FOR ASSESSMENT



Also see NOTE on TABLE 2 concerning NR status.

The following contains the original guidance provided to implement the program plan guidance. This task analysis activity was stopped prior to the walk-through activity described in this attachment. See section 5.1.2 for actual task analysis methods used.

Worksheets

There are two worksheets associated with this effort: an EOP worksheet and a CRD worksheet.

EOP WORKSHEET

The EOP worksheet is filled out by an engineer or operator familiar with both the emergency procedures and the transient and accident analyses performed on Watts Bar. If the person filling out these sheets was not actively involved in writing the emergency procedures, then review by the procedure writers should be performed.

The EOP worksheets are completed using the latest revision or draft (for unissued procedure) available at the time. The sheets should be revised as necessary to bring them up to date with the current revision at the time of the "walk-through"/"talk-throughs."

Figure 1 is a blank copy of the EOP sheet.

- o The "task" column lists the tasks as described in the procedure. A separate page should be used for each procedural step. The sheets should be filled out as if no expected responses are obtained (except do not transfer to another procedure).

- o The "parameter/control necessary to perform the task" column lists all the indications and controls necessary to successfully perform the corresponding task.

- o The "parameter/control attributes necessary to perform task" column lists the attributes (i.e., range, accuracy of indicators, on-off, open-closed, throttling abilities of controls, etc.) necessary to perform the associated task.

Watts Bar emergency procedures are based on the Westinghouse owners group emergency response guidelines (WOG/ERG). As such,the guidelines, background, and executive volumes should be used to help identify instrumentation and controls needs. In those cases where plant specific actions/steps are utilized, a knowledge of the system/components being used and their required characteristics and responses based on upset and accident conditions is needed. FSAR chapter 15 accident analysis, any plant specific best estimate analysis, and other documents, such as the WOG training programs on loss of reactor or secondary coolant and steam generator tube rupture are used.

Due to the complexity of the question of instrumentation accuracy/precision, a detailed discussion is warranted.

- o An accuracy is not listed if this action is duplicated by an automatic function or if the operator is simply verifying a design function is taking place. For those parameters that have a required accuracy listed, a check of design documents is made to ensure the installed indicator is acceptable.

- o Precision refers to the resolution to which displays must be read in order for the operating crew to obtain required information.

The term "precision" should not be confused with "accuracy." Precision involves only those display characteristics that affect readability, such as scale divisions, display size, pointer design, etc. Accuracy involves the electrical, mechanical, and hydraulic aspects of an instrument loop that limit the certainty that a measured parameter value is the "true" value.

If a procedural task requires the operator to take some action when the pressurizer level reaches 50 percent, then the pressurizer level should be displayed on an instrument that is capable of being read to that value. If the procedure calls for the operator to maintain total feed flow of greater than 377 gpm, then the display should be readable to a precision of 1 gpm. A common situation where precision is important is when two values must be compared and some action taken when they differ by more than some value.

Finally, it should be emphasized that the EOP sheets are filled out based on what is necessary to perform a task. No consideration should be given as to what is actually in the MCR.

CRD WORKSHEET

The second sheets are the CRD worksheets. These sheets are used to identify the actual instrumentation and controls used to perform each task in the emergency procedures. Figure 2 is a blank copy of the CRD worksheet. The program plan section 6.6 provides a detailed discussion of how to fill this sheet out. It should be noted that when post accident monitoring (PAM-RG1.97 Cat 1) instrumentation is available to monitor a required parameter, it is listed as either the primary or alternate indication (whichever is appropriate). As on the EOP worksheets, the CRD worksheets should be filled out as if no expected responses are obtained.

The CRD worksheet is filled out by plant personnel familiar with the MCR boards and the actual instruments/controls used by the operators during emergencies.

The emergency procedures occasionally reference other plant procedures, such as SOIs and AOIs. During this subsequent walk-through/talk-through phase, reference procedures are to be addressed and documented on the form shown in Figure 3 as follows:

- o The referenced procedure is briefly discussed as to the purpose.
- o The procedure is reviewed by a licensed operator who notes problems or difficulties.
- o Critical timing or potential misoperations are noted.
- o A HEC is written on any concern.

There will not be a checklist survey of the local panels used in the referenced procedure, but the person doing the review will be briefed on basic human factor principles and HECs will be written on clear violations of HFE principles.

The third part of task analysis is an actual walk-through/talk-through of the emergency procedures. A licensed unit operator walks through each procedure utilizing the MCR boards or the Watts Bar MCR mockup. This process is described more fully in the program plan.

FIGURE 1

EMERGENCY OPERATING PROCEDURE
TASK ANALYSIS WORKSHEET

Page ____ of ____

Plant ______________________

Emergency Instruction ______________________ Number ______________________ Rev No______________________

Task	Parameter/Control Necessary to Perform Task	Parameter/Control Attribute Necessary to Perform Task

______________________ Prepared By: ______________________ Date

______________________ Operations Review ______________________ Date

FIGURE 2

CONTROL ROOM DESIGN
TASK ANALYSIS WORKSHEET

Plant ____________________

Emergency Operating Instruction ______________________________ Number __________ Rev. No. ________

Step Title ___________________________ Step No. ________ AER _____ RNO _____

Step Objective ____

ub-tep	Subject			Immediate Object of Action Available to Perform Task		Remote Object of Action		Alternate Control and Displays Available	Assistance or Communication Required	Comments	HEC Identified
	Who	Location	Behavior Verb	Name/Desc/ID No./Location	*	Component - System State	Parameter State				

*Does control/display meet the Human Factors criteria for the identified attributes ( ).

____
Prepared By:

FIGURE 3

Referenced Procedure ____________ Rev No. ______

Title: ____

____

____

What does the procedure do? ____

____

____

____

Panel performed __________ __________ __________ __________

Any time restraints? ____

____

____

Walk-through By ______________________ Date ____________

Concerns found: ____

____

____

____

____

____

____

HECs written ______________ ______________

Use additional sheets if necessary.

ACTION-INFORMATION REQUIREMENTS DETAIL (AIRD)
(SORT BY EI)

PAGE 13

NT: WBN | UNITS: 1 & 2 | ORIGINATOR: R. KAYE | DATE: 04/11/86
ESSEX REVIEWER: DALE PILSITZ | DATE: ________
TVA REVIEWER: ____________________ | DATE: ________

E-0 ERG NO: E-0
..EP: OBP ERG STEP: 16
OBJECTIVE: ENSURE AFW STATUS

OBJECTIVE: VERIFY AFW FLOW - GREATER THAN 470 GPM

BEHAVIORAL ELEMENTS

VERB	SYS	COMPONENT	PARAM	DIRECTION	STATE/ VALUE	UNITS/ RATE	PREC	RNG/ R.T.	TREND PSV REQ	COMMENTS
OBS	AFW	AFW	FLOW	>	470	GPM	10	460-480	N	TOTAL AFW FLOW.
STA		AFW PP	POS	N/A	START	N/A	N/A	N/A	N	NONE
OBS	AFW	AFW PP	STATUS	N/A	RUNNING	RPM PSIG GPM	100 100 20	0-6000 0-3000 0-940	N	TURBINE SPEED**PP DISCHARGE PRESS**PP RUNNING LIGHT, SYS FLOW, THROTTLE & TRIP VLV POS
.N	AFW	AFW VLVS	POS	N/A	OPEN	N/A	N/A	15 SEC	N	HS-3-164A, 156A, 148A, 171A
OBS	AFW	AFW VLVS	POS	N/A	OPEN	N/A	N/A	N/A	N	IMPLICIT VERIFY*VLV POS STATUS IND
OBS	AFW	AFW	FLOW	>	470	GPM	10	460-480	N	TOTAL AFW FLOW.

ACTION-INFORMATION REQUIREMENTS SUMMARY (AIRS)
(SORT BY EI)

: TVA - WATTS BAR

6K

SORT BLOCK	
REQS TYPE:	ACT
SYSTEM:	SGBD15
COMPONENT:	S/G BLWDN ISO VLVS
PARAMETER:	POS

SUMMARY OF REQUIREMENTS BLOCK
VALUE/RANGE:
UNITS:
PRECISION:
RESPONSE TIME:
TYPE:

VERIFICATION SUMMARY BLOCK

I.D. NO	PANEL	PASS	FAIL	ACTUAL RANGE	ACTUAL PRECISION	HED NO.
1-HS-1-9/181	1-M-3	✓		CLOSE/A-P AUTO/OPEN		---
1-HS-1-14/182	1-M-3	✓				
1-HS-1-25/183	1-M-3	✓				
1-HS-1-32/184	1-M-3	✓				

INDIVIDUAL DETAILS

EI	STEP	ACT	VERB	DIRECTION	STATE/ VALUE	UNITS/ RATE	RNG/ R.T.	PREC	TREND REQ	CMT
E-0	07	WOG*	CLOSE	N/A	CLOSED	N/A	15 SEC	N/A	N	Y
E-0	08P	D	CLOSE	N/A	CLOSED	N/A	15 SEC	N/A	N	Y
E-2	02P	E	CLOSE	N/A	CLOSE	N/A	15 SEC	N/A	N	Y
E-3	03	WOG*	CLOSE	N/A	CLOSE	N/A	15 SEC	N/A	N	N

APPENDIX E

WATTS BAR NUCLEAR PLANT

Resumes of DCRDR Personnel

Jerome J. Erpenbach, Jr.
Manager of Projects
Watts Bar Nuclear Plant
TVA

EXPERIENCE HISTORY

08/86 - Present	Manager of Projects, Site Director's Staff, Watts Bar Nuclear Plant (WBN) Provide project management for projects and programs assigned by the Site Director. Supervise managers coordinating projects such as RVLIS upgrade, Control Room Design Review, RTD Bypass Removal, Site Simulator, Core Barrel Upflow Modification, UHI Removal, Emergency Preparedness, Q-List, and Reg. Guide 1.97 upgrade.
01/86 - Present	Project Manager, Control Room Design Review, Site Director's Staff, WBN Assembled team and re-established a systematic and integrated process to evaluate human engineering of the control room.
08/85 - 01/86	Project Manager, Support Services, WBN Coordinated major evaluation and response preparation activities for INPO and Construction appraisal team reviews. Coordinated and managed teams performing pre-evaluation using INPO criteria. Coordinated initial site-required implementation of the Corporate Commitment Tracking System.
01/83 - 08/85	Quality Analyst, Quality Improvement Branch, Division of Quality Assurance, Knoxville, Tennessee Applied a wide variety of performance analysis and improvement concepts to projects such as: BLN Hanger Improvement, BFN RPIP Analysis of Deviations, BLN Deviation Root Cause Analysis, Cable Bend and Instrument Tubing Quality Problems, Plan for BFN Procedure Overhaul, Improvement and Performance Measurement Programs for Power and Engineering. Coordinated operational readiness reviews. Prepared management review guides for quality surveillance of the compliance area. Developed detailed quality and performance checklists for review of startup testing program activities.

01/81 - 12/82 **Assistant Engineering Supervisor**, Engineering Section, WBN

Served 7 months as Acting Supervisor for 65 employees. Coordinated activities of chemical, mechanical, and reactor personnel.

Took the lead in projects such as budget, and work item tracking systems.

08/77 - 12/80 **Reactor Unit Supervisor**, Engineering Section, WBN

Initially staffed and supervised the Reactor Engineering Unit.

Coordinated, supervised, or performed WBN ONP site compliance activities before establishment of separate Compliance Section. Prepared and coordinated revisions and responses for FSAR. Coordinated and effectively tracked development of technical specifications, including environmental specifications. Other compliance duties included handling: NRC inspection reports, nuclear and non-nuclear experience review, post-TMI review, NUREG implementation, REP preparation, and review of bulletins, circulars, and notices.

At WBN, coordinated all site activities for units 1 and 2 fuel receipt, inspection, and storage. Areas of experience included preparation of SNM license, development and implementation of SNM accountability program, fuel handling, and storage equipment.

Participated in initial installation of the PRIME computer at WBN. Developed or participated in the development of several useful applications including: Action Item List, Open Item Status List, Commitment Tracking, Deviation Tracking, and tracking of technical specifications development problems and solutions.

Developed or supervised development of startup, ASME Section XI, and portions of the surveillance test programs at WBN.

08/76 - 08/77
02/75 - 08/75 **Preoperational Test Engineer**, Preop Test Section, Sequoyah Nuclear Plant (SQN)

Prepared initial detailed draft of safety injection (CVCS, SIS, RHR) preop tests.

08/75 - 08/76 **Retest Coordinator** (Fire Recovery), Browns Ferry Nuclear Plant (BFN)

08/75 - 08/76 (continued)

Coordinated the test activities and schedules of 30 engineers during the BFN fire recovery program.

01/73 - 02/75 Nuclear Engineer, ONP, Chattanooga and BFN

Coordinated and implemented core performance objectives defined by fuel warranty and technical specifications during initial startup and full power operation at BFN units 1 and 2. Served as cognizant engineer for BFN unit 2 fuel receipt and inspection; experienced in BWR SNM accountability and fuel handling facilities. Served as both a preop and startup test engineer at BFN during initial startup of units 1 and 2.

EDUCATION

Bachelor of Science, Mechanical Engineering (cooperative Plan), Georgia Institute of Technology, 1971

Master of Science, Nuclear Engineering, Georgia Institute of Technology, 1972

ADDITIONAL TRAINING

Westinghouse 12-week Station Nuclear Engineering Training

Participated in and completed the majority of PWR STA training. Included were system training and walk-downs at WBN and 3-week simulator operations and 4-week Transient and Accident Analysis.

Completed training in Fire Brigade, Leadership, Health Physics, Health and Safety, Fuel Receipt and Inspection, Management Development, PRIME computer, Nuclear Engineering, INCORE, and portion of Operator Onsite Lecture Program.

Other training in management skills, reliability engineering, project management, statistics, human factors, communication, and public speaking.

PROFESSIONAL LICENSES/AFFILIATIONS

Registered Professional Nuclear Engineer, Tennessee

Member of: American Nuclear Society
American Society of Mechanical Engineers
National Management Association
American Society of Quality Control
Human Factors Society
Project Management Institute

James Royce Maner
Senior I & C Engineer
Division of Nuclear Power
TVA

EXPERIENCE HISTORY

1977 - 1986 Senior Instrumentation and Controls Engineer, Tennessee Valley Authority, Division of Nuclear Power, Chattanooga, Tennessee

Analyzed power plant instrument and control systems to enhance performance; resolve operating problems; and improve safety, reliability, and maintainability.

Co-leader of TVA's Human Factors Control Room Design Review team. Supervised installation of upgraded instrumentation system at Browns Ferry Nuclear Plant. Directed the work activities of an engineering unit comprised of up to nine engineers. Established project priorities, developed schedules, allocated manpower, monitored progress, and reviewed technical aspects of work performed.

1973 - 1977 Electrical Engineer, Tennessee Valley Authority, Division of Construction, Sequoyah Nuclear Plant, Daisy, Tennessee.

Supervised the installation, checkout, and startup of various electrical equipment including high, medium, and low voltage switchgear, motors, transformers, and associated equipment. Also, supervised the installation and startup of data acquisition systems and uninterruptible power supplies. Developed a detailed knowledge of power equipment, control systems, and related instrumentation equipment. Supervised the work of several engineers and technicians.

1970 - 1972 Cooperative Electrical Engineer, Tennessee Valley Authority, Division of COnstruction, Cumberland City Steam Plant.

Supervised the installation, checkout, and startup of various electrical equipment including motors, transformers, and switchgear.

EDUCATION

Bachelor of Science, Electrical Engineering, University of Alabama, 1973.

ADDITIONAL TRAINING

Attended a 12-week Westinghouse Electric Corporation Instrument and Control Engineers Training Course, 1978.

ADDITIONAL TRAINING (continued)

Attended a 1-week course on PWR reactor operation at TVA's Power Operations Training Center, 1984.

PROFESSIONAL LICENSES/AFFILIATIONS

Registered Professional Engineer in the State of Tennessee
Member of the Institute of Electrical and Electronics Engineers
Senior Member of the Instrument Society of America
Past President of the Chattanooga Section of the Instrument Society of America

James A. Martin
Technical Supervisor
I & C Man-Machine Interface Section
Electrical Engineering Branch
TVA

EXPERIENCE HISTORY

02/79 - Present — Technical Supervisor, TVA, Instrument and Controls Man-Machine Interface Section, Electrical Engineering Branch, Knoxville, Tennessee

Team leader for the control room design reviews for TVA's nuclear plants, both PWRs and BWRs. Presently a co-team leader for the Watts Bar and Sequoyah Nuclear Power Plants.

Responsible for the development of detail conceptual designs of control station layouts for both nuclear and fossil power plants.

Responsible for the integration and development of computer graphics.

05/74 - 02/79 — Technical Supervisor, TVA, Instrument and Controls, BWR Units, Knoxville, Tennessee

Responsible for the design, development, and review of instrumentation and control systems.

Responsible for the conceptual design of the control systems used in TVA's BWR 6 units including the design of systems using programmable controllers.

08/67 - 05/74 — Group Leader, Bendix Corporation, Analog and Digital Control Section, Kansas City, Missouri

Responsible for the design, evaluation, and drawing definition for production of complex radar control systems used on the nuclear weapons program. This included safety and reliability studies of the systems and production of computerized schedules.

08/66 - 07/67 — Systems Engineer, IBM, Huntsville, Alabama.

Responsible for the redesign of logic and control circuits in the Saturn V Instrument Unit.

09/65 - 08/66 — Systems Engineer, General Electric Company, Huntsville, Alabama

Responsible for design and checkout of interfaces between the Saturn Vehicle and the system computer.

EDUCATION

Bachelor of Science, Electrical Engineering, Tennessee Technological University, Cookeville, Tennessee, 1965

Master of Science, Electrical Engineering, University of Missouri, Columbia, Missouri, 1970

ADDITIONAL TRAINING

Battery Application and Sizing Seminar given by Excide, 1975.

ISA Sponsored 30-week course on Instrumentation Fundamentals, 1975.

Two-week BWR course on Reactor Operation and Principles given at TVA's Power Operations Training Center, 1977.

One-week Human Factors Course given by General Physics Corporation, Columbia, Maryland, 1980.

One-week EPRI workshop on Human Factors, Atlanta, Georgia, 1980.

One-week Computer Graphics Course at George Washington University, Washington, D.C., 1981

One-week PWR course on reactor operation at TVA's Power Operations Training Center, 1984.

PROFESSIONAL AFFILIATIONS

TVA representative to the Boiling Water Reactor Owners Group which is responsible for review of control rooms and development of Safety Parameter Display Systems.

TVA representative to the Institute of Electrical and Electronics Engineers Working Group on "Alarm Monitoring and Reporting Systems (676)."

TVA representative to the Institute of Electrical and Electronics Engineers Working Group on "Guide to Evaluation of Man-Machine Performance in Nuclear Power Generating Station Control Rooms and Other Peripheries."

Member of the Instrument Society America Working Group on Response Time Testing (ISA 67/06).

Member of the IEEE and ISA.

Member of Nuclear Utility Active Committee on Safety Parimeter Display System and Control Room Design Review.

James F. Brooks
CRDR Implementation Manager
Sequoyah Nuclear Plant
TVA

Experience History

Recently assigned to Sequoyah Nuclear Plant as CRDR Implementation Manager.

Served as team leader for the Watts Bar CRDR.

Experience in human factors as co-team leader for Browns Ferry Nuclear Plant Control Room Design Review. Performed checklist survey for annunciator system during Sequoyah Nuclear Plant Control Room Design Review.

Extensive field support at Sequoyah and Watts Bar Nuclear Plant during pre-operational testing.

Conducted special tests and investigations at Watts Bar and Sequoyah with special emphasis on response time testing. This also included the writing of response time test procedures.

