VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

W. L. STEWART
VICE PRESIDENT
NUCLEAR OPERATIONS

March 1, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Attn: Mr. D. G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Serial No. 087
NO/HWB/TAH:jab
Docket Nos. 50-280
50-281
50-338
50-339
License Nos. DPR-32
DPR-37
NPF-4
NPF-7

Gentlemen:

VIRGINIA ELECTRIC POWER COMPANY
SURRY POWER STATION UNITS NO. 1 AND 2
NORTH ANNA POWER STATION UNITS NO. 1 AND 2
CONTROL ROOM DESIGN REVIEW
PROGRAM PLAN

In accordance with our April 15, 1983 response to Supplement 1 to NUREG-0737, Serial No. 006, the attached Program Plan is provided to delineate Vepco's approach for the performance of the Control Room Design Review (CRDR) at our North Anna and Surry Power Stations. Our current schedule date for completion of the Control Room Design Review is August 30, 1985. At that time, Vepco will submit a Final Summary Report containing:

a) Review findings

b) A description of the review process

c) A summary of the identified Human Engineering Discrepancies (HEDs)

d) Proposed corrective actions

e) Proposed implementation schedules

As directed by Supplement 1 to NUREG-0737, the implementation of the CRDR and the development of new symptom-based EOPs are highly integrated. Please note therefore, that the results of the upcoming March 13 meeting on EOPs between the NRC and the Westinghouse Owners Group could have a significant impact on the implementation of the CRDR. For this reason, it may become necessary for Vepco to revise Section 4.4 SYSTEM FUNCTIONS AND TASK ANALYSIS, Section 4.7

VALIDATION OF CONTROL ROOM FUNCTIONS, and to reschedule the CRDR completion date. If this occurs, Vepco will provide a schedule for developing the required revisions within thirty (30) days after the resolution of the EOP issue.

Very truly yours,

W. L. Stewart

Attachments

cc: Mr. James P. O'Reilly
Regional Administrator
Region II
USNRC
Suite 2900
101 Marietta St.
Atlanta, Georgia 30303

Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Mr. James R. Miller, Chief
Operating Reactors Branch No. 3
Division of Licensing

Mr. J. Don Neighbors
Surry Project Manager
Mailstop 438
7920 Norfolk Ave.
USNRC
Bethesda, Maryland 20014

Mr. Leon B. Engle
North Anna Project Manager
Mailstop 438
7920 Norfolk Ave.
USNRC
Bethesda, Maryland 20014

Mr. D. J. Burke
NRC Resident Inspector
Surry Power Station

Mr. M. W. Branch
NRC Resident Inspector
North Anna Power Station

CONTROL ROOM DESIGN REVIEW

PROGRAM PLAN

FOR

NORTH ANNA AND SURRY POWER STATIONS

Submitted by:

Virginia Electric and Power Company

TABLE OF CONTENTS

SECTION 1.0 REVIEW PLAN

1.1 INTRODUCTION

This Program Plan has been prepared in response to NUREG-0737, clarification of TMI Action Plan Requirements, para. I.D.1, and describes the Control Room Design Review that will be conducted for the Surry Power and North Anna Power Stations, owned and operated by Virginia Electric Power Company. The format of this report follows that recommended by NUREG-0700, Guidelines for Control Room Design Reviews, published September 1981, paragraph 5.1, as follows:

1. Review Plan
2. Management and Staffing
3. Documentation and Document control
4. Technical Approach (Review Procedures)
5. Assessment and Design Solutions

This program plan addresses the acceptance guidelines stated in Section 2 of the October 1981 Draft of NUREG-0801, Evaluation Criteria for Detailed Control Room Design Review, and in Section 2.0 "Planning Phase" of NUREG-0700.

1.2 BACKGROUND

1.2.1 General

This Program Plan report describes how Vepco plans to conduct a Control Room Design Review (CRDR) for Surry Power Station Units 1 and 2 and North Anna Power Station Units 1 and 2. The CRDR is part of a broad effort within the nuclear industry to evaluate the adequacy of control rooms to support safe and effective operations. Although the CRDR is specifically directed toward evaluating the control room, Vepco recognizes interfaces between the CRDR and other related activities, such as the design of a Safety Parameter Display System (SPDS), development of Emergency Operating Procedures, operator training, and the inclusion of post-accident monitoring (PAM) instrumentation. The organization of this plan considers coordination of the CRDR with these related efforts. Guidance for the CRDR has been provided by the Nuclear Regulatory Commission (NRC) in the form of various NUREGs and regulatory guides. Vepco has used all relevant guidance in developing this Program Plan and has dedicated the necessary resources to this CRDR to ensure success of the project.

1.2.2 Surry Power Station

The Surry Power Station contsists of two Westinghouse pressurized water reactors (788 Mwe each). Unit 1 began commercial operation in December of 1972 and Unit 2 is May of 1973.

1.2.3 North Anna Power Station

The North Anna Power Station consists of two Westinghouse pressurized water reactors (934 Mwe each). Unit 1 began commercial operation in June of 1978 and Unit 2 in December of 1980.

1.2.4 Program Plan Objectives

a. This Program Plan provides a means to ensure that an adequate CRDR will be conducted. It is intended that this Program Plan be a baseline for any audit of Vepco's CRDR by NRC personnel or contractors.

b. This plan also provides the umbrella plan on which detailed implementation of the CRDR will be based.

1.3 CRDR PROGRAM STRUCTURE

1.3.1 CRDR Phases

The CRDR is to be conducted in three phases as follows:

a. Phase I - Project Planning

The objective of this first phase was to develop a plan for conducting the review that describes project milestones, schedules, review methods, personnel responsibilities, and project interfaces. Submission of this Program Plan to the NRC completes the planning phase.

b. Phase II - Review and Assessment

The second phase of the CRDR will involve collection, reduction and analysis of data pertaining to the adequacy of the CR design from a human factors perspective, and assessment of any human engineering descrepancies (HEDs) identified during this process. This assessment procedure will include:

1) A determination of the error potential and consequences of each HED.

2) Identification of HED resolutions

3) Assurance that no additional HEDs are introduced as a result of these resolutions.

At the conclusion of Phase II, a Final Summary Report for each station describing the methods, results and implications of each CRDR will be submitted to the NRC. This report will also describe Vepco's plans and schedules for correction of the HEDs.

c. Phase III - Implementation

The final phase in the CRDR will be to implement the corrective actions for the HEDs. Following implementation, the HEDs will be re-reviewed to ensure that the corrective actions were complete, adequate and that no new HEDs have been introduced. If, for some reason, a HED cannot be fully corrected, the cause and consequence of this condition will be documented.

Figure 1-1 shows, in general, the phases and task flow for conducting the CRDR. A brief discussion of the activities conducted in each phase of the review is described below. For more detailed descriptions of the objectives, approach, data collection methodology, and specific evaluation methods, refer to Section 4.0, Review Procedures of this plan.

1.3.2 Project Planning

This plan is the output of the Project Planning Phase. Acceptance of this document essentially concludes Project Planning. The guidelines provided in NUREG-0700 and NUREG-0801 form the primary basis of this document.

1.3.3 Control Room Review

The CR review phase is subdivided into six tasks as described below:

1.3.3.1 Operating Experience Review - This task is composed of two sub-tasks.

- o Review of historical documents
- o Operator questionaires and interviews

1.3.2.2 Conduct Surveys - Much of the detailed assessment of the control room is conducted via a total of 14 surveys. The surveys to be conducted are:

- o Ambient Noise - Direct measurements of noise levels are taken and compared to individual checklist items.

- Illumination - Measurements are taken under various ambient conditions (e.g., emergency lighting) and are compared to individual checklist items.

- CR Environment (HVAC) - Assessments are made by direct measurement of the parameters listed below and comparison of the data to the 0700 guidelines

  - Temperature
  - Humidity
  - Ventilation

- Workspace - The CR workspace is evaluated by checklist survey

  - Workspace Arrangement
  - Document Organization, Use, and Storage
  - CR Access

- Conventions - The CR is evaluated by survey for the conventions listed below and data are subsequently compared to 0700 guidelines

  - coding methods (color, shape, pattern, etc.)
  - standardization of abbreviations and acronyms
  - consistency of control use
  - consistency of display movement of indication

- Controls - Controls are evaluated by measurements, observations or other assessment methods.

- Displays - Displays are evaluated by measurements, observations or other assessment methods.

- Computer System - Computer systems are assessed by measurements, observations or other assessment methods.

- Emergency Equipment - Data are collected by walk-throughs, emergency garment use, speech intelligibility analysis, and checklist application.

- Labels and Location Aids - Labels and location aids are evaluated by measurements, observations or other assessment methods.

- Annunciator System - The annunciator system is evaluated by measurements, observations or other assessment methods.

- o Anthropometrics - Reach and visual access to CR components are analyzed, given physical configuration of boards, panels, layout, etc. The data are subsequently compared to checklist item requirements.
- o Communications - Communications systems are evaluated by checklist and speech intelligibility of communications modes is analyzed.
- o Maintainability - Checklist and questionnaire data concerning operator-maintained components (trend recorders, bulbs, etc.) are collected.

Survey data are collected from preconstructed task plans which contain checklists, interview forms, and methods for direct measurements of CR parameters, such as noise levels, light levels, etc. The guidance for the conduct of the survey is found in NUREG-0700.

1.3.3.3 System Functions and Task Analysis (SFTA) - System functions and tasks are identified and evaluated in this task. A 4-step procedure is employed:

- o Identification of systems and subsystems by review of plant documentation and Westinghouse Owner's Group Emergency Response Guidelines and Task Analysis.
- o Identification of normal and emergency operating procedures to undergo task analysis.
- o Identification of system/subsystem functions through document review and operator interviews.
- o Identification and analysis of CR operational tasks.

Task analysis data are used as input for the Verification of Task Performance capabilities and the Validation of Control Room Functions (see paragraphs 1.3.3.5 and 1.3.3.6).

There are two basic types of products produced by this analysis. The first product is a tabular listing of major

operating systems and subsystems. This listing, when taken in conjunction with the group of selected procedures, is used to develop tables and/or functional flow block diagrams showing specific operator functions required to complete the procedures.

The second product records the actual task analysis of the required operator functions. The result is a description of specific tasks associated with the operator functions in terms of operator input-output and decision requirements.

1.3.3.4 Control Room Inventory - A comprehensive inventory of control room instrumentation, controls and other equipment will be developed for each unit of the Surry and North Anna Power Stations. The inventory will include the necessary information (e.g. type of component, application/function, range, divisions, location) required to verify the availability of the required displays and controls (see paragraph 1.3.3.5). The inventory process is described in detail in paragraph 4.5 of this plan.

1.3.3.5 Verification of Task Performance Capabilities - This analysis is composed of two subtasks: Verification of instrument/control availability, and verification of human engineering suitability. The first, verification of availability, determines whether the instrumentation and controls required by the control room operator are actually available to the operator for completion of the tasks identified in the task analysis. The control room inventory and the task descriptions from the SFTA are the two major inputs to this task. The SFTA documentation describes the instruments and controls which are necessary for the required tasks, whereas the control room inventory lists the components which are actually available. A comparison of these lists will determine if a required instrument or control is not available.

The second subtask, verification of human engineering suitability, will examine the components for characteristics which may degrade operator task performance, and which are not necessarily apparent in a control room survey. This analysis will focus on the practical suitability considerations such as control-display relationships.

The primary products of the verification phase are the documentation of missing task related instrumentation and/or controls and the identification of problems regarding component suitability.

1.3.3.6 Validate Control Room Functions - This involves analysis of workload and distribution of workload for operators for specific task and event sequences. The primary means of analysis are traffic analysis and walk- and talk-through simulation of task sequences. Checklists will be used to aid in the validation of CR functions.

1.3.4 <u>Assessment and Design Solutions</u>

The basic procedure to be employed in identifying and selecting enhancements and design solutions is based on NUREG-0700, Exhibit 4-2.

1.3.4.1 Assess Discrepancies - Assessment is discussed in Section 5.0 of this plan. In general, the process follows that discussed in NUREG-0801 (draft, published in October 1981), and is as follows:

- Assess extent of deviation from NUREG-0700 guidelines
- Estimate increase in human error for the discrepancy
- Determine if discrepant component is safety function related
- Determine if errors in using discrepant component(s) could lead to violation of tech specs or unsafe operation
- Assignment of category and priority, based on the above.

1.3.4.2 Analysis of Correction by Enhancement - Discrepancies selected for correction are first examined for possible correction by enhancement (labeling, demarcation, procedure aids, etc.). Each HED is considered and where such correction is possible, the discrepancy is reassessed for its effect on operator performance. As appropriate, HEDs are reevaluated via checklisting and task analysis until HE suitability is verified. Where it is determined that correction by enhancement is not possible, the discrepancy is analyzed for correction by design alternatives.

1.3.4.3 Analysis of Correction by Design Alternative - Design alternatives will be identified by examining the HED, referring to task analysis data, and identifying potential constraints (e.g., availability of equipment, Reg. Guide 1.97, etc.). The acceptability of design alternatives will be verified by reapplication of 0700 Guidelines and task analysis.

1.3.4.4 Assessment of Extent of Correction - For all HEDs selected for correction, the extent of correction (by enhancement or redesign) will undergo evaluation. In addition, the correction will be reviewed to ensure that no new HEDs are introduced into the control room as a result of the change.

1.3.5 Implementation

The final phase in the CRDR will be to implement the corrective actions for the HEDs. As suggested in NUREG-0801, the implementation of corrective actions will be scheduled according to the respective priorities of the HEDs (see paragraph 5.2). Since the implementation process is expected to extend beyond the CRDR, Vepco

intends to maintain an ongoing review activity to ensure that all HED resolutions are properly implemented.

As part of this ongoing activity, all HED resolutions will be evaluated to ensure that each resolution is complete and adequate. This activity will also ensure that no new HEDs will have been introduced into the control room as a result of the resolution. If, for some reason an HED cannot be fully corrected, Vepco will assess the potential impact on operator performance. This assessment will be document and submitted as an amendment to the Final Summary Report.

The implementation process is discussed in Section 7.0 of this plan.

1.4 GLOSSARY OF TERMS

Since there are differences in usages of terms (even among practitioners within the same field), the following definitions are provided to reduce ambiguity.

CONTROL ROOM: For the purpose of this plan, the control room is defined to include the primary operating area of the main control room and the auxiliary shutdown panels.

CONTROL ROOM DESIGN REVIEW: The control room design review as required by NUREG-0660, Item I.D.1 and implemented in accordance with NUREG-0700.

CRDR PROGRAM PLAN: A work plan designed to provide high-level guidance on the scheduling and performance of the CRDR.

ENHANCEMENTS: Surface modifications that do not involve major physical changes, for example, demarcation, labeling changes and painting.

FINAL SUMMARY REPORT: Final summary report of the results of the CRDR as required by NUREG-0660, Item I.D.1 and in accordance with Generic Letter 82-33.

FUNCTION: An activity performed by one or more system constituents (people, mechanisms, structures) to contribute to a goal..