Served as lead engineer for plant support activities at Bellefonte Nuclear Plant. This involved resolution of design problems related to the main control room to auxiliary control room transfer for testing purposes, and other design problems related to response time testing.

Conducted special testing at various TVA Fossil and Hydro plants for determining condition of major plant equipment.

Education:

B.S., Engineering Science, University of Tennessee at Chattanooga, 1978.

Professional Affiliations:

Engineer in Training, State of Tennessee

Guy T. Denton
Operations Supervisor (Retired)
Watts Bar Nuclear Plant
TVA

EXPERIENCE SUMMARY

Fifteen (15) years fossil power plant operation with TVA which included work in plants of 135 MWE to 550 MWE.

Eighteen (18) years nuclear plant experience with TVA which included Browns Ferry Nuclear Plant, 3-unit boiling water reactors (3311 MWT each); and the starting and testing of pressurized water reactor equipment at Watts Bar Nuclear Plant.

EXPERIENCE HISTORY

06/84 - 07/86 (ret.)	Assistant Operations Supervisor, Watts Bar Nuclear Plant (WBN)
02/80 - 05/84	Operations Supervisor, WBN
01/77 - 02/80	Assistant Operations Supervisor, WBN
07/71 - 01/77	Shift Engineer, Browns Ferry Nuclear Plant (BFN)
08/68 - 07/71	Assistant Shift Engineer, BFN
03/63 - 08/68	Assistant Shift Engineer, Widows Creek Steam Plant (WCSP)
02/57 - 03/63	Unit Operator, John Sevier Steam Plant (JSSP)
02/56 - 02/57	Assistant Unit Operator, JSSP
08/55 - 02/56	Student Operator (SGPO) Step IV, JSSP
02/54 - 08/55	SGPO, Steps I-III, WCSP
11/53 - 02/54	Material Tester II, Watts Bar Steam Plant

EDUCATION

Attended Tennessee Technological University, 1947-50

ADDITIONAL TRAINING

Small Reactor Operations, Oak Ridge National Lab, 2 weeks
Basic Nuclear Course (Electrical Training), BFN, 12 weeks
Observation Training (Basic Supervisory Training), BFN, 26 weeks
Observation Training, D. C. Cook Nuclear Plant, 4 weeks

ADDITIONAL TRAINING (continued)

Cold License Simulator (SRO), POTC, 12 weeks
Accident/Transient Analysis, POTC, 1 week
Onsite Lecture Program, WBN, 8 weeks

PROFESSIONAL LICENSE

NRC-SRO License Nos. SOP-1826, 1826-1, 1826-2
Browns Ferry Nuclear Plant - Unit 1, April to December 1973
Browns Ferry Nuclear Plant - Units 2 and 3, December 1973 to October 1976

G. ALLEN ELLIFF

EDUCATION:

Ph.D., Industrial Engineering/Operations Research, Texas A&M University, 1973
M.S., Industrial Engineering/Operations Research, Texas A&M University, 1971
B.S., Industrial Engineering, Texas A&M University, 1970

AFFILIATIONS:

American Institute of Industrial Engineers
Operations Research Society of America
Alpha Pi Mu (Industrial Engineering Honor Society)
Sigma Xi

PROFESSIONAL BRIEF:

Dr. Elliff is a Division Manager in Essex Corporation's Alexandria office. He is responsible for management, technical direction, and technical review of projects for industrial and government clients of the Industrial Services Division. Dr. Elliff's experience at Essex includes direct project management responsibility for several nuclear power plant control room design reviews and procedure development projects, control center facility layout for refinery operations, and management oversight and review of related projects for several process control industry clients. He has 13 years consulting experience with the military (Navy, Air Force, and Office of the Secretary of Defense); other federal agencies (Department of Energy, Department of Transportation); and private sector clients (utilities, motor carriers, railroads, military hardware vendors). His experience includes applied human factors analysis, maintenance management, logistic support analysis, weapon system acquisition management, life cycle cost/design to cost analysis, information system validation, business and financial management, market analysis, transportation operations analysis, mathematical modelling, reliability/maintainability analysis, production engineering, statistical quality control, and training course development and presentation. Prior to joining Essex in 1981, Dr. Elliff was associated with Evaluation Research Corporation; Peat, Marwick, Mitchell, & Co.; Logistics Management Institute; and the Texas A&M University graduate faculty. Dr. Elliff also has three years experience as a full-time graduate faculty member at Texas A&M University teaching industrial engineering and operations research courses and supervising thesis research.

EXPERIENCE:

ESSEX CORPORATION (1981 - Present)
Alexandria, Virginia

Director, Industrial Services Division - As Division Director, has line management responsibility for Essex Corporation support to utilities and other commercial clients. Supervise approximately 30 specialists in human factors, nuclear power plant operations, maintenance management, training, and related disciplines. Provide management oversight and technical direction for client projects involving human factors analysis and evaluation, operations support, procedures development, CRT display system design and analysis, facility layout, training course development, and maintenance analyses.

Support utility clients in presentations to the Nuclear Regulatory Commission on licensing issues. On behalf of utility clients, participate in selected owners' group committee meetings to develop and discuss effective strategies for integrating related activities required to comply with regulatory guidance.

Provide management review of project plan, technical scope, and resource estimates for Industrial Services Division projects. Provide technical and management support and direction to Department Managers for client projects. Provide technical review of client deliverables. Assign appropriate personnel to client projects as needed. Monitor cost and schedule status on all division projects to ensure completion of products to client satisfaction.

Project Director for development of Procedure Writer's Guide and for EOP verification and validation program plan for Waterford-3 nuclear power plant, and for human factors review of Waterford-3 plant monitoring computer. Project Director for detailed control room design review (DCRDR) for Public Service Electric and Gas Company's Hope Creek Generating Station (HCGS). The HCGS control room is one of the more advanced design nuclear power plant control rooms in the United States.

Managed detailed human factors control room design review for Texas Utilities Generating Company's Comanche Peak Steam Electric Station (CPSES) Unit 1. Evaluated control room for compliance with human engineering principles and applicable regulatory guidelines. Directed Essex human factors analysts and SROs in assessment of proposed client rearrangement of CPSES control boards. Assisted client in design and application of mimics, demarcation, and hierarchical labeling of the CPSES Unit 1 control boards.

Developed a model for predicting human reliability in nuclear power plant control room operations. For a foreign nuclear utility, developed estimates of expected improvements in operator reliability for suggested backfits to resolve 30 generic control room design problems.

Provided general management direction for major procedures development and production project for a near term operating license (NTOL) plant. The first phase of the project involved rewriting/reformatting of all emergency, abnormal, and standard operating procedures. As a result of project team performance, Essex was also awarded contract for development and production of approximately 300 surveillance/test procedures. This phase involved rewrite/reformat, technical review, and editing of procedures; technical direction of all project staff; and coordination of the production of the procedures from initial writing through final word processing. Essex project team was composed of 6 to 8 technical writers, two editors, two nuclear plant operations specialists, and 8 word processors, plus two shift supervisors from client organization.

EVALUATION RESEARCH CORPORATION (1979-1981)
Vienna, Virginia

Principal Engineer and Branch Manager, Systems Engineering and Analysis Group - Provided technical and engineering support to NAVSEA, NAVELEX, NAVAIR, and other Federal government clients. This support included integrated logistics support (ILS) analyses, systems analysis, systems engineering, cost analysis, and application of operations research techniques for ship and system acquisition programs and ILS functional offices.

Participated in development of NAVSEA Reliability and Maintainability Technical Seminar.

Performed a comparative life cycle cost (LCC) analysis of JERED and CHT marine sanitation systems for DD 963 class ships. Results were a prime input to NADEC briefing.

As a member of CAPTOR Production Readiness Review (PRR) Team, assessed the capability of prime contractor and first tier subcontractor to effectively manage full-scale production. As a result of the PRR, the contractors were required to make substantive improvements to production control procedures prior to full production release.

Developed an analytic approach and plan for trade-off and cost impact analysis of alternative aviation intermediate maintenance support strategies for the Aviation Intermediate Maintenance Improvement Project Office. Objective of this task was identification of the complement of intermediate-level maintenance equipment, spare parts, and personnel skills that would most improve mission effectiveness of the deckload of a given aircraft carrier. Analytic approach integrated existing Navy data files and models to the greatest extent practical.

Managed project to assess performance and effectiveness of defense contractor in providing supply and depot repair support on AN/SLQ-32(V). Evaluated timeliness, quality, and cost of depot repair and supply support provided by contractor. Integrated and cross-validated transaction data from numerous contractor internal data sources, including ADP reports, manual log books, and source documents. Assessed operational availability based on analysis of CASREPTS and 4790-2K forms and data.

Determined system stock and maintenance repair parts requirements to support AN/SLQ-32(V). Assisted in conducting FY 1981 provisioning conference. Prepared contract orders to implement results of provisioning conference. Attended program reviews in support of program office.

Provided technical review of Logistic Support Analysis (LSA) Program Plan for Army Stand-off Target Acquisition System (SOTAS) under contract to Motorola.

Senior Analyst and Project Manager, Planning and Sciences Group - Managed and directed numerous projects for U.S. Department of Energy clients. Senior technical analyst for quantitative analysis tasks for the Planning and Sciences Group. Directed independent validations of various DOE and industry information systems and models.

Developed scenarios for assessment of refinery industry capability to respond to various supply and demand scenarios. Analysis required familiarity with two refinery models: Bonner and Moore Refinery and Petrochemical Modeling System (RPMS) and Turner, Mason, Solomon (TMS) refinery model. RPMS and TMS models were linked to account for refinery processing capabilities, transportation network, and petroleum inventory management considerations.

Developed product prices and cost, quality, and quantity characteristics of crude slates for several refineries using DOE data in quick-reaction support for the Office of Special Counsel (OSC). Data was input to RPMS, which was used in support of OSC audit and compliance analysis.

Managed a project to validate the DOE Crude Oil Transfer Pricing System (ERA-51). Project included assessment of user requirements, respondent reporting and measurement practices, and DOE data processing procedures. Performed qualitative and quantitative analyses for data consistency and validity, both within ERA-51 and between ERA-51 and related DOE reporting systems.

Provided technical and management direction for quantitative data analyses for four data systems providing information on major industrial combustors to support enforcement of the Power Plant and Industrial Fuel Use Act. Systems analyzed included the DOE Boiler Manufacturer's Report (ERA-97), DOE 1975 Major Fuel Burning Installation Coal Conversion Report (FEA-C-602-S-0), DOE 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors (EIA-463), and EPA National Emissions Data System (NEDS).

PEAT, MARWICK, MITCHELL & CO. (1975 - 1979)
Washington, D.C.

Senior Consultant and Project Manager - Managed the development and implementation of a life cycle cost/budgetary projection model for the HARPOON cruise missile Project Office. Determined logistics resources required to support a given procurement schedule; developed and validated predictive cost estimating relationships; identified appropriation and budget sponsors for each end item and logistic resource category; and developed time-phased funding requirements by appropriation to support a particular acquisition scenario.

As a member of a management audit team, evaluated the analytic capability of the F-16 System Project Office organization. Evaluated life cycle cost/design to cost (LCC/DTC) estimation and tracking capability, configuration management, ILS planning and coordination, and the extent to which a common data base of cost and performance parameters was maintained for use in performing the various analytic tasks.

Defined and developed an integrated project/task management information system (MIS) for the Shipboard Intermediate Range Combat System Project Office. Surveyed information requirements; conducted an inventory and assessment of information sources; defined information flows; investigated information processing and display alternatives; and developed an MIS to provide key project personnel with current and projected cost/schedule status, variance analyses, financial flexibility analyses, and assessment of the probable impact of potential management decisions.

Developed and presented seminars for commercial clients on life cycle cost/design to cost, Department of Defense (DOD) acquisition policies, and DOD marketing. Served as corporate representative to the Weapon System Life Support (WSLS) group under National Security Industrial Association (NSIA) Logistics Management Committee (LOMAC).

Managed a project for the Federal Railroad Administration to perform systems engineering for intermodal freight systems. Identified, described, and analyzed the full range of improved and innovative components, subsystems, and systems. Assessed proposed innovations and improved technologies for potential to improve profitability and return on investment for rail-based intermodal freight systems.

Principal Investigator for a project to develop an improved passenger car maintenance and utilization program for the National Railroad Passenger Corporation (AMTRAK). Specific responsibilities included assessment of the effectiveness of the current AMTRAK passenger car maintenance process, identification of trade-offs between passenger car maintenance and passenger car utilization, and development of recommendations for improving both the quality of AMTRAK maintenance and utilization of its passenger car fleet.

Managed a study for the Federal Railroad Administration to assess alternative organizational structures for yards and terminals for the United States rail industry. Analyzed management control systems, measures of effectiveness, and the effect of organizational alternatives for yards and terminals on the infrastructure of the rail industry.

Managed projects for private railroads involving market, operations, and traffic analysis, and development of business strategies. For a major motor carrier, performed an analysis of terminal and line-haul operations to improve carrier profitability and operational efficiency.

LOGISTICS MANAGEMENT INSTITUTE (1974 - 1975)
Washington, D.C.

<u>Senior Research Associate</u> - For PMS 306, under joint sponsorship with the Assistant Secretary of Defense (Installations and Logistics), evaluated the capability of the Navy's intermediate-level maintenance organization to support the surface fleet in the mid-1980's. Assessed the adequacy of the Navy's maintenance data collection system (MDCS) in documenting maintenance delivered to the Fleet, conducted trade-off analyses to determine the most effective utilization of Navy resources in supporting the surface fleet, and developed specific recommendations for improvement.

Developed a management information system and the associated data base to assist planners in the Office of the Assistant Secretary of Defense (Installations and Logistics) in making policy decisions regarding avionics standardization. The system was capable of producing annual projections of the demand for avionics systems in terms of functional requirement and/or associated hardware by type/model/services of aircraft, at the equipment level, for aircraft scheduled for major modification or acquisition during the 1975-1985 timeframe. The data base could be readily updated on an annual basis, thereby enabling the system to continue providing 10 year projections.

Developed a cost element structure (CES) for life cycle cost (LCC) analysis of tracked vehicles to support a DOD project addressing the feasibility of a standardized LCC CES for various types of DOD systems.

TEXAS A&M UNIVERSITY (1972 - 1974)
College Station, Texas

Assistant Professor of Industrial Engineering - Taught graduate courses and supervised thesis research in operations research, reliability and maintainability engineering, production engineering, manufacturing processes, production management, engineering cost estimating, production and inventory control, quality assurance, and safety engineering to graduate students in reliability and maintainability engineering programs sponsored by the Army Material Command (now DARCOM). Dissertation topic addressed economic design of a continuous sampling quality assurance plan, which has resulted in a publication and presentations.

SECURITY CLEARANCE:

SECRET, granted by DISCO (1974).

Donald W. Fletcher
Instrument Engineer
Technical Services Branch
Chattanooga, Tennessee
TVA

Experience History:

Instrument Engineer, Technical Services Branch, Division of Fossil & Hydro, Chattanooga, TN.

Instrument Engineering Specialist - Watts Bar Design Project

Lead responsibility for eight major systems. This involved the design of new subsystems, procurement of new instrumentation, review of field generated design change request, and review of Westinghouse Field Change Notices.

Communications Security Specialist - US Army Security Agency
The Presidio of San Francisco, California

Preformed classified surveys of electronic communications at western military installations.

Education

Bachelor of Science, Electrical Engineering, Georgia Institute of Technology, 1981.

Professional Organizations

Instrument Society of America (ISA)

Engineer-In-Training.

James Fletcher Gibbs
Supervisor
Simulator Services Section
Watts Bar Nuclear Plant
TVA

EXPERIENCE HISTORY

Employer: Tennessee Valley Authority (1979 - Present)

1985 - Present

Supervisor, Watts Bar Simulator Services Section, Watts Bar Nuclear Plant

Responsible for all aspects of simulator software and hardware maintenance and for ensuring compliance with ANSI/ANS 3.5-1985 and 10 CFR 55.

Continue to act as lead engineer for the Watts Bar simulator procurement team.

1983 - 1984

Lead Engineer, Watts Bar simulator procurement team

Co-authored simulator specification, evaluated bids, made award recommendations, answered bid protests, provided contract administration support for technical issues, directed all technical correspondence with simulator vendor.

1981 - 1983

Software System Specialist, Bellefonte Simulation Unit

Responsible for the technical accuracy of software modifications made to the Bellefonte simulator, proper operation and maintenance of the simulation computer operating system, and development of software tools to support a software configuration management system.

Also, acted as technical advisor to the (now defunct) Clinch River Breeder Reactor simulator project team.

1979 - 1981

Software Engineer, Sequoyah Simulation Unit

Implemented assigned software design changes and worked assigned problem reports.

Designed a system to allow on-line interactive source code modifications to simulator software in lieu of using card key-punches.

Designed software to allow continued simulator operation from magnetic tape in the event of a disk failure.

EDUCATION

Bachelor of Nuclear Engineering, Georgia Institute of Technology, 1978
Master of Nuclear Engineering, Georgia Institute of Technology, 1979

BARBARA H. GLICKSTEIN

EDUCATION:

B.S., Psychology, Pennsylvania State University, 1984
Graduate coursework in visual perception at North Carolina State University
Graduate coursework in human factors engineering at George Mason University

AFFILIATIONS:

Psi Chi Honor Society (National Psychology Society)
Human Factors Society

PROFESSIONAL BRIEF:

Ms. Glickstein's experience in the nuclear industry has included: verification and validation of procedures, control room design review which involved performing a computer-based task analysis for the identification of human engineering discrepancies, on-site surveys, HED writing, evaluation of surveys, and report generation. She has also been involved with the evaluation of labeling and demarcation of the control room in addition to the development of standard abbreviation and acronyms list.

Outside the nuclear industry, Ms. Glickstein has participated in the evaluation and redesign of Exxon's (Baytown) Crude Distillation Control Center.

Previous work experience at the National Institutes of Health and the Pennsylvania State University has included research in the areas of visual perception and the effects of [illegible]se on performance. Ms. Glickstein holds a B.S. in psychology and is currently pursuing graduate studies in the area of human factors engineering. She is a member of the Human Factors Society and Psi Chi (Psychology National Honor Society).

EXPERIENCE:

ESSEX CORPORATION (1985 - Present)
Alexandria, Virginia

<u>Research Associate</u>. Virginia Power Company — Project manager for procedure verification and validation at the North Anna Power Station. Responsibilities include use of appropriate documents and human factors principles in the review of the Writer's Guide and emergency operating procedures, as well as the writing and review of deficiences. Also responsible for ensuring work is completed on schedule as well as writing monthly status reports.

Participated in the validation of emergency procedures at the Surry Power Station. The validation was conducted using both the simulator and table-top methods. Also involved in the writing of the summary report for the review, verification and validation of the emergency procedures.

Exxon, Baytown — Worked on a two — person team in the evaluation and redesign the Crude Distillation Control Center for the Baytown Oil Refinery. Responsibilities luded conducting on-site interviews, evaluation of the building — including size, work-space availability, and employee needs — and the development and presentation of suggested redesign. Developed knowledge of Drafix software in order to create suggested layouts using a computer.

Tennessee Valley Authority — Involved in computer-based task analysis for nuclear power plant control room design review and identification of human engineering discrepancies. Developed methodology for Emergency Instruction (EI) validation at Watts Bar Nuclear Power Plant. Conducted EI validation and identified human factors difficulties in executing EIs.

Carolina Power and Light Company — Participated in the human factors evaluation of the Shearon Harris Nuclear Power Plant, H.B. Robinson Nuclear Power Plant, and Brunswick Steam Electric Plant. Responsibilities included: conducting on-site surveys of the control room using NUREG-0700 guidelines, and operator interviews, and evaluating, labeling and demarcation. Assisted in the development of standardized abbreviations and acronyms list. Responsibilities also included evaluation of surveys, HED writing, and report preparation. Also involved in computer-based task analysis for CRDR.

NATIONAL INSTITUTES OF HEALTH (1984 - 1985)
Bethesda, Maryland

Project Manager. Responsible for ensuring the smooth flow of the research project ough the organization and handling of details. Assisted in the research study through programming and analysis of computer data using Statistical Analysis System (SAS), sting of subjects, participating in interviews, and conducting library research.

PENNSYLVANIA STATE UNIVERSITY (1983)
State College, Pennsylvania

Research Assistant. Assisted in the study of the effects of varying luminance and size on optokinetic nystagmus and induced motion. Aided in the development of a more efficient apparatus for testing. Responsibilties included the operation of a Beckman recording device and interpretation of data output as well as the preparation and testing of subjects.

PENNSYLVANIA STATE UNIVERSITY (1982 - 1983)
State College, Pennsylvania

Student Researcher. Designed own experiment for course project. Project involved testing subjects in order to study the effects of varying types of music on mathematical performance. Analyzed statistical data, interpreted results and communicated the results of the study through written reports following APA guidelines.

John Regan Hennessy
Consultant
Human Factors Engineering
Electrical Engineering Branch
TVA

EXPERIENCE HISTORY

06/84 - Present:	Human Factors Engineering Consultant to Electrical Engineering Support Branch, Division of Engineering Design, Tennessee Valley Authority, Knoxville, Tennessee
02/81 - 08/83	Contract Employee of Consultants & Designers, Inc., 355 Lexington Avenue, New York, NY Served as Human Factors Engineering Consultant to Electrical Engineering Support Branch, Division of Engineering Design, Tennessee Valley Authority, Knoxville, Tennessee.
09/79 - 05/80	Engineering Psychologist, The Excel Corp,, Reston, VA, in residence at Motorola Government Electronics Division, Tempe, AZ, on a US Army R & D system
06/78 - 01/79	Senior Staff Scientist, Kinton, Inc., Alexandria, VA Worked in a team writing functional specifications for US Air Force training devices and simulators.
07/74 - 07/76	Engineering Psychologist, Camouflage Laboratory, US Army Mobility Equipment R & D Command, Ft. Belvoir, VA Wrote plans for T & E of camouflage material under R & D. Analyzed test data and prepared reports of research studies. Served as Consultant in Experimental Psychology and Human Factors Engineering.
02/69 - 07/74	Engineering Psychologist and Human Factor Engineer, US Army Advanced Materiel Concepts Agency, Alexandria, VA Wrote psychological reports on proposed future US Army materiel. Analyzed conceptual materiel systems for their Human Factors impact.
06/60 - 02/69	Research Psychologist, US Army Electronics Command, Ft. Monmouth, NJ, including five years as Supervisory Research Psychologist, Chief, Human Factors Engineering Section, Applications Engineering Branch, Division of Engineering Design, Directorate of R & D

06/60 - 02/69 (continued)

Wrote plans and conducted psychological experiments.

Coadjutant Professor of Social Science at Ocean County College, Tom's River, NJ, from February 1967 to February 1969.

11/59 - 06/60 Educational Specialist, The Signal School, Ft. Monmouth, NJ

Researched motivation, educational measurement, and learning problems of students at the US Army Signal School.

07/52 - 11/59 Instructor, US Army Signal School, Ft., Monmouth, NJ.

Taught educational psychology and various Signal Corps subjects, including maintenance, cryptography, and communications center operations.

EDUCATION

Bachelor of Arts, Mathematics, Brooklyn College, Brooklyn, NY, 1938
Master of Arts, Mathematics Education, New York University, New York, NY, 1949
Doctor of Philosophy, Psychology, New York University, New York, NY, 1964

PROFESSIONAL LICENSES/AFFILIATIONS

Licensed Psychologist, District of Columbia
American Psychological Association
Human Factors Society
Institute of Electrical and Electronics Engineering
New York Academy of Sciences

MILITARY SERVICE

10/41 - 11/45 Enlisted and commissioned in the US Army Signal Corps, US and Europe

09/50 - 07/52 US Air Force, 11 months in communications/electronics supply and maintenance, Mitchel AFB, NY, and 11 months as Assistant Professor of Air Science and Tactics, Air Force ROTC, Princeton University, NJ.

David A. Kulisek
Regulatory Licensing Manager
Watts Bar Nuclear Plant
TVA

EXPERIENCE HISTORY

06/86 - Present — Manager, Regulatory Licensing, Watts Bar Nuclear Plant (WBN)

Direct supervision over nine engineers and two technical assistants. Responsible for interface with NRC-NRR on all Watts Bar specific activities. Also responsible for the nuclear experience review program at Watts Bar. Served on interdivisional committees preparing PMPs (interdivisional procedures) and the Watts Bar Engineering Project Integrated Transition Planning Program.

09/85 - 06/86 — Section Supervisor, Regulatory Engineering, WBN

Direct supervision over five engineers and one engineering aide. Responsible for all activities performed by Regulatory Engineering Section which include program areas such as nuclear experience review, technical specification development, FSAR, and general licensing activities on Watts Bar.

08/84 - 08/85 — Nuclear Engineer, Regulatory Engineering, WBN

Technical responsibility for various plant submittals to NRC such as technical specifications and FSAR changes.

Served on interdivisional working groups such as the Watts Bar Appendix R resolution committee, the detailed control room design review team, and the Watts Bar Safety Evaluation Report (SER) commitment review task force.

12/82 - 07/84 — Nuclear Engineer, PWR Engineering and Analysis Section, Reactor Engineering Branch, Chattanooga, Tennessee

Technically responsible for Unreviewed Safety Question Determinations (SQN); technical specification change submittals (SQN), draft technical specification preparation (WBN), Final Safety Analysis Report changes (SQN and WBN), and various other reports intended for submittal to the NRC. Served as the TVA technical spokesman at numerous meetings with the NRC staff.

01/81 - 12/82 — Nuclear Engineer, Nuclear Licensing Staff, Chattanooga, Tennessee

TVA interface with the Nuclear Regulatory Commission (NRC) on Sequoyah (SQN) and Watts Bar (WBN) Nuclear Plants.

EDUCATION

Bachelor of Science, Nuclear Engineering, University of Illinois (1980)

ADDITIONAL TRAINING

Senior Reactor Operator Equivalency Certification Program - completed 1983.
Shift Technical Advisor Certification Program - completed 1984.
Management and Supervisory Skills Program - completed 1984.
Basic Human Factors Engineering Principles - completed 1985.

PROFESSIONAL AFFILIATIONS/ACTIVITIES

American Nuclear Safety - 9 years

Participated in the Westinghouse (W) Model D steam generator feedwater nozzle modification review group as TVA's licensing representative.

Participated in W Owners Group (WOG) NTOL (near term operating license) subgroup meetings.

Participated in both the WOG technical specification subcommittee and procedures (emergency operating procedures) subcommittee meetings.

Participated as a member of the WOG David-Beese working group.

Member AIF NTOL subcommittee.

Robert G. Orendi
Senior Engineer
Westinghouse

EXPERIENCE HISTORY

1983 - Present	Senior Engineer, Plant Operations and Evaluation, Nuclear Technology Division, Westinghouse

Responsible for participation in WOG Emergency Response Guideline (ERG) programs. Assisted in the development of the WOG ERGs. Participated in the WOG Steam Generator Tube Rupture and Loss of Reactor Coolant seminars. Currently involved in the WOG Davis-Besse Working Group.

Responsible for participation in utility Emergency Operation Procedure (EOP) and Control Room Design Review (CRDR) programs. Participated in EOP seminars at San Onofre 1, North Anna, and Taiwan. Assisted in the development of the San Onofre 1 EOPs. Coordinated the development of the D. C. Cook and Taiwan EOPs. Developed task analysis documentation and instrumentation and control characteristic (ICC) documentation for D. C. Cook. Developed ICC documentation for Millstone 3 and currently developing ICC documentation for Vogtle. Developed task analysis documentation for Beaver Valley 2 and participated as the Operations member of the Beaver Valley 2 CRDR Core Team. Developed scenarios and coordinated the CRDR Verification and Validation exercises at D. C. Cook and Beaver Valley Unit 2.

1981 - 1983 — Senior Engineer, Installation and Startup Services, Nuclear Operations Division, Westinghouse

Responsible for development of plant specific Emergency Operating Procedures (EOPs) and detailed startup procedures for W PWR plants. Responsibilities include the preparation and review of procedures, as well as overall program coordination. Participated in the San Onofre Generating Station Unit 1 and Manshaan Station EOP programs.

1980 - 1981 — Senior Engineer, Emergency Planning Services, Energy Consultants, Inc. (ECI)

Responsible for development of Emergency Response Plans and associated implementing procedures for the Three Mile Island Unit 1, and Oyster Creek Nuclear Power Plants. Responsibilities included procedure preparation, procedure walk-throughs, emergency drill scenario preparation, and emergency drill exercise coordination and observation.

1974 - 1980 — Shift Reactor Engineer, Shippingport Atomic Power Station, Duquesne Light Company

1974 - 1980 (continued)

Licensed Senior Reactor Operator (SRO) on the Light Water Breeder Reactor (LWBR) at the Shippingport Atomic Power Station, December 2, 1974 through April 16, 1980.

Responsible for performing and maintaining records of all reactor systems' operational checks, coordinating all waste processing activities, preparing and revising all operational procedures, and performing the duties of Shift Supervisor on a periodic basis. Also, coordinated all operational, maintenance, and testing activities during semi-annual shutdowns.

1970 - 1974 Test Engineer, Duquesne Light Company

Responsible for performance of efficiency tests on operating power station equipment to determine need for cleaning and/or repairs.

EDUCATION

Associated Engineer, Pennsylvania State University, 1966
Bachelor of Science, Mechanical Engineering, Pennsylvania State University, 1970
Master of Science, Nuclear Engineering, Carnegie-Mellon University, 1980

PROFESSIONAL LICENSES/AFFILIATIONS

Professional Engineer, Pennsylvania Certification No. PE-033404-E
Member American Society of Mechanical Engineers
Member Human Factors Society
Member Western Pennsylvania Chapter Health Physics Society

RICHARD F. PAIN

EDUCATION:

Ph.D., Applied Experimental Psychology, Michigan State University, 1968
M.A., Clinical Psychology, Michigan State University, 1964
B.A., Psychology, Hofstra University, 1962

AFFILIATIONS:

Fellow, American Psychological Association
Fellow, American Academy of Safety Education
Member, Human Factors Society (National and Potomac chapters)
Member, American Driver and Traffic Safety Education Association
Chairman: Research Division, 1977 and 1978
Transportation Research Board
Chairman: Driver Education Committee, 1973-1981
Chairman: Section B of Group 3 Council, 1982-1985
Member: Simulation and Measurement and Traffic Safety in Maintenance and Construction Operations committees
Project Panel for NCHRP 3-35, Speed-Change Lanes
Psi Chi (Psychology Honorary Society)
Pi Gamma Mu (Social Science Honorary Society)

PROFESSIONAL BRIEF:

Dr. Pain has been actively engaged in human factors research and evaluation in the transportation, nuclear, civil/social and military areas for more than 22 years. In these contexts, Dr. Pain has conducted numerous laboratory, simulation, and fully operational experiments; training development and evaluation; and human engineering reviews. He has directed major prime contracts and subcontracts and contributed to multiple research and development projects. In addition, Dr. Pain has 15 years of administrative and management experience.

EXPERIENCE:

ESSEX CORPORATION (1984 - Present)
Alexandria, Virginia

Director, Ergonomics Division (August 1985 - Present). Dr. Pain provides management and technical direction for the two departments and two activities making up the Division. Recent technical work he has done includes performing laboratory and closed field experiments on service vehicle markings and warning lights, analyzing simulator data for motorist comprehension of symbol signs, conducting hazard and human factors analyses of consumer products, accident and human factors analyses of ATVs, design of human engineering measures of effectiveness for Army vehicles, development of human engineering guides and review plans for railroad facilities; engineering design guides for LRT control rooms, address and check imaging systems, C^3 system display development and experimentation, human engineering deficiency assessment and EOP validation for nuclear power plants, and instructing workshops on human factors for DOE contractors.

Senior Staff Scientist and Manager, Human Factors Engineering Department (April 1984 - August 1985). Dr. Pain provided management and technical direction for the conduct of this department's projects. He served as a technical resource for human performance and experimental design and directs projects in the transportation area. He provided management review of project plans, activities, budgets, and products to assure client satisfaction. His areas of focus include military test and evaluation methodology and field testing; design and evaluation of automated office equipment; the human-computer interface; and research, design, and evaluation of human-system interface for transportation systems; and safety data collection and analyses for transportation systems and consumer products.

BIOTECHNOLOGY, INC. (1975 - 1984)
Falls Church, Virginia

Staff Scientist and Head, Transportation Group. In this capacity, Dr. Pain was the principal investigator for two Federal Highway Administration projects, "Motorist Comprehension of Warning, Regulatory, and Symbol Signs" and "Signing and Delineation of Special Usage Lanes"; a subcontract on "Application of Human Factors Expertise to Arrow Board Operation and Maintenance"; a project on flashing lights for the American Traffic Safety Association; and two National Cooperative Highway Research Program (NCHRP) projects, "Evaluation of Traffic Cones and Tubes for Highway Work Zones" and "Service Vehicle Lighting and Traffic Control Systems for Short-Term and Moving Work Zones." He also was responsible for the laboratory and instrumented vehicle studies conducted for another NCHRP project, "Evaluation of Traffic Controls for Highway Work Zones."

In addition, Dr. Pain provided experimental design and human engineering expertise to a variety of other transportation, military, and consumer product safety projects. As a consultant to the American Driver and Traffic Safety Education Association, Dr. Pain was the evaluator (experimental design and statistical analysis) for seat belt training in schools and Cub Scout units. In other consulting, he assisted CAR, Inc., in developing left-turn, two-way reversible-flow signing and marking systems; helped Wilson-Hill Assoc., Inc., develop a hazardous cargo trail blazer sign; provided for Martin Parker Associates behavioral science expertise in a study to reduce speed variance; and worked with the Transportation Research Corporation on reflectorized signing.

In the energy area, Dr. Pain participated in projects to develop an R&D program in nuclear power plant work structure and organization for EPRI and to determine the application of human factors throughout Department of Energy (DOE) nuclear facilities. He helped develop and teach a two-day workshop on human factors for DOE and its contractors. He worked on studies to extract transfer of training principles relevant to control room modifications to develop evaluation criteria for control room reviews (NUREG-0801), and he was a reviewer during the development of NUREG-0700. Also, he participated in a control room design review for Taiwan Power Company.

Dr. Pain also functioned as manager of BioTechnology, Inc.'s Publications and Operational Support sections and served as company ombudsman.

URS/MATRIX COMPANY (1973 - 1975)
Falls Church, Virginia

Director, Capitol Division. Dr. Pain led such projects as the evaluation of motorcycle teacher training workshops and the development of a motorcycle training part-task simulator. He developed and tested a video vehicle measurement and monitoring (V^2M^2) system for recording the events leading to an accident or critical incident, and conducted the "Accident Avoidance Skill Training and Performance Testing Measures" project. Dr. Pain also performed the "Rockville Corridor Transportation Alternatives Feasibility Study (Socio-Economic Task Force)." He was responsible for a literature review for diagnostic assessment of driver problems in the areas of information processing, response selection, and on-road driver measurement. Dr. Pain served in supporting roles on projects to survey behavioral changes due to energy shortage, to develop a nonintrusive human performance measurement and data analysis methodology, and to analyze human performance while using the Apollo Telescope Mount control panel during Skylab space missions.

He was responsible for all technical, marketing, personnel, and administrative activities connected with the projects he managed, as well as for the Capitol Division.

Independent Consultant (1973)

Dr. Pain spent much of his time as a consultant in the transportation and safety field. He consulted with such clients as the American Institutes for Research, Human Sciences Research, Inc., the Motorcycle Safety Foundation, STAR, Inc., the California Traffic Safety Education Task Force, and HumRRO.

AMERICAN UNIVERSITY (1970 - 1973)
Washington, D.C.

Senior Research Scientist. Dr. Pain was project director for a training evaluation and development study using USCG recruits. He was responsible for field office operations (data collection, training, logistics), test development, data bases, follow-up accident data collection, training development and evaluation, and report preparation. He also used this data to help the U.S. Air Force redesign its driver training program.

GRUMMAN AEROSPACE CORPORATION (1968 - 1970)
Bethpage, New York

Research Scientist. Dr. Pain planned and conducted experiments on vigilance and motion thresholds. He was a member of teams working on waste handling, Alaskan ecology, and F14 pilot center-of-gravity data.

MICHIGAN STATE UNIVERSITY (1962 - 1967)
East Lansing, Michigan

Graduate Research Assistant. Carried out the literature search, design, and data analysis for 15 laboratory and field experiments on highway guide sign attention value.

Graduate Assistant. Taught introductory psychology courses.

GRUMMAN AEROSPACE CORPORATION (1962, 1963, 1964)
Bethpage, New York

Engineering Aide. Assisted in conducting flight simulator and other experiments and data analyses.

OTHER

Lecturer. Taught (part-time) graduate level course on Traffic Safety Evaluation for the University of Southern California.

Lecturer. Presented introduction to human engineering to career classes at West Springfield High School, Fairfax, Virginia, and to District of Columbia science teachers for the University of District of Columbia.

BARBARA PARAMORE

EDUCATION:

M.A., Education, The George Washington University, 1969

B.A., English Literature, The George Washington University, 1967

Special courses in system safety analysis, job analysis, and communications.

AFFILIATIONS:

Member, American Association for the Advancement of Science
Member, Human Factors Society

PROFESSIONAL BRIEF:

Ms. Paramore has 12 years of experience in human factors consulting for industry and government. She has worked in the fields of nuclear power operations, toxic and hazardous materials processing, commercial vessel operations, offshore drilling, oil refinery operations, and consumer product safety. Much of her work has involved work system operations and safety analysis, directed to identification of training program and procedural requirements and evaluation of man-machine interface requirements. Ms. Paramore has extensive experience in the development of designs and procedures for job-task analysis and human factors safety evaluation, and in directing implementation of those methods in the field.

EXPERIENCE:

ESSEX CORPORATION (1983 - Present)

Director, Systems Development Section. Ms. Paramore is responsible for management and technical direction of projects to enhance personnel performance reliability and productivity in new and established work systems. The following are examples of her project work in this capacity. (1) Assisted in developing the human interface design, staffing requirements, and training concepts for a new processing facility to destroy obsolete chemical munitions. (Client: U.S. Army Toxic and Hazardous Materials Agency.); (2) Directed projects to evaluate and improve control room design characteristics at nuclear power and oil refining facilities. (Clients: Public Service Electric and Gas, Bechtel Power Corporation, Toledo Edison, and three refineries owned by a leading U.S. oil company.); (3) Assisted clients in establishing programs for preparation and evaluation of procedures at nuclear power facilities; developed aids for procedure writers and reviewers. (Clients: Louisiana Power and Light, Public Service Electric and Gas, Toledo Edison.); (4) Developed procedures and aids for use by Department of Energy contractors to perform their own human factors evaluations of facility design, procedures, and organizational communication. (Client: The Lawrence Livermore National Laboratory.); (5) Responsible for development and updating of a human factors bibliography for use by Department of Energy contractors, which has now become an on-line reference information system. Directed evaluation to enhance the usability of the on-line system.