FUNCTIONAL ALLOCATION: The distribution of functions among the human and machine constituents of a system.

FUNCTIONAL ALLOCATION REVIEW: The examination of system goals to determine what function they require; also, examination of the required functions to determine how the functions may be allocated and executed; primarily, the identification of established functions and examination of how they are allocated and executed.

HUMAN ENGINEERING DISCREPANCY (HED): A departure from some benchmark of system design suitability for the roles and capabilities of the human operator.

HED ASSESSMENT TEAM (HEDAT): Those individuals of the CRDR Team who have the responsibility for review and assessment of all HED reports.

HUMAN FACTORS ENGINEERING: The science of optimizing the performance of human beings, especially in industry; also, the science of designing of equipment for efficient use by human beings.

LONG-TERM CORRECTIVE ACTIONS: Corrective actions to be implemented according to a schedule to be developed by Nuclear Operations and submitted to the NRC with the final summary report.

NEAR-TERM CORRECTIVE ACTIONS: Corrective actions to be made according to a schedule developed by Nuclear Operations and submitted to the NRC. The schedule will indicate that the corrections will be completed by the end of the second refueling outage after submittal of the final summary report and after NRC acceptance.

<u>OBJECTIVE (MISSION, GOAL)</u>: The end-product as a result of a coordinated group of activities.

<u>LICENSED OPERATOR</u>: Any individual currently licensed by the NRC who manipulates a control or directs another to manipulate a control.

<u>PLANT SYSTEM</u>: Group of people and/or equipment constituents linked together to perform a particular function, (e.g., CVCS, Feedwater).

<u>PROMPT CORRECTIVE ACTIONS</u>: Corrective action to be made according to a schedule to be developed by Nuclear Operations and submitted to the NRC. In the Final Summary Report, the schedule will indicate that the corrective actions will be completed by the next fuel load, assuming prompt NRC acceptance.

<u>SIGNIFICANT HEDs</u>: Those HEDs which, alone or in combination with other HEDs, may (in the judgement of the HEDAT) increase the potential for operator error and/or may have serious impact on system performance.

<u>SUBTASK</u>: An activity (action step) performed by a person (or machined) directed toward achieving a single task.

SYSTEM: A whole which functions as a whole by virtue of the interdependence of its parts; an organization of interdependent constituents that work together in a patterned manner to accomplish some purpose.

SYSTEM ANALYSIS: Examination of a complex organization and its constituents to define (usually, but not necessarily, in mathematical terms) their relationships, and the means by which their actions and interactions are regulated to achieve goal states.

TASK: A specific action, performed by a single system constituent -- person or equipment -- that contributes to the accomplishment of a function. In NUREG-0700, only tasks allocated to people, in particular to control room operators, are addressed in detail. Moreover, in accordance with Generic Letter 83-22, only tasks associated with emergency systems will be evaluated.

VALIDATION: The process of determining if the physical and organizational design for operations is adequate to support effective integrated performance of the functions of the control room operating crew.

<u>VERIFICATION</u>: The process of determining if instrumentation, controls, and other equipment meet the specific requirements of the tasks performed by operators.

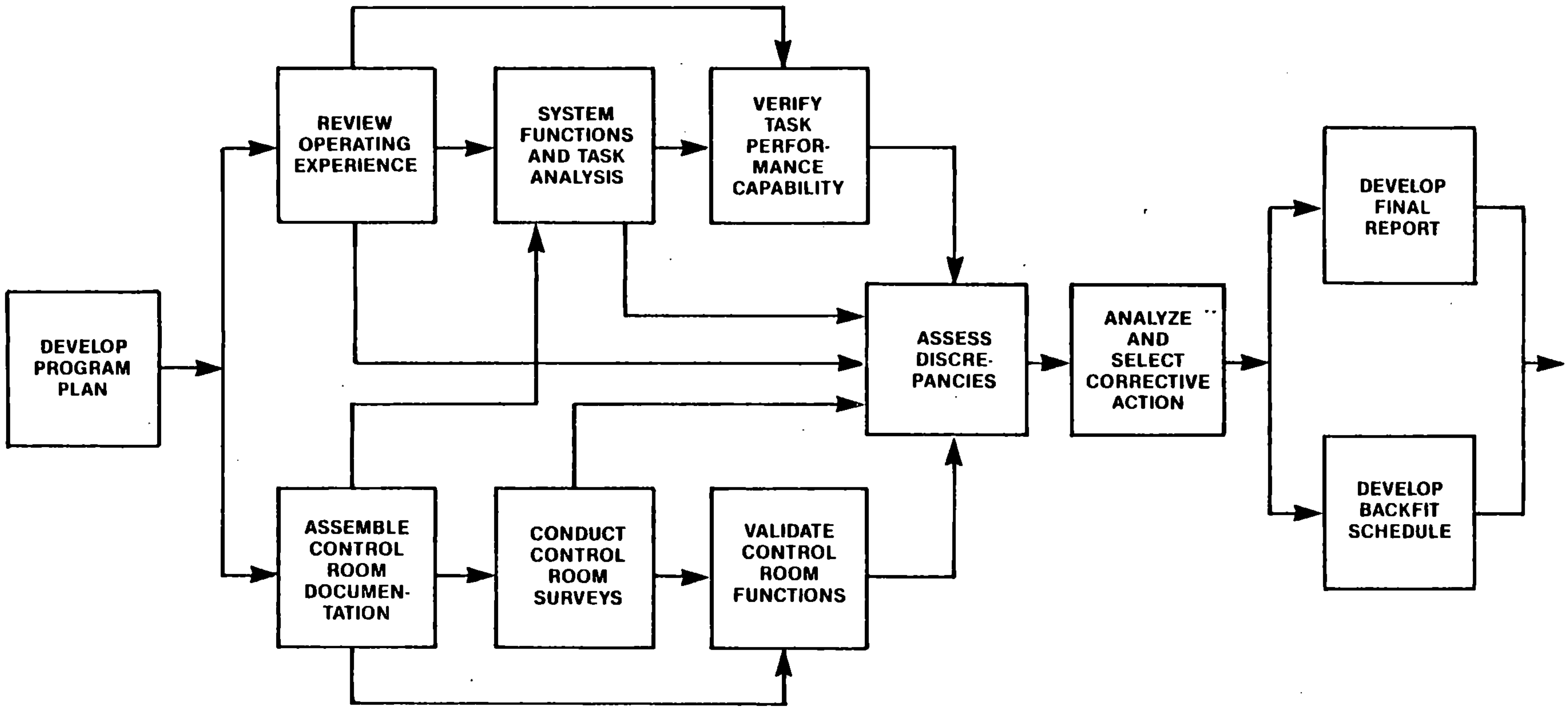
1.5 ACRONYMS

A number of acronyms have been used in this report. They are presented to facilitate the reader's use and comprehension of the report.

CR	Control Room
CRDR	Control Room Design Review
DBMS	Database Management System
DDC	Document and Documentation Controller
EWR	Engineering Work Request
ERG	Emergency Response Guidelines (<u>W</u>OG)
ERP	Emergency Response Procedure
HED	Human Engineering Discrepancy
HEDAT	Human Engineering Discrepancy Assessment Team
HFS	Human Factors Specialist
I&C	Instrument and Control Engineer
INPO	Institute for Nuclear Power Operation

LDE	Lead Discipline Engineer
LER	Licensee Event Report
LHFS	Lead Human Factors Specialist
NCPC	NOD Corporate Project Coordinator
NOD	Nuclear Operations Department
NRC	Nuclear Regulatory Commission
NSAC	Nuclear Safety Analysis Center
PAR	Problem Analysis Report
PDA	Preliminary Design Assessment
PSE	Power Station Engineering
PSR	Problem Status Report
PSSF	Personnel Survey Summary Form
PWR	Pressurized Water Reactor
QISF	Questionnaire Item Summary Form
RO	Reactor Operator
SER	Significant Event Report
SESR	Safety Engineering Staff Reports
SME	Subject Matter Expert

SOC	Site Operations Coordinator
SOER	Significant Operating Event Report
SRO	Senior Reactor Operator
STA	Shift Technical Advisor
WOG	Westinghouse Owners Group



THE TASK FLOW/RELATIONSHIPS OF THE CR REVIEW

FIGURE 1-1

SECTION 2.0 MANAGEMENT AND STAFFING

2.1 INTRODUCTION

a. The quality of the review effort and the results of the CRDR depend upon the composition, balance, and management of the review team. The Vepco CRDR team has been assembled to include representatives from the various human factors, operations and engineering disciplines necessary to insure optimum performance of the review team. The structure and functions of the team have been established to allow for maximum flexibility and interaction between team members and station personnel, yet retain a rational organizational structure.

b. The management and staffing is most easily described in terms of the Vepco structure that is responsible for initiating and supporting this project the review team composition and the functional responsibilities.

c. Subsequent paragraphs of this section describe the:

1) Vepco Management Support Structure
2) CRDR Team Composition and Responsibilities
3) CRDR Team Task Responsibilities

2.2 VEPCO MANAGEMENT SUPPORT

Establishment of the Vepco CRDR project and the development of the project team was initiated by Mr. W. L. Stewart, Vice President of Nuclear Operations and Mr. R. H. Leasburg, Senior Vice President of Engineering & Construction. Directly below this level of management are the Station Managers for the Surry and North Anna Power Stations, the Manager of Nuclear Operations Support, the Manager of Nuclear Engineering, and the Manager of Construction. It is this level of management that has the directive responsibility for the development of the review team and its on-going support. Figure 2-1 illustrates this upper management organization.

2.3 CRDR TEAM

2.3.1 General

a. The CRDR team is composed of up to 27 members, 10 constituting the dedicated core team. This core group will be supplimented on an as-required basis by the remaining individuals. This support group is composed of representatives from all required disciplines such as nuclear, mechanical, electrical, industrial, and human factors engineering. This structure is shown in Figure 2-2.

b. Within the core CRDR team, 6 individuals have been designated as members of the Human Engineering Discrepancy Assessment Team (HEDAT). Principle responsibilities of the HEDAT will be to review and assess all HED reports as described in Section 5.0 and, to develop recommended resolutions, and establish preliminary scheduling of all backfit activities.

2.3.2 <u>CRDR Core Team</u>

2.3.1.1 Structure and Function - The core team is structured as illustrated in Figure 2.2. As can be seen, the primary management structure is comprised of the HEDAT members. This, as stated earlier, enhances the review team's ability to rapidly respond at a competent technical level to the broad spectrum of review activities on a day-to-day basis. Core team resumes, contained in Appendix A, document the proven track record of this team as managers, administrators, supervisors, and technical experts.

2.3.2.2 Lead Discipline Engineer - The Lead Discipline Engineer (LDE) for the CRDR is Mr. H. W. Burruss. Mr. Burruss, with 9 years of technical and managerial experience, has the overall responsibility for insuring that the review is conducted as

planned and scheduled. As the team manager, he will review the project's progress, identify any problems concerning schedules and planning and, with the aid of the team coordination staff, he will resolve all identified coordination problems. He will also chair all project meetings required during the course of the review and will be responsible for reporting project status and progress to his immediate manager. As the review team's technical leader he will insure that adequate technical resources are applied to all review activities. As a member of HEDAT, he will function as their team leader and be responsible for insuring strict adherence to HEDAT review procedures.

2.3.2.3 NOD Corporate Project Coordinator - Mr. T. A. Harding is the project's NOD Corporate Project Coordinator (NCPC). Mr. Harding represents 14 years of nuclear power generation experience in both station operation and human factors. As can be seen from the CRDR Project Team Organization Chart (Figure 2-2), Mr. Harding's position has multiple responsibilities. He functions as a representative of corporate NOD management policy, he acts in concert with all other coordinators in a staff function to the LDE, he insures that adequate direction is received by the Site Operations Coordinators for both power stations, and he is responsible for contributing technical input to the total review process and to all HEDAT activities. As can be seen, Mr. Harding is uniquely qualified for this role due to his interdisciplinary experience base.

2.3.2.4 Surry and North Anna Site Operations Coordinators - Mr. S. R. Burgold and Mr. A. G. Neufer are the Site Operations Coordinators (SOCs) for the Surry Power Stations and North Anna, respectively. As station coordinators, they will be responsible for determining station facilities and personnel availability for project activities and coordinating these factors with the project schedule. As technical team members, they will supply operational input to all phases of the review. Of essential value will be their operational expertise which will reflect the individual styles and philosophies that exist at each station. Both Mr. Burgold and Mr. Neufer hold SRO licenses and collectively represent 35 years of nuclear operations experience, 27 of which are at the Surry and North Anna Power Stations.

2.3.2.5 Surry and North Anna Lead Human Factors Specialists - Mr. W. T. Talley and Mr. D. R. Eike are the Lead Human Factors Specialists (LHFSs) for the Surry and North Anna Power Stations, respectively. Mr. Eike and Mr. Talley collectively represent over 18 years of applied human factors experience, the majority of these years within the nuclear power industry. An additional 20 years of technical and engineering experience is also represented in Mr. Talley's background that includes electrical, piping and mechanical, and electronics work in the power generation and aerospace industries and the military. These two

individuals will be primarily responsible for insuring the technical quality of human factors work and the availability of appropriate human factors specialists as required throughout this project. The LHFSs will work closely with the SOCs and will coordinate all HF activities with the LDE and NOD CPC. They are directly responsible to the LDE for progress of the HF areas of the project and will report any deviations from planned activities, methods or procedures in a timely manner. They will also be responsible for technical justifications related to any proposed methodological or procedural changes. As members of the HEDAT, they will establish accurate and realistic statements of human performance aspects for all identified problems. Of considerable value will be their input in determining suggested resolutions to HEDs which will not potentially create other, additional HF concerns.

2.3.2.6 Training Representatives - Mr. L. E. Gardner from Surry and Mr. G. E. Pederson from North Anna, will be required to contribute to the task analytic process and, due to the specialized discipline, will furnish valuable adjunct information on operational scenario design and cognitive task elements.

2.3.2.7 Human Factors Specialists - Human Factors support personnel are composed of two major groups of people. As indicated in Figure 2-2, the Human Factors Specialists, whose resumes appear in Appendix A, are committed to this project for direct support of all data collection; data reduction and analysis; and HED generation, analysis, and resolution. Also, in support of this project is a pool of human factors support personnel that represent diverse and current specialized experience backgrounds in human factors. The support group, headed by Dr. H. P. Van Cott (identified in Figure 2-2 as the HF Project Manager) will be available on an as-needed basis throughout the review.

2.3.3 Review Team Support Members

2.3.3.1 General - Review Team Support members have been assigned support roles from the various required disciplines to insure an appropriate level of technical quality for the project. Although not assigned full-time, their availability has been assured by Vepco management directive and has been pre-planned to the degree possible during the initial planning and implementation phases of the project. Individual disciplines represented in this support group include but will not be limited to:

1) Operations
2) Training
3) I&C Engineering
4) A&E
5) Human Factors

2.3.3.2 Operations - Experienced operators from both stations will participate in various phases and activities of this project. Of particular concern will be their contribution to the Operating Experience Review (OER) described in paragraph 4.2. They will also furnish additional assistance during the verification of task performance activities, validation of CR functions processes, and the clarification of HEDs as required. Each operator will have specific, unique experiential information that, when required, can contribute significantly to appropriate HED resolutions.

2.3.3.3 I&C Engineering - The instrumentation and control (I&C) engineer will be primarily involved in the control room inventory process and HED assessment tasks. Intimate knowledge of plant instrumentation from the I&C viewpoint will also utilize during the verification of availability of CR functions.

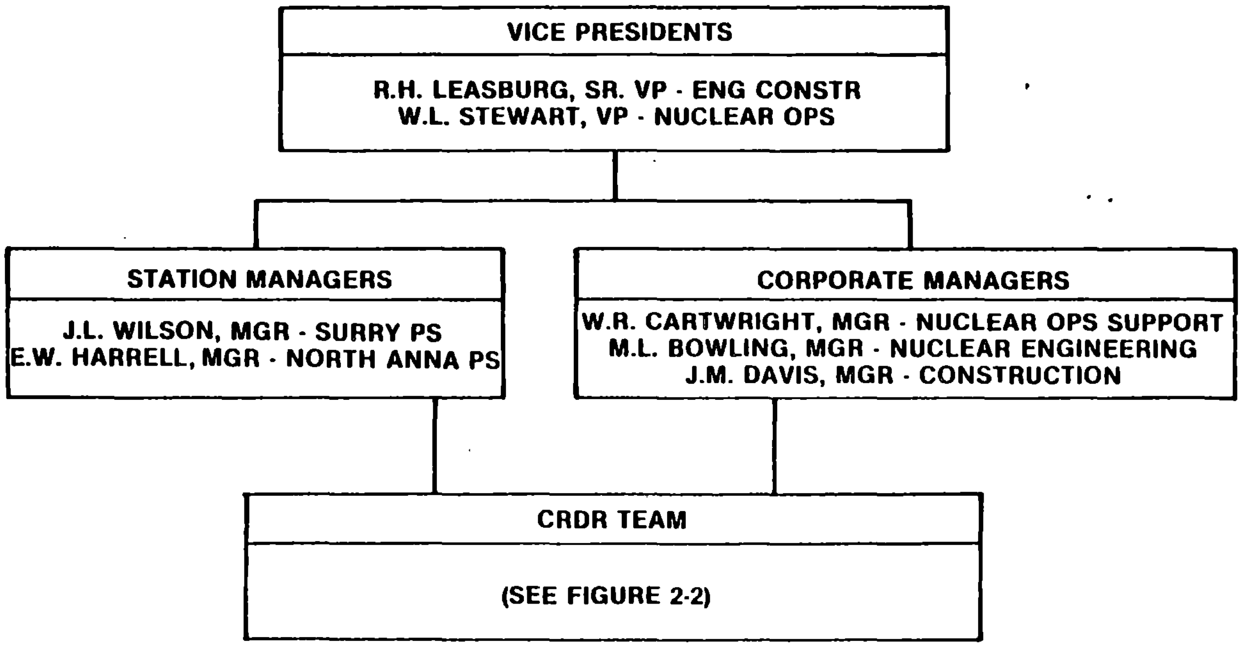
2.3.3.4 A&E Representative - The primary importance of an A&E representative is seen as contributing design rationale concerning the plant characteristics and to aid in the determination of HED resolutions that fit within the plant design constraints.

2.3.4 <u>CRDR Team Task Responsibilities</u>

a. Figure 2-3 illustrates, in matrix format, the task responsibility by team member. It should be recognized that the dynamic aspects of the CRDR will probably introduce requirements to adjust or supplement these anticipated assignments with additional team members. Any such changes of a significant nature will be documented and explained in the CRDR Final Summary Report.

b. Major activities and approval cycles are illustrated in Figure 2-4. This figure illustrates the general managerial and technical responsibilities of the core and support team from project planning to summary report preparation.

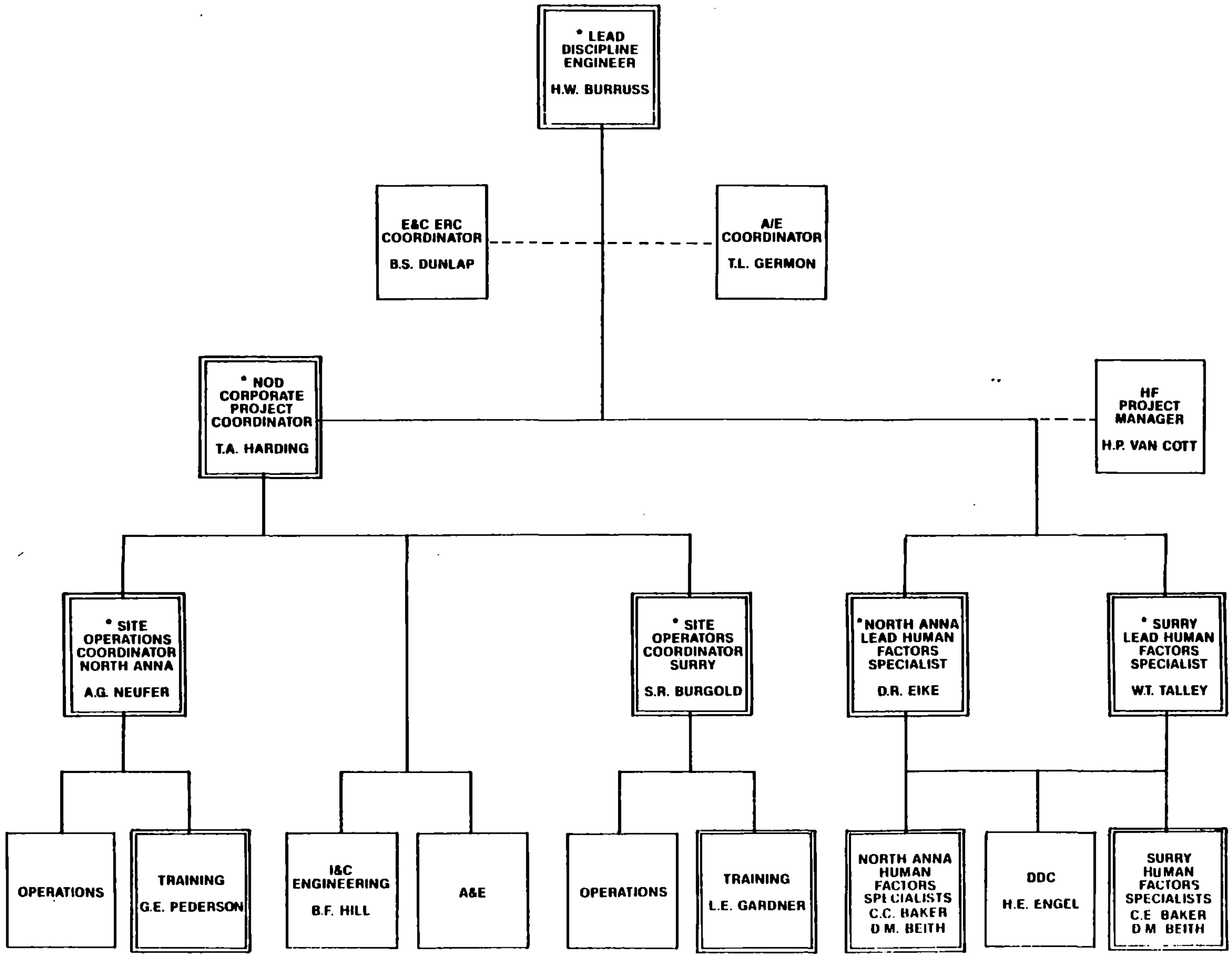
VEPCO MANAGEMENT ORGANIZATION



VEPCO CRDR PROJECT MANAGEMENT SUPPORT

FIGURE 2-1

VEPCO CRDR PROJECT TEAM



* MEMBER OF HEDAT

☐ CORE TEAM MEMBERS

VEPCO CRDR PROJECT TEAM

FIGURE 2-2

TASK	LDE	NCPC	SOC	LHFS	HFS	A/E
1. Program Definition	X	●		●		
2. Master Schedule Preparation and Revisions	X	●		●		
3. Sub-schedule Preparation and Revisions	0	0	●	X	●	
4. Detail Schedule for Plant-Specific CRDR Preparation and Revisions		0	X	●	●	
5. Periodic Update Reports	0	●	●	X	●	
6. Define CRDR Human Factors Requirements	●	●		X	●	
7. Conduct Plant-Specific Review (CRDR)		●	●	X	●	●
8. Review HEDs and Determine Corrective Actions	X	X	X	X	●	●
9. Present Recommended Corr. Actions to Management and Assess Program	0	0	0	X	●	●
10. Final Summary Report Preparation				X	●	
11. Final Summary Report Review	X	●	●			
12. Final Summary Report Approval	0	0	0			
13. Final Summary Report Delivery	●	X				
14. Implementation of Corrective Actions (Phase III)	X	●	●	●		●
15. Review of Corrective Actions (Phase III)	X	●	0	0		

X = Primary Responsibility
● = Support Responsibility
0 = Approval Authority

LDE = Lead Discipline Engineer
NCPC= NOD Corporate Project Coordinator
SOC = Site Operations Coordinator
LHFS= Lead Human Factors Specialist
HFS = Human Factors Specialist
A/E = Architect Engineer

Figure 2.3 CRDR (Project Management)
Task Responsibilities

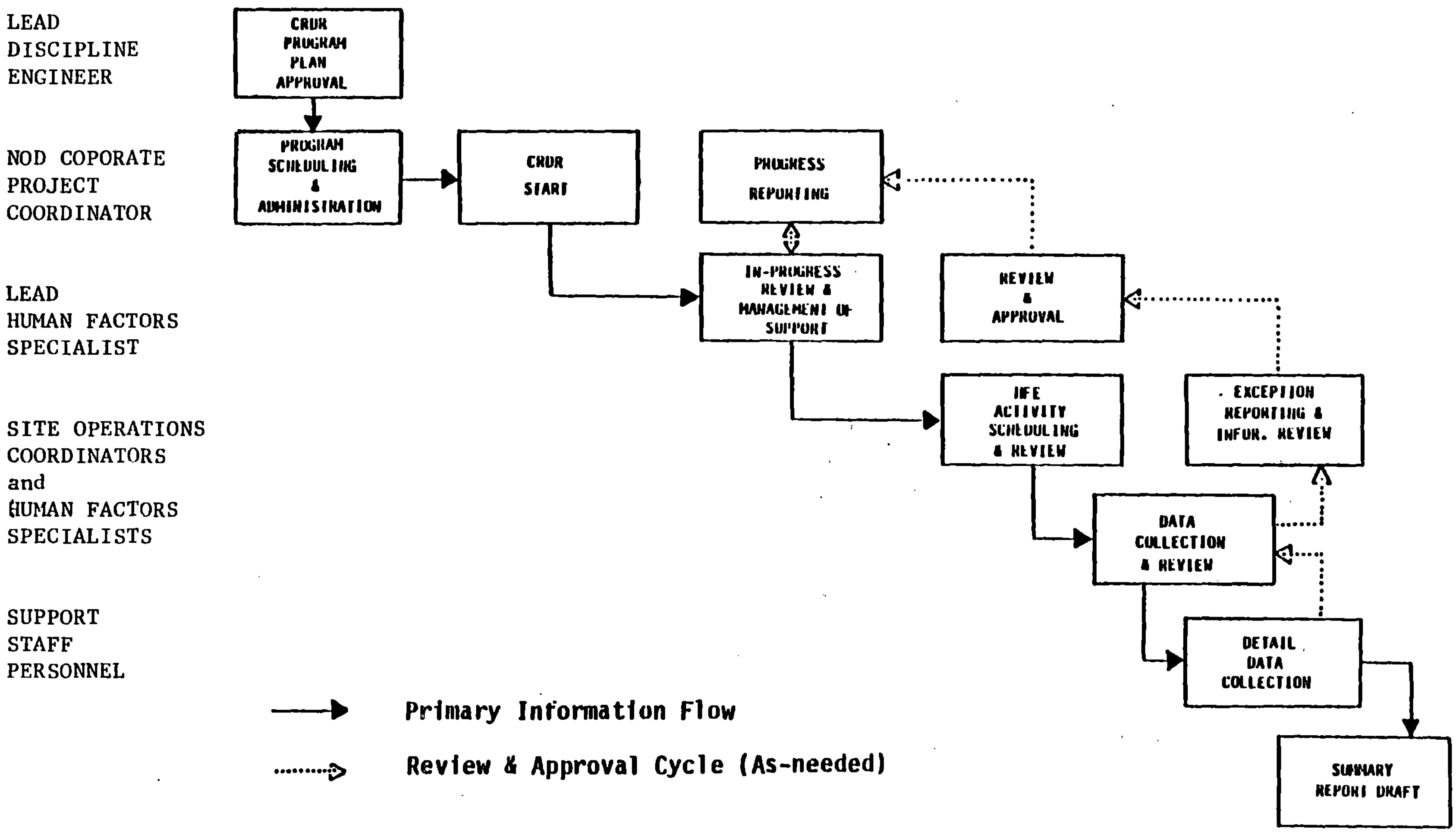


Figure 2.4 CRDR Activities Plan and Approval Cycle

SECTION 3.0 DOCUMENTATION AND DOCUMENT CONTROL

Vepco recognizes the critical role of document control during the CRDR process. To this end, the project team includes an individual experienced in document and office management who will be responsible for controlling who will be responsible for controlling all project documentation, including: letters and memos, progress reports, interim reports, HED reports, and summary reports. All final versions of primary project documents will be assigned a unique designator prior to distribution, and a hard copy will be maintained in a central project file.

The primary emphasis in the documentation control system will be the control of the review project documents to ensure an accessible and fully auditable review data file. The system to be used is also compatible with the existing document control systems currently in place at both Vepco nuclear stations and the corporate headquarters.

SECTION 4.0 REVIEW PROCEDURE

4.1 INTRODUCTION

4.1.1 General

This section of the Program Plan describes the procedures to be used by VEPCO to review the completeness and suitability of the Surry and North Anna Control Rooms. As suggested in NUREG-0700, the specific objectives of the review effort will be:

a. To determine whether the control room provides the system status information, control capabilities, feedback, and performance aids necessary for the control room operators to accomplish their functions and tasks effectively.

b. To identify characteristics of the existing control room instrumentation, controls, other equipment, and physical arrangment that may detract from operator performance.

Throughout the review process, VEPCO will focus on ensuring that the functions and tasks assigned to the operators can be accomplished in an effective manner within the existing control rooms

4.1.2 Method

The review process planned by VEPCO will be conducted in six activities that roughly parallel those described in Section 3 of NUREG-0700. Each of these activities is described below.