BIOTECHNOLOGY, INC. (1979 - 1983)

Senior Program Professional. Ms. Paramore served as principal investigator and project/task leader in the safety and personnel performance areas. Projects included: (1) task analysis of nuclear power plant control room operations conducted for the Nuclear Regulatory Commission's Office of Research, with the participation of eight utilities; (2) support to the NRC in the development of guidelines for a systems approach to human factors engineering design reviews of nuclear power plant control rooms (NUREG-0700); (3) human factors engineering reviews of nuclear power plant control rooms prior to licensing; (4) methodology development for utility control room design reviews, human factors advisory support during design review activities, and participation in assessment of the safety significance of design discrepancies identified in reviews; (5) development of preliminary procedures, training requirements, and risk indicators for a proposed new facility at Rockwell International's Hanford site operated for the Department of Energy; and (6) studies of hazards associated with children's products and identification of factors affecting age suitability of such products, hazard analysis of thermal insulation products, and evaluation of the potential effectiveness of a new safety standard for architectural glazing for the U.S. Consumer Product Safety Commission.

ORI, INC. (1970 - 1979)

Project Director and Associate Program Director. In these capacities, Ms. Paramore conducted and coordinated job-task analyses of commercial marine operations for the purpose of identifying training and licensing requirements. Analyses addressed commercial vessel control, liquefied natural gas (LNG) cargo handling, and mobile offshore drilling unit operations. She also conducted a program of accident data analysis for the Coast Guard in which behavioral factors in accidents were defined in terms of performance requirements identified through task analysis. Other projects involved identification of risk sources and assessment of the potential effectiveness of risk reduction measures in marine operations.

DALE L. PILSITZ

EDUCATION: Senior Reactor Operator License, Three Mile Island Nuclear Power Station Unit 1, 1976-1981

Reactor Operator License, Three Mile Island Nuclear Power Station Unit 1, 1974-1976

Pressurized Water Reactor Training Program, Babcock and Wilcox Simulator, Lynchburg, Viginia, 1973

Reactor Familiarization Program, Penn State University Reactor Facility, State College, Pennsylvania, 1971

Reactor Operator Training Course, Metropolitan Edison Company, 1969

AFFILIATIONS: Professional Reactor Operator Society (Member)
Human Factors Society, Potomac Chapter

PROFESSIONAL BRIEF:

Dale Pilsitz is a senior Operations Specialist in Essex Corporation's Alexandria office who provides nuclear power plant operational expertise to support Essex Human Engineering services to the Nuclear Power industry. Has directed system function and task analysis of detailed Control Room Reviews, developed formats and texts of emergency and operating procedures and provided support for the revisions to previously written procedures. Has also operationally reviewed human engineering deficiencies and performed detailed control panel design layout analysis for several nuclear power plants. Participated in the development of the Human Engineering Design Handbook for Nuclear Power Plants prepared for Electric Power Research Institute. Is presently performing a human engineering analysis of a CRT system for an advanced control room.

Prior to joining Essex in 1981, spent 12 years in nuclear power plant operations. Has participated in initial plant startups and several refueling outages. Licensed by the NRC as a Senior Reactor Operator and served for over 5 years in that capacity. Extensive training includes time spent at the Babcock & Wilcox Reactor Simulator in Lynchburg, Virginia, and Penn State University Reactor Facility, State College, Pennsylvania.

EXPERIENCE:

ESSEX CORPORATION (1981 - Present)

Senior Nuclear Operations Specialist. Provided nuclear power plant operational expertise to support Essex human engineering services to the nuclear power industry. Ensured practicality of recommended backfits identified by human engineering analysis. Directed system function and task analysis portion of detailed control room reviews for Florida Power & Light St. Lucie Power Plants Units 1 and 2. Developed format and text of Emergency and Operating Procedures and provided technical support for previously written procedures. Reviewed human engineering deficiencies for St. Lucie and Texas Utility Generating Company nuclear power stations. Participated in control room design and control panel layout reviews for Comanche Peak and St. Lucie. Performed detailed control panel design layout analysis at a component level for Comanche Peak and St. Lucie Unit 2. Utilized Piping and Instrumentation Diagrams (P&IDs) to evaluate rearrangement of Comanche Peak Unit 1 control panels to improve mimics and demarcation to maximize operator efficiency in handling routine and emergency situations. Participated in developing Human Engineering Design Handbook for Nuclear Power Plants prepared for Electrical Power Research Institute. Performed System Review and Task Analysis for Surry and North Anna Power Stations, Virginia Power Company. This included the analysis of response selection and sequences of operator actions, evaluation of procedures and task requirements analysis.

Project Manager for Turkey Point Plants Units 3 and 4, Florida Power & Light Company, control room design review, task analysis and verification. Activities include operator interviews, data collection, analysis, preliminary backfit/enhancement recommendations, supervisory review and approval of human factors findings, assessment of human factors concerns, recommendations concerning proposed solutions and provide support to the client during NRC audits.

Project Manager for Turkey Point Plants Units 3 and 4, Florida Power & Light Company, noise survey evaluations. Activities include noise data collection, operator interviews, analysis, recommendations and corrective actions necessary to improve the auditory environment and acoustic design of the control room.

INSTRUMENT AND ENGINEERING SERVICE COMPANY (1981)

Consultant. Provided technical support and wrote operational and emergency procedures for nuclear power stations. Prepared lesson plans for transient and accident analysis lectures.

GPU NUCLEAR/METROPOLITAN EDISON COMPANY (1961 - 1981)

Nuclear Shift Supervisor. Senior Reactor Operator, Three Mile Island Power Station, Unit 1 - Accountable for overall shift supervision and direction of foreman and production personnel in the efficient and safe operation of Unit 1 at Three Mile Island Nuclear Generating Station to ensure plant and system reliability within the guidelines of Plant Technical Specifications and the unit operating license. Developed training courses and media for licensed nuclear operator training, including identification of learning objectives, coursewares selection, conduct of training seminars, and training effectiveness testing. Developed and reviewed all procedures and changes to procedures involving operations. Implemented changes dealing with plant problems. Responsible for ensuring that plant operations are conducted in such a manner that no detrimental environmental conditions arise, and that operations in no way jeopardize the health and safety of plant personnel or the public. Directed shift operation during plant startups, shutdowns, and refueling outages. Assisted in the recovery program following the accident at Three Mile Island, Unit 2. Assisted in planning operations and scheduling maintenance for refueling outages.

Nuclear Shift Foreman. Senior Reactor Operator, Three Mile Island Power Station, Unit 1. Responsible for daily on-shift supervision to ensure that the generating unit was erating safely and efficiently in accordance with the technical specifications and the operating license. Responsible for scheduling shift personnel to ensure required shift coverage. Instructed personnel in the performance of their duties. Administered Surveillance Testing program in accordance with the Final Safety Analysis Report required by the NRC. Coordinated all plant technical, operational, and auxiliary support functions during all phases of plant operation.

Nuclear Control Room Operator. Reactor Operator. Participated in initial plant hot functional testing and in initial plant startup. Developed format and text for Operating Procedures, Emergency Procedures, and Response to Alarm Procedures. Performed startup, emergency, and routine duties associated with operating the 870 MW Pressurized Water Reactor, including preoperational checkouts and design modification drafting of safety-related and non-safety-related systems.

Electrical Technician. Crawford Station. Performed assignments on electrical transmission and distribution systems at coal fired and oil fired units at Crawford Generating Station.

HAROLD E. PRICE

EDUCATION:

Electrical Engineering, University of Maryland, 1949-1953
Experimental Psychology, American University, 1954-1957

AFFILIATIONS:

Human Factors Society, Fellow and
Executive Council Member, 1979-1981, 1986-1989
Chairman, Public Interest Committee, 1977-1986
President, Potomac Chapter, 1972

IEEE SC-7, Human Factors in Nuclear Control Facilities,
Member and Technical Chairman for the 1985 IEEE Third Conference on Human Factors and Power Plants
General Chairman for the 1988 IEEE Fourth Conference on Human Factors and Power Plants

U.S. Nuclear Regulatory Commission
Selected Member of the Human Factors Society Project Team to Develop a Long Range Plan for Human Factors Research in Support of Nuclear Reactor Regulation, 1981-1983

National Academy of Science, National Research Council
Invited Member of the Committee on Demilitarizing Chemical Munitions and Agents, 1983-1985

International Joint Commission, Great Lakes Science Advisory Board
Invited Participant, Man-Machine Interface Workshop, 1986-1987

PROFESSIONAL BRIEF:

Mr. Price has been active in human factors and training since 1953 and joined Essex in 1983. His broad experience in systems analysis and human factors is reflected in a recent 3-year effort he directed for the Department of Defense Human Factors Engineering Technical Advisory Group concerned with determining the contribution of human factors in the development of complex military systems. He was one of the early advocates of the Personnel Subsystem (PSS) approach emphasizing the integration of human engineering, training, and job performance aids in system development.

Prior to joining Essex he was Executive Vice President and Director of the Human Factors and Training Division of BioTechnology, Inc. At BioTechnology he started the Transportation and Safety Program and was the responsible manager for all human factors and training work since 1974 including major projects for nuclear power safety and productivity. Prior to joining bioTechnology, Mr. Price was Senior Vice President of Serendipity, Inc., and one of its founders in 1962. From 1953 to 1962 he was with the Matrix Corporation, advancing to the position of Senior Research Analyst.

EXPERIENCE:

ESSEX CORPORATION (1983 - Present)

Staff Vice President. Coordinate efforts in human factors, training and security operations, and participates in applied human factors engineering projects. Current and recent project efforts include:

- o Project manager for a study of the most effective use of automation in the design of a 21st Century Naval Surface Combatant Ship.

- o Co-author on a method for allocation of functions as part of a USAF Human Engineering Design Compendium.

- o Staff advisor on human factors and training issues as a part of a system design for demilitarizing chemical munitions and agents in the United States.

- o Staff advisor on a project for curriculum development for selected Naval Reserve tracing needs. Training products include self instructional materials, videotapes, and interactive videodisk.

- o Consulting on the Man-Machine Interface concept for the Advanced Automation System for Air Traffic Control.

BIOTECHNOLOGY, INC. (1970 - 1983)

Executive Vice President and Director of the Human Factors and Training Division. Mr. Price started the Transportation and Traffic Safety Program at BioTechnology in 1971. This program has included significant projects in motorist information research, pedestrian safety, and operational or safety studies concerning motorcycles, trucks, trains, school buses, and passenger vehicles. While at Biotechnology he directed or participated in the following training related projects:

- o Directed the development of a training course for Positive Guidance in traffic control — an approach to provide solutions to highway safety problems through better information to the driver — , i.e., Positive Guidance.

- o Directed a project for the Navy Enlisted Personnel Individualized Career System (EPICS). The project developed a total personnel system design to foster early job assignment, distributed training, and job performance aids for improved personnel utilization.

- o Developed and taught a short course in "Integration of Engineering, Human Factors, and Training in Successful Systems" as a part of the Systems Approach to Naval Training.

Since 1974, Mr. Price has been engaged in activities and projects for increasing the utilization of Training and Personnel Systems R&D. As Chairman of the Public Interest committee of the Human Factors Society, he worked to provide information to legislative l policymaking government personnel on the utilization and payoff of people-related research. This included preparing and giving testimony before the House and Senate Appropriations Committees in support of Department of Defense funding for Training and Personnel Systems Technology R&D. Mr. Price also performed projects for the Navy and Army to document the utilization and payoff of people-related R&D. In 1980 he directed a tri-service study of the contribution of human factors in military systems.

SERENDIPITY, INC. (1962 - 1970)

Senior Vice President and General Manager. Mr. Price was one of the founders of Serendipity in 1962 where he had both technical and management roles. Key technical efforts included: pilot acceptance factors in the development of all-weather landing systems, potential roles of supersonic transport crews, crew requirements on a long-duration space mission, and development of a descriptive model for determining man's role and the allocation of functions in a system. Also at Serendipity he was involved in the initial planning for Project PIMO and contributed as a staff consultant to the solution of many project technical issues. While Director of the Eastern Operations, Mr. Price had management responsibility for projects to determine recreational requirements for astronauts, driver information requirements for route guidance, a ship manning simulation model, and several efforts to support development of a business information system program for Bell Laboratories.

THE MATRIX CORPORATION

Senior Research Analyst. During his ten years with the Matrix Corporation, Mr. Price directed or participated in projects concerned with operations and maintenance problems of airborne intercept radar, human engineering recommendations for the F4H-1 and A3J-1 weapon system trainers, and human engineering recommendations for test sets of the MK 52 mine for the Bureau of Ordnance. He was also involved in several projects supporting operational and maintenance personnel system design for ballistic missile systems development, and the crew role in a manned orbiting bomber.

C. Gary Seaman
Senior Reactor Operator
Watts Bar Nuclear Plant
TVA

EXPERIENCE HISTORY

09/85 - Present	Assistant Shift Engineer, Watts Bar Nuclear Plant (WBN) Currently assigned to the Operations Instructions Staff working on Emergency Instructions and Abnormal Operating Instructions.
02/83 - 09/85	Unit Operator, WBN
09/81 - 02/83	Assistant Unit Operator, WBN
02/81 - 08/81	Assistant Unit Operator, Sequoyah Nuclear Plant
04/79 - 02/81	Student/Assistant Unit Operator Trainee

PROFESSIONAL LICENSES/AFFILIATIONS

Senior Reactor Operator Pre-License Training, 09/85

Reactor Operator License OP-20187, 06/84

Member of Westinghouse Owner's Group - Operation's Subcommittee (formerly Procedures Subcommittee) working on Revision 1A validation and issue of the Generic Guidelines.

Edward Sheehy
Nuclear Engineer
Sequoyah Nuclear Plant
TVA

Experience Summary:

Eighteen years nuclear power experience:

- Former Reactor Operator
- Engineering
- Behavioral Scientist
- Nuclear Safety Expertise

Experience History:

Human Factors Accomplishments:

Task Analysis Methodology. Participated in the development of the INPO/TVA Pilot Systems Review, the only task analysis methodology endorsed by the NRC at this time.

The Operator as a Safety Function. Obtained formal recognition from NRC's Division of Human Factors Safety that "the ability of members of an operating crew to utilize their understanding and training of plant procedures hardware and operations to maintain the plant within the bounds of safety system requirements" is a safety function.

Systems Engineering Accomplishments:

Emergency Response Capability. Developed design criteria for technical support center and emergency operations facility for all TVA's nuclear plants.

Appendix R. Applied systems engineering techniques to Sequoyah Nuclear Plant under postulated fire conditions to develop what the NRC has since used as their benchmark for an acceptable safe shutdown analysis.

Spurious Actuations. Developed and applied to Bellefonte Nuclear Plant a meaningful method for evaluation of fire-induced spurious actuations that avoid unrealistic simplifying assumptions.

Emergency Core Cooling System. Identified an industry-wide potential common mode failure of the ECCS due to vortexing in the borated water storage tank during the injection phase of the accident response.

Operational/Maintenance Experience:–

Crew Member Two Nuclear Submarines. Senior chemist/health physics technician, qualified submariner, secondary plant operator, primary plant operator, reactor operator.

Maintenance Duty Holy Loch, Scotland. Cited for professional performance as shift supervisor of tender health physics facility, wrote procedure for submarine repair activities.

Education:

B.S., Electrical Engineering, Purdue University, 1971

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dward Sheehy

<u>Professional Affiliations</u>:

Member of Human Factors Society.

HAROLD P. VAN COTT

EDUCATION:

Ph.D., Experimental Psychology, University of North Carolina, (Minor: Anthropology), 1954

M.A., Experimental Psychology, University of North Carolina, (Minor: Philosophy of Science), 1951

B.A., Experimental Psychology, University of Rochester, (Minor: Philosophy), 1948

AFFILIATIONS:

Fellow, American Association for the Advancement of Science
Fellow, American Psychological Association
Fellow, Human Factors Society
Fellow, Washington Academy of Science
Member, American Society of Biomechanics
Member, Society of Sigma Xi

PROFESSIONAL BRIEF:

For over 30 years, Dr. Van Cott has been actively involved in applied research on human performance and human factors engineering for industry, government, and private research and consulting firms. He has planned and managed major programs in the areas of human factors engineering, job and task analysis and performance measurement for nuclear, defense, consumer product, transportation, computer and information systems. He has been a consultant to scientific, federal, and private organizations in the areas of human perception, training, information processing, staffing, and organizational effectiveness performance evaluation. As a member of the executive staff of the Essex Corporation, Dr. Van Cott plans, directs and conducts research programs in the above areas and gives seminars and workshops on human factors to DOE and industrial clients.

EXPERIENCE:

ESSEX CORPORATION (1983 - Present)

Vice President and Director, System Operability and Design Division. Dr. Van Cott plans and manages Essex' support to industrial and government clients. This work is concerned with research, development, and testing of existing and new systems in which human performance has a major impact on system effectiveness, productivity, reliability, and safety. Client support services currently emphasize control room design reviews, maintainability design assessments, training program evaluation and upgrade, office automation systems, military test and evaluation methods, studies of human error and its causes, and research on factors that affect organizational effectiveness. Clients include the nuclear industry (e.g., Tennessee Valley Authority: Watts Bar and Sequoyah; Virginia Power; Duke Power); the Electric Power Research Institute; the Department of Energy; IBM; Xerox; RCA; Exxon, the U.S. Navy and Army, the National Cooperative Highway Research Program and the Association of American Railroads. Current projects in which Dr. Van Cott is technically involved include: expert system specifications (DARPA);

computer delivery of procedures (U.S.N.P.R.D.C.); control room design (Virginia Power, TVA, Toledo Edison) and consultation on human factors (Lawrence Livermore National Laboratory).

BIOTECHNOLOGY, INC. (1981 - 1983)

Chief Scientist. Dr. Van Cott provided scientific coordination across all program areas. He directed projects in the Human Factors Division, including human factors research and applications on nuclear power plants, weapon and support systems, and scientific information systems. Nuclear projects which Dr. Van Cott directed or to which he was a major contributor included: (1) development of a long-range human factors plan for the Atomic Energy Control Board of Canada, (2) development of maintainability design guidelines and a human factors review plan for Department of Energy nuclear facilities, (3) an industry-wide task analysis of control room operator tasks for the U.S. NRC, (4) assessments of control room deficiencies for Duke Power Company, (5) guidelines for avoiding negative transfer of training in modified control rooms for INEL, (6) analysis of work management practices in the nuclear industry for EPRI.

NATIONAL BUREAU OF STANDARDS (1976 - 1981)

Chief, Consumer Sciences Division, National Engineering Laboratory. Dr. Van Cott planned and managed research in human engineering, biomechanics, operations research, and systems engineering. These programs supported the development of standards and test methods for consumer products, buildings, designs for the handicapped, nuclear power plants and secure nuclear storage sites, mining vehicles, weather forecasting, and fire safety systems. He provided human factors support to other NBS programs and agencies such as the Nuclear Regulatory Commission, Consumer Product Safety Commission, Federal Trade Commission, Department of Energy, Defense Nuclear Agency, and the U.S. Weather Service. He managed the NBS Consumer Ergonomics and Biomechanics Laboratories, served on the NBS Postdoctoral Fellows Program Advisory Committee and the Merit Performance Review Panel, and was senior advisor on behavioral science to the director of the National Engineering Laboratory.

AMERICAN INSTITUTES FOR RESEARCH (1975 - 1976)

Director, Social Ecology Research Group. Planned and managed research on social, technological, and information systems and their relationship to individual and group performance. Emphasis was placed on designing organizations, work environments, procedures, and systems to facilitate human performance, safety, comfort, and group effectiveness.

AMERICAN PSYCHOLOGICAL ASSOCIATION (1969 - 1975)

Director and Managing Editor, Office of Communications. Responsible for the planning, development, and direction of the Association's publishing program and information services including: 19 scientific journals, the Psychological Abstracts Information Services (published and computer-searchable records of the world's behavioral and social science literature), operation and evaluation of a selective literature dissemination service, publication of scientific books, and research and development related to advanced methods of information dissemination. Dr. Van Cott pioneered in the use of computer-photocomposition for publication of periodical literature. The development of the Association's scientific information system was supported in part by a $5 million NSF grant which Dr. Van Cott managed.

AMERICAN INSTITUTES FOR RESEARCH (1964 - 1969)

Director, Institute for Research on Human Performance. Responsible for planning and directing field and laboratory research on human learning and performance as they relate to individual performance, skilled behavior and safety. During this period Dr. Van Cott was senior editor of the Human Engineering Guide to Equipment Design, a standard government reference prepared under joint sponsorship of the Army, Navy, and Air Force. Projects supervised included human engineering of visual displays, keyboards, programmed instruction and training devices; research on compressed speech; research on human performance in response to drugs; and research in support of such military systems as helicopters, tanks, and aircraft.

IBM CORPORATION (1958 - 1964)

At the Product Development Laboratory in Poughkeepsie, N.Y., Dr. Van Cott did developmental research on advanced displays for some of IBM's early scientific and management information computers. At the Military Products Division in Kingston, N.Y. Dr. Van Cott established a human factors group that participated in the development of software and hardware for military command and control systems. Later, from 1960-64, at IBM's Washington System Center, Dr. Van Cott's Human factors group supported the developmet of the 473L and 465L command and control systems and managed IR&D research on 3-dimensional displays for air traffic control.

AMERICAN INSTITUTES FOR RESEARCH (1955 - 1958)

Program Director, Human Engineering and Highway Safety Programs. Planned and directed research on human performance, training, and design for military, and highway safety systems. He participated in the devlopment and application of job and task analysis methods. He was among the first to develop for the Air Force a method for systematically incorporating human engineering considerations into weapon system RDT&E.

VISION LABORATORY, (1953 - 1955)
U.S. NAVAL MEDICAL RESEARCH LABORATORY

Supervisory Research Psychologist. Conducted basic and applied research on human vision and visual performance. Developed a device for testing the night vision capability of submariners. Worked on the display system for control of the Nautilus nuclear submarine.

DEPARTMENT OF PSYCHOLOGY, ALFRED UNIVERSITY (1952 - 1953)

Assistant Professor and Director, Experimental Psychology Laboratory. Taught undergraduate and graduate courses in experimental psychology, sensory processes, human learning, social and developmental psychology. Established and maintained the psychology ment's research laboratory. Conducted research to establish taste threshold data for response to monosodium glutamate.

CONSULTING AND PART-TIME EMPLOYMENT:

1980 - 1981 National Bureau of Standards Consultant to the U.S. Nuclear Regulatory Commission.

1964 - 1969 Scientific Advisor: U.S. Army Research Office; U.S. Army Material Command; and the U.S. Army Electronic Proving Ground on human factors test and evaluation methods.

1967 - 1968 Consultant to the National Research Council. Participated in a study of the design and safety requirements of an improved non-rail urban transit system.

1966 - 1967 Consultant to Temple University on educational evaluation methodology (Title III Program).

6 - 1967 Consultant to the Ford Foundation on the teaching of English as a second language in the Nigerian educational system.

1950 - Present Guest lecturer to departments of psychology and engineering at the Johns Hopkins University, University of Maryland, State University of New York at Buffalo, North Carolina State University, and others.

PROFESSIONAL ACTIVITIES:

1983 - Present Member of the Committee on the Performance of Military Personnel, National Research Council, National Academy of Science. Participates in an evaluation of DOD programs to relate measures of the job performance of military personnel to Armed Services Vocational Aptitude Battery Test scores and other performance predictors.

1981 - 1983 President-elect and President, Division of Applied Experimental and Engineering Psychology, Division 21 of the American Psychological Association.

1980 - 1983 Member of the National Research Council, National Academy of Science Committee on Army Manpower. Participated in a study by the National Research Council on the utilization of scientific and technical personnel in Army laboratories.

1979 - 1982 Chairman, Joint Committee on Human Factors Guidelines, a committee jointly sponsored by the System Safety Society and the Human Factors Society.

1974 - 1975 Member, Committee on International Scientific and Technical Information Programs, National Academy of Sciences.

1973 - 1976 Member, Planning and Steering Committee, International Council of Scientific Unions Abstracting and Indexing Board.

1971 - 1975 Member, Board of Directors, National Federation of Indexing and Abstracting Services (1972-73). Member of Planning Committee (1971-72). Member, Government Relations Committee (1972-75).

1971 - 1973 Member, Council of Representatives, American Association for the Advancement of Science.

1969 - 1975 Member, Publications Committee, International Union of Psychological Science.

1968 - 1969 Chairman, Fellows Selection Committee, Human Factors Society.

1966 - 1968 Chairman, Awards Committee, Human Factors Society.

[illegible]0 - 1964 Chairman, Panel on Human Factors Engineering, Electronic Industries Association.

EDITORIAL AND REVIEW:

1984 - Present Associate Editor, Human Factors.

1978 - Present Member, Overseas Advisory Board, Journal of Consumer Studies and Home Economics.

1973 - 1975 Associate Editor, American Psychologist.

1960 - 1972 Reviewer for Computing Reviews, Personnel Psychology, and voluntary abstractor for Psychological Abstracts.

HONORS:

1986	Franklin Taylor Award, Division 21, American Psychology Association
1980	Outstanding Performance Rating, National Bureau of Standards
1957, 1958	Best Research Design Award, American Institutes for Research
1952	Society of Sigma Xi, University of North Carolina
1951	Elisha Mitchell Scientific Society, University of North Carolina
1947 - 1948	Senior Honors Program, University of Rochester
1943	National Honor Society, Nott Terrance High School, Schenectady, New York

Ira Gregory Warren
Operations Representative
CRDR Team
Watts Bar Nuclear Plant
TVA

Experience History:

3/86 - Present — Operations Representative, ASE, CRDR team, WBN

The Operations Representative's function during the assessment phase of DCRDR was to explain to the team, the nature of the "concern" and effects of the problem to plant operations, including probabilities of various scenarios. Also participated in the disposition of the "concerns" and subsequent classification of the "deficiencies".

In the corrective action phase of DCRDR the operator devised solutions to deficiencies particularly related to operations, including final recommendations for enhanced control board layouts.

During validation and verification of the WBNP Emergency Instructions the operator worked to ensure the Essex data base was correct and usable for documentation of this requirement. During verification of local actions the operator acted as "Human Engineering Representative" to comply with NUREG-0737 and 0899.

Acted as "DCRDR Operations" Representative in decisions on buying RVLIS 86, Technical Support Center Computer Upgrade, Radiation Monitoring Task Force, Configuration Control and Q-list problems, and CISP and Reg Guide 1.97 requirements.

7/85 - 10/85 — Instructor, Electrical Lesson Plans, ASE Electrical Step III, WBN

Wrote and/or rewrote all WBNP electrical lesson plans. Assisted the instructor in teaching class electrical theory and plant specifics needed to work as Assistant Shift Engineer.

5/85 - 7/85 — Instructor, Unit Operator Upgrade, Electrical Step II-B, WBN

Instructed unit operator candidates in electrical theory and specifics needed to perform as control room operator.

2/85 - 5/85 — Instructor, Assistant Unit Operator Refresher, WBN

Instructed AUO concerning plant modifications, industry events and review of plant procedures.

1/84 - 1/85 **Control Room Operator**, WBN

Functioned as control room operator during performance of functional tests at WBNP.

9/79 - 12/83 **Assistant Unit Operator/Unit Operator**

Nuclear Student Generating Plant Operators Program and AUO carrying shift at WBNP.

Acted as AUO during the first part and UO during the last part of Hot Functional testing (1983).

1/79 - 9/79 **Mechanic/Electrician** - Several auto dealerships

6/71 - 6/77 **Avionics Technician**, US Navy

Duties included Plane Captain/Line Supervisor on the SH-2D helicopter. Supervision of maintenance and repair of the Avionics systems on the S2-G aircraft. Component level maintenance on Anti-submarine Warfare Electronics and organizational maintenance on the P3-C Aircraft Avionics systems.

EDUCATION:

Associate of Science, Mechanical Engineering Technology (Nuclear Power Operations Option). Chattanooga State Technical Community College, 1982.

Additional Training

US Navy:

Avionics 'A' School, NAS Memphis, Tennessee. September, 1971 to March, 1972 (6 months)

Advanced Avionics 'B' School, NAS Memphis, Tennessee. March, 1972 to September, 1972 (6 months)

AQA-7 DIFAR Component Level School, NAS Moffett Field, CA. April, 1975 to June, 1975 (3 months)

TVA:

Nuclear Student Generating Plant Operator Program (26 months)

Unit Operator Upgrade Electrical Step II-B (1 month)

Onsite Lecture Program (3 months)

PWR Reactor Operator Certification Program (3 months)

Prelicense Training (3 months)

ASE Upgrade Electrical Step III (2 months)

License:

Watts Bar Nuclear Plant, Unit 1 Operator License No. 20201

Maurice L. Young
Electrical Engineer
Process Instrumentation and Controls
Watts Bar Engineering Project
TVA

EXPERIENCE HISTORY

04/86 - Present — Engineering Representative, CRDR Team, WBN

The Engineering Representative's function during the assessment phase of DCRDR was to assist in the team's assessment of the concern; to provide engineering references, standards, etc., to the team during assessment; to obtain information for completion of HECs requiring surveys; and to coordinate the completion of the administrative/data base activities following the transfer of the CRDR team leader.

During the corrective action phase of DCRDR, developed corrective plans for many of the HEDs developed during CRDR assessment.

Coordinated with the Configuration Control and Q-List Task Force for interfaces with CRDR. Coordinated activities which resulted in the development of CAQRs for selected items.

09/84 - 04/86 — Electrical Engineer, Process I & C, Investment Recovery Project, TVA

(Recovery of TVA's investment in electrical equipment and materials bought for cancelled nuclear plants) Handled inquiries of potential customers and followed up on the inquiries. Coordinated and expedited completion of sales and transfers.

Researched alternate applications for surplus equipment such as use of electric motors as induction generators for low-head hydro projects or cogeneration facilities.

Coordinated TROI items; environmental qualification of items for Browns Ferry, Sequoyah, and Watts Bar; closure of electrical contracts on the cancelled plants; and storage and preventive maintenance documents.

06/81 - 09/84 — Technical Supervisor, I & C Activities, Deferred Nuclear Project, TVA

The main responsibility was to maintain plant design and licensability so that the option to restart was retained.

Reviewed memoranda, drawings, vendor letters, NRC IE bulletins, regulatory guides, NCRs, and other documents to determine Restart Action Items (RAI).

Directing others in the development of computerized list of electric motors at the cancelled sites; checking of functional control and logic diagrams versus design criteria for Bellefonte; Browns Ferry work included designing and checking several aspects of variuos systems such as wiring design, equipment selection, single-line diagram design, connection drawing design, or logic design for Post-Accident Sampling Facility, Radiation Monitoring System, Condensate Demineralizer Air Surge Backwash; HVAC; and assisted in the preparation of lists of QA items for several systems on Sequoyah and Watts Bar.

06/78 - 06/81 — Technical Supervisor, Electrical Design Unit, Yellow Creek Project, TVA

Provided technical supervision to engineers, engineering aides, and draftsmen.

Worked and coordinated extensively with Combustion Engineering on the design of the main control room boards and auxiliary control boards. Coordinated the engineering of all the design changes of the control boards utilizing the full size mock-up of the control panels.

Coordinated the layout arrangement of the control building control complex. This work involved extensive changes and rearrangement due to changing space requirements of various panels, boards, and cabinets.

Technically supervised engineers assigned as "system engineers" for systems such as: turbogenerator systems, heating and ventilation systems, chillers, etc.

Worked with the development of purchase requisitions and data sheets for instruments on various systems.

01/78 - 06/78 — Electrical Engineer, Electrical Engineering Branch, TVA

Coordinated the ongoing panel (main control room), process computer and unit annunciation design efforts on Bellefonte Nuclear Plant among the design project, Mechanical Engineering Branch, and the nuclear steam supply system (NSSS) contractor. This included reviewing drawings and schedules, obtaining information from other instrumentation and controls contractors, and making recommendations on changes and procedures.

05/76 - 01/78 — Electrical Engineer, Electrical Engineering Branch, TVA

Coordinated Electrical Engineering Branch aspects of the main control room design on Bellefonte. This included the panel layouts, annunciators, SEAMS interfaces, structural interfaces, operator actions, and security interactions.

During this period work was done on the front-end engineering and design on control room panel layouts for Yellow Creek.

05/73 - 05/76 — Electrical Engineer, Electrical Engineering Branch, TVA

Coordinated the main control room panel layouts for Bellefonte; worked on the technical coordination of the Browns Ferry remote multiplexing system; performed identification of damaged electrical circuits caused by the fire at Browns Ferry; implemented design changes on the Cumberland process computer; developed design specifications for the Radiation Rate Release computer system at Browns Ferry.

07/70 - 05/73 — Electrical Engineer, Browns Ferry Design Project, TVA

Reviewed manufacturer's prints and made designs for the AC portion of the battery boards, revised portions of the plant fire protection system. Completed design changes for the plant process computer. Obtained information for the 120-volt AC and 250-volt DC valves to complete schematic and connection drawings. Completed work on the containment leak rate system, off-gas system, and containment atmospheric dilution system.

06/67 - 05/69 — Second and First Lieutenant, US Army

03/67 - 06/67 & 05/69 - 07/70 — Electrical Engineer, HQ Eastern Ground Engineering Installation Agency, USAF Communications

09/64 - 09/65, 09/62 - 09/63 — Co-Op Student, John Oster Manufacturing Company

EDUCATION

Bachelor of Science, Electrical Engineer, Tennessee Technological University, 1967

APPENDIX F

WATTS BAR NUCLEAR PLANT

Summary Of HEDs And

Corrective Action Plans

SUMMARY OF HEDS AND CORRECTIVE ACTION PLANS

HED 001 There are problems with operator workload, control room organization, and communications between personnel.

HED 002 There are problems with overcrowding in the Main Control Room (MCR): too many people during shift turnover, and too much testing and maintenance.

HED 003 There are problems concerning chain of command, AUO work assignments, and communications links within the MCR.

Correction:
These three HEDs have been combined for review and action by management personnel. Management will reemphasize the chain of command to all personnel. (Refer to Administrative Instruction and job descriptions.) Management will also review other concerns to minimize any effects of identified problems.

HED 004 There are a number of HECs about training needs of operations personnel.

Correction
The HECs will be formally transmitted to Training to determine if each is a problem and if corrective action is necessary. All decisions will be supported by documentation.

HED 005 The Reactor Vessel Level Indication System (RVLIS) is perceived to be unreliable. Operators report it is difficult to use and displays are poorly grouped on the panel.

Correction:
An improved RVLIS will be installed. This will be microprocessor based plasma display system. In addition to the RVLIS function, the system will also provide displays for incore thermocouple temperatures and subcooling margin. Subcooling trending capability will also be added on RVLIS. This will improve the man-machine interface.

HED 006 Problems with control room procedures were identified.

Correction:
This HED will be formally transmitted to the Procedures Group for review of each procedure-related concerns. Specific dispositions will be documented by the Procedures Group and changes will be implemented through the established process for procedure revision/change.

HED 007 Numerous concerns about labeling were identified.

Correction:
Specific corrective actions for various labeling concerns within the MCR and ACR will be implemented. A standard will be developed with operational input. A survey of the panels will be performed and necessary changes made to ensure acceptability with the new standard.

HED 008 Replacing fuses on the 125V vital battery boards can result in electrical shock as the individual must place hand and head between live fuse arrays to read the labels and change fuses.

Correction:
As a temporary measure, a caution sign will be placed on the door. This is considered a partial corrective action and a team will be formed to review this problem further and generate solution alternatives for management review.

HED 009 This HED contains several HECs that are not within the scope of the DCRDR, but which came to the team's attention during the DCRDR process. These are concerns about plant equipment not in the MCR or ACR and not used for emergency operations. Nevertheless, it was felt that they should be addressed.

Correction:
Corrective action will be taken as follows: (1) conductivity cells will be installed in the Waste Gas Decay Tanks; (2) training will be conducted on instrument sense lines with vents to common header; (3) the local control station for the turbine-driven AFW pump room will be rewired; (4) labels will be added to the DG Air Dryer control panels (5) H_2 detectors have been installed on CT's in switchyard, new SF-6 gas CT's have been ordered..

HED 010 Problems were identified with the availability of drawings and provisions for storage of drawings in the MCR.

Correction:
A controlled set of specified drawings will be put in the MCR and in or adjacent to the ACR. Binders will be improved. Laminated flow prints will be placed near selected panels.

HED 011 Some operators consider the green color of the main control boards inappropriate and would prefer a different color. Cleanliness of the control room was also cited as a problem.

Correction:
The green main control boards do not cause any adverse effects on performance and therefore was found to be acceptable. Cleanliness of the control room will be handled administratively.

HED 012 Problems were identified with MCR furniture and furnishings, including chairs, stools, tables, communication devices, and personal storage.

Correction:
New chairs and furnishings will be provided. Unused intercoms and radios will be removed. Unneeded equipment will be removed and lockers will be installed nearby.

HED 013 Problems were identified with MCR lighting.

Correction:
Prior to fuel load a new lighting survey will be conducted after all lighting related corrective actions are completed in the control room. Lighting problems will be addressed and corrected.

HED 014 The results of the environmental survey indicated there were problems with heating and air conditioning in the MCR.

Correction:
Air deflectors will be added for Unit 1, Unit 2 Operator, ASE, SE desk, and System 13 desk to prevent drafts. Pressures and flows set by pre-op tests will be reverified. A new environmental survey of the MCR, ACR, and Shift Engineer's office will be conducted prior to fuel load to verify acceptability.

HED 015 The noise level in the Main Control Room is too high. Ongoing construction on Unit 2 interferes with operations on Unit 1. The settings for some alarm horns are too loud, specifically on the radiation monitors and the fire alarm panel.

Correction:
The Radiation Monitor will be removed from the Main Control Room or noise will be abated. Alarm settings will be reset. A Sound/Noise Survey will be done to verify acceptablity.

HED 016 The binders used for storage of procedures are inadequate. Pages are torn and loosely inserted, causing pages to fall out during use. Too many pages are stuffed into binders, causing them to inadvertently open. Change sheets are missing from the binders.

Correction:
Multi-ring locking binders will be supplied for procedures. Site administrative instructions will be revised to include a statement to ensure this storage method. Consideration will be given to reinforcing the edges of pages with laminate to reduce the possibility of tearing. A periodic review of the EIs, AOIs, and FRGs will be implemented to replace worn, torn, illegible, and missing pages.

HED 017 Operators are required to leave the control room horseshoe to verify/operate equipment located in the common and back panel areas.

Correction:
Other HEDs will move needed equipment into the horseshoe. The required staffing described in the Technical Specifications is such that there will always be sufficient personnel available to verify/operate the equipment located in the common and back panel areas without leaving the main control area unattended. Therefore, no further corrective action is needed. This was rated a Category 4, non-safety significant.

HED 018 Inconsistent use or lack of color coding was found in the MCR and ACR. In addition, the choice of colors (green) used to denote the RHR and SI systems do not provide clear distinction between systems.

Correction:
The color coding scheme used at Watts Bar is acceptable with the following changes. The RHR and SI system color designators will be changed to improve system recognition. Other modifications include, replacing black reactor trip hand switches with white hand switches, painting black vertical indicators green, and changing 161KV mimic lines from orange to light red to ensure color consistency. Blank panel covers will also be painted to match the panel. A plant document for color use within the MCR will be developed.