4.1.2.1 Operating Experience Review - The objective of the Operating Experience Review (OER) is to identify any characteristics in the design, layout or operation of the Surry and North Anna Control Rooms that may contribute to or alleviate operator performance problems. The focus during this activity is on control room characteristics of concern that have been documented through plant and industry reports, or are reflected by the experience of the control room operators. This activity will be conducted in two parts:

1) A review of plant and industry historical documents (e.g., LERs, Vendor Tech Bulletins)
2) Interviews with licensed plant operating personnel

Any problems identified during the OER will be reviewed to determine their causes and effects. Where appropriate, HEDs will be written and scheduled for assessment.

4.1.2.2 Control Room Surveys - The objective of the control room surveys is to ensure that the Surry and North Anna Control Rooms conform to established principles of human engineering as contained in Section 6 of NUREG-0700. Surveys will be conducted through the application of checklists developed from the Section 6 guidelines. Any deviation from the guidelines will be noted. HEDs will then be written and scheduled for assessment.

4.1.2.3 System Functions and Task Analysis - A System Functions and Task Analysis (SFTA) will be conducted at each station to identify information and control requirements associated with operator tasks performed during emergency conditions. These requirements will serve as evaluation criteria during the Verification of Task Performance Capabilities and Validation of the Control Room Functions.

Any problems in the design or layout of the control room identified during the SFTA will be noted, and HEDs will be written and scheduled for assessment.

4.1.2.4 Control Room Inventory - In order to ensure the availability of required instrumentation and controls, a comprehensive inventory of all control room components will be prepared for each unit at the Surry and North Anna Power Stations. The inventory will be organized by major control room panels, and will serve as a reference document during the Verification of Task Performance Capabilities activity. As part of the control room inventory, a 1/2 scale photomasaic will be prepared for each station, as well as photo-documentation of differences between units at each station.

4.1.2.5 Verification of Task Performance Capabilities - Task performance capabilities will be verified by ensuring that all operator information and control requirements identified during the SFTA are met both in terms of the availability of the components and human factors suitability of the components. Any requirements not met will be identified, and HEDs will be written and scheduled for assessment.

In addition, this activity will identify any control room components that are unnecessary and subject to consideration for relocation outside the primary operating area.

4.1.2.6 Validation of Control Room Functions - The final activity in the review process will be to ensure that all operator functions can be performed within the existing control room. This activity will employ walk-through, talk-through exercises at the Surry and North Anna simulators using selected event sequences identified during the SFTA. Any problems identified in performing control room functions will be documented and HEDs will be written and scheduled for assessment.

4.1.3 Products

The product of the review process will be a set of human engineering discrepancies identified in the Surry and North Anna control rooms. These HEDs will specify the type and extent of the problem, the potential impact on operator performance in relation to plant operation, and a suggestion for corrective action.

A detailed description of the review process is presented in the following sections.

4.2 OPERATING EXPERIENCE REVIEW

4.2.1 Introduction

The Operating Experience Review (OER) will identify CR design attributes and procedural activities that may contribute to or alleviate operator performance problems. This review consists of two tasks which are:

1) A review of plant and industry historical documents.
2) A survey of plant operations personnel.

4.2.2 Review of Historical Documents

4.2.2.1 General - This documentation review will focus on the analysis of relevant plant and industry documents to identify any reported problems that may have contributed to degraded operator performance. Identified problems will be documented in HED reports and subsequently assessed by the HEDAT (see Section 5.0, Assessment and Implementation).

4.2.2.2 Historical Reports - The following documents will be reviewed:

1) Licensee Event Reports (LERs)
2) Significant Operating Experience Reports (SOERs)
3) Engineering Work Requests (EWRs)
4) INPO Significant Event Reports (SERs)
5) INPO Operations and Maintenance Remainders (O&MRs)
6) Westinghouse Data Letters (WDLs)
7) Westinghouse Technical Bulletins (WTBs)

4.2.2.3 Review Methods - All documentation will be reviewed for human performance-related potential problems. This initial screening, conducted by the human factors specialists, will result in a collection of historical reports which identifies one or more of the following problem/error causes:

1) Human Error - a classification that indicates an action or actions originating from within the control room by station personnel which caused a problem.

2) Equipment Failure - a classification that indicates a failed piece of plant equipment caused the problem <u>and</u> the failure was not readily or easily detected from the available CR instrumentation including alarms.

3) Procedure Problem - a classification that indicates a procedure was inadequate.

4) Other - a classification that, while not explicitly categorized as human error, equipment failure, or procedure problem, appears to have a potential human performance element involved.

All historical reports so classified will have a Historical Report Summary completed by the reviewer (see Appendix B). All report summaries will subsequently be reviewed by the LHFS. As indicated on the sample Historical Report Summary, the LHFS will indicate concurrence or non-concurrence with the reviewer's classification. HED reports will be generated on all historical reports classified as "Follow-up Action Inadequate". A copy of the Historical Report Summary will be attached to its related HED report to aid in subsequent assessment.

4.2.3 Operations Personnel Survey

4.2.3.1 General - The Operations Personnel Survey (OPS) will focus on the analysis of experiential information to identify potential problems that may have contributed to degraded operator performance. Additionally, information will be solicited which identifies possible outstanding design features which appear to facilitate operator performance. This survey consists of three tasks which are:

1) The distribution and collection of self-administered questionnaires.

2) The conduct of structured interviews.

3) The analysis of all questionnaire and interview responses.

4.2.3.2 Self-Administered Questionnaires - Questionnaires will be distributed to all licensed SROs and ROs, all STAs and licensed training staff. It will also be distributed to selected station administrative personnel. This questionnaire will solicit experiential information concerning the following areas:

1) Availability and usability of CR information
2) Design and location of controls and displays
3) Annunciator warning system effectiveness
4) Adequacy of workspace layout and anthropometry
5) Operation of process computer
6) Adequacy of panel labeling
7) CR communications
8) CR environment
9) Maintenance in the CR
10) Units 1 and 2 operator interfaces
11) Personnel Human Error
12) Respondent biographical data

4.2.3.3 Structured Interviews - Based upon an analysis of the biographical and response data from the self-administered questionnaires, a straitified sample of operators will be selected for structured interviews. This sample will include, as a minimum, 50% of the licensed SROs and ROs. The format of the interview will systematically address and document details concerning the following areas from NUREG-0700:

1) Workspace
2) Anthropometrics
3) Emergency Equipment
4) Heating, Ventilation and Air Conditioning
5) Illumination
6) Ambient Noise
7) Maintainability (Operator Performed)
8) Communications
9) Annunciator System
10) Controls
11) Displays
12) Labels and Location Aids
13) Computer System
14) Conventions

In addition, operators will be encouraged to provide any other comments or concerns they may have regarding the design or operation of the control room.

4.2.3.4 Response Analysis - All response data will be reviewed and tabulated. Questionnaire/Interview checklists constructed from specific guidelines contained in Section 6.0 of NUREG-0700 will be used to aid in the analysis of all responses. A negative

response which identifies a deviation from guidelines or a potential human performance problem will result in the generation of an HED report. All HED reports will be assessed by the HEDAT during the assessment and implementation phase.

4.3 CONTROL ROOM SURVEYS

4.3.1 Introduction

a. The CR surveys are planned to follow the guidance of NUREG-0700. Human factors specialists, in concert with experienced operations and engineering personnel, will measure and observe a number of CR design features. Central to this survey effort are the HF guidelines contained in Section 6.0 of NUREG-0700. These guidelines will be used as specific and discrete criteria to which all survey data will be compared.

b. The surveys have been organized, and methodology has been developed which parallels the structure of Section 6.0 of 0700. Fourteen specific surveys are planned which are:

1) Workspace
2) Anthropometrics

3) Emergency Equipment

4) HVAC

5) Illumination

6) Ambient Noise

7) Maintainability

8) Communications

9) Annunciator Systems

10) Controls

11) Displays

12) Labels and Location Aids

13) Computer Systems

14) Conventions

c. In order to facilitate data collection, reduction, and analysis and to support the review documentation requirements, task plans have been developed for each of the above 14 survey areas. Each of these task plans direct the data collection, data analysis, and HED report generation based upon a mix of four basic data collection procedures. These are:

1) Measurements

2) Observations

3) Questionnaires/Interviews (see paragraph 4.3.2.e)

4) Document Reviews

Each of these task plans uses one or more of these procedures to collect the data needed to evaluate the task plan-designated area of CR design. Task plan organization, and these procedures are explained in more detail in paragraph 4.3.2.

4.3.2 Task Plan Procedures

a. Each task plan contains an identical format and outline. Content is varied only where necessary for the particular design area discussed. A typical task plan outline is as follows:

1.0 - Objectives
2.0 - Review Team
3.0 - Criteria Summary
4.0 - Procedures
5.0 - Equipment/Facility Requirements
6.0 - Inputs and Data Forms Listing
7.0 - Required Outputs/Expected Results
8.0 - Figures and Tables (if required)
9.0 - Procedure Exceptions (if any)

Appendix A - Detailed Criteria
Appendix B - Data Collection and Analysis Forms
Appendix C - Criteria-to-Procedure Matrix
Appendix D - Task Plan Critique

b. Sections 1.0 through 8.0 of the text are brief summaries intended primarily to familiarize the task conductor with the overall task requirements. Upon completion of the task, the task conductor completes Section 9.0, if necessary, and submits a completed Task Plan Critique from Appendix D to the Vepco technical reviewer. The critique is to identify any difficulties or problems with the task plan and is not a central part of the review process. The important and detailed criteria and procedural information are contained in Appendix A and B of each task plan.

c. Appendix A contains a subset of the guidelines from NUREG-0700, Section 6.0. Each guideline is worded identical to the 0700 guideline and the 0700 guideline paragraph number is preserved for ease of cross-referencing. When taken in total, all 14 of the Task Plan criteria sets represent subsections 6.1 through 6.7 of 0700.

The last two subsections, 6.8 and 6.9 of 0700 Section 6.0, are used as criteria for the SFTA and the verification and validation activities. The task plans, themselves, occur in the same order as the Section 6.0 subsections of 0700 and, with one

main exception, are titled similar to the Section 6.0 subsection titles. For example, the Annunciator System Review Task Plan (numbered as TP-3.1) incorporates as criteria the guidelines contained in 0700 Section 6.3. The main exception to this approach is that Section 6.1 - Workspace, of 0700, was further subdivided into seven task plans that, in general, follow the additional breakdown of Section 6.1. Thus, General Layout - 6.1.1 becomes the Workspace Task Plan, Workstation Design - 6.1.2 becomes the Anthropometrics Task Plan, Emergency Equipment - 6.1.4 becomes the Emergency Equipment Task Plan, and Environment - 6.1.5 becomes HVAC, Illumination, Ambient Noise, and Maintainability Task Plans. The guidelines in Section 6.1.3 - Multi-Unit Control Rooms, was integrated into all other task plans as appropriate.

d. Some minor exceptions to this general classification scheme for the evaluation criteria occurred that was caused, primarily, by individual interpretations of specific guideline statements. As an example, 6.1.1.6b of 0700, while appropriately in subsection 6.1 - Control Room Workspace, explains the need for dedicated communication links between the control room boundary and a remotely located shift supervisor's office (note that it also refers to guideline 6.2.1.7 - Point-To-Point Intercom Systems).

It was felt that the evaluation of that design feature would be easier to accomplish if 6.1.1.6b appeared as a criterion in the Communications Task Plan.

e. Appendix B in each task plan is subdivided into as many subappendices (e.g., B1, B2, B3, etc.) as is necessary to describe the detailed data collection and analysis procedures used for that plan. Appendix B1 is always measurements data forms and directions, B2 is always an Operator Interview/Questionnaire, B3 is always an Observations Checklist, and B4 is always a Document Review Checklist. B5 through B9 are additional analyses directions and supplement forms as required. To preserve consistency from task plan to task plan, Appendices B1 through B4 always exist. As an example, if measurements are not required data for the Conventions Survey Task Plan, an Appendix B1 - Measurements sheet is inserted, in place, with the notation of "non required." In this way, it is possible to conduct any or all of a given type of procedure across one or more task plans during a review. This flexability allows for optimizing the review data collection and analysis activities to fit the review scheduling, personnel availability constraints, and equipment access constraints, all without adversely impacting data quality or review comprehensiveness.

Of special interest here, is that the Interview/Questionnaire sections of each of the 14 task plans (with the addition of operationally related criteria from Sections 6.8 and 6.9 of 0700) constitute the prepared structured interview that is described in paragraph 4.2.3.

f. The various data types are determined by the 0700 criteria. Measurement data are those data which must be numerically compared to the 0700 guidelines for evaluation. These consist of such design features as display height, noise levels, or illumination levels. Observation data are those data that a trained human factors specialist can adequately evaluate by observing the design feature. These consist of such features as procedure and document storage, office locations, and restroom facilities. Questionnaire/Interview data are data that require a knowledge of the equipment, frequently operational, before such data can be adequately or realistically evaluated. These consist of such features as the possible meaning attached to color codes, identification of degraded illumination characteristics in certain indicator lights, or controls that are extremely difficult to operate. Documentation Review data are data that must (or may) be obtained by reviewing available documents that pertain to the design and/or operation of the

plant. These consist of such design features as the availability and adequacy of a dictionary of standard terms, abbreviations, and acronyms, or an administrative procedure for the control of temporary labels.

g. As each data type collection procedure is complete, the task conductor may choose to proceed to the next data collection procedure, or may choose to reduce, analyze, and generate HED reports (if any) on the just-completed data collection step. This additional flexibility allows for involving plant personnel (who are members of the CRDR Project Team) in a manner in which they are either frequently but moderately involved, or infrequently but heavily involved in reviewing HED reports and furnishing needed plant information into the review process.

h. All task plan procedures require that, before an HED report can be generated, the collected data must be compared to one or more referenced criterion. In comparing the data to the criteria, the task conductor will annotate the checklist column next to the criterion guideline as either yes, no, or N/A. For all "no" check marks, an HED report is then generated and the HED report number is entered in the criterion comments column. As a cross-reference, the data collection appendix number and the

guideline paragraph number are entered on the HED report form. Once this process is complete for each data point within a task plan, and all task plans are complete, the surveys and reviews of the human factors suitability of the evaluated design (independent of the task requirements) are completed and documented.

i. Copies of all completed task plans are filed in the Review Data File.

4.4 SYSTEM FUNCTIONS AND TASK ANALYSIS

4.4.1 Introduction

The objective of this activity is to establish the information and control requirements and the performance criteria for the tasks which operators are required to accomplish under emergency conditions. These requirements and criteria will serve as benchmarks for the examination of the adequacy of control room instrumentation and other equipments.

4.4.2 Method

The procedure to be employed by Vepco in conducting the System Functions and Task Analysis (SFTA) involves a top-down approach starting with an identification of system units and progressing through analysis of selected operator tasks. Throughout this process, the emphasis will be on identifying and analyzing operator information and control requirements with respect to maintaining critical plant safety functions (i.e., containment integrity, reactivity control, RCS inventory control and heat transfer).