HED 019 The storage of spare parts and expendable items, especially spare bulbs and fuses, is inadequate in the MCR. Supplies are not inventoried on a regular bases and the ordering of replacements does not allow for delays. A centrally located supply cabinet is not available for storage of these items. Also, a timer is not available for use.

Correction:
A supply cabinet is to be provided. Inventories of supplies and spare parts will be conducted on a regular basis. A timer will be provided.

HED 020 Cords for sound-powered telephones create a tripping hazard for MCR personnel.

Correction:
A lockable storage location within the MCR will be provided to store sound powered headsets when not in use. Therefore these headphones can be removed from the lower panel hangers.

HED 021 Communication (visual/voice) between the shift engineer (SE) and the MCR is limited due to the SE office location.

Correction:
Minimum Tech Spec staffing requires an SRO to always be present in the MCR. Not having the shift supervisor in direct line of sight does not pose any safety hazards. An executive override function is provided on the shift supervisors' phone in the event that the unit operator wishes to contact the SE and the line is busy. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 022 Controls and displays mounted on panel M-8 are not within recommended height (high/low) criteria.

Correction:
The lower height discrepancy is marginal (1/2 inch) and the components which are mounted too high are used by testing personnel. No corrective action is planned. This was rated Category 3, nonsafety significant.

HED 023 Operation of the Turbine Auxiliary Feedwater control switch (HCS-46-57-S) is not consistent with other related control switches.

Correction:
Switch will be changed to a "Pull for Auto/In for Manual" operation. In addition, nameplate engraving modifications will be made to clarify the ACC OVRD/RESET function.

HED 024 Lack of visual relief from arrays of instrumentation.

Correction:
Implementation of other HED modifications (panel layout optimization, labeling, demarcation, etc) will help to alleviate effects from this problem. No other corrective action is planned. This was rated Category 4, nonsafety significant

HED 025 ACR is cramped.

Correction:
The size of the ACR is adequate for its function. Improvements will be made to increase the operators' comfort by providing stools, tables, folding chairs, etc., and limiting the number of personnel in the ACR.

HED 026 There is limited space between panels and walls in the MCR and ACR.

Correction:
The space between panels and walls is adequate for performing the required tasks without contributing to error. Administrative controls will, however, limit the number of personnel in the control rooms.

HED 027 The Pyrotronics Console provides insufficient knee/legroom and the console keyboard is unprotected.

Correction:
Operators spend a minimal portion of their work time at this console. Keyboard is permanently affixed to console table and probability of accidental activation of keys is minimal. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 028 Ambient lighting in the Main Control Room is inadequate due to poor maintenance.

Correction:
An inspection of MCR lighting will be conducted on a periodic basis, at which time dirty diffusers will be cleaned and burned out bulbs will be replaced.

HED 029 It is difficult to distinguish trend recorder pen colors under emergency low level illumination.

Correction:
When emergency low level lighting conditions are present, recorders generally are not used for trending. Additional lighting surveys are to be performed (HED 013) and will identify and correct deficient lighting.

HED 030 Communication problems between the MCR horseshoe and M-9 panel.

Correction:
Portable/cordless phones and hand held radios currently in use have alleviated the need for any further corrective action. This was rated Category 3, nonsafety significant.

HED 031 There are communication and maintenance problems related to hand-held radios.

Correction:
More transmitter power, radio distribution and repeaters will be provided. Acoustically shielded phone booths will be added in certain locations, and hand-held radios will be replaced with new models. A study will determine if further enhancement is desired.

HED 032 There are communications and maintenance problems related to telephone.

Correction:
Special instructions will be incorporated into training for proper usage of telephones in cases of physical injuries or emergencies. Also, acoustically shielded phone booths will be installed at various locations in the plant. The maintenance program for telephones has been improved. A study will confirm overall acceptability of communications.

HED 033 Numerous problems with the paging system, such as poor availability, poor sound quality, low volume, no beepers, etc.

Correction:
One channel of the radio system will be dedicated totally to operations. Operations personnel will be provided with smaller radios. Power and supply problems with sound powered phones will be resolved by revising procedures to provide instructions for power transfer schemes and by adding labels in the MCR and ACR. These will be performed to adjust power system volumes and ensure effectiveness. Training will be provided to personnel on proper operation and use of the paging system. A study will confirm overall acceptability of communications.

HED 034 Difficulty communicating using sound powered telephones due to ground induced "hum" and heaviness of headsets.

Correction:
Maintenance Requests will be written to correct the hum in the system. A new type of connector will be installed which avoids the ground problem causing the hum. Future maintenance problems relating to sound powered telephones will be handled through the maintenance program. Lighter weight headsets will be purchased to minimize discomfort and improve communications.

HED 035 Lack of good communications when using breathing apparatus.

Correction:
The Motorola "EXPO" Model H33XPB radio (or similar) and a compatible face mask kit will be available to MCR and fire brigade personnel.

HED 036 Numerous false fire alarms.

Correction:
It is believed that the false fire alarms are generally due to the number of personnel on site, and will cease once construction is completed. No corrective action is recommended at this time. If false fire alarms persist after the completion of construction, a study will be conducted to identify and correct false alarms. This was rated Category 4, nonsafety significant.

HED 037 Alarms are not located in appropriate Annunciator Panels and alarms within panels are not functionally grouped.

Correction:
Detailed recommendations for relocation of specific annunciators have been made. In addition, an evaluation will be made of the Reactor First-Out Annunciator Panel to rearrange all Safety Injection windows in one vertical row. This will be integrated with the studies in HED 47.

HED 038 The setpoints on the Steam Generator Lo and Lo-Lo Level annunciators are set too low to be of any value to the operator.

Correction:
Annunciator setpoint changes and corresponding nomenclature engraving changes will resolve this HED.

HED 039 The T-AVG and T-REF Deviation alarm setpoint is set too close.

Correction:
No corrective action is planned. The annunciator is properly set to alert the operator to transient conditions. This was rated Category 4, nonsafety significant.

HED 040 There are numerous problems concerning "Nuisance Alarms" in the MCR.

Correction:
Presently identified nuisance alarms will be corrected. The annunciator system will be evaluated for nuisance alarms once the plant is operational. The Spent Fuel Pit Cooling System Heat Exchanger Outlet Flow alarm will be evaluated after plant startup and be corrected if found to be a problem.

HED 041 The Dark Panel concept has not been applied to the Annunciator System. Narrow tolerances on limits may be causing nuisance alarms.

Correction:
A review of Annunciator System alarms will be initiated and annunciators will be changed so that annunciator windows are dark at full power unless an alarm condition exists.

HED 042 Improvements are needed in the consistency, clarity, and completeness of annunciator tile legends.

Correction:
Recommendations have been prepared to improve the wording of numerous specific annunciator tiles. Part of the problem is inconsistent use of acronyms and abbreviations. This is being addressed in the corrective action for HED 135. Upon completion of that effort, all annunciator tiles will be reviewed for consistency. Wording improvements as well as acronym and abbreviation changes will then be implemented.

HED 043 There are numerous multiple input annunciators in the control room.

Correction:
Each multiple input annunciator was evaluated using criteria from NUREG/CR-3217 to determine the need for reflash. Reflash will be provided accordingly, as detailed in the HED Corrective Action Plan. This will be integrated with studies in HED 47.

HED 044 A number of alarms were identified as unnecessary.

Correction:
The need for each alarm was reviewed in detail. In some cases, the alarm was found to be necessary. The unnecessary alarms will be removed. Several alarms were included in this HED because of their identification as nuisance alarms in the Sequoyah DCRDR. A nuisance alarm review will be conducted at WBN after the unit is operational.

HED 045 There are several nuisance alarms associated with CCS and ERCW flows (Systems 70 and 67, respectively).

Correction:
For the applicable instruments, the following will be performed: (1) loop instrument calibration; (2) system or partial system flow balance; (3) survey to determine whether nuisance alarms still exist; (4) DCR to change alarm setpoints, addressing contact bounce characteristics of instruments, if necessary.

HED 046 Additional annunciator alarms are needed for: control room isolation, aux. building isolation, containment vent isolation, containment isolation Phase A, feedwater isolation, and "trip to local" relay tripped in the DG building.

Correction:
The correction to HED 054 will meet the need for isolation signal annunciation by putting in a master isolation panel. Annunciator windows will be added to indicate that the trip to local relay is energized, with input from each diesel generator.

HED 047 Problems exist with annunciator window layout (location of some windows), and prioritization criteria and coding.

Correction:
An annunciator study will be conducted to evaluate additional needs, to define a plant standard for alarm prioritization and priority coding, and to recommend specific changes to the annunciator system/panels. Also refer to HED 51.

HED 048 Improvements are needed in the grouping/labeling/color coding on status lights panels.

Correction:
Grouping of tiles for Phase A and Phase B Isolation (panels XX-55-6E and 6F) will be improved per corrective action plan for HED 200. Red/green color coding has been provided for the steam dump valve status lights (panel XX-55-4A). Functional labels will be added for the trip status bistable panels per corrective action plan for HED 064.

HED 049 A separate alarm horn for Common Panel alarms has not been provided for each unit.

Correction:
A separate motor trip-out alarm and annunciator alarm is being evaluated for the Unit 1 portion of vertical panels 1-M-15, 0-M-12, and 0-M-26, and for Unit 2 portion of vertical panels 2-M-15, 0-M-27A, and 0-M-27B. The vertical panel horns would be located on the end of the vertical panels towards the applicable unit. A cost estimate will be prepared. This was rated Category 4, nonsafety significant.

HED 050 The "blue" permissive panel lights on M-4 change state as unit power is increased or decreased. These lights reflect the mode change, but there is no auditory signal to alert the operator to the change.

Correction:
An alarm module will be added to the lightbox. Specific windows have been designated for auditory alert, according to criteria established with operations.

HED 051 The Annunciator System does not provide a signal when an alarm clears.

Correction
The needs for ringback will be evaluated in the annunciator study (see HED 047).

HED 052 Many alarms require the operator to dispatch an AUO to determine the specifics of a problem.

Correction:
The alarms identified in this HED do not require time-critical operator action. In most cases, the corrective action must be taken locally. Therefore, no corrective action is planned. The alarms that do require time-critical operator action, with inadequate indication in the control room, are addressed in HEDs 043, 047, and 053. Integrate with HED 47.

HED 053 Operators are unable to prevent a generator trip because the existing annunciators are not properly designed to allow sufficient time to respond.

Correction:
The inputs to XA-55-2A window 22 ("Generator Cooling Failure") will be changed to make this a pretrip annunciator. See HED 043 for related action to add a new temperature switch with a higher setpoint to provide input to the pretrip annunciator.

HED 054 There is no master isolation status panel.

Correction:
Panel XX-55-6J (formerly used for UHI) will be modified to meet this need. This panel will indicate the following automatic isolation/actuation signals: (1) Phase A isolation; (2) Containment Vent isolation; (3) Phase B isolation; (4) Containment Spray actuation; (5) Auxiliary Building isolation; (6) Control Building isolation; (7) Feedwater isolation.

HED 055 An annunciator is needed to tell operator to close UHI isolation valves during cooldown.

Correction:
The UHI system is to be removed before fuel loading. No corrective action planned. This was rated Category 4, nonsafety significant.

HED 056 There is no alarm for high seal water flow to the reactor coolant pumps.

Correction:
The concern in this HED arises from Tech Spec wording which implies that seal flow must always be less than 40 gpm as a Limiting Condition of Operation. The DCRDR team will submit a Technical Specification Interpretation Request. The final disposition of this HED will be based on the Tech Spec interpretation.

HED 057 A low header pressure alarm is needed for the fire protection system.

Correction:
An annunciator alarm will be provided on panel XA-55-15A.

HED 058 Annunciator flash rates do not meet criteria. One MCR annunciator panel has a different flash rate than the others.

Correction:
These discrepancies have no operational significance. Although in both cases the rate is slower than recommended, it is sufficient to attract operator attention. Since flash rate is not used for alarm prioritization, the different rate for panel XA-55-1A is not of concern. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 059 There is no common control to silence annunciator alarms. Silence controls are provided at individual work stations and the auditory signals time out after approximately 5 seconds.

Correction:
The DCRDR team concludes that the current design is appropriate. Operators believe that a common silence feature could be detrimental. The 5-second timer prevents excessive noise therefore, no corrective action is planned. This was rated Category 4, nonsafety significant.

HED 060 The letter height of annunciator window legends is in some cases less than the criterion height for readability from the location of the annunciator response controls.

Correction:
The Annunciator System is designed to bring the operator to the area of the problem. There is no requirement to read the legend from the control station. The operators are trained to go to the annunciator panels as necessary to read window legends. All windows are easily seen from their associated control locations, with two exceptions: the annunciator control on panel M-26A is too low, making it difficult to operate as well as interfering with the viewing of the associated windows. This control will be moved. In addition, management agrees in principle that it would be helpful, although not essential, for the operator to have an additional annunciator response control, dedicated for ERCW, on panel M-27. The length of this panel results in a poor viewing angle from the present control location to some annunciator windows. A cost estimate will be prepared. This was rated Category 3, nonsafety significant.

HED 061 Annunciator legends are inconsistently engraved with respect to letter height and stroke width.

Correction:
Engraving guidelines will be developed and issued. Although the windows will not be replaced just to correct this discrepancy, as they are replaced for other reasons (e.g., to improve wording and consistency of acronyms and abbreviations), and when new windows are added, they will be engraved in accordance with the guidelines.

HED 062 Several annunciator alarms for shared equipment are not duplicated in the Unit 2 control room.

Correction:
Alarms that may require action by both Unit 1 and Unit 2 operators will be provided in both control rooms. Some alarms for common equipment do not need to be duplicated -- i.e., those for which Unit 1 has the controls and takes all actions.

HED 063 Annunciator controls are inconsistent in location and type.

Correction:
The annunciator control location problem on panel M-26 will be corrected per HED 060. In addition, the potential for confusion caused by the two joysticks on panel 0-L-4 will be corrected by combining their functions and removing the unnecessary control. All annunciator response controls are of the same type except for those on the post accident radiation monitoring panel (M-30).

HED 064 Some annunciator panels have more than 50 tiles.

Correction:
Demarcation with group labels will be added.

HED 065 There is danger of electrical shock when changing annunciator and status light light bulbs.

Correction
A survey of all Statalarm annunciator boxes in the MCR will be performed to ensure that Tygon insulation has been installed over the bus contacts near the hold-down screws. For the Statalarm monitor light boxes for trip status, the fuses can be removed before replacing bulbs. The light compartments will be numbered with the window numbers to assist operators after fuses have been pulled. For ACR annunciator boxes, labels will be installed inside the boxes to remind personnel to turn power off before replacing bulbs.

HED 066 Statalarm light boxes XI-61-187 (on panel M-10) and XX-55-4A (on panel M-4) do not have lamp test capability.

Correction
These light boxes have dual indication in lieu of lamp test capability. No corrective action is needed. This was rated Category 4, nonsafety significant.

HED 067 The window legends on Statalarm boxes (XX-55-27A-A and -B) on panel 0-M-27A contain more than three lines of text.

Correction:
The legends are easily readable. Although there are four lines of text this does not create any difficulty for the operator. No corrective action is planned. This is rated Category 4, nonsafety significant.

HED 068 All annunciator inputs are not included in the window legends.

Correction:
It is not necessary or appropriate to identify all annunciator input sources in the window legends. Operating instructions are available to the operator which list all possible inputs. There are some cases in which this type of information on the window is useful to the operators. Guidelines for including input source identification in annunciator legends were prepared by the DCRDR Team. These will be implemented in conjunction with the corrective actions for HED 042 and 135.

HED 069 The actuation logic for Phase A and Phase B isolation status lights is inconsistent (XX-55-6C through 6H and 6J). Some lights energize on component position, while others require the presence of the isolation signal as well.

Correction:
This logic will be made consistent so that actual status of the component is accurately displayed.

HED 070 A single switch is used to control both the reactor coolant pump and its associated oil lift pump. The switch is a W-2 style J-handle. The "in" position is for the RCP; the "pull" position is for the oil lift pump. The concern was that an operator might stop the RCP instead of the oil lift pump.

Correction:
A note or caution will be added to relevant instructions to remind the operators of how this switch works. Training and/or the simulator at WBN will provide operators with training on the operation of this switch.

HED 071 Certain reset switches (on panel M-6) are not the typical pushbuttons.

Correction:
These resets are unlikely to be confused with other switches because of their placement on the panel and the fact that they have white indicator lights in contrast to the red and green lights associated with the other switches. The corrective action for HED 163 will improve the overall layout of panel M-6, further distinguishing the reset switches. This is considered sufficient; no change in the type of switch is necessary. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 072 The emergency borate hand switch does not have a protective cover.

Correction:
A protective cover is not needed. The hold-to-actuate design of this switch precludes accidental actuation, and operators are thoroughly trained on the use of this switch. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 073 There is potential for confusing the CVCS makeup mode selector switch with the boric acid pump controls.

Correction:
The CVCS makeup mode selector switch, currently a W-2 type J-handle, will be replaced with a star-handle, which is the normal type of control used for selector switches.

HED 074 The containment spray valve controls are W-2 J-handle switches, whereas OT-2 lever type switches are normally used.

Correction:
These switches have a P-Auto function which requires the W-2 type switch. They are labeled as valve controls. The labels will be improved by the addition of a valve symbol and improved nameplate design (per the correction for HED 007).

HED 075 The pocket sump pump controls (panel M-9) differ from the convention for pump controls. These are OT-2 lever type switches (used for valves), whereas pump controls are normally W-2 J-handle switches.

Correction:
The pocket sump pump controls will be moved from panel M-9 to panel M-15, per the correction for HED 172. They will be changed to J-handle controls in conjunction with the move.

HED 076 Trip signal is needed for the centrifugal charging pumps when the RHR pumps are not working (after station blackout, transfer to containment sump, SI reset, LOCA). The RHR pumps do not automatically load like the CCPs. Both CCPs could be burned out.

Correction:
An automatic CCP trip could be detrimental to SI system reliability. The concern in this HED is covered in simulator training, requalification, and "AOI and EI Monthly Review." Procedures address this concern. A similar caution will be added to AOI-35 as part of the correction for HED 006. No further action is necessary.

HED 077 Some handswitches for test valves are the same type as used for control valves and pumps.

Correction:
Available handle types and handswitch functions make unique shape coding for test valve switches impractical. These switches are clearly labeled and, where necessary, demarcated. The identified pump-type test valve switches were for UHI valves and have been removed. The correction for HED 007 includes the addition of nameplate symbols for the type of component controlled by each switch. This will in general minimize any potential for confusion between pump and valve handswitches of similar design. No other corrective action is planned.

HED 078 It is difficult to balance steam/feed flow due to accuracy of steam flow instruments at low flow. Operator has no useful steam flow indication at low power levels; steam generator level is used to balance steam/feed flow.

Correction:
Automatic bypass controllers have been installed, which should eliminate this problem. Proper operation of these controllers will be verified during low power testing.

HED 079 The ends of panels M-1 and M-6 are not protected from accidental disturbance of handswitches by people leaning against the panels.

Correction
Hand switches on the elevated panel ends are not easily bumped due to orientation and spacing. In addition, these are not locations where personnel normally stand. If someone does, this will be controlled by the unit operator. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 080 Reactor trip handswitches are inconsistent with the typical trip switch convention.

Correction
No correction is needed. The cited switches are consistent with the WBN convention for trip switches that actuate protective systems. In all cases, the trip function is on the right (actuate) and the reset function (restore to ready standby) is on the left. Although this arrangement may appear to be inconsistent with the breaker switches, where trip is on the right, the logic is in fact consistent. For breakers, trip is associated with the green light (breaker open/not actuated) and is therefore on the left. This is also consistent with the general control design convention for the left position to mean not actuated. This was rated Category 4, nonsafety significant.

HED 081 There are inconsistencies in controller conventions pertaining to direction of control and display movement. In addition, a labeling convention is needed to clearly identify directionality where a setpoint change is made to operate a valve (e.g., increase setpoint to close).

Correction:
Labeling enhancements will be made to emphasize direction of control movement for all controllers in the MCR and Auxiliary Control Room (ACR). Additional training will be provided on differences in controller operation. The feasibility of engineering changes to achieve completely consistent directionality is under investigation.

HED 082 Setpoint adjustments on controllers can be changed accidentally by brushing up against the setpoint controls.

Correction:
No correction is needed. All controllers are set back an adequate distance from the edge of the benchboard. In the horseshoe, guardrails are provided as well. Red carpet is used to denote areas so that personnel stay away from the control panels. This was rated Category 4, safety significant.

HED 083 Shape coding of switches is inconsistently applied.

Correction:
Switch functions and the availability of different types of handles make complete consistency in shape coding impractical. However, symbols will be added to control labels to indicate the type of plant component being operated (per correction for HED 007). In addition, where the potential for and effects of operating the wrong control are significant, demarcation or protective covers will be added. This HED also addresses concerns about size of some star handles. The large star handles which obscure labeling will be replaced with a smaller version.

HED 084 The maintenance test switch (panel M-2) rotates more than 90 degrees and is not oriented vertically when in the "off" position.

Correction:
This key-operated switch is used for instrument maintenance, not operations. The current key positions are not a problem for the instrument technician's needs. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 085 Vibration monitors occupy too much space on panel M-3.

Correction:
See corrective action plan for HEDs 156 and 157. This moved these monitors to M-11. If, at a later date, the vibration monitoring system is to be updated, replacement of associated MCR instrumentation will be considered.

HED 086 There are inconsistencies related to control positions on some hand switches.

Correction:
The concerns identified in this HED were reviewed in detail by the team and were determined either to be incorrect or to be very minor in nature and therefore to have no significant operational implications. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 087 The process Rad Monitoring System functional test selector switches could be accidentally activated. They are so low on M-12, they could be kicked. Their pulled position makes this more likely.

Correction:
The switch function in the pull position is to disable automatic functions for the selected monitor. This position is used for testing purposes. The team does not believe it is credible for these switches to be kicked or bumped into the pull position. It should also be noted that the switches must be pushed in to change position. When the switches are pulled out they are in a blocked position. No corrective action is planned. This was rated Category 4, safety significant.

HED 088 The T-AVG blocks must be operated slowly (P-11 and P-12 switches, HS-63-135A & -B and -136A & -B). If released too quickly, they will occasionally make the reset contacts, just by the spring return to neutral action. This could lead to an unintentional safety injection.

Correction:
The reset function will be removed from these switches. These permissives have auto-reinstate.

HED 089 There are inconsistencies in scale design with respect to a number of human engineering criteria.

Correction:
Each individual case identified was evaluated by the DCRDR Team for operational implications. In many cases, the design discrepancy was not found to create any significant error potential. Scale enhancements will be made for those cases in which it was determined that performance might be affected. A standard is under development for the design of indicator and recorder scales to prevent new problems from arising and to develop increasing uniformity as instruments are added/changed out.

HED 090 Zone and setpoint/limit marking is needed on certain indicators.

Correction:
An operational review will be conducted to establish criteria for when this type of marking should be used, conventions for marking (e.g, color, material, width), and guidelines for updating. This will establish the basis for consistent marking of indicators as needed throughout the control room.

HED 091 Scale/mathematical conversion is required to relate controller setpoint indication to associated parameter displays.

<u>Correction</u>:
Placards showing the conversion scales will be added to the panels, where needed, beside the controllers. Also, a main feed pump delta P program will be added to the TSC computer.

HED 092 Indicators or status lights are needed to show which station air compressor is running and controls are needed to start/stop each of the station air compressors.

<u>Correction</u>:
System is designed to run automatically. Indication will be added to MCR panel M-15 to provide status of pressure in the A and B Aux Control Air receiver tanks. There are local controls available.

HED 093 Recorder 1-RR-90-1 has problems including scale compatibility and transformation factors, and readability.

<u>Correction</u>:
If proposed modifications to the current recorder do not improve its readability for operations, it will be replaced with a recorder that has better human engineering characteristics.

HED 094 There is no indication in the MCR to verify that the permissive P-4 contacts reset when the reactor trip breakers are reset. Automatic safety injection is blocked until these contacts are reset.

<u>Correction</u>:
No corrective action is needed. The SI block status light on panel XA-55-4A goes dark when the P-4 contacts reset, indicating that the auto SI function is restored. If there is any doubt, the control room operator must send an instrument mechanic to physically check the P-4 contacts. Operators are sufficiently trained to manually initiate SI equipment if an auto SI is required and does not occur. In addition, it is planned to initiate the SPDS display by the operation of the P-4 contacts, which will provide another means of determining their status. This was rated Category 3, nonsafety significant.

HED 095 Lack of continuously monitored Main Turbine bearing vibration.

<u>Correction</u>:
The Westinghouse Turbine Supervisory Instrumentation System will be replaced and operator interface improved.

HED 096 Auxiliary Feedwater Total Flow indication range may not be large enough. The current range is 550 gpm.

Correction:
Minimum design requirements for total AFW flow (with or without a reactor trip) is within the range of the existing flow indication. For an accident situation where total flow could exceed the indication available, the operator need only to verify that minimum flow requirements have been met. Another scenario where the total flow could exceed the scale range is for a failed (open) control valve, in which case the operator could use Steam Generator Level indication to monitor flow, in addition to, manually isolating the failed valve. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 097 Erroneous Control Rod Bank Position indication caused by loosely mounted indicators and static discharge.

Correction:
Replace loose connectors if necessary. Include spare connectors as stock item for future replacements. If after loose connectors are replaced the erroneous indication persists, the addition of retainers to secure the indicators within their enclosure will be investigated. An "anti-static" spray and/or "2-step screen cleaner" will also be stocked in the control room.

HED 098 Lack of Reactor Coolant Drain Tank Level indication.

Correction:
RCDT level indication is available at the Waste Disposal panel where control actions take place. RCDT level can also be monitored on the plant computer. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 099 There is not a narrow range containment pressure indication in the horseshoe.

Correction:
A pressure differential indicator recorder will be added to panel M-6. Exact placement of this recorder on the panel will be coordinated with the panel layout changes to correct HED 163.

HED 100 Indication is needed for DI head tank level.

Correction:
After researching and evaluating the concerns identified in this HED, it was concluded that the DI head tank level control valve should be modified to operate automatically without causing damage to the makeup DI. The MCR has high and low level alarms, and the local control panel has high and low level indicator lights. These are judged to be sufficient. A level indicator in the shutdown board room will be considered.

HED 101 Some scales have more than the recommended number of graduations between numbers.

Correction:
This HED identifies items considered to be minor violations. The possible errors resulting from these violations were reviewed in detail by the team and are considered unlikely. A standard is being developed (see HED 89) for future scales. No immediate corrective action is planned. This was rated Category 4, nonsafety significant.

HED 102 Pointer tips on meters obstruct view of scale graduations of meter face.

Correction:
All recorders/indicators/controllers outlined in this HED have pointer tips that cover part of the scale graduations. Although these do not meet guidelines, the pointers are not such a size that they prevent the reading of a parameter on the scale. If possible, during routine maintenance, the scale lines may be extended and/or the pointers lowered slightly for easier reading of scales. The recorders with two pens will need the lower pen marker raised slightly. No other corrective action is planned. This was rated Category 4, nonsafety significant.

HED 103 GE controllers have moving-scale, fixed-pointer indicators.

Correction:
The operators are familiar with this type of controller used throughout the industry. It presents no problem or point of confusion in operation. No corrective action is planned. This was rated Category 4, safety significant.

HED 104 Valve numbers are not listed on legend pushbuttons.

Correction:
This HED will be resolved by the correction for HED 131, which places labels, including valve number identifiers, above the legend pushbutton components.

HED 105 Some indicators and recorders have scale graduations and numbering progressions that do not conform to the recommended criteria.

Correction:
This HED identifies items considered to be minor violations and the possible error resulting from these violations is considered unlikely. Modifications will, however, be made to H2I-35-29, PI-3-34, and FR-62-139 to reduce confusion and improve readability. Future changes will conform to the new standard.

HED 106 The RCP seal return flow recorders have square root scales, which is not the preferred design.

<u>Correction</u>:
The normal range for seal return flow is in the expanded range of the scale and is not difficult to read. The low range recorders will be rescaled to 0-2 gpm to provide scale overlap at the lower end of the scale.

HED 107 The BIT flow indicator has a square root scale. It is difficult to verify flow through the BIT when RCS pressure is maintained. Emergency Instructions require BIT flow to be verified. Operators are not able to read lower portion of the scale.

<u>Correction</u>:
The square root scale will be changed to a linear scale with range 0 to 1000 gpm.

HED 108 The Radiation Monitoring System indicating module status lights have single bulbs with single filament and no lamp test capability.

<u>Correction</u>:
A burned out bulb can be readily detected. Each module has three lights. The green light is normally on. It goes off upon circuit failure; therefore a check would be made. The yellow and red lights indicate trip conditions, but they are secondary indications. There is an annunciator alarm for each trip condition. If an alarm comes in and the corresponding light is off, the operator verifies the trip condition from the associated meter. No corrective action is planned. This was rated Category 3, nonsafety significant.

HED 109 There are problems in the coding and/or labeling of some indicator lights.

<u>Correction</u>:
The Radiation Monitoring System lights will be relabeled. Other corrective actions will be considered.

HED 110 The incore thermocouple indicator ITI-94-A20 has a dual scale with fixed pointers dual range. The scale is the moving type, with label upside down.

<u>Correction</u>:
The installation of RVLIS with incore thermocouple readout capabilities will resolve this HED. The existing indicator will be removed when the new system is in service.

HED 111 The Incore Thermocouple System is inappropriately placed.

Correction:
ECN 4961, which would have moved an improved system to panel M-4, will be cancelled. Instead RVLIS, which incorporates the incore thermocouple and subcooling margin monitoring function, will be placed on panels M-4 and M-6. See HED 005 Corrective Action Plan. This will also reduce panel congestion.

HED 112 HS-62-125 does not provide positive indication of valve status.

Correction:
Zone switches on FCV-62-125 will provide valve status at the hand switch.

HED 113 AC megawatt and megavar indicators fail midscale (zero megawatts and megavars).

Correction:
The indicators are read and logged periodically. These readings, along with other available indications (i.e. Phase A, B, and C amps), would provide early identification of a failed indicator. No corrective action is planned. This was rated Category 3, nonsafety significant.

HED 114 A number is not provided for the top and bottom graduation marks on some scales.

Correction:
Operators have experienced no difficulties in using these scales. When future scales are placed in the control room, they will contain this enhancement feature. No other corrective action is planned. This was rated Category 4, nonsafety significant.

HEC 115 Lack of fire protection system status indication. The present system status indicator alerts operator to power and control voltage available. The issue is the lack of green light indicating solenoid de-energized.

Correction:
Amber light indicates power available. White light is in parallel with the solenoids and indicates power is available to the solenoids. Red light indicates pressure is on the spray head. Additional status is not needed. The solenoids are reset locally and a green status light is not needed. See HED 007 (HEC 5271) for labels. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 116 The Turbine eccentricity recorder is a 24-point recorder with many channels not used. It must cycle through all points before repeating, which causes too much lag time when rolling the turbine off.

Correction:
This HED will be resolved by the corrective action for HED 095. The Westinghouse Turbine Supervisory Instrumentation System will be replaced.

HED 117 Ice Bed Temperature monitoring recorder records 48 discrete channel values on the chart paper. The channel numbers are printed on the paper in several different colors. Operators have difficulty discerning the colors and reading the channel numbers.

Correction:
Recorder will be adjusted to try to improve its readability. If the readability cannot be made acceptable, the recorder will be replaced.

HED 118 Multichannel discrete recorders on panel M-1 are often unreadable since multiple channels print on top of each other. Cannot read individual channel.

Correction:
Recorders will be adjusted to try to improve their readability. If the readability cannot be made acceptable, the recorders will be replaced.

HED 119 Multipoint recorders are slow and difficult to tell which point is printing. Operators would like digital display.

Correction:
Recorders will be adjusted to try to improve their readability. If the readability cannot be made acceptable, the recorders will be replaced.

HED 120 RVLIS recorder is difficult to interpret. Cannot relate any of the three pens to their individual scales. None of the three recorder scales agrees with the chart paper scale. Lower scale prevents reading real-time position of any pen.

Correction:
This concern will be addressed by the RVLIS upgrade. See HED 005.

HED 121 Paper speed on some recorders is too slow to provide the desired trend information during some plant modes. Steam Generator Level recorders lag Auxiliary Feedwater Steam Generator Level indicators.

Correction:
The operator is not as dependent on trend data from the SG level recorders for control. A new SG auto level control program has been installed. If the existing recorders are still needed for control, or if they are replaced for any reason in the future, the recorders will be more sensitive and have variable chart speed.

HED 122 Pens in recorders clog with ink, causing loss of trends or ink smearing on paper.

Correction:
Replacement felt cartridge kits are being provided for appropriate recorders. For those recorders where seismically qualified felt marker pens are not available, replacement of the recorders will be investigated.

HED 123 Values on certain recorder scales are difficult to read with the recorder door closed.

Correction:
To facilitate reading counts per second on NR-45, removal of a small upper portion of the door is planned. Door inserts will be removed or modified to allow the top scales to be visible with doors closed for the three recorders on Panel 0-M-12.

HED 124 Indicators and recorder pens sometimes stick, causing difficulty in verifying an increase or decrease in parameters.

Correction:
Because of the inherent design of analog recorders, static buildup on faceplates, and propensity for sticking from capillary-type pens, operators are aware of problems concerning reading these recorders and indicators, and monitor them closely. When specific problems are identified, a maintenance request will be initiated. (See HED 097 for information on the static problem.) No other corrective action is planned. This was rated Category 3, nonsafety significant.

HED 125 Recorder pen pointers are too far from the recorder scale to allow reading current value from recorder scale without significant probability of error.

Correction:
Pen pointers will be adjusted. It should be done when pens are scheduled to be replaced by new felt tip pens. For recorders which are considered the only source of information (display) and cannot be adjusted to within 1/16 inch (pointer to scale), the recorder will be replaced.

HED 126 Scale is missing on #3 Heater Drain Tank flow recorder; also, operators are unable to determine flow from #7 Heater Drain Tank.

<u>Correction</u>:
The #3 Heater Drain Tank scale will be replaced, and a cost estimate prepared to use the spare pen on this recorder to monitor flow from #7 Heater Drain Tank. This was rated Category 4, nonsafety significant.

HED 127 Missing red lens for status light has not been replaced.

<u>Correction</u>:
Lens filter for status light will be replaced. Historically, there have been few occurrences of light filters falling out. Filter lenses will be glued in place or replaced with colored covers if this becomes a recurring problem.

HED 128 Scales for AFW Pump A-A & B-B controllers and indicators are labeled by hand, not engraved. Numbering is inconsistent.

<u>Correction</u>:
These scales will be replaced.

HED 129 There is extraneous information on Westinghouse and General Electric meters located on the Electrical Control and Recording Instrument Boards.

<u>Correction</u>:
The extraneous information is in very small lettering and is not located on the scale face. No correction is planned. This was rated Category 4, nonsafety significant.

HED 130 The indicators for the Common Station Service Transformer Feeds are small and difficult to read.

<u>Correction</u>:
The indicators were reevaluated by the team and determined to be readable without minimizing accuracy. No correction is planned. This was rated Category 4, nonsafety significant.

HED 131 The legend lights on the Reheat Control Panel are not legible.

<u>Correction</u>:
Labels will be installed above each pushbutton/legend light and will identify the function and/or tag number for the component.

HED 132 The failure mode for the percent flux differential indicators is not apparent. They fail midscale, the zero graduation mark.

<u>Correction</u>:
There are four independent channels monitoring percent flux differential. This instrumentation should be indicating about the same during the life of the core. They are frequently checked; a channel reading that was different from the others would be easily detected. Out-of-service marks will be put on the scale at the failure position. (See HED 089 for details.)

HED 133 Legend covers are not keyed to prevent interchange during bulb replacement.

Correction:
To enable operators to quickly identify the correct module, a reference TVA print number will be considered as a panel label by legend pushbutton matrices where appropriate.

HED 134 The Generator Core Condition/Temperature monitor uses single filament bulbs. No test capability is provided.

Correction:
The monitor is used in conjunction with an annunciator alarm and pushbutton control. If after operating the pushbutton, there were no response (no light indication), the operator would assume the bulb was out and take appropriate steps. No correction is planned. This was rated Category 4, nonsafety significant.

HED 135 Inconsistent use of acronyms, abbreviations, and labeling in the MCR and procedures.

Correction:
A standard for abbreviations, acronyms and special terminology, specific to Watts Bar Nuclear Plant, will be generated and used for related DCRDR activities and changes.

HED 136 Auxiliary Steam Supply valves need to be opened slowly after an isolation to prevent waterhammer.

Correction:
A manual gate valve and bypass line have been installed upstream of the Auxiliary Steam Supply valve to help prevent water hammer. A caution label will be added to the panel to remind the operators to close the manual isolation valve and open the bypass prior to opening FCV-12-79 and -82.

HED 137 The Unit 2 Containment Pressure Recorder is on Unit 1 back panel 1-M-9.

Correction:
This recorder is a wide range recorder (-5 to 60 psig) for containment pressure. Although it would be better located on Unit 2, no operational problems are expected by leaving it on the Unit 1 panel. There is a wide range pressure indicator on panel 2-M-9. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 138 Difficulty in accessing computer information

Correction:
The man-machine interface will be enhanced for the P2500. The computer access will be through a keyboard. The use of menus, mimics, etc., will be considered.

HED 139 Information is lacking on the computer for several items, including reactor coolant leak rate and radiation release rate. Also, training on computer use is insufficient.

Correction:
The Reactor Coolant Leak Rate and Radiation Release rate will be added to the computer. An interface for the Morgan Temp. Monitoring System to the P-2500 will be considered, as well as a program to calculate containment temperature. Training will be provided on changes.

HED 140 The process computer is not reliable. It is sensitive to temperature and has a history of tripping out or giving false output.

Correction:
The reliability of the P-2500 has been improved by system modifications made in 1984 and 1985. Since computer room temperature is critical for maintaining reliability, a dedicated air conditioning system will be provided for the computer room.

HED 141 The process computer is too slow in responding to requests.

Correction:
Response time will be improved by planned hardware and software modifications and enhancements.

HED 142 Operators would like the computer system to provide system status/configuration information (e.g., valve lineups).

Correction:
Computer capability will be enhanced to provide as much of the desired information as possible by interfacing the TSC computer or equivalent with the P-2500.

HED 143 The printer has no instructions for reloading paper or ribbon, nor does it have a takeup for printed paper. In addition, when the printer is down, information normally printed is lost.

Correction:
Instructions for loading paper and ribbon will be added at the front of the P-2500 Operator's Guide and a copy of the guide will be provided at the MCR computer console.

HED 144 All annunciator alarms are not recorded by the process computer.

Correction:
Computer points are provided for alarms related to the Solid State Protection System, trip-related alarms, and alarms related to the operating status of critical equipment. This is adequate. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 145 Alarm sequence cannot be determined within a scan window. Alarms are recorded in multiplexer rack order when multiple alarms occur within a scan period.

Correction:
The process computer is not used for sequence of events. The sequence-of-events recorder is separate and includes those alarm points which have been determined to be important. They are either trip-related points or inputs that monitor the operating status of critical equipment. Post-trip inputs are monitored on a first-event basis within each protection set. These features are considered sufficient. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 146 There are too many independent process computers.