Since the ERGs and associated generic task information were based on a technically sound rationale for the allocation of functions to operators and plant subsystems, it should not be necessary to perform an independent system functions analysis and allocation. Instead, the ERGs and generic task information, together with available plant specific emergency response procedures, will be used as the starting point for the top-down analysis of tasks and task elements which control room personnel must perform. Therefore, the first step in this process will be to review the ERGs to identify all safety-related functions for each major plant system.

The next step in this activity will be to select emergency event sequences that challenge safety-related functions. Event scenarios such as the following will be considered for inclusion in this process:

- Small loss of coolant accident
- Inadequate core cooling
- Anticipated transient without reactor trip following a loss of off-site power
- Multiple failure of tubes in a steam generator and tube ruptures in more than one steam generator.

Other scenarios will be considered, as necessary, to meet the objectives of the task analysis. Functions such as the following will be challenged by the event sequences chosen:

- Subcriticality
- Containment integrity
- Heat sink
- Reactor coolant system inventory
- Core cooling
- Reactor coolant-system integrity.

Selection of event scenarios and system functions will form the basis for the selection of appropriate ERGs. The WOG generic task analysis data will provide the initial input for the development of unit-specific task analysis information for the Surry and North Anna Power Stations.

This approach to task analysis has the following general characteristics:

- o An inventory of tasks that must be accomplished for each event scenario is developed. A sample of a typical Task Sequence Chart indicating the tasks required for a reactor trip or safety injection event illustrates the output of this step (see Figure 4-1).

- o For each of the tasks identified above, a typical Task Data Form (see Figure 4-2) will be prepared indicating:

  - the operating event

  - the title of the task

  - the task objective

- the cue or signal that initiates the task
- the number of the task
- the behavioral or subtask elements that identify which operator performs the element, where it is performed, the action that is taken, and other data necessary to describe components, parameters, and parameter states

The unit-specific task analysis information will identify the required instruments and controls for each task.

As appropriate, HEDs that are identified will be assigned an identification number and fully described on separate HED forms.

These task data forms have several unique characteristics. The form is formatted so that the behavior, instruments, controls, and other information associated with a subtask can be read across the data form as a sentence beginning from the left column and moving to the right. This format also permits task data to be entered into a computer for subsequent selective searches if appropriate.

In completing the task data forms for each event scenario, the task analyst will select and enter descriptive terms from a controlled vocabulary (see example in Figure 4-3). This standard vocabulary will reduce to a minimum variation in the choice of terms used by different analysis to describe tasks and task elements.

Since the choice of verbs that describe operator actions can sometimes present a problem, an additional list of behavioral verbs arranged in hierarchical form will be used. (see example in Figure 4-4).

As the task analysis is being conducted it may become evident that some instruments or controls are not suitable for the performance of a required task. This may occur during the development of the task analysis or in subsequent verification and validation activities performed on a simulator or control board photomosaic. As these HEDs are identified, they will be designated by number on the appropriate task data form and documented in HED forms for subsequent assessment.

4.4.3 Products

The product of the SFTA process will be a detailed listing of all operator information and control requirements for selected event sequences. This list will be used as input to the verification of task performance capabilities to assess the availability and suitability of instruments and equipment used by the control room operators. In addition, the results of the SFTA will be used to assist in the selection of event sequences to be analyzed during the validation of control room functions.

4.5 DEVELOP CONTROL ROOM INVENTORY

4.5.1 Introduction

The objective of the control room inventory is to develop a comprehensive listing of all instrumentation, controls, and equipment contained in each of the control rooms at the Surry and North Anna Power Stations. This list will be used in subsequent tasks to determine the adequacy of CR components for supporting operator information and control requirements identified during the task analysis.

4.5.2 Method

Project personnel will conduct a systematic review of relevant control room documentation (e.g., instrument lists, engraving lists, FSAR, etc.) to develop a preliminary inventory for each unit. The preliminary inventory will be expanded and made unit-specific through reference to the photomosaics and visits to the control rooms and/or simulators.

The specific data fields to be included in the inventory have been selected to accommodate the Vepco data base management system (DBMS). The inventory process has been designed to support creation of five files:

- o System instrumentation
- o System manual controls
- o System automatic controls
- o Annunciator system
- o Miscellaneous CR instrumentation and controls and operator equipment.

The inventory sheets will record the following fields for all components:

- o System name and number
- o Station
- o Unit
- o Reviewer's name
- o Date
- o Physical location of item in CR
- o Vendor or manufacturer information, including model number
- o Status: safety-related, non-safety-related, miscellaneous, operator work station code.

For components in the system instrumentation file, the following data will be recorded on the sheet:

- Nameplate information
- Type of instrument
- Parameter measured
- Instrument characteristics (scale range, markings, divisions).

For components in the manual controls file, the following data will be recorded:

- Nameplate information
- Type of control switch
- Equipment/parameter being controlled
- Number of switch positions
- Position designations (on, channel A, increase, etc.)
- Type of action
- Associated displays.

For components in the automatic controls file, the following data will be recorded:

- o Nameplate information
- o Type of control switch
- o Equipment/parameter being controlled
- o Control response
- o Associated displays.

For the annunciator system file, the following information, will be recorded:

- o System associated with annunciator
- o Annunciator matrix location
- o Annunciator message.

Similar data will be recorded for components in the miscellaneous and operator work station files, as necessary. In addition to the above information the following information also be recorded for each component, where appropriate:

- o Component photograph or drawing, if available
- o Photomosaic location code
- o Surveys and checklists applied to component
- o Identification of HEDs written for component, if any.

4.5.3 Products

The product of the CR inventory will be a comprehensive list of all instrumentation, controls and equipment contained in each of the control rooms at the Surry and North Anna Power Stations. The CR inventory will be used to assist in the verification of availability of CR instrumentation (see paragraph 4.6).

4.6 VERIFICATION OF TASK PERFORMANCE CAPABILITIES

4.6.1 Introduction

The objective of this activity is to verify that operator emergency tasks can be performed in the existing control room with minimum potential for human error, by ensuring the availability and suitability of required control room instrumentation and controls. As recommended in NUREG-0700, this activity will be conducted in two parts: verification of availability and verification of suitability.

4.6.2 Verification of Availability

Verification of availability will be accomplished through a comparison of the operator information and control requirements

identified during the task analysis to the results of the control room inventory. The comparison will be conducted on a panel-by-panel basis to verify the presence or absence of instruments and equipment that provide the information and control capability necessary to perform each task sequence analyzed during the SFTA.

The results of the verification of availability will be analyzed from both an inventory perspective and a task analytic perspective. From the inventory perspective, the application (i.e., associated tasks) of a component will be recorded on the appropriate data sheet. From the task analytic perspective, satisfaction of an information or control requirement will be noted, including the appropriate component designation.

4.6.3 Verification of Suitability

Verification of suitability will involve examination of the human engineering characteristics of instrumentation and equipment identified during the verification of availability. During this process, selected guidelines from NUREG-0700 and criteria derived from the task analysis will be used to determine the suitability of CR components. This process will consider such aspects of components design as adequacy of display range,

usability of displayed values, relative location of related components, and other characteristics not easily evaluated without reference to specific task sequences. Any deviations from established criteria will be noted, and HED forms generated.

4.6.4 Products

The results of the verification of task performance capabilities will be any discrepancies noted in the availability or suitability of instrumentation, controls and other equipment required by the control room operators to perform tasks in the selected event sequences. Such discrepancies will be recorded on the standard HED form and assessed during the assessment and implementation phase. In some cases, HEDs identified during the verification process will not result directly from a Section 6.0 guideline but may result from task analysis derived criteria. Such HEDs will be properly annotated and the criteria described.

4.7 VALIDATION OF CONTROL ROOM FUNCTIONS

4.7.1 Introduction

The objective of this activity is to determine if the functions allocated to the control room operating crew during emergencies can

be accomplished effectively within: 1) the structure of defined emergency procedures, and 2) the design of the control room as it exists. As with Verification of Task Performance Capabilities, Validation of Control Room Functions is an extension of the SFTA. In this case, emphasis is placed on determining the adequacy of the control room design for supporting operator task sequences required to identify and evaluate plant status and diagnose selected transients.

4.7.2 Method

NUREG-0700 recommends that the validation process involve selected sequences analyzed during the SFTA. Therefore, the exact combination of task sequences to be included in the validation effort will be determined based on the results of the sequence selection process of the SFTA.

The principal activities during this task involve observation of operators performing selected event sequences on the Surry and North Anna simulators. The following process will be employed during this task:

1) A set of task sequences will be selected from those analyzed during the SFTA. This set will include the sequences previously analyzed, as well as any other sequences deemed appropriate by the CRDR project team.

2) Surry and North Anna ERPs associated with the selected sequences will be obtained.

3) All participants in the validation effort will be briefed concerning the objectives and procedures of the walk-throughs, including assumptions concerning the status of the plant at the onset of the event sequence.

4) Control room personnel will be observed as they perform the selected sequences. The operators will be instructed to describe their actions as they perform the sequences, including:

   - indication that sequence should be initiated

   - sources of information (displays, procedures, knowledge, etc.)

- o application of information, including any conversions or uncertainties
- o controls selected and expected system response
- o methods for verifying system response and selection of alternative actions if response is not obtained
- o indications that sequence is proceeding as expected
- o indication that sequence is complete
- o other comments, as appropriate.

During this process, the observers may interrupt the operators to obtain clarification or additional information.

5) Observers will record significant operator comments, as well as any observations that relate to the performance of CR functions.

6) Significant event sequences may be video-taped and, where appropriate, voice-over commentary by the performing operators will be recorded. As a general rule, video-taping will be

reserved for documenting selected event sequences which are of known interest, rather than as an all-purpose data collection method.

7) The results of the observations will be analyzed to identify any problems with the CR layout, location of related components, operator workload, or other human engineering concerns. Any HEDs observed during the validation process will be noted and recorded.

Observers will record: 1) any difficulties the operators had in responding to the event, 2) the impact on operator performance of any previously identified HEDs, and 3) any additional discrepancies identified during this task.

4.7.3 Products

The results of the validation process will be used by the HEDAT primarily to assess the impact of previously identified HEDs on actual operator performance. If additional HEDs are identified during the validation process they will be recorded and assessed in the same manner as other HEDs.

TASK SEQUENCE CHART (TSC)

PLANT, UNIT # ______

SEQUENCE NO. E0 SEQUENCE TITLE REACTOR TRIP OR SAFETY INJECTION REV. # ______

TASKS IN MAIN SEQUENCE		W REF.	SEQUENCES/TASKS POTENTIALLY BRANCHED TO			COMMENTS
NUMBER	TASK TITLE		SEQUENCE NUMBER	TASK NO.	TITLE	
1	VERIFY REACTOR TRIP	E00.1		B-1	MANUALLY TRIP REACTOR	
		E00.1	ECA-1	1A	TRY TO TRIP REACTOR MANUALLY	
		C10.1				
2	VERIFY TURBINE TRIP	E00.2		B-2	MANUALLY TRIP TURBINE	
		E00.2				
3	VERIFY AC EMERGENCY BUSSES ENERGIZED	E00.3				
		C20.1	ECA-2	3	TRY TO RESTORE POWER TO AC EMERGENCY BUS	
4	CHECK IF SI ACTUATED	E00.4				
		E01.1	ES-0.1	1	CHECK NC SYSTEM AVERAGE TEMPERATURE	
5	VERIFY FEEDWATER ISOLATION	E00.5				
		E00.5		B-5	MANUALLY PERFORM FEEDWATER ISOLATION	
6	VERIFY CONTAINMENT ISOLATION PHASE A	E00.6				
		E00.6		B-6	MANUALLY PERFORM CONTAINMENT ISOLATION PHASE A	
7	VERIFY CA PUMPS RUNNING	E00.7				
		E00.7		B-7	MANUALLY START CA PUMPS	

FORM REVISION:

PAGE 1 OF 7

FIGURE 4-1

TASK DATA FORM (TDF)

PLANT, UNIT # ____________________

OPERATING SEQUENCE NAME REACTOR TRIP RECOVERY NUMBER ES-0.1 REV. # ____________ PAGE 1 OF ______

TASK TITLE CHECK NC AVERAGE TEMPERATURE TASK # 1

TASK OBJECTIVE ENSURE ADEQUATE DECAY HEAT REMOVAL

TASK CUE PROCEDURE

COMMENTS ____________________

SUBJECT			IMMEDIATE OBJECT OF ACTION (CONTROL ROOM COMPONENT)				REMOTE OBJECT OF ACTION					COMMUNICATION	HED I.D. NO.
WHO	LOCATION	BEHAVIOR VERB	NAME	DESCRIPTION	I.D.	LOC.	SYSTEM	PLANT COMPONENT	COMPONENT/ SYSTEM STATE	PARAMETER	PARAMETER STATE	(OTHER PARTY & LOCATION)	
	MC-1	OBSERVES	AUCT TAVE	RECORDER	IR 9	MC-1	NC			TEMPERATURE	557° & STEADY		
	MC-1	OBSERVES	S/G FDW CTRL CF-37 CLOSED	STATUS PANEL (ON)	MD 4	MC 14	IPE			TEMPERATURE	553°		C-1-0035
	MC-1	OBSERVES	S/G A FDW CTRL CF-37 CLOSED	STATUS PANEL (ON)	MD-4	MC-14	IPE			TEMPERATURE	553°		C-1-0035
	MC-1	OBSERVES	S/G C FEW CTRL CF-46 CLOSED	STATUS PANEL (ON)	MD-4	MC 14	IPE			TEMPERATURE	553°		C-1-0035
	MC-1	OBSERVES	S/G D FEW CTRL CF 55 CLOSED	STATUS PANEL (ON)	MD 4	MC-14	IPE			TEMPERATURE	553°		C-1-0035

FIGURE 4-2

STANDARD DATA BASE ENTRIES
FOR TASK DATA FORM (TDF)

SUBJECT			IMMEDIATE OBJECT OF ACTION (CONTROL ROOM COMPONENT)				REMOTE OBJECT OF ACTION					COMMUNICATION	HED I.D. NO.
WHO	LOCATION	BEHAVIOR VERB	NAME	DESCRIPTION	I.D.	LOC.	SYSTEM	PLANT DEVELOPMENT	COMPONENT/SYSTEM STARTS	PARAMETER	PARAMETER STARTS	(OTHER PARTY & LOCATION)	
NEO ANCO NCO SS STA AOE OE SO SM US SRO RO	(FROM LIST OF CONTROL BOARDS FOR PLANT)	VERB REPRESENTING CREW BEHAVIOR FROM MODIFIED BERLINER CLASSIFICATION INSPECTS OBSERVES READS MONITORS SCANS DETECTS IDENTIFIES LOCATES INTERPOLATES VERIFIES REMEMBERS CALCULATES CHOOSES COMPARES PLANS DECIDES DIAGNOSES MOVES HOLDS PUSHES/PULLS TURNS TWEAKS POSITIONS ADJUSTS TYPES LOCKS OUT ANSWERS INFORMS REQUESTS RECORDS DIRECTS RECEIVES ATTACHES REMOVES	AS ON NAME PLATE	THIS IS THE OPERATOR PLANT INTERFACE A CONTROL, DISPLAY, OR OTHERS CONTROL GROUP CONTINUOUS/VARIABLE CONTROL DISCRETE CONTROL SWITCH CONTROLLER DISPLAY GROUP ANNUNCIATOR INDICATOR LIGHT METER COMPUTER RECORDER COUNTER DIGITAL DISPLAY CRT STATUS PANEL OTHER GROUP VERBAL SAFETY EQUIPMENT COMMUNICATION EQUIPMENT CONVENTIONAL POWERED TELEPHONE SYSTEM (CPTS) SOUND POWERED TELEPHONE SYSTEM (SPTS) -WALKIE TALKIE RADIO TRANSCEIVERS (WTRT) PAGE PARTY ANNOUNCING SYSTEM (PPAS) PROCEDURE NOTE: *WHERE UNITS ARE NEEDED (E.G., DPM), ENTER AFTER WORD IN ( ).	PLANT NUMBER	PANEL	LOCAL PLANT NOMENCLATURE	CHOOSE ONE WORD FROM ONE OF THE FOLLOWING GROUPS MECHANICAL GROUP ACCUMULATORS BLOWERS/FANS BOILERS COMPRESSORS CONDENSER CONTAINMENT DAMPER PENETRATIONS CONTROL RODS DEMINERALIZERS FILTERS STRAINERS HEAT EXCHANGERS HEATERS MAIN STEAM LINE PUMPS REACTOR STACK SUMP TANKS TURBINE VALVE OPERATORS VALVES ELECTRICAL GROUP BATTERIES CIRCUIT CLOSURE DEVICES CIRCUIT BREAKERS SWITCHGEAR ELECTRICAL CONDUCTORS ELECTRICAL DISTRIBUTION BUSES GENERATORS TURBINE(G) DIESEL [illegible] INTERLOCK [illegible] MOTORS RECTIFIERS TRANSFORMERS INSTRUMENTATION & CONTROLS EQUIPMENT COMPUTER SENSORS/CONTROL INSTRUMENTS CONTROLLER MASTER CONTROLLER SENSORS [illegible]	ON OFF OPEN CLOSED FAST SLOW MANUAL AUTOMATIC LOCKED OUT TRIPPED RESET TEST ACKNOWLEDGED SILENCED IN OUT SETPOINT OR SPECIFIC VALVE SYSTEM ACTIVATION SYSTEM ISOLATION ENERGIZED DE ENERGIZED	CHOOSE ON WORD FROM ONE OF THE FOLLOWING GROUPS MECHANICAL GROUP DIFFERENTIAL PRESSURE DIFFERENTIAL TEMPERATURE FLOW HUMIDITY LEVEL POSITION PRESSURE SPEED TEMPERATURE TIME VACUUM VIBRATION SATURATED MARGIN DEMAND ELECTRICAL GROUP CURRENT * FREQUENCY POWER RESISTANCE VARS VOLTAGE RADIATION GROUP DOSE RATE RADIOACTIVITY DOSE REACTOR GROUP *DELTA FLUX *NEUTRON FLUX *STARTUP RATE CHEMISTRY GROUP CONCENTRATION OF GAS CONCENTRATION OF SOLIDS	INCREASING DECREASING STEADY ABOVE/BELOW LIMIT ON/OFF SCALE FAST/SLOW IN/OUT OF BAND BELOW SPECIFIC VALVE OPEN/CLOSED IN/OUT	JOB CATEGORIES (SEE LEFT COLUMN) ALSO LOAD DISPATCHER HEALTH PHYSICS TEAM HEALTH PHYSICS SECTION NRC HQ BETHESDA NRC REGIONAL OFFICE COUNTY CIVIL DEFENSE LOCAL PD SHERIFF STATE ENERGY MANAGEMENT AGENCY STATE NUCLEAR ENERGY DIVISION PLANT SECURITY (PS) MAINTENANCE SECTION CHEMISTRY SECTION NON SPECIFIC CALLER LOCATIONS CONTROL ROOM ON SITE OFF SITE	PRE PRINTED ON HED FORM

MODEL SENTENCE -- DESCRIPTION OF ELEMENT:

FOR NON COMMUNICATIONS ACTIONS:

(1) THE SUBJECT (PERSON WHO PERFOMS THE ACTION OF THE ELEMENT)
(2) AT (PANEL OR OTHER WORKSTATION)
(3) PERFORMS THE FOLLOWING BEHAVIOR (VERB)
(4) DIRECTLY ADDRESSING (IMMEDIATE OBJECT OF ACTION) LOCATED AT (OBJECT LOCATION)
(5) AND REMOTELY ADDRESSING (REMOTE OBJECT OF ACTION).

FOR COMMUNICATIONS ACTIONS:

(1) THE SUBJECT (PERSON WHO PERFORMS THE ACTION OF THE ELEMENT)
(2) AT (PANEL OR OTHER WORKSTATION)
(3) PERFORMS THE FOLLOWING COMMUNICATIONS BEHAVIOR (VERB)
(4) USING (COMPONENT)
(5) WITH (OTHER PARTY) LOCATED AT (OTHER PARTY LOCATION).

FIGURE 4-3

STANDARDIZED LIST OF BEHAVIORS (VERBS) FOR USE IN TASK ELEMENT DESCRIPTION

PROCESSES	ACTIVITIES	SPECIFIC BEHAVIORS	DEFINITIONS
1. PERCEPTUAL	1.1 SEARCHING FOR AND RECEIVING INFORMATION	1.1.1 INSPECTS	TO EXAMINE CAREFULLY, OR TO VIEW CLOSELY WITH CRITICAL APPRAISAL.
		1.1.2 OBSERVES	TO ATTEND VISUALLY TO THE PRESENCE OR CURRENT STATUS OF AN OBJECT, INDICATION, OR EVENT.
		1.1.3 READS	TO EXAMINE VISUALLY INFORMATION WHICH IS PRESENTED SYMBOLICALLY.
		1.1.4 MONITORS	TO KEEP TRACK OF OVER TIME.
		1.1.5 SCANS	TO QUICKLY EXAMINE DISPLAYS OR OTHER INFORMATION SOURCES TO OBTAIN A GENERAL IMPRESSION.
		1.1.6 DETECTS	TO BECOME AWARE OF THE PRESENCE OR ABSENCE OF A PHYSICAL STIMULUS.
	1.2 IDENTIFYING OBJECTS, ACTIONS, EVENTS	1.2.1 IDENTIFIES	TO RECOGNIZE THE NATURE OF AN OBJECT OR INDICATION ACCORDING TO IMPLICIT OR PREDETERMINED CHARACTERISTICS.
		1.2.2 LOCATES	TO SEEK OUT AND DETERMINE THE SITE OR PLACE OF AN OBJECT.
2. COGNITIVE	2.1 INFORMATION PROCESSING	2.1.1 INTERPOLATES	TO DETERMINE OR ESTIMATE INTERMEDIATE VALUES FROM TWO GIVEN VALUES
		2.1.2 VERIFIES	TO DETERMINE CONFORMITY TO PRESUMED CONDITION.
		2.1.3 REMEMBERS	TO RETAIN INFORMATION (SHORT-TERM MEMORY) OR TO RECALL INFORMATION (LONG-TERM MEMORY) FOR CONSIDERATION
	2.2 PROBLEM SOLVING AND DECISION MAKING	2.2.1 CALCULATES	TO DETERMINE BY MATHEMATICAL PROCESSES.
		2.2.2 CHOOSES	TO SELECT AFTER CONSIDERATION OF ALTERNATIVES.
		2.2.3 COMPARES	TO EXAMINE THE CHARACTERISTICS OR QUALITIES OF TWO OR MORE OBJECTS OR CONCEPTS FOR THE PURPOSE OF DISCOVERING SIMILARITIES OR DIFFERENCES.
		2.2.4 PLANS	TO DEVISE OR FORMULATE A PROGRAM OF FUTURE OR CONTINGENCY ACTIVITY.
		2.2.5 DECIDES	TO COME TO A CONCLUSION BASED ON AVAILABLE INFORMATION.
		2.2.6 DIAGNOSES	TO RECOGNIZE OR DETERMINE THE NATURE OR CAUSE OF A CONDITION BY CONSIDERATION OF SIGNS OR SYMPTOMS OR BY THE EXECUTION OF APPROPRIATE TESTS.
3. MOTOR	3.1 SIMPLE/DISCRETE	3.1.1 MOVES	TO CHANGE THE LOCATION OF AN OBJECT.
		3.1.2 HOLDS	TO APPLY CONTINUOUS PRESSURE TO A CONTROL.
		3.1.3 PUSHES, PULLS	TO EXERT FORCE AWAY FROM/TOWARD ONES BODY.
		3.1.4 TWEEKS	TO ADJUST IN DISCRETE FINE STEPS.
		3.1.5 TURNS	TO ROTATE.
		3.1.6 LOCKS-OUT	TO PUSH OR PULL AND TURN TO LOCKED POSITION.
	3.2 COMPLEX/CONTINUOUS	3.2.1 POSITIONS	TO OPERATE A CONTROL WHICH HAS DISCRETE STATES.
		3.2.2 ADJUSTS	TO OPERATE A CONTINUOUS CONTROL.
		3.2.3 TYPES	TO OPERATE A KEYBOARD.
4. COMMUNICATION		4.0.1 ANSWERS	TO RESPOND TO A REQUEST FOR INFORMATION.
		4.0.2 INFORMS	TO IMPART INFORMATION.
		4.0.3 REQUESTS	TO ASK FOR INFORMATION.
		4.0.4 RECORDS	TO DOCUMENT SOMETHING, AS IN WRITING.
		4.0.5 DIRECTS	TO ASK FOR ACTION.
		4.0.6 RECEIVES	TO BE GIVEN WRITTEN OR VERBAL INFORMATION.

FIGURE 4-4

SECTION 5.0 ASSESSMENT PHASE

5.1 INTRODUCTION

NUREG-0700 defines a Human Engineering Discrepancy or HED as "a departure from some benchmark of system design suitability for the roles and capabilities of the human operator". Section 6 of NUREG-0700 contains these design benchmarks or guidelines. While it can be expected that the CRDR process will produce reports of Human Engineering Discrepancies, it does not follow that all discrepancies will necessarily degrade operator performance to the point that plant safety would be affected. The objective of the assessment process is for the HED Assessment Team (HEDAT) to evaluate the relative significance of the HEDs produced during the review phase. The HEDAT will separate those HEDs that are unlikely to degrade performance from those that may degrade performance.

5.2 PRIORITIZATION

a. The approach to be employed by Vepco in assessing HEDs involves prioritization of each HED based on estimations of the potential for error and the consequence of errors resulting from the HED. Assessment of the potential for error will be based on:

- o component design factors (e.g., extent of deviation from guideline, conformance to plant design conventions),

- o task factors (e.g., difficulty, frequency, time demands), and

- o human factors (physical performance; sensory and perceptual performance; cognitive performance).

In addition, error potential will be evaluated with respect to the probability of error recovery by considering the method for error detection, the form and location of the error indication, and the latency and severity of the affected system's response to the error. Error potential will be rated on a scale from low probability to high probability based on the expert judgment of the Lead Human Factors Specialist. For components having multiple HEDs, the cumulative error potential will be assessed. All HEDs associated with a reported error occurence will be summarily assigned a rating of high error potential.

b. Once the probability of error has been established, the consequences of the error will be estimated for each HED by the HEDAT. Error consequence will be defined in terms of the potential impact on plant safety by considering the system/functions affected by the

error. HEDs related to systems and functions identified as safety-related during the SFTA or which increase the probability of an error that could result in violation of technical specification or unsafe operation will receive the highest rating.

This assessment process will result in up to nine classes of HEDs (see Table 5-1).

c. The HEDAT will analyze all Category I, II and III HEDs for correction (see Figure 5-1). Category IV HEDs, while considered optional for correction, will be assessed for their cumulative and interactive effects on all other HEDs. Those Category IV HEDs shown to possess the above effects will be recategorized to the appropriate category.

The next step in this procedure is for the HEDAT to identify those HEDs which can be corrected by enhancements, training of operators, and/or procedural revisions. The remaining HEDs will be analyzed to identify and provide design improvement alternatives. Since there is a limit to the number of changes which can be made as a result of this review, a cost-benefit analysis will also help determine which corrections are the most feasible and acceptable from a human engineering point of view.

d. Additionally, the CR review process will be reapplied as appropriate to ensure:

- o Any new HEDs are identified and addressed
- o That other corrections are not invalidated
- o Compliance with human engineering guidelines.

5.3 CORRECTION

Regardless of the HED priority ranking, potential corrective action will be identified by the HEDAT for all HEDs. The basic procedure to be employed in identifying and selecting corrective actions involves:

- o Analysis for correction by enhancements
- o Analysis for correction by design alternatives
- o Assessment of the extent of correction.

5.3.1 Analysis for Correction by Enhancement

Discrepancies selected for correction are first examined for possible correction by enhancement (labeling, demarcation, operator aids, etc.). Each HED is considered and where such correction is possible, the discrepancy is reassessed for its effect on operator performance. As appropriate, HEDs are reevaluated via checklisting and task analysis until HF suitability is verified. Where it is determined that correction by enhancement is not possible, the discrepancy is analyzed for correction by design alternatives.

5.3.2 Analysis for Correction by Design Alternative

Discrepancies not correctable by surface enhancement may require a design effort. Corrective action may involve simple modification to the communication, lighting or alarm system, or alterations to the control boards. In either case, identification of design alternatives will be achieved by examination of the HED, reference to task analysis data, and identification of potential constraints (e.g., availability of equipment, Reg. Guide 1.97). The backfit design development process, if used, will also consider the need to minimize cost of the change and its impact on the existing design. Multiple design alternatives will be considered, as appropriate. Cost and schedule estimates will also be considered for each proposed change. The impact of each proposed design change on operator training, plant maintenance and documentation will also be considered, as will the reduction in probability of operator error. The acceptability of design alternatives will be verified by further evaluation using functional analysis, task analysis, and reapplication of the NUREG-0700 guidelines.

5.3.3 Assessment of the Extent of Correction

For all HEDs selected for correction, the extent to which each discrepancy will be corrected (by enhancement or redesign) will undergo HEDAT evaluation. The basis for assessment involves reapplication of the guidelines in Section 6.0 in NUREG-0700 or reference to other criteria (e.g., results of SFTA). The solutions

should ideally eliminate all discrepancies and bring the control room into full compliance with the intent of the guidelines. This is accomplished by verifying the human factors suitability of all proposed changes. However, discrepancies which are not fully corrected will be identified and documented by the review team and a justification will be prepared for each one.

5.3.4 Scheduling of Corrections

HEDAT-approved solutions to HEDs will be scheduled for implementation. The category guidelines established in Paragraph 5.2 of this plan will be used as a basis for the corrective action schedule. Additional considerations in the development of the implementation schedule will be:

- Safety consequences of operator errors that could be caused by the discrepancy

- Integration with other NUREG-0737 Supplement 1 programs

- Plant operation constraints

- Operator training/retraining requirements

- o Outage schedules
- o Equipment procurement schedules.

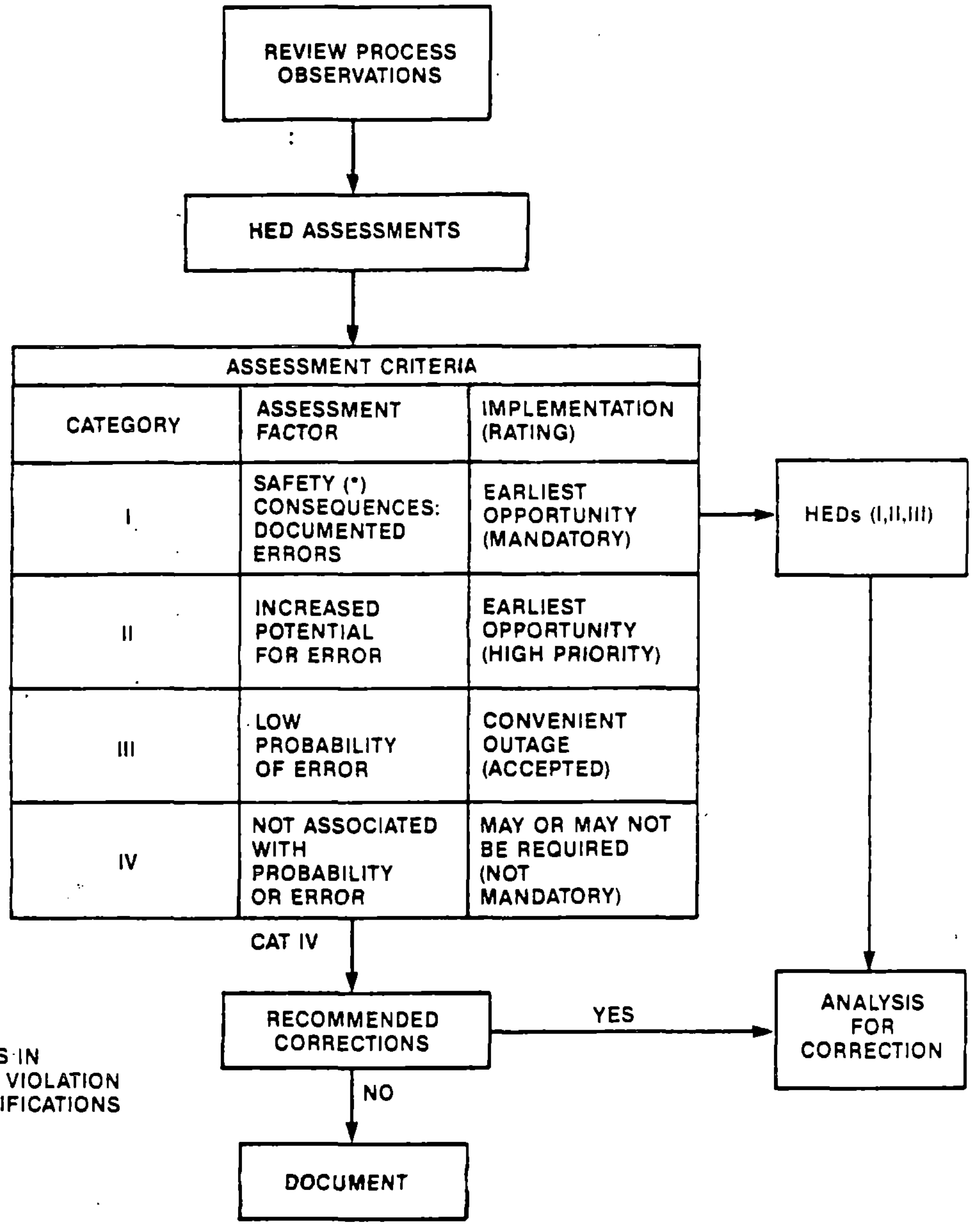
5.3.5 Simulator Involvement in the Correction Process

Where appropriate, the control room simulator will be utilized to test corrections required on various panels. In addition to evaluating the correction, this validation affords an opportunity to look for possible violations of other HF criteria resulting from the original correction. Finally, the simulator testing of the correction can function as a training phase for operators to become familiar with panel changes.

HED CATEGORIZATION

CATEGORY LEVEL		DOCUMENTED ERROR	POTENTIAL FOR ERROR	HIGH SAFETY IMPORTANCE	LOW SAFETY IMPORTANCE	DOCUMENTED UNSAFE CONDITION/VIOLATION OF TECH. SPEC.	POTENTIALLY UNSAFE CONDITION/VIOLATION OF TECH. SPEC.
I	A	YES	———	YES	NO	YES	———
	B	YES	———	NO	YES	YES	———
	C	YES	———	EITHER		NO	YES
	D	YES	———	EITHER		NO	NO
II	A	NO	YES	YES	NO	NO	YES
	B	NO	YES	NO	YES	NO	YES
	C	NO	YES	EITHER		NO	NO
III		NO	LOW	EITHER		NO	YES
IV		NO	NO, ASSUMING INTERACTIONS HAVE BEEN CHECKED AND NO ERROR POTENTIAL IS LIKELY			NO	NO, BUT INTERACTIONS SHOULD BE CHECKED

TABLE 5-1



ASSESSMENT CRITERIA		
CATEGORY	ASSESSMENT FACTOR	IMPLEMENTATION (RATING)
I	SAFETY (*) CONSEQUENCES: DOCUMENTED ERRORS	EARLIEST OPPORTUNITY (MANDATORY)
II	INCREASED POTENTIAL FOR ERROR	EARLIEST OPPORTUNITY (HIGH PRIORITY)
III	LOW PROBABILITY OF ERROR	CONVENIENT OUTAGE (ACCEPTED)
IV	NOT ASSOCIATED WITH PROBABILITY OR ERROR	MAY OR MAY NOT BE REQUIRED (NOT MANDATORY)

(*) EXAMPLE: RESULTS IN UNSAFE OPERATION, VIOLATION OF TECHNICAL SPECIFICATIONS

HED ASSESSMENT

FIGURE 5-1

SECTION 6.0 FINAL SUMMARY REPORT

Upon completion of the CRDR, a summary of the results from each station will be prepared and submitted to the NRC for review. The Final Summary Reports will describe the results of each CRDR and will be submitted within six months after completion of each review. These reports will summarize the CRDR process, provide summary descriptions of the identified human engineering discrepancies and their proposed corrective actions, and provide implementation schedules for each corrective action. They will also describe any modifications or revisions made to this Program Plan. Samples of control room inventory and control room survey forms and summmaries of the inventory and survey procedures will be provided.

The details of the CRDR, along with complete documentation, will be maintained as part of the permanent station records.

SECTION 7.0 IMPLEMENTATION PHASE

The following general procedure will be followed to implement the recommendations:

1. The HEDs to be corrected will be ordered according to the priorities described in paragraph 5.2 of this plan.

2. The stations' outage work schedules will be reviewed to arrange manpower and time, as necessary, to implement the correction actions.

3. Upon completion of each HED's recommended correction, the responsible department will notify the NCPC who will arrange for the corrections to be reviewed an HFS.

The Implementation Phase will be described in detail as part of the Final Summary Report.

APPENDIX A

HED ASSESSMENT TEAM RESUMES

CLIFFORD C. BAKER is a specialist in test and evaluation, data collection, analysis and reporting, and in task analysis. He will fill the role of human factors specialist on the VEPCO CRDR projects. Mr. Baker, a research scientist in the Industrial Services Division of Essex Corporation holds a B.S. degree in psychology from the University of Maryland. Mr. Baker is currently completing the requirements for a M.A. degree from the George Mason University. He has seven years of professional experience in the conduct of human engineering activities in military, transportation, and energy environments. With regard to experience in human engineering and the conduct of nuclear power plant CRDRs, Mr. Baker has directed or participated in the conduct of over ten CRDRs over the past three years. He is experienced and knowledgeable in all phases of the CRDR process including; environmental data collection; detailed design assessments of controls, displays, labels, control/display integration, and panel layout; conduct of interviews; application of surveys and questionnaires; and task analysis. Mr. Baker is currently an associate member of the Human Factors Society.

DANNA M. BEITH is a specialist in human factors, test and evaluation, research and design. She will be a human factors specialist for Essex' human factors support to the VEPCO CRDR. Ms. Beith, a research scientist in the Industrial Services Division at Essex Corporation has a B.A. degree in psychology from the University of California at Santa Barba. Ms. Beith has been a member of the technical team for CRDR's conducted at CP&L's Shearon Harris, H.B. Robinson and Brunswick NPPs, TUGCO's Comanche Peak PS, Toledo Edison's Davis-Besse NS, HL&P's South Texas Project and FP&L's Turkey Point. She also was project manager for rewriting/reformatting procedures for V.C. Summer NS. Prior to joining Essex, Ms. Beith worked for Xerox Corporation in the human factors group for the Business Machines and Copier/Duplicator divisions. She also worked as a field investigator for BioTechnology, collecting data for a "Large Truck Accident Study". She is a member of the Human Factors Society.

STEPHEN R. BURGOLD is a specialist with 14 years of nuclear operations and maintenance related experience. He will be the Site Operations Coordinator for the Surry Power Station. Mr. Burgold, a Shift Supervisor at the Surry Power Station holds an Associate's Degrees in Science and in Engineering from the Tidewater Community College. He also holds a valid USNRC SRO license for Surry, issued in 1975. In addition to being responsible for shift operations at Surry's two 822 MWe PWRs, he is the Lead for the Surry Emergency Procedures Update Program, he developed the Surry Emergency Response Procedures Writer's Guide, and is working member for a number of current, nuclear-related projects such as the SPDS, WOG Procedures Subcommittee activities, shift supervisor's CR console, and the VEPCO Emergency Response Capability Working Group. As a senior Nuclear Instrumentation Technician for VEPCO and a Technician for the U.S. Army, he has experience in the calibration and repair of commercial power station instrumentation and military precise power and nuclear instrumentation.

HENRY W. BURRUSS, JR. is a systems engineer with nine (9) years of experience as a project, lead, and test engineer that includes nuclear plant operations and maintenance engineering projects. He will be the Lead Discipline Engineer for the VEPCO CRDR. Mr. Burruss, a Staff Engineer in Vepco's Power Station Engineering, Nuclear Group, holds a BSME from the University of Virginia and is a licensed professional engineer in the Commonwealth of Virginia. Prior to joining VEPCO, he was a Materials Handling Engineer for Phillip Morris, a test engineer for the Charleston Naval Shipyard, and an Environmental Engineer for the U.S. Environmental Protection Agency. Since joining VEPCO, he has performed a wide range of engineering duties that include the development and performance of pre-operational systems tests and the implementation of plant and maintenance engineering projects at the North Anna Power Station. He has also developed project scopes and resolutions for station operational problems at both North Anna and Surry Power Stations. As the Startup Test Engineer for North Anna Unit 2, he developed and performed various pre-operational tests on primary and auxiliary systems including the Residual Heat Removal, Component Cooling, Chemical Addition and Containment Air Handling Systems. As Design Control Engineer for the North Anna Power Station, Mr. Burruss was also responsible for the review and approval of all plant modifications to Category I, Safety Related Systems for compliance with 10CFR, Part 50, Appendix B.

DAVID R. EIKE is a research psychologist with eight (8) years of experience in human factors design, test and evaluation of man-machine systems for military, aerospace and commercial applications. Mr. Eike will be the North Anna Lead Human Factors Specialist for the VEPCO CRDR. Mr. Eike, a Program Manager in the Industrial Services Division of Essex Corporation, holds a B.I.S. degree and a M.A. degree in Experimental Psychology from George Mason University in Fairfax, Virginia. Mr. Eike has been the program manager for CRDRs conducted at Toledo Edison's Davis-Besse, BG&E's Calvert Cliffs, and FP&L's St. Lucie and Turkey Point power stations. He has also participated in the planning and conduct of CRDRs at Rancho Seco, Comanche Peak, Beaver Valley, Cofrentes (Spain) and Hamaoka (Japan) stations. Mr. Eike has conducted HFE test and evaluation of a variety of military systems, including shipboard aircraft landing systems, helicopter systems, satellite communications systems and radiation detection systems. Mr. Eike was the principal investigator in a project to expand and update the military's primary human engineering criteria document (MIL-STD-1472), and has assisted in the development of methods for evaluating the design of computer systems for the Army.

LAWRENCE E. GARDNER is a training specialist with nine (9) years of VEPCO training-simulator experience and an additional six (6) years of U.S. Navy Nuclear Reactor Operator experience. Mr. Gardner will serve as the Surry Training Representative for the VEPCO CRDR. He is currently working on a technical degree at Tidewater Community College and received his Senior Reactor Operator License in 1980. In addition to his duties as Supervisor of Operator Training at VEPCO's training center, Mr. Lawrence has human factors-related experience with a number of VEPCO projects such as the development of the shift supervisor's console, the conduct of the Interim CRDR, and the validation of the ASPDS panel. He is also a member of the Surry Power Station ERC Working Group that is addressing the SPDS, EOP development, TCS development, and other NUREG-0696.

THOMAS A. HARDING is a Staff Engineer with the Safety Evaluation and Control Section of the corporate Nuclear Operations Department. He is the NOD corporate coordinator for all NUREG 0737 Supplement 1 items and maintains an interface with VEPCO's Power Station Engineering and Construction Department. It is his responsibility to monitor the progress and ensure the integration of all ERC projects.

From May, 1980 to April, 1983 he was a Staff Nuclear Operations Specialist with the Essex Corporation. He provided means of correlating disciplines of theoretical and operational human factors engineering. This included developing format and text of various emergency and operation procedures and evaluation of procedures content and task requirements.

From 1970 through April 1980 he was in operations with Virginia Electric and Power Company in both nuclear and fossil power stations as follows:

Shift Supervisor - Senior Reactor Operator, North Anna Power Station - Directed shift operation during routine, emergency, and start-up duties of the 944Mw Pressurized Water Reactor Units. Coordinated the revisions of Emergency Procedures for implementing two unit operation and served as Site Coordinator of the Control Room Review Task Force to determine and to correct human engineering deficiencies in the North Anna control room.

Control Room Operator - Reactor Operator, North Anna Power Station - Performed start-up, emergency and routine duties of two 944 Mw Pressurized Water Reactor Units including pre-operation checkouts and design modifications drafting of safety and nonsafety related systems.

Control Room Operator - Reactor Operator, Surry Power Station - Performed start-up, emergency and routine duties of two 822 Mw Pressurized Water Reactor Units including preoperational checkouts of safety and nonsafety related systems.

Twelfth Street Power Station - Performed start-up and routine operations on two unit coal fired station.

ANDREW G. NEUFER is an operations specialist with 17 years of nuclear power experience. Mr. Neufer will serve as the Site Operations Coordinator for the North Anna Power Station. Mr. Neufer, an Operations Administrative Coordinator for VEPCO, has completed nuclear training at VEPCO's Nuclear Training Centers for reactor operator and senior reactor operator. He is also a graduate of the U.S. Navy's Nuclear Power School.

He holds a Senior Reactor Operators license at North Anna Power Station and has been a shift supervisor at North Anna Power Station since 1974. During this time he participated in the VEPCO program to evaluate and upgrade the North Anna control boards. Prior to his assignment at North Anna, he was a licensed reactor operator at VEPCO's Surry Power Station for four (4) years. Before joining the VEPCO operations staff in 1970, he was a nuclear plant operator in the U.S. Navy for four (4) years.

GERALD E. PEDERSON is a training specialist with over 17 years of nuclear power experience. He will serve as the North Anna Training Representative for the VEPCO CRDR. Mr. Pederson, who is currently Supervisor of Training - Power Station support, supervises training for Chemistry technicians, Health Physics technicians, I&C, Power Station electricians, Power Station mechanics, Basic systems and Emergency preparedness. Mr. Pederson is also a simulator instructor, and is responsible for RO/SRO license class instruction for I&C and licensed operator requalification instruction. He received a Senior Reactor Operator Certificate in 1982. Prior to joining the VEPCO training staff in 1975, Mr. Pederson was a shift Lead Reactor Operator for the U.S. Navy. As a member of the Emergency Response Capability Working Group at VEPCO, he has applied human factors principles to the design of the SPDS and TSC. Mr. Pederson has also participated in INPO task analysis activities.

WALTER T. TALLEY is a specialist with 10 years experience in human factors design, test and evaluation, and task analysis with an additional 20 years experience in electrical and electronics for the aerospace industry, power generating industry, and the military. He will be the Surry Lead Human Factors Specialist for the VEPCO CRDR. Mr. Talley, a Program Manager in the Industrial Services Division of the Essex Corporation, holds a M.S. degree in applied psychology from Stevens Institute of Technology at Hoboken, New Jersey and a B.A. degree in general experimental psychology from New Mexico State University. At Essex, Mr. Talley has been the program manager for CRDRs conducted at SCE&G's V.C. Summer NS, BG&E's Calvert Cliffs NPP, and CP&L's Shearon Harris, H.B. Robinson, and Brunswick NPPs. He has also been a senior team member in support of the CRDR for TUGCO's Comanche Peak PS and FP&L's Turkey Point PS. He has conducted test and evaluation activities, including task analysis for U.S. Army and for AT&T's Human Performance Laboratories. He was a Member of the Technical Staff at Bell Telephone Laboratories where he was responsible for the design and development of the human interface requirements for large software systems. As an electro/mechanical designer for Dynalectron Corporation, he was responsible for the structural, mechanical and electrical designs and modifications to cryogenic storage and pumping systems. Employed by A.G. Schoonmaker Company as a project engineer, he developed all phases of detailed designs for diesel and gas turbine powered generator sets including NPP emergency generators. As an electronics technician for various aerospace firms and the U.S. Air Force, he performed electronics maintenance and research and development activities for the military and NASA. He is a member of the Human Factors Society and the National Psychological Honor Society, Psi Chi.

HAROLD P. VAN COTT is a specialist with 30 years experience in human factors design, test and evaluation and task analysis. He will be the Program Manager for Essex' human factors support to VEPCO CRDR. Dr. Van Cott, Director of Essex Industrial Services Division, holds a Ph.D. and M.A. degree in psychology from the University of North Carolina and a B.A. from the University of Rochester. Prior to joining Essex, he was Chief Scientist with BioTechnology, Inc., a firm specializing in human factors. He was also Chief of the Consumer Sciences Division of the National Bureau of Standards where he planned and directed R&D in human factors and biomechanics; Manager of Human Factors with the IBM Corporation Federal System Division; and Director of the Institute for Human Performance Research of the American Institutes for Research. He has participated in numerous human factors projects in support of CRDR's and task analysis efforts for the nuclear industry, the Department of Energy, the Office of Regulatory Research of the NRC, and the Atomic Energy Control Board of Canada, as well as the Idaho, Oakridge, Brookhaven and Lawrence Livermore National Laboratories. He is a Fellow of the AAAS, the Human Factors Society, the Washington Academy of Science and Past President and Fellow of the Division of Applied Experimental and Engineering Society of the American Psychological Association.

APPENDIX B

DATA FORMS

HISTORICAL REPORT SUMMARY

APPLICATION:

Utility: ____________ Station: __________________________ Unit: ____
Reviewer: ___________________ Date: ____________________ Ref No.: ____

SUMMARY:

Utility/Station/Unit (if different): ______________________________
Report Type: ____
Report Date: _______________________ Report No.: _____________
Report Title: ____

Summary:

Effect on Unit:

__ Trip (Scram) ____ hrs
__ Shutdown ____ hrs
__ Derated to ___%, ____ hrs

Error Classification by Utility:

__ Operator Error
__ Equipment Failure
__ Procedure Problem
__ Other ____________________

Immediate corrective action:

Follow-up action:

OER ANALYSIS:

Follow-up action adequate? __ Yes __ No, explain:

HEDAT Review: __ Concur __ does not concur

Reason for nonconcurrence:

HEDAT Member Initials: __________________ Team Leader: _________________

HED report generated: __ No __ Yes, HED No.: _________________

HUMAN ENGINEERING DISCREPANCY

Page 1 of ___

(000) HED SERIAL NUMBER (000) ORIGINATOR [ ] (000) DATE [/ /]

(000) PLANT SYSTEM [ ] (000) SUBSYSTEM OR MODE [ ]

(000) CONTROL BOARD NO. [ ] (000) CONTROL BOARD DEVICE NO. [ ]

(000) PHOTO I.D. NO. [ ] (008) PHOTO INSTRUCTIONS [ ]

(000) SKETCH ATTACHED? Y ____ N ____ (000) [ ]

HED SOURCE/PRINCIPLE

(000) ☐ OER ( ) ☐ SPDS

( ) ☐ CRS ( ) ☐ PAM

( ) ☐ T/A ( ) ☐ OTHER

PROBLEM AREA OR COMPONENT TYPE

(000) ☐ ENVIRONMENTAL
(000) ☐ WORKSPACE
(000) ☐ ANNUNCIATORS
(000) ☐ LABELS & LOCATION AIDS
(000) ☐ –LABELS
(000) ☐ –NAMEPLATES
(000) ☐ –BEZELS/ESCUTCHEONS
(000) ☐ –DEMARCATION
(000) ☐ –MIMICS
(000) ☐ –COLOR CODING
(000) ☐ –OTHER ____________
(000) ☐ COMMUNICATIONS
(000) ☐ PLANT COMPUTER
(000) ☐ PANEL LAYOUT
(000) ☐ C/D INTEGRATION

(000) ☐ CONTROLS
(000) ☐ –GE SBM
(000) ☐ –CH E30
(000) ☐ –CH 10250T
(000) ☐ –OTHER ____________
(000) ☐ CONTROLLERS
(000) ☐ –
(000) ☐ –
(000) ☐ –
(000) ☐ VISUAL DISPLAYS
(000) ☐ –METERS
(000) ☐ –RECORDERS
(000) ☐ –STATUS/MONITOR LIGHTS
(000) ☐ –INDICATOR LIGHTS
(000) ☐ –OTHER ____________

HED DESCRIPTION:

(000) [ ]

(000) [ ]

(000) [ ]

(000) [ ]

RECOMMENDATION BY REVIEWER/(000) SURFACE ENHANCEMENT Y____ N____

(000) [ ]

(000) [ ]

(000) [ ]

(000) [ ]

HED NO. |_|_|_|_|_|_|_|_|_|_|_|_|_| (Continued)

HED 1st ORDER ASSESSMENT

(000) By ________

(000) ☐ NON-DEFICIENCY—JUSTIFY AND DISCARD
(000) ☐ OPERATOR AWARENESS ENHANCEMENT
(000) ☐ COMBINE WITH HED NO. ____________
(000) ☐ PART OF OUTSTANDING DESIGN CHANGE OR INCOMPLETE
(000) ☐ SPECIAL STUDY (000) ________________________
(000) ☐ SURFACE ENHANCEMENT
(000) ☐ SIMPLE PHYSICAL CHANGE
(000) ☐ COMPLETE ASSESSMENT REQUIRED
(000) ☐ OTHER ____________________

HED COMPLETE ASSESSMENT

(000) POTENTIAL FOR ERROR |_|_|_|_|_|
(000) POTENTIAL FOR RECOVERY |_|_|_|_|_|
(000) CONSEQUENCES OF ERROR |_|_|_|_|_|
(000) IMPORTANCE TO OPERATORS |_|_|_|_|_|
(000) SIMPLE SIGNIFICANCE |_|_|_|_|_|
(000) EFFECTS MULTIPLIER |_|_|_|_|_|
(000) EXTENDED SIGNIFICANCE |_|_|_|_|_|

HED SOLUTION DESCRIPTION

(000) |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|
(000) |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|
(000) |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|
(000) |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|A|T|T|A|T|C|H|E|D| |S|H|E|E|T| |Y| |N|

(000) SOLUTION FEASIBLE Y___ NO ___
(000) SOLUTION CATEGORY (1) ☐ PTL (2) ☐ COMPONENT MOD (3) ☐ COMPONENT RELOCATE (4) ☐ DESIGN
(000) SOLUTION COST ESTIMATE $ __________
(000) BENEFIT/COST RATIO __________

IMPLEMENTATION REQUIREMENTS

(000) ☐ SURFACE ENHANCEMENT CHANGE
(000) ☐ TRAINING CHANGE
(000) ☐ PROCEDURE CHANGE
(000) ☐ TECH SPEC CHANGE
IMPLEMENTATION DATE ____/____
(000) APPROVED Y____ N ____

(000) ☐ OUTAGE NECESSARY
(000) ☐ R.G. 197 COORDINATION
(000) ☐ SPDS COORDINATION (000)
(000) ☐ OTHER ______________

HED POTENTIAL SIGNIFICANCE

HED #_____ Date __/__/__
By: ____________

I. POTENTIAL FOR ERROR

DESIGN FACTORS:

• COMPONENT LOCATION	GOOD	FAIR	POOR	BAD
• COMPONENT IDENTIFICATION	GOOD	FAIR	POOR	BAD
• COMPONENT UTILIZATION	GOOD	FAIR	POOR	BAD
• WITHIN UNIT CONSISTENCY	IDENTICAL	SIMILAR	NONE	
• BETWEEN UNIT CONSISTENCY	IDENTICAL	SIMILAR	NONE	
• OTHER				

TASK FACTORS:

• DIFFICULTY	LOW	MEDIUM	HIGH
• FREQUENCY OF USE	HIGH	MEDIUM	LOW
• TIME/STRESS CONDITION	LOW	MEDIUM	HIGH
• OTHER			

COMPOSITE EVALUATION (ERROR)	1	2	3	4	5	6	7	8	9	10

II. POTENTIAL FOR RECOVERY (Prior to consequences)

DETECTABILITY FACTORS:

• METHOD OF ERROR DETECTION	NOT SPECIFIED	ALARMED	NORMALLY VERIFIED
• FORM OF INFORMATION	INFERRED FROM OTHER INFORMATION	DIRECT DISPLAY	
• PROXIMITY OF INFORMATION	NOT READILY ACCESSIBLE	READILY ACCESSIBLE	

RECOVERABILITY POTENTIAL

• SYSTEM RECOVERABILITY	DIFFICULT	MODERATE	EASY
• OTHER			

COMPOSITE EVALUATION (RECOVERY)	1	2	3	4	5	6	7	8	9	10

III. CONSEQUENCE OF ERROR

HED NO:____

INDICATES ALL FUNCTIONS, MAIN SYSTEMS, AND SUBSYSTEMS THE COMPONENTS(S) IN THE HED CAN BE APPROPRIATELY RELATED TO.

MAINTAINING FUEL INTEGRITY................ ☐
MAIN SYSTEMS (80 pts. each)

MAINTAINING REACTOR COOLANT SYSTEM INTEGRITY .... ☐
MAIN SYSTEMS (70 pts. each)

MAINTAINING REACTOR BUILDING INTEGRITY .... ☐
MAIN SYSTEMS (60 pts. each)

PREVENTING UNMONITORED RADIOACTIVE RELEASES .... ☐
MAIN SYSTEMS (50 pts. each)

PREVENTING A FORCED OUTRAGE .... ☐
MAIN SYSTEMS (40 pts. each)

PREVENTING REACTOR/TURBINE TRIP OR REACTOR RUNBACK .... ☐
MAIN SYSTEMS (30 pts. each)

PREVENTING LIMITING CONDITIONS OF OPERATION .... ☐
MAIN SYSTEMS (20 pts. each) IDENTIFY

OTHER PERFORMANCE FACTORS .... ☐

TOTAL CONSEQUENCE POINTS .... ☐

IV. IMPORTANCE TO OPERATORS

INDICATES THE VALUE OF CORRECTING THIS DEFICIENCY FROM THE POINT OF VIEW OF THE OPERATOR

NUMBER OF OER REPORTS ________

OTHER / RATIONALE ____

____

____

RECOMMENDED MULTIPLIER FOR OPERATOR ACCEPTANCE . . . . [ ]

V. CALCULATION OF RELATIVE SIGNIFICANCE

$$\text{SIMPLE SIGNIFICANCE} = \frac{\text{POTENTIAL FOR ERROR}}{\text{POTENTIAL FOR RECOVERY}} \times \text{CONSEQUENCE OF ERROR}$$

$$= \frac{(\qquad)}{(\qquad)} \times (\qquad)$$

= [ ]

EFFECTS MULTIPLIER = OPERATOR ACCEPTANCE + NUMBER PROBLEMS RESOLVED

= ________ + ________

= [ ]

EXTENDED SIGNIFICANCE = SIMPLE SIGNIFICANCE x EFFECTS MULTIPLIER

= ________ x ________

= [ ]

COMMENTS: ____

____

____

____

HED SOLUTION COST ESTIMATE

HED#_____ DATE __/__/__

I. MATERIAL COST

- COMPONENT COST ________
- CABLE COST ________
- OTHER ________________ ________

TOTAL .... ________

II. DESIGN ENGINEERING COST

- SYSTEMS ________
- ELECTRICAL ________
- MECHANICAL ________
- NUCLEAR ________
- DRAWINGS ________
- OTHER ________________ ________

TOTAL .... ________

III. CONSTRUCTION COST

- SURFACE ENHANCEMENTS
  - -LABELS ________
  - -METER-RECORDER SCALES ________
  - -CONTROL CHANGES ________
  - -ANNUNCIATOR CHANGES ________
  - -MIMIC/DEMARCATION ________

TOTAL .... ________

- PHYSICAL CHANGES
  - -CUT-OUT / FILL-IN ________
  - -COMPONENT WIRING ________
  - -COMPONENT INSTALLATION ________
- OTHER

________________ ________

________________ ________

TOTAL .... ________

IV. SUPPORTING COSTS

- TRAINING ________
- PROCEDURES ________

TOTAL ALL COSTS [ ]