Correction:
Long term improvements include studying the feasibility of one computer system for the plant.

HED 147 There are a number of problems with the Morgan Data Temperature System. The major deficiencies are: poor reliability, poor operator interface, poor location, no trending until alarm condition is reached, no printout of instrument identification/description, no printout of points in alarm.

Correction:
A design study has been performed. The present system will be removed and all inputs will be connected to either the process computer or the Technical Support Center computer to provide the desired reliability, interface improvement and information capabilities.

HED 148 Some pushbuttons on the P-2500 keyboard have four lines of engraving. Also, keyboard pushbuttons and indicators are backlit by single lamps. In case of lamp failure there is no feedback as to key activation.

Correction:
The existing keyboard will be evaluated for replacement when the enhancement to the man-machine interface is made. (This addition also will resolve the concerns of HED 138, 139, 142, and 152).

HED 149 There are a number of shortcomings in the operator interface design of the Pyrotronics Fire Protection System.

Correction:
An upgrade of the plant process computer system is under study. Incorporation of the fire protection system computer capability will be included in this study, including MCR information and operator interface needs. Although the Pyrotronics System has many shortcomings, they do not have significant consequences for operations. The system is usable until such time as the process computer upgrade is decided.

HED 150 There are a number of shortcomings in the operator interface design of the Eberline System.

Correction:
The main function of this system is automatic, preprogrammed, and alarms call the operators attention to read the printout. Thus the system's shortcomings related to good operator interface design are considered minor and unlikely to cause error. The system is currently under study for improvement because of other problems (see HED 151). No other corrective action is planned. This was rated Category 3, nonsafety significant.

HED 151 Eberline System problems (e.g., reliability, accuracy, information inputs and processing capabilities, and documentation/procedure adequacy) detract from the usability of the system.

Correction:
A task team has been formed to investigate and correct the system problems and ensure Eberline operability. Upgrades are being considered.

HED 152 Certain characteristics of the operator interface with the P-2500 do not meet checklist criteria (e.g., table formats, illuminated pushbuttons on computer console, and printer output rate).

Correction:
Improved interfacing with the P-2500, to the computer console in the MCR will improve the operator interface characteristics. (This upgrade is planned to address other HEDs such as 138, 142). A faster, more reliable printer will be provided.

HED 153 The Pyrotronics System has individual fire detector alarm lights on each of the MCR panels. The power supply for these lights does not have capacity for more than one light.

Correction:
The remote lamp circuit will be modified to ensure that multiple lights can be energized simultaneously.

HED 154 The Automatic Dispatch System on panel M-2 is not needed; the system is not used.

Correction:
It is not taking up space required for other components at this time and its presence is unlikely to cause error. It will be left in place until such time as the space may be needed. No corrective action is planned at this time. This was rated Category 4, nonsafety significant.

HED 155 Status lights for turbine drains are not arranged in numerical order. The 10/11 valve lights are in the middle of the sequence.

Correction:
This has no operational effect. One switch operates all of these valves, and the status lights are either all on or all off unless the turbine is tripped. When a trip occurs the 10/11 valves open automatically. The 10/11 valves have different functions and layout. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 156
HED 157 Improvements are needed in the layout of the condensate and feedwater system components on panels M-2, M-3, and M-4.

Correction:
Layout improvements will be implemented as a result of these two HEDs. The changes have been defined with Operations input.

HED 158 There is no status indication for feedwater regulation bypass valves.

Correction:
Status lights will be added on panel M-3.

HED 159 The feedwater isolation reset pushbuttons are presently located in the Auxiliary Instrument Room. They should be moved to the MCR.

Correction:
These pushbuttons will be relocated to panel M-3 in the MCR.

HED 160 Improvements are needed in the layout of components on panels M-4 and M-5.

Correction:
Layout improvements will be implemented. Changes have been defined with Operations input.

HED 161 Improvements are needed in the layout of panels M-5 and M-6.

Correction:
Layout improvements will be implemented. Changes have been defined with Operations input.

HED 162 There is no status indication for the Cold Overpressurization Mitigation System.

Correction:
Status lights will be installed on HS-68-334AD and HS-68-340AD to indicate when system is armed.

HED 163 Panel layout improvements for the Emergency Core Cooling System are needed to improve operability.

Correction:
Components related to the Emergency Core Cooling System on panel M-6 will be relocated or removed to achieve functional grouping of controls and displays. Labeling and demarcation improvements will be made to ensure immediate recognition of system/component.

HED 164 Trend information for containment sump and refueling water storage tank level is not available inside the horseshoe area.

Correction:
Trend recorder UDR-278-765 (now located on panel M-10) provides this information. The recorder will be moved to panel M-1 adjacent to recorders with similar functions.

HED 165 The location of the containment humidity recorders on back panel M-10 could delay detection of a small LOCA event.

Correction:
Computer points are available to be trended if desired on the computer trend recorders. There are two annunciators on panel M-5 to alert the operator to high moisture conditions. This is sufficient for this parameter. No corrective action is planned. This was rated Category 3, nonsafety significant.

HED 166 Immediate Actions for small LOCA or SG tube rupture require the operator to leave the horseshoe to start Component Cooling System pump.

Correction:
Unit operators interviewed during the DCRDR Validation exercises stated that this is not a problem. No Validation HECs were written against this finding. Therefore no corrective action is planned. This was rated Category 3, nonsafety significant.

HED 167 Improvements are needed in the layout of panel M-9.

Correction:
An improved layout design using functional grouping and mimics has been proposed by the DCRDR team with Operations input.

HED 168 Lack of flow indication of Panel M-9.

Correction:
There is sufficient instrumentation to determine the status of the ventilation/air conditioning systems operated from panel M-9. AUO's check fans once per shift and most H/V fans have an MCR alarm and/or auto switchover to redundant backup fans upon loss of flow. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 169 There are layout problems on panels M-12 and M-30 for System 90.

Correction:
Panel M-30 will be laid out in a more logical manner. Revision of the M-12 layout was evaluated and determined to be unnecessary.

HED 170 There are layout problems on panel M-15.

Correction:
Panel M-15 switches and displays will be rearranged to group them by system. Each system will then be outlined by demarcation lines.

HED 171 Shunt trip breakers switches on panel M-27 are not with other fire protection controls, which are located on another panel.

Correction:
These switches remove power from valves which are operated on panel M-27 (to comply with Appendix R requirements). The team concluded that they are appropriately located with the control for the valves they affect. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 172 The controls and level indicators for the Reactor Building floor and equipment drain sump and auxiliary sump are not located on panel M-15

Correction:
HS-77-410, LI-77-410, and LI-77-411 will be moved from their present location on panel M-9 to M-15. The Corrective Action Plan for HED 170 shows their desired location on M-15. This move will group these controls with other drainage controls. The present valve type control handles will be replaced with pump type handles as appropriate when this change is made.

HED 173 The Radiation Monitor signal block controls do not follow the standard control room convention; status lights are not provided on these controls.

Correction:
All block switches are not the same. However, the operator has a light on the switch, an annunciator, or a permissive panel light for guidance in using block switches. This is considered sufficient. No corrective action is planned. This was rated Category 3, nonsafety significant.

HED 174 There are problems with the layout of panel M-27.

Correction:
An improved layout design using functional grouping and mimics has been proposed by the DCRDR team with Operations input.

HED 175 Emergency Gas Treatment System hand switches control several components but have only a single status light. Status indication should be provided for all controlled components. Damper position does not have status indication.

Correction:
Procedures will be revised to direct the operator to observe delta pressure indications and system flow. A status light will be installed for each fan damper.

HED 176 Pressure indication for the annulus vacuum control portion of the Emergency Gas Treatment System is not located on Panel M-27B. This indication is needed to support an existing Tech Spec requirement.

Correction:
Consideration will be given to a setpoint/Tech Spec change. Installation of redundant delta pressure indication for the annulus fan on panel M-27B will be considered.

HED 177 Outlet temperature indicator and recorder and inlet pressure indicator and recorder are provided for CCS Heat Exchangers A&B. Heat Exchanger C is provided with outlet temperature indication only.

Correction:
Outlet temperature recorder and inlet pressure indicator and recorder for Heat Exchanger C will be installed.

HED 178 Hydrogen analyzers and ignition controls, required early during a transient, are located outside the horseshoe.

Correction:
No problems were identified with the operator leaving the horseshoe area during the DCRDR Validation exercises. Also, two different measurements of hydrogen concentration are on the TSC computer. The Annunciator Response SOI for windows 26 & 36 on XA-55-6D will be revised to reflect that the alarm origin also includes high hydrogen.

HED 179 The 6.9KV Shutdown Board ammeter array is out of sequence on Panel M-1. Also, the association between related controls and displays is not obvious due to inappropriate demarcation.

Correction:
Rearrangement of the this array is planned. Demarcation lines will be removed and the panel will be re-demarcated.

HED 180 There are layout problems on panel L-4.

Correction:
The unit board and CSST hand-switches on L-4 will be arranged uniformly between both trains. Corresponding layout rearrangements for ammeters on panels M-26A and -26C will be implemented.

HED 181 Panel L-10 components are not arranged in logical order and are not in the same same relative positions as similar components in the MCR.

Correction:
Panel layout will be rearranged in a more logical and consistent order.

HED 182 An RCS temperature trend recorder should be provided in the ACR to permit operators to maintain cooldown rate, pressurizer level and pressurizer pressure.

Correction:
This will be investigated and a trend recorder will be considered for the ACR. Loops to be used as recorder inputs are the existing four Hot-Leg temperatures, pressurizer level and and wide range pressurizer pressure.

HED 183 Arrangement of transfer switches on panels L-11A and L-11B is not sequential.

Correction:
When operators are required to use these switches, the AOI-27 Checklist directs the operator to place all transfer switches in the Aux position, then to verify that all switches are in the Aux position. The checklist matches the panel layout from top to bottom and from left to right. There is no time-critical situation when the operator will have to transfer an individual transfer switch. No corrective action is recommended. This was rated Category 4, nonsafety significant.

HED 184 SG level controllers are located in the adjacent Transfer Room for the ACR.

Correction:
Under conditions for using the ACR, SG level would not be continually controlled or monitored, since no accident would be in progress involving SG level. Therefore, no additional staff is required. Therefore no additional corrective action is required. This was rated Category 4, nonsafety significant.

HED 185 Valve position indication for RHR System Isolation Bypass Valves FCV-74-8 and FCV-74-9 is not present in the MCR.

Correction:
There are Statalarm white status lights on M-6 to monitor valve position. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 186 Ventilation System control switches on panel M-9 do not have indicator lights.

Correction:
Indicator lights will be installed on HS-30-7, -8, -9, -10, -14, -15, -19, and -20 per Reg. Guide 1.97 requirements for post-accident monitoring.

HED 187 Containment temperature indicators (TI) are not available where needed (no upper containment TI; lower containment TI is located on panel M-9 behind the horseshoe).

Correction:
Computer points are available to the operator in the horseshoe for verification of upper and lower containment temperature. There is also an annunciator for high temperature in lower containment. Containment humidity and containment radiation alarms are also available. A calculation will be provided on the process computer.

HED 188 Ammeters read zero when turned off.

Correction:
These ammeters are for the 125V Vital Bus. A reading of zero is appropriate when the meter is off. Positive and negative ranges exist on the meter. No corrective action is needed. This was rated Category 4, nonsafety significant.

HED 189 There is no flow indicator or recorder for SG blowdown.

Correction:
Flow transmitters will be added as inputs to the TSC computer, providing individual flow for any system lineup. A calculated point will give total flow. This point will also be input to the P-2500 for backup.

HED 190 There is no position indication for the Boron Injection Tank recirc flow control valves (FCV-62-237 and FCV-62-241).

Correction:
These valves have orificed bypasses designed to prevent dead heading the pumps and to ensure continual and sufficient recirculation flow for pump protection. Therefore an indication of the position of these larger recirculation valves is not essential. No corrective action is planned. This was rated Category 3, nonsafety significant.

HED 191 The Hydrogen Recombiner temperature indicator has a man-machine interface problem.

Correction:
This problem was reviewed in detail and analyzed to not require correction. It was rated Category 3, nonsafety significant.

HED 192 The AFW level controllers and the level program can be changed, and the level control hand switches can be disabled, from the ACR.

Correction:
A caution label will be added to each of these components, requiring that the MCR operator be notified before adjustments in setpoints are made.

HED 193 It is difficult to distinguish an unilluminated rod bottom light.

Correction:
The lights will be demarcated and the area around each light will be changed to white to increase contrast.

HED 194 A number of problems were identified with the TSC computer.

Correction:
A task force will address this HED and recommend necessary corrections.

HED 195 Handswitches in the MCR do not have status lights on the hand switches.

Correction:
HED 54 recommends a master isolation/reset status panel which will provide status for feedwater isolation reset. HED 162 adds lights for cold overpressuration block/arms. For HS-47-292 on panel M-2, a label will be added. Suggested content for the label includes "Operation of local reset pushbutton may be required to close valves." HED 186 adds lights for other valves.

HED 196 There is potential for certain hand switches to be bumped because of their location, which could result in inadvertent changing of the control position.

Correction:
The red carpet area will be extended to include the front of panels M-7 through M-11, where these switches are located.

HED 197 Pressure indication and amp meters are not provided for 480V motors.

Correction:
Pressure indication for CCS Heat Exchanger C will be added through the corrective action for HED 177. Instrumentation for other 480V motors is considered sufficient. No further corrective action is recommended. This was rated Category 4, nonsafety significant.

HED 198 Red lights on W-2 switches go out when the switch is in "Stop" of "Pull to Lock" position.

Correction:
A green light circuit showing the actual status of equipment when in "pull to lock" will be added.

HED 199 Certain valves could be opened when Phase A isolation has not been reset.

Correction:
An evaluation of air-operated valves (using schematic drawings) determined that it would take a deliberate act for the operator to open one of these valves. Once he released the switch, the valve would close. Thus the error of inadvertently opening a valve is very unlikely. No corrective action is recommended. This was rated Category 4, safety significant.

HED 200 Lack of Phase B isolation status lights in the MCR.

Correction:
Modifications will be made to the Monitor Light Panels which include;

1. All lights lit concept, whereby all lights will be illuminated when the valve is in the correct position.
2. All lights used to verify Phase B Isolation will be located together.
3. Lights will be added to indicate that all valves in the ERCW and Control Air systems are positioned in their correct Phase B alignment.
4. Additional modifications will be made to the monitor lights to incorporate Phase A and Containment Vent Isolation verification.

HED 201 There are various panels with displays and controls mounted beyond the height and depth guidelines.

Correction:
Each display and control identified in this HED was reviewed. None of the deviations from guidelines were found significant in their potential to contribute to operator error. No corrective action is recommended. This was rated Category 4, nonsafety significant.

HED 202 Modifications do not contain written functional descriptions. This results in Operations, Training, and Procedures personnel not being fully aware of the implications of the modification.

Correction
Modification Packages will be changed to include a functional statement identifying any operational impacts of the change.

HED 203 If Standby Feedpump begins cavitating, operators have no indication and must be notified by phone of this problem.

Correction:
Installation of a Low Suction Pressure Trip in Instrument Loop P-2-273 is planned. A time-delay mechanism will be implemented to prevent spurious trips.

HED 204 DG start/stop and increase/decrease controls are located close together on the panel, creating potential for accidental activation of the wrong control.

Correction:
The shape coding and labeling of these switches makes error unlikely. No corrective action is planned. This was rated Category 3, nonsafety significant.

HED 205 Valve position indication for letdown and changing control valves FCV-62-81A, -89A, and -93A is not provided in the MCR.

Correction:
Indications and alarms such as pump amps, charging flow and pressure indication, and seal flow and alarm verify these valve positions. Injection water filter delta pressure can be used to confirm isolation or block functions. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 206 Single status lights for Pressurizer Spray valves may not be adequate to determine valve positions.

Correction:
Modification of XI-68-340 B&D status lights is planned to include a press-to-test function, and these lights are to be added to a procedurally required checklist. Operators can also verify the positions of the Pressurizer Spray valves by use of other indications such as Pressurizer Spray Line Temperature and Pressure.

HED 207 THIS HED NUMBER WAS RESERVED BUT NOT USED.

HED 208 Glare and reflection degrade the readability of displays.

Correction:
All new instruments purchased will be equipped with visually non-degradable, glare-minimizing glass. No other corrective action is planned. This was rated Category 4, nonsafety significant.

HED 209
HED 210 THESE HED NUMBERS WERE RESERVED BUT NOT USED.

HED 211 Control Rod position counters and Hydrogen Recombiner power adjust knob for drum counters do not meet guidelines for readability and direction of movement.

Correction:
Since counters must be read head-on due to recessed design, the probability of reading errors is minimal. Movement of numbers is of the type conventionally used in speedometer-type indications and, therefore, stereotype expectations are not violated. Adjustment knobs are infrequently used and are readable and usable. No corrective action is needed. This was rated Category 4, nonsafety significant.

HED 212 SG Feedwater Inlet flow transmitter selector switches do not follow A-B convention.

Correction:
These switches will be modified to comply with the A-B convention.

HED 213 Power supply to the annunciators cannot be verified in the MCR.

Correction:
An alarm will be provided for loss of annunciator. The alarm will be on annunciator panel 1-A (control panels 1-M-1 and 2-M-1). An alarm will also be provided for loss of power to annunciator panel 1-A.

HED 214 The 6.9KV Shutdown Board voltmeters do not have sufficient resolution to identify degraded voltage.

Correction:
Sufficient resolution is accomplished by meter color banding to mark acceptable limits. A degraded voltage condition is annunciated, and the operator has 5 minutes to take action to clear the condition before the Shutdown Board transfers to an alternate source. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 215 CCS flow through the RHR Heat Exchanger cannot be adjusted from the MCR.

Correction:
The feasibility of installing an equalizing line between the two surge tanks will be investigated.

HED 216 Ice Condenser status panel lights are inconsistent with the standard red/green convention.

Correction:
Red and green filters will be added behind the lights on XI-61-187 as appropriate to indicate that the Ice Condenser doors are open/closed.

HED 217 There is no Spent Fuel Pit level indication in the MCR.

Correction:
The corrective action for HED 062 adds a Spent Fuel Pit level alarm to the Unit 2 control room (the alarm currently exists only in the Unit 1 control room). Procedures will be modified to reflect the use of this alarm.

HED 218 Excess Letdown Flow indication is not available in the main control room.

Correction:
No corrective action is planned. Excess letdown is designed to let down the amount of RCP Seal Supply flow that goes in the RCS (approx. 20 gpm). Since temperature limits the amount of flow through the heat exchanger, a flow indicator is not needed. This was rated Category 4, nonsafety significant.

HED 219 Lack of operator protective clothing.

Correction:
A review will be performed and, if necessary, changes made in inventory to ensure protective clothing is available for operators. Operations staff will be surveyed to determine number and sizes required.

HED 220 Unused switch positions on phase angle selector switch.

Correction:
This selector switch is used for instrument maintenance testing only. No correction is planned. This was rated Category 4, nonsafety significant.

HED 221 High Pressure Fire Pump (HPFP) pressure indication is not available in the MCR.

Correction:
An HPFP low pressure alarm is recommended in the corrective action for HED 057. When the HPFP is aligned to the AFW System, flow indication is sufficient. Therefore, additional indication of pressure is not needed. Local indication is available as needed to determine if the Fire Protection System is spilling into Containment. No corrective action is planned. This was rated Category 4, nonsafety significant.

HED 222 Indicators on Electrical Control Boards are single filament indicators with no test capability.

Correction:
These bulbs will be included in the inventory of supplies in the MCR (refer to HED 019). The design of the system alerts the operator to failed bulbs. These components are within a system mimic; therefore, a burned out bulb would be noted